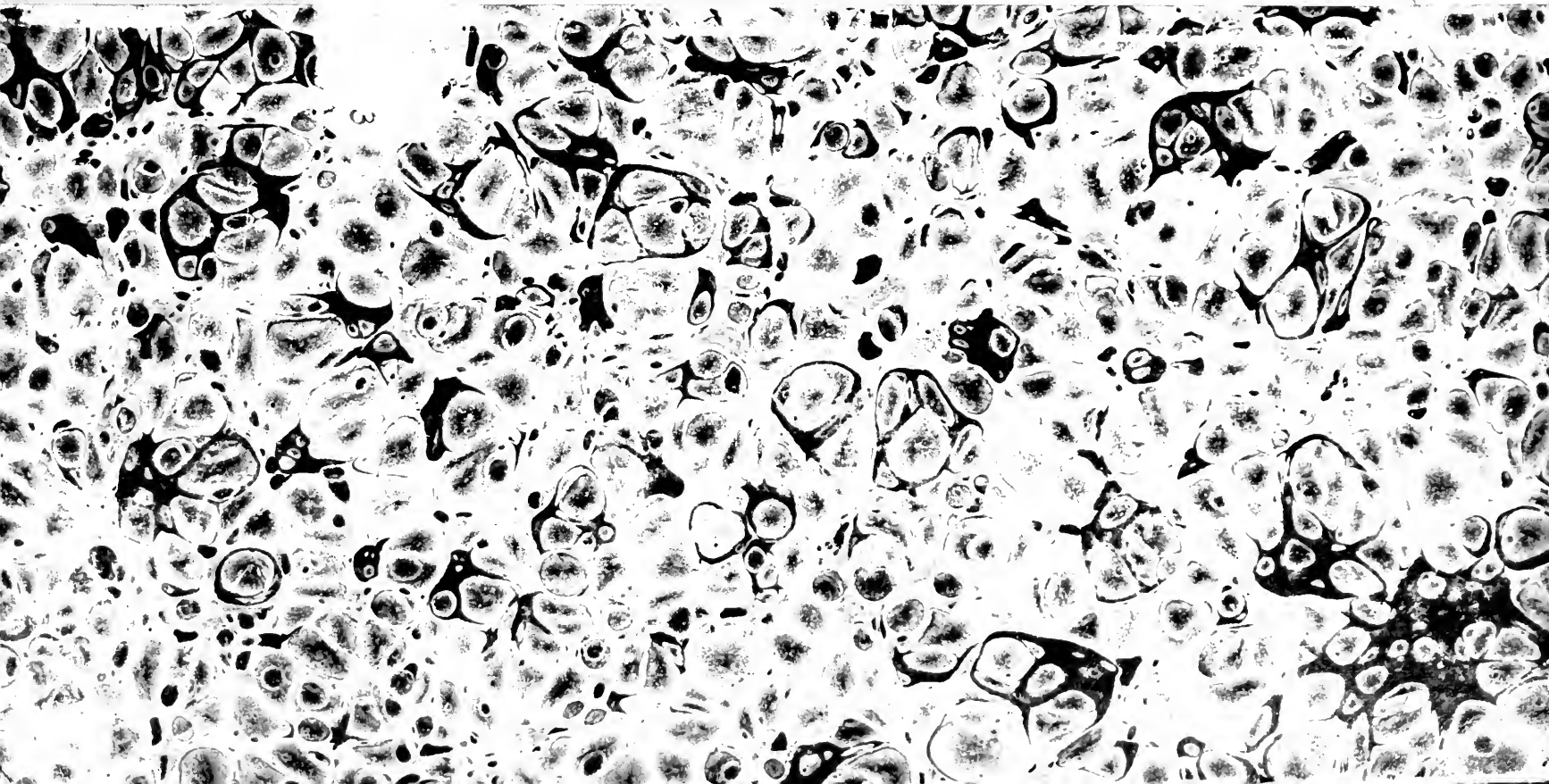

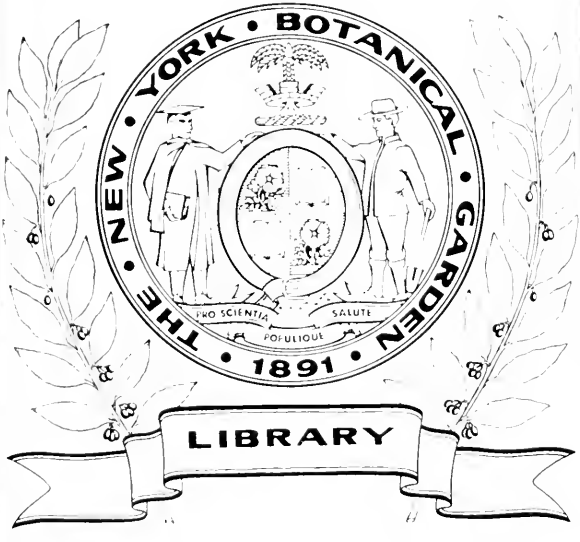

THE FLORA OF THE MATAWAN FORMATION

(CROSSWICK'S CLAYS)

By EDWARD W. BERRY

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INTRODUCTION.

Some of the earliest of American geological writings refer to the New Jersey Cretaceous, and the accessibility of this area has ever since made it a favorite field for investigation. Interest for a long time centered about the marl deposits and those of the plastic clays because of their economic importance: the present Matawan formation was included in the "plastic clay and sand formation" of the geologists of the first half of the nineteenth century, and their stratigraphic position was considered to be Lower Cretaceous by Rogers in his first report published in 1840, although they were not clearly

defined by him. Professor Cook from 1863 until his death in 1889 published annual reports as state geologist of New Jersey and early subdivided the Cretaceous into the three marl beds, the clay-marls and the plastic clays. The Cretaceous was extensively summarized and described by him in the Geology of New Jersey, published in 1868, the clay-marls being divided into a lower member of clay containing greensand and an upper member consisting of laminated sands The thickness of the formation was placed at 277 feet, 170 feet for the upper, and 107 feet for the lower member, and over a dozen localities were enumerated where the clay-marls were dug as fertilizer. In 1891 Professor William Bullock Clark commenced a study of the coastal series of New Jersey which has been in progress ever since. Three official reports have been published: a Preliminary Report,* a Report of Progress,† and a Final Report;‡ besides numerous other papers from which many of the following facts in regard to the areal distribution and thickness of the Matawan formation have been quoted.

The name Clay-marls was proposed by Cook; his characterization was incomplete, however, and was confined almost entirely to their development in northern New Jersey. This name does not adequately designate the formation lithologically and has been superseded by the name Matawan formation of Clark.§ The Matawan is separated from the Piedmont plateau by a tract of Raritan, or Lower Cretaceous, which is some ten to fifteen miles wide. The Matawan is nine to twelve miles wide in Monmouth county, becoming narrower to the southward, being reduced to about six miles in width in southern New Jersey; on the western shore of the Delaware river in Delaware it is further reduced to from two to three miles; further south on the eastern shore of Maryland it broadens, being about five miles wide

*Ann. Rep. State Geol. N. J. 1892: 167–245. 1893. (Clay-marls, pp. 186–190.)

†Ann. Rep. State Geol. N. J. 1893: 329–355. 1894.

‡Ann. Rep. State Geol. N. J. 1897: 161–210. 1898.

§Jour. Geol. 2: 163. 1894.

below the Sassafras river; on the western shore in Anne Arundel county the areal distribution is variable on account of the broken character of the country, but is on the whole narrower: further south, in Prince George county, it forms but a narrow strip less than a mile in width.

The materials are variable; sands and clays predominate. The sands are sometimes white and coarse, but more commonly fine-grained and colored by iron, even causing local induration, or they may be mixed with argillaceous materials forming silvery micaceous sand, or chocolate-colored marl, glauconite grains being present in greater or less amounts. The clays are generally black or drab, locally carrying seams and pockets of glauconite; occasionally they are calcareous as a result of their molluscan contents.

The thickness is variable, but becomes reduced to the southward. It increases considerably to the southeast, judging from the well records.* In northern Burlington county the Matawan is less than 200 feet thick; east of Philadelphia and Camden it is 125 feet; in Gloucester county it is 175 feet in places; in Salem county it is 80 feet; in Delaware not over 60 feet; near the mouth of the Sassafras river in Maryland it is 100 feet; in eastern Anne Arundel county it is 60 feet; in western Anne Arundel county and Prince George county it is thinner, until at Fort Washington bluffs it is a little more than 15 feet. Its farthest known southern appearance is in the valley of Piscataway creek; on the opposite shore of the Potomac the Eocene rests directly on the Potomac formation.

Long thought to conformably overlie the Raritan, an unconformity is now known to exist, although the time interval was not very great. Along Raritan Bay in the vicinity of Cheesequake creek where the upper Raritan contains dark-colored clays, the interbedded sands and clays gradually grade from Raritan into the Matawan. Further inland and to the southward the interval was greater since the Matawan gradually transgresses the Raritan and comes to rest, in cen-

* Woolman, Ann. Rep. State Geol. N. J. 1895: 63–95. 1896.

tral and southern Maryland, upon the lower members of the Potomac group which are not represented in New Jersey. Elsewhere in New Jersey the upper Raritan consists of white sands or fine gravel and the line of contact is sharp, except where it is obscured by Tertiary or later deposits. The Matawan is conformably overlain by the lower Monmouth formation; the lithological differences are clearly marked, however.

In its northern portion the Matawan is readily separable upon lithological grounds into Crosswicks Clays and Hazlet Sands; outside of New Jersey in Delaware and Maryland these divisions cannot be recognized with any certainty. The Crosswicks Clays consist of slate or drab-colored clays with thin seams and pockets of glauconite, becoming dark, almost black, locally interstratified with white sand, containing much lignite and beds of leaves on Raritan Bay. The lignified trunk of a large tree was found in the clays in this vicinity, as well as many fragments. Further southward the clays become brittle, more arenaceous and micaceous and contain less iron sulphide. The Hazlet Sands are highly ferruginous, brown in color, with indurated crusts in their lower layers; above these there is frequently a well-developed layer of dark-colored clay, overlain with very micaceous sands, which are sometimes dark-colored, especially toward the south where they are also argillaceous.

In his report on surface geology Professor R. D. Salisbury states * that his assistant, Mr. G. N. Knapp, distinguished five layers in the clay-marls and traced them across the state. These he designates Merchantville bed (marly clay), Woodbury bed (dove-colored clay), Columbus bed (sand), Marshalltown bed (marly-clay sand), and Wenonah bed (sand). These features, although more or less marked, are not sharply defined throughout the entire area of the Matawan, and Professor Clark has never attempted to name or map any subdivisions other than the lower clay member and the upper sandy member.

The Matawan is abundantly fossiliferous, especially along

* Ann. Rep. State Geol. N. J. 1898: 35. 1899.

Crosswicks and Pensauken creeks. Clark enumerates 86 species of invertebrates, mostly molluscs, and Lewis Woolman in his artesian well reports has added several others, as has also Mr. C. W. Johnson,* who points out their identity with the Ripley fauna of the Gulf region. Other remains include sharks' teeth; Foraminifera, of which 20 species are recorded by Bagg; † echinus and other spines; Ostracoda; gavial (?) teeth: dinosaurian bones; ‡ etc.

The exposure fronting on Raritan Bay near Cliffwood, N. J., and forming a bluff some thirty feet high northwest of Matawan creek, has been admirably described by Hollick,§ who records obscure crustacean and molluscan remains, from which Professor Whitfield identified eight species of molluscs, and enumerates twenty-six species of plants, of which ten were new. I have found some few molluscan remains here, occurring in the ferruginous concretions picked up on the beach, from which Professor Clark has identified the following: *Idonearca vulgaris* Morton, *Veleda lintea* Conrad, *Cardium* sp., *Turritella vertebroides* Morton and one or two other species, new to the formation, not yet thoroughly studied.

I have nothing to add to the details of the exposure. It is capped with gravel and in places consists of regularly alternating beds of fine sand several inches thick and seams of comminuted vegetable matter an inch or two in thickness (*pl. 56*). These are replaced by alternating beds of clay and sand with lignite, and sparingly with greensand. The face of the bluff is almost entirely hidden as shown in *pl. 55*, and while the majority of my plant remains have been collected from dropped boulders of clay, all have come from near the base of the exposure except the large cone (*Sequoia* sp.). These plant beds are some distance above the base of the formation, however, and their preserva-

* New Cretaceous Fossils from an Artesian Well-boring at Mount Laurel, N. J. Proc. Phila. Acad. 1898: 461-464. 1898.

† U. S. Geol. Surv. Bull. 88, 1898.

‡ Ann. Rep. State Geol. N. J. 1896: 248. 1897.

§ Trans. N. Y. Acad. Sci. 16: 124-136. *pl. 11-14*. 1897.

tion is due in a large measure to the character of the materials, as vegetable remains are abundant in the form of lignite, forming thin seams intercalated in the sands nearly to the top of the exposure. The various layers are not continuous for any distance along the bluff and evidently indicate an inshore shallow fresh-water deposit which as time progressed gradually became marine through encroachments of the sea; the upper layers of sand with thin seams of comminuted vegetable matter indicating changed conditions and deposits in less quiet waters.

It is quite evident that sufficient material has not yet been accumulated to warrant an exhaustive discussion of the flora. I am enabled to enumerate sixty-seven different species of plants of which fourteen are new; of these sixty-seven species some nineteen are of doubtful affinities, such as the various species of *Carpolithus*, *Arisaema*, *Podozamites*, *Phragmites*, and the various fragments provisionally determined. There are present, however, in great abundance, such characteristic mid-Cretaceous forms as *Dammara*, *Cunninghamites*, *Dewalquea*, *Moriconia*, *Salix flexuosa*, *Proteoides daphnogeneoides*, *Sassafras acutilobum*, *Laurus plutonia*, *Sapindus Morrisoni*, *Andromeda Parlatorii*, etc.

The flora has more in common with the middle (Woodbridge) stage of the Raritan than with the other layers of that formation, eleven of the seventeen identical species occurring there, but this is undoubtedly due to the fact that this horizon is the best known; the upper Raritan (South Amboy) layers have not been sufficiently exploited to give us a clear idea of the vegetation prevalent when they were deposited. Forty-nine of the Matawan species have not as yet been found in the Raritan, although two of these are found on Long or Staten Island in beds probably of Raritan age. While this comparison might argue a considerable interval between the two formations, it remains to be pointed out that the following ten species are confined to the Raritan of New Jersey or the Islands and the Matawan formations on this continent: *Chondrites flexuosus*, *Geinitzia formosa*, *Cunning-*

hamites elegans, *Moriconia cyclotoxon*, *Magnolia Woodbridgensis*, *Laurophyllum angustifolium*, *Aralia palmata*, *Ficus Woolsoni*, *Paliurus integrifolius* and *Celastrophyllum Newberryanum*, and all except possibly *Paliurus* and *Chondrites* with well-characterized remains. Of the numerous species which are identical with those of the Dakota group of the West only eight are confined to the Dakota and Matawan formations. There are twenty-three species identical with Dakota group forms, but it may be remarked that the latter horizon is not precisely defined and its flora is exceptionally well known.

Fifteen of the Matawan species are found in the Raritan Cretaceous of the islands; nine occurring on Staten Island, eight on Long Island, seven on Martha's Vineyard, and four on Block Island. Eleven of the Matawan species reappear in the Atane beds of Greenland, and one additional in the Patoot beds; of these several are dominant forms of great vertical or areal distribution, or both, and thus have little significance; such forms are *Sequoia Reichenbachi*, *Sapindus Morrisoni*, *Laurus plutonia* and *Andromeda Parlatorii*. Others are more suggestive; thus, exclusive of its occurrence in the clays at Aachen, *Moriconia* is confined to the ancient Atlantic coastal plain and Greenland, and its remains are common; several species of *Magnolia* emphasize the similarity of these floras, as does the presence of the large-leaved *Aralia Ravniana*. This species is confined to the Atane and Matawan floras in so far as I can judge from the published descriptions or figures of Aralias, and its remains are unmistakably characterized. *Dewalquea Groenlandica* is also confined to these floras. With the Potomac flora as elaborated by Fontaine there seems to be no affinity, and the time that elapsed between them must have been very long.

Of species which occur in the Cenomanian of Europe we have *Geinitzia formosa*, *Sequoia Reichenbachi*, *Cunninghamites squamosus*, *Cunninghamites elegans*, *Moriconia cyclotoxon*, *Sassafras acutilobum*, *Laurus plutonia*, *Banksia pusilla*, *Sapindus apiculatus* and *Eucalyptus Geinitzi*, a

total of ten species or over 15 per cent.; or, on excluding doubtful species such as those of *Banksia*, *Eucalyptus* and *Sapindus*, and such wide ranging forms as *Sequoia Reichenbachi*, over 9 per cent.

The most striking feature about the Matawan flora is the entire absence of ferns, which form 5½ per cent. of the Raritan flora, *Anemia stricta* being commonly found at Woodbridge. Ferns form 1⅓ per cent. of the Dakota flora, 11 per cent. of the Atane flora, and about 2 per cent. of the existing New Jersey flora. In the most recent southern flora with which the Matawan may be compared, that of Alabama,* sixty-two species of Pteridophytes are listed forming about 2½ per cent., and this percentage would be greatly increased if we excluded herbaceous plants, which as a rule do not occur as fossils. It is difficult to account for the absence of this order, as the balance of the flora is proportionally normal, containing nearly 11 per cent. of Coniferae against 11⅕ per cent. in the Raritan and 10 per cent. in the Atane beds. Presumably the environment was unsuited to ferns, although, of course, future discovery may disclose them. Judging by such forms as *Dammara*, *Araucarites*, *Eucalyptus*, *Sterculia*, *Aralia*, *Myrsine*, *Ficus*, etc., we may infer that the climate was considerably warmer than at the present day in this latitude, and at least sufficiently humid to make the absence of ferns remarkable. A palm (*Serenopsis*) occurs at Glen Cove, Long Island,† and the Raritan furnishes many additional representatives of genera which are exclusively tropical at the present time, as for instance *Cinnamomum*, *Bauhinia*, etc.

Plants especially abundant in the Raritan formation and for which we have repeatedly searched in the Matawan are *Thinnfeldia subintegrifolia* (Lesq.) Knowlton, *Tricarpellites striatum* Newb., and *Tricalycites papyraceus* Newb. The genera *Myrica* (7 sp.) and *Liriodendron*, (4 sp.) which are abundantly developed in the Raritan, and on the islands, have

* Mohr, Plant Life of Alabama. Contr. U. S. Nat. Herb. v. 6. Jl 1901.

† Dr. Hollick writes that material recently collected may result in altering his views as to the botanical affinity of these remains.

thus far been found wanting. Other Raritan genera which do not appear in the Matawan formation are *Menispermites*, *Diospyros*, *Cissites*, *Ilex*, *Cinnamomum*, *Dalbergia*, *Bauhinia*, *Colutea*, *Planera*, *Viburnum*, *Juglans*, etc.; several of these occur in the upper layers of the Raritan, and future search ought to disclose some of them in the Matawan. *Celastrophyllum* with abundant remains of ten species in the Raritan (all horizons) has but two species in the Matawan, one of these being new and unrelated to any of the known Raritan species. *Widdringtonites* is abundant in the Raritan as are also *Salix inaequalis* and *Hedera primordialis; Myrsine borealis* Heer is one of the commonest leaves at all localities in the Raritan, as *Sequoia heterophylla* Vel. is one of its commonest conifers. *Celastrus arctica* is abundant at South Amboy, and should extend up into the Matawan. Numerous specimens of *Ophioglossum granulatum* are also found in the Raritan according to Newberry (localities not given). The genus *Aralia*, so abundantly represented in the Raritan, continued to develop during Matawan time. We record six species, the large-leaved *Aralia Ravniana* emphasizing the similarity of these Atlantic coastal Cretaceous floras with those of Greenland. It is of course quite possible, indeed it seems probable, that these numerous species of *Aralia* may for the most part be the variable leaves of a considerably less number of actual species; especially is this so of the Raritan species.

This is the extreme northeastern extension of the Matawan, and the only locality where plant remains have been found, although the underlying Raritan continues northeastward as far as Buzzard's Bay and doubtfully on Cape Cod. This northeastern extension has been much modified by forces which acted upon it during the Quaternary age and is for the most part entirely covered with drift or totally eroded, and if the Matawan formerly extended so far north and east this has been its fate. Professor Lester F. Ward* proposed the name Island series for the northeastern extension of the Raritan and makes it the uppermost member of the Potomac,

* Ann. Rep. U. S. Geol. Surv. 15: 335, 336. 1895.

unrepresented in New Jersey. Hollick would consider it the equivalent of the New Jersey Raritan, its distinctive characters being due to morainal action, with which view I entirely concur.

From the evidence of the flora alone we would consider the Matawan slightly more recent than the Raritan; a direct continuation of the latter, however, with several species added which are unknown from the Raritan. Thus, aside from the dissimilar species due to our imperfect knowledge of the flora of the two formations it remains to be pointed out that the occurrence of *Nelumbo* argues a somewhat later age for the Matawan, as this genus is not found below the Belly River Cretaceous on this continent.* Time must also have elapsed for the development or introduction of the various species of *Sterculia* which are found here as well as for the changed species of *Aralia*. The scarcity (absence) of ferns, the absence of *Brachyphyllum* which is essentially a Lower Cretaceous genus, and the much larger leaved *Moriconia* all point to a somewhat later time than the Raritan.

The Matawan, then, represents the transition period from the Lower to the Upper Cretaceous, when marine conditions replaced fresh-water estuarine conditions; and the flora is undoubtedly the latest Cretaceous flora of the Atlantic coastal plain which has been preserved. Professor Ward suggests that this ancient coastal plain may have extended to Greenland, but no evidence other than the remarkable similarity of the floras is known.

Just a word in regard to the remains. In common with the vast majority of New Jersey Clay specimens, the Matawan plants were hermetically sealed in the clay and slowly carbonized, so that when reëxposed to the air, the thick sheet of lignite dries, becoming cracked, and is soon dissipated, leaving only a faint impression behind. This has for years proved an obstacle to the proper investigation of these floras and it is only with the discovery of leaf-layers carrying con-

* Dr. Hollick has found *Nelumbo* on Martha's Vineyard and Long Island, the latter locality as yet unpublished, which vitiates the above statement.

Atlantic Coastal Plain			C. A. White.*	W. B. Clark.†	L. F. Ward.‡			W. B. Clark.§			
	Tertiary	Marine	Upper Marl Bed	Manasquan				Eocene	Shark River Manasquan	Old upper marl bed.	
			Middle Marls	Rancocas				Upper Cretaceous	Rancocas	Vincentown limesands Sewell marls	Middle Marls.
				Red Bank					Monmouth	Redbank Sands Navesink Marls Mt. Laurel Sands	Redsands and Lower Marl Bed.
			Lower Marls	Navesink							
			Clay Marls	Matawan					Matawan	Hazlet Sands Crosswick Clays	Clay Marls.
	Cretaceous	Non-marine			Newer Potomac	Upper	(Island Series.)	Clark & Bibbins.‖			
							Albirupean				
			Plastic Clays	Raritan			Iron Ore (?)	Lower Cretaceous	Raritan		
					Older Potomac	Middle	Aquia Creek		Patapsco	Ward's plant-bearing series held to be local exposures of this formation.	
			Potomac			Basal	Mount Vernon Rappahannock James River	Upper Jurassic (?)	Arundel	Marsh's supposed Jurassic vertebrates are from this formation.	
									Patuxent		

Jura-Trias.

* Correlation Papers, U. S. Geol. Surv., Bull. 82. † Bull. Geol. Soc. Am. 6: 479–482. 1894. Jour. Geol. 2: 161–177. 1894.

‡ Ann. Rep. U. S. Geol. Surv. 15: 307–397. 1895. § Ann. Rep. State Geol. N. J. 1897. ‖ Science, II. 15: 84. 1902.

siderably less carbonaceous matter that much progress can be made. All of my specimens have been sketched immediately, before becoming dry, so that they are fairly satisfactory; the specimens however might almost be thrown away as far as concerns their value as types.

While usage would sanction the designation of poor specimens of doubtful botanical affinities as "sp." after referring them provisionally or otherwise to some genus, which practice is supposed to obviate any undue definiteness on the part of the describer; the writer in these notes has followed the laudable practice of Professor Ward, as quoted above, in believing that whatever is worth mentioning is worth a name.

Acknowledgment is due Dr. Arthur Hollick, of the New York Botanical Garden, and Professor W. B. Clark, of Johns Hopkins University, for material assistance. The specimens are all deposited at the New York Botanical Garden.

CONIFERAE.

GEINITZIA Endl. Syn. Conif. 280. 1847.

This is an entirely extinct genus of the Taxodieae with several species on both sides of the Atlantic: *G. cretacea* Unger (Austria), *G. formosa* Heer (America and Quedlinburg), *G. hyperborea* (Greenland), *G.* sp., from the Dakota, and *G. Jenneyi* Font. from the Lower Cretaceous of the Black Hills. It was founded by Endlicher in his Synopsis Coniferarum to include certain forms referred by Geinitz to *Sedites* and *Araucarites* and by Corda to *Cryptomeria*. Among the former was *Araucarites Reichenbachi* of Geinitz, which Heer in 1868 identified with the living genus *Sequoia*. Since that date this plant has been almost uniformly called *Sequoia Reichenbachi*, and many place Endlicher's *Geinitzia cretacea* under it as a synonym. Others retain the older forms under *Geinitzia*. Ward contends that the retention of the genus *Geinitzia* logically carries *Sequoia Reichenbachi* with it into that genus as the type, while on the other hand the recognition of *Sequoia Reichenbachi* logically abolishes the genus *Geinitzia*.

GEINITZIA FORMOSA Heer.

Geinitzia formosa Heer, Kreidefl. Quedlinburg (Neue Denkschr. Schweiz. Ges. **24**:) 6. *pl. 1. f. 9; pl. 2.* 1871. Newb. Fl. Amboy Clays, 51. *pl. 9. f. 9.* 1896. (Foliage.) Hollick, Trans. N. Y. Acad. Sci. **16**: 129. *pl. 12. f. 1, 2.* 1897. (Cones.)

Foliage has somewhat the appearance of that of *Sequoia Reichenbachi*, but the leaves are more crowded. Not collected by me.

Raritan: Woodbridge, N. J. Matawan: Cliffwood, N. J., foliage not found. Europe: Moletein, Quedlinburg.

SEQUOIA Endl. Syn. Conif. 197. 1847.

The genus is unique in that it contains but two dwindling representatives of its former numerous species, one of which is the most majestically graceful of trees. These two species have barely held their own through the vicissitudes of centuries since the glacial period in the little strip of country where the climate is locally favorable. Many fossil species have been described, ranging upward from the Upper Jurassic; about forty-four from this continent alone, some of them with a great lateral and vertical range.

Potomac 12, Kootanie 6, Trinity 1, Ft. Pierre 1, Cheyenne Sandstone 2, Raritan 7, Island Raritan 2, Dakota 6, Belly River 3, Montana 4, Vancouver 1, Laramie 4, Canadian Upper Laramie 3, Lignitic 1, Livingston 1, Ft. Union 2, Green River 4, Alaskan Eocene 3, Miocene 3, Payette 1, Kome beds of Greenland 5, Atane beds of Greenland 5, Patoot beds of Greenland 5, Tertiary of Greenland 6, of which 4 occur in Europe and 2 on the continent of North America.

Heer records two species from the Tertiary of Siberia, and Ettingshausen records species from the Tertiaries of eastern Australia, Tasmania and New Zealand.

SEQUOIA GRACILLIMA (Lesq.) Newb. *Pl. 48. f. 21, 22.*

Glyptostrobus gracillimus Lesq. Am. Jour. Sci. II. **46**: 92. 1868; Cret. Fl. 52. *pl. 1. f. 8, 11, 11f.* 1874; Cret.

& Tert. Fl. 32. *pl. 1. f. 6, 6b.* 1883. "Cone of Sequoia" (not described) Ill. Cret. & Tert. Pl. *pl. 11. f. 9.* 1878. Fl. Dak. Group, 36. 1892.

Sequoia gracillima Newb. Fl. Amboy Clays, 50. *pl. 9. f. 1–3.* 1896; Later Ext. Fl. 19. *pl. 14. f. 6; pl. 26. f. 9* (?).* 1898.

The earliest mention of what is presumably this species is in a contribution by Newberry,† in which he refers to cones occurring in the Cretaceous Clays near Keyport (probably this is the Cliffwood locality) which he referred to *Geinitzia*, and associated branches which he referred to *Ullmannia* Goepp. In his posthumous Later Extinct Floras, these cones are referred to *Sequoia gracillima;* in the Flora of the Amboy Clays, which was also issued posthumously, he makes the same reference and compares them to Heer's *Sequoia macrolepis* (Fl. Foss. Arct. 7: 16. *pl. 51. f. 13*) considering them identical.

Hollick describes two cones from Cliffwood as *Geinitzia formosa* Heer. They are much distorted and incrusted with pyrites and possibly should be referred to *Sequoia gracillima*. Cones of this species are very common, the silicified ones washing out of the clay on the beach and the lignified ones occurring in considerable abundance in place in the clays. I have in my collection the remains of 32 cones, some of them nearly perfect and but slightly compressed, and I have refrained from collecting innumerable poor specimens seen. The largest is 8.5 cm. long, cylindrical, somewhat flattened, measuring 14 mm. in its shorter diameter and 18 mm. in its longer diameter. Most of them average nearly this thickness but are somewhat shorter, being about 7 cm. long.

Matawan: Cliffwood, N. J. (foliage not found).

Raritan (?): Keyport, N. J.

Cheyenne Sandstone: Belvidere, Kansas. Dakota Group: Sioux City, Iowa. Cretaceous (Dakota?): Whetstone Creek, New Mexico.

* Questioned by Hollick, editor of Newberry's work.

† Proc. N. Y. Lyc. Nat. Hist. 2: 10. 1873.

Kootanie, British Northwest Terr. (Table of dist., Lesq. Fl. Dak. Gr., 222.) Forks of Pine River, Northwest Terr.*

SEQUOIA REICHENBACHI (Gein.) Heer. *Pl. 48. f. 15, 16, 17, 20.*

Araucarites Reichenbachi Geinitz, Characteristik Schichten und Petrefacten Sachs-böhm. Kreidegebirges, 3: 98. *pl. 24. f. 4.* 1842.

Cryptomeria primaeva Corda; Reuss, Verstein. Böhm. Kreidef. 89. *pl. 48. f. 1–11.* 1846.

? *Geinitzia cretacea* Endl. Syn. Conif. 281. 1847.

Araucaria Reichenbachi Debey, Entwurf. Geogn.-geogenet. Darst. Gegend Aachen 63, 64. (Nachträge) 1849.

Sequoia Reichenbachi Heer, Fl. Foss. Arct. 1: 83. *pl. 43. f. 1d, 2b, 5a.* 1868; 3: 77, 101, 126. *pl. 20. f. 1–8; pl. 12. f. 7c, d; pl. 28. f. 2.* 1875; 4: 50 (Cape Staratschin, Spitzbergen); 6²: 16, 52. *pl. 28. f. 7.* 1882. Lesq. Cret. Flora, 51. *pl. 1. f. 10, 10b.* 1874; Fl. Dak. Group, 35. *pl. 2. f. 4.* 1892. Dawson, Trans. Roy. Soc. Can. 21. 1882. Fontaine, Potomac Flora, 243. *pl. 118. f. 1, 4; pl. 119. f. 1–5; pl. 120. f. 7, 8; pl. 122. f. 2; pl. 167. f. 5.* 1889. Newberry, Fl. Amboy Clays, 49. *pl. 9. f. 19.* 1896. Hollick, Trans. N. Y. Acad. Sci. 12: 30. *pl. 1. f. 18.* 1892; 16: 128. *pl. 12. f. 3b, 5.* 1897.

Abietites dubius Lesq. Tert. Flora, 81. *pl. 6. f. 20, 21, 21a.* 1878.

Our specimens from near Cliffwood are possibly related to the fragments which Hollick refers to *Geinitzia formosa* Heer, but I think this is rather unlikely, as his specimens are much more elongated and more like the cones of *Sequoia gracillima*. I feel certain that these cones are those of this species rather than fragments or immature cones of some other, for while the specimens preserved are rather fragmentary, resembling except in length those cones of *Sequoia*

* Lesquereux figures (Tert. Fl. *pl. 65. f. 5, 5a*) fragments of cones from the Green River group (Tertiary) at Castellos Ranch, Colorado, which are very similar if not identical with this species.

gracillima which have become lignified instead of silicified, I found one nearly perfect cone, which was about 3 cm. in length by about 2 cm. in diameter, which agreed almost exactly with Heer's figures of this species.

This was unfortunately smashed in transit, so that I now have only the recollection of it, which is not apt to be considered good evidence. However, my first thought on uncovering it was that it was a cone of *S. Reichenbachi.* The foliage of this species is rather common in the clays at this point and we would reasonably expect to find the cones; the former are very fragmentary. Poorly preserved branchlets of *Cunninghamites squamosus* can often be traced for several inches, but the *Sequoia* remains are usually not over an inch in length. The leaves are less closely set than in *C. squamosus* and longer, often 9 to 10 mm., much more slender and more spreading.

The best known localities for this species are:

True Laramie and Livingston Beds: Bozeman coal field, Montana. Montana Formation: Point of Rocks, Wyoming. Raritan: Woodridge, N. J. Matawan: Clifford, N. J. Belly River series: Belly River, Canada. Potomac Formation: Dutch Gap Canal and Fredericksburg, Va. Dakota Group: Ft. Harker, Kansas. Kootanie: Great Falls, Montana. Kome Beds: Pattorfik, Avkrusak, Angiarsut, Erkorfat, Kaersuarsuk. Atane Beds: Unter Atanekerdluk. Europe: Wernsdorf (Urgonian) Saxony (Cenomanian), Quedlinburg, Moletein (Senonian), Rainberg bei Salzburg, Brandenberg, Tyrol, southern France (Turonian), Clays at Aachen, Prussia, Quadersandstein at Hartz, Bohemia. Cretaceous: Tottenville, Staten Island. Lower Cretaceous: Black Hills.

While this species had a wide vertical and areal distribution ranging from the Upper Jurassic through the Cretaceous, it is best developed in the Lower Cretaceous.

SEQUOIA REICHENBACHI (Gein) Heer.? *Pl. 48. f. 18.*

An oval shaped cone 3 cm. in diameter by 4 cm. long, too obscure for exact determination. It resembles some of the

cones from the Potomac formation which Fontaine refers to this genus. Is about the same size and character as the cone of *Sequoia Reichenbachi* which Ward figures from the Black Hills (Ann. Rep. U. S. Geol. Surv. 19²: 674. *pl. 166. f. 1*).

ARAUCARITES Presl, in Sternb. Vers. 2: 203. 1833.

ARAUCARITES OVATUS Hollick.

Araucarites ovatus Hollick, Trans. N. Y. Acad. Sci. 16: 128. *pl. 12. f. 3a, 4.* 1897.

While these remains are undoubtedly related to the genus *Araucaria*, their size would seem to indicate a nearer relationship to the genus *Agathis* Salisb. (*Dammara* Lam.). The only other American post-Jurassic references to *Araucarites* are two species of cones from the Potomac which Fontaine so identifies. The genus *Araucaria* of Jussieu occurs abundantly from the Jurassic upward; Fontaine describes three species from the Potomac formation and Lesquereux a doubtful species from the Dakota Group. Wood of this type has been identified by Knowlton from the Triassic (?) and the Lower Cretaceous of South Dakota. All of the foregoing have very small, more or less imbricated and compressed leaves, while this species of Hollick's is much larger and suggests similarity with *Nageiopsis*, so largely developed in the Potomac, or various forms referred to *Podozamites*, *Dammara*, etc., the exact affinity of which is unknown.

DAMMARA Lam. Encycl. 2: 259. 1786.

The living species are included in the genus *Agathis* Salisb. and are four in number, ranging from the Malayan Islands and Philippines to Australia and New Zealand.

DAMMARA CLIFFWOODENSIS Hollick. *Pl. 48. f. 8–11.*

Dammara (?) Cliffwoodensis Hollick, Trans. N. Y. Acad. Sci. 16: 128. *pl. 11. f. 5–8.* 1897.

These problematical remains are very abundant in the clays at Cliffwood as well as in the Amboy Clays and the Cretaceous of Staten Island and Block Island (Hollick). David

White and Hollick have found them at Martha's Vineyard and they are known from the Atane and Patoot beds where Heer differentiates *Dammara borealis*,* *D. macrosperma*, and *D. microlepis* as well as very similar remains which he describes as *Eucalyptus Geinitzi*. These latter remains Newberry considers are generically the same as those referred to *Dammara* and not related to *Eucalyptus*. However this may be, undoubted leaf-remains of *Eucalyptus* have been found in these various American Cretaceous strata and it does not seem unreasonable that the fruit should also be present. It is quite true that various leaves have been referred to *Eucalyptus* upon rather doubtful evidence, but others from both their form and venation, are unquestionably related to that genus.

The Cliffwood remains are exceedingly common; often fragmentary, however, sometimes only a portion of the resin ducts being preserved; they are very fragile and crumble readily upon handling. They vary considerably in size, some being as small as *Dammara borealis* and others being larger than those figured by Hollick from this formation.

Pl. 48, f. 10 is strikingly like the forms which Heer considers *Eucalyptus*, but the balance of our collections are evidently coniferous scales, consisting internally of a rather central resin-duct enlarged above, with four or five angular resin-ducts on each side, which seem to descend to the base of the scale; externally the scales seem to be more rounded and finely lined as in *f. 10*.

Our remains are almost exactly kite-shaped and many of them seem to have straight ascending sides and are not abruptly narrowed from above the middle as in Hollick's specimens (l. c.). Neither is there any evidence of the short mucronate point on the crown; on the contrary *f. 10* is evenly rounded. At the same time it seems best to refer our remains to Hollick's species, at least until we can be more certain as to the exact affinity of all these *Dammara*-like remains.

Newberry (*l. c.*) doubts their relation to *Dammara*, point-

* This species has been recorded from the Cenomanian of Bohemia.

ing out that no *Dammara*-like foliage has been found associated with them and that in the very abundant Amboy Clay specimens the scales seem to be associated with an extremely delicate juniper-like conifer; this association has never been confirmed, however. He also finds some indications of two seeds in his specimens, the living *Dammara* scales being one-seeded. Merely negative evidence as to the occurrence of *Dammara* leaves is not very conclusive, especially in view of the fact that Lesquereux has described the remains of certain leaves from the Dakota Group (*Dammarites*), which are undoubtedly related to those of the existing *Dammara robusta* Moore, of Australia, and various other remains both in this country and abroad have been referred to *Dammarites*.

Furthermore, the remains from Cliffwood which Hollick describes (*l. c.*) as *Araucarites ovatus* are very similar to those of *Agathis Dammara* Rich. (*Dammara orientalis* Lam.; *D. alba* Rumph.) the existing *Dammara* of the Malayan Islands and Philippines.

Fontaine (Potomac Fl. 264. *pl. 133. f. 8–12*) describes wedge-shaped scales under the name *Araucarites Aquiensis* from the Potomac Formation near Brooke, Va., where they are common and always found detached and unassociated with other remains. While their resemblance to those of *Dammara* may be considered somewhat far-fetched, their similar mode of occurrence is suggestive. They are as a rule larger than *Dammara*, but vary considerably in size and shape and have a transverse furrow on their upper margin.

CUNNINGHAMITES Presl, in Sternb. Vers. **2**: 203. 1833.

Pending the discovery of fruit the identification of these remains with those of the existing genus *Cunninghamia* is not beyond question. *Cunninghamia* R. Br., with a single species, is at the present day an endemic genus of the China-Japan region.

CUNNINGHAMITES SQUAMOSUS Heer. *Pl. 48. f. 14, 19.*

Cunninghamites squamosus Heer, Beitr. Kreidfl. Quedlinb. 9. *pl. 1. f. 5–7.* 1872. Hollick, Trans. N. Y. Acad. Sci. **16**: 129. *pl. 11. f. 3.* 1897. (Not of Hosius and Von der Marck.)

Remains of this species are the most abundant coniferous fossils in the clays at Cliffwood. They occur as twigs about the size of those figured by Hollick or smaller and demand no extended discussion. This is the only locality in this country where they have been found, but additional collections from the Amboy Clays ought to disclose them. The two specimens figured are more robust than the majority of the remains and are ten sevenths of the average size, although several large specimens were collected. On the usual-sized specimens the leaves are about 6 mm. long, closely set, stout, incurved, very much crowded in some instances and quite different in appearance from those of *Sequoia Reichenbachi* with which it is often associated.

CUNNINGHAMITES ELEGANS (Corda) Endl.

Cunninghamia elegans Corda; Reuss, Verstein. Böhm. Kreidef. 93. *pl. 49. f. 29–31.* 1846.

Cunninghamites elegans Endl. Syn. Conif. 270. 1847. Heer, Beitrag. Kreidefl. (Neue. Denkschr. Schweiz. Gesell.) 12. *pl. 1. f. 14.* 1869. Schimper, Pal. Vég. **2**: 256. Heer, Fl. Foss. Arct. **7**: 17. *pl. 53. f. 1.* 1883. Newb. Fl. Amboy Clays, 48. *pl. 5. f. 1–7.* 1896. Hollick, Trans. N. Y. Acad. Sci. **16**: 129. *pl. 11. f. 2.* 1897. Hollick, Bull. N. Y. Bot. Garden, **2**: 402. *pl. 41. f. 11.* 1902. (Knowlton, U. S. Geol. Surv. Bull. 163: 29. *pl. 5. f. 3.* 1900, probably belongs here.)

Cunninghamites squamosus Hosius & Von der Marck, Fl. Westfal. Kreide. 54. *pl. 37. f. 137–141.* (Palaeontographica, v. 26.) 1880.

Originally described from Moletein in Moravia and Mseno in Bohemia (Cenomanian), then from the chalk of Westphalia;

Heer records it from the Patoot beds of Greenland. Newberry's specimens are from "near Keyport" and are probably not from the Raritan, however in a table on page 135 he gives as an additional locality South Amboy, which is within the Raritan formation. Hollick (*l. c.*) records unmistakable remains of this species from the Matawan, but much search has not resulted in my finding it except one specimen which is doubtfully referred to this species (too poor to figure).

MORICONIA Deb. & Ett. Urweltl. Acrobryen Aachen, 59. 1859.

MORICONIA CYCLOTOXON Deb. & Ett. *Pl. 43. f. 4; 48. f. 1–4.*

Moriconia cyclotoxon Deb. & Ett. Urweltl. Acrobryen Aachen (Denkschr. Wien. Akad. **17**: 239), 59. *pl. 7. f. 23–27.* 1859. Newb. Fl. Amboy Clays, 55. *pl. 10. f. 11–21.* 1896. Heer, Fl. Foss. Arct. 3^2: 97. *pl. 26. f. 18*, under the name of *Pecopteris Kudlisetensis;* 6^2: 49. *pl. 33. f. 1–9;* **7**: 11. *pl. 53. f. 10, 10b; pl. 54. f.* 1c (the latter figure probably represents a *Brachyphyllum*).

Originally described from the clays at Aachen, Heer found it in the Atane and Patoot beds of Greenland and Disco Island, and Newberry in the Amboy Clays at South Amboy, N. J., where it is common. Heer's forms have the stem naked in a majority of cases; the branchlets are about 21 mm. long and the widest is 4.5 mm. wide; one branchlet with the tip missing is still 36 mm. long but only 3 mm. wide. Newberry's Amboy Clay specimens have some of the branchlets long and slender like the Arctic forms, but the majority are shorter and stouter, being 10 to 12 mm. in length by 4 mm. in width, and the stems are more uniformly leaved. Specimens from Staten and Block Islands recently reported by Hollick are also small.

All of my specimens from Cliffwood have the main stem leaved; my only complete branchlet is 34 mm. long by 9 mm. wide, in fact all of my specimens are nearly, or quite, twice as wide as any of the Amboy Clay or Greenland forms.

The figure (*pl. 43. f. 4*) shows the appearance of the main stem of a fragmentary specimen which might readily enough be taken for the pinna of a fern.

The markings on all the specimens are very obscure and it is only after the carbonized layer has dried out and blown away that they show plainly the leaf-markings as shown in the balance of the figures. No fruit has anywhere been found associated with these twigs, so that their exact relationship remains to be determined. Judging from the foliage alone Heer is inclined to place it among the Cupressineae and near to *Libocedrus*.

Libocedrus Endl. is unknown from the American Cretaceous or later formations, although the existing incense cedar, *Libocedrus decurrens* Torr., ranges from Oregon southward to southern California and is commonly cultivated. This typically northern genus reaches Australia through the East Indian region and penetrates far into South America along the Andes, thus almost surrounding the Pacific. Heer has described three fossil species from the Arctic regions, *Libocedrus gracilis* from Spitzbergen, *Libocedrus cretacea* from the Atane schists (Kardlok, Isunguak), and *Libocedrus Sabiniana* from Greenland (Atanekerdluk B, Naujat, Kugsinek, Haseninsel, Isunguak) and Spitzbergen.

ARACEAE.

ARISAEMA Martius, Flora, 14: 459. 1831.

There are about fifty existing species, mostly of temperate and tropical Asia; three in eastern North America. Two fossil species have been provisionally referred here as follows:

ARISAEMA CRETACEUM Lesq. *Pl. 46. f. 4.*

Arisaema cretacea Lesq. Fl. Dak. Group, 38. *pl. 46. f. 1.* 1892.

Arisaema (?) *dubia* Hollick, Trans. N. Y. Acad. Sci. 16: 130. *pl. 12. f. 6.* 1897.

The above species was founded by Lesquereux for a

monocotyledonous, probably Araceous spathe from the Dakota Group of Kansas. In all probability Hollick's specimen is of the same species. It is doubtfully a species of *Arisaema*, however, and might equally be a cycadaceous spathe. In appearance the specimen before us is very similar to some of Lesquereux's figures of *Dammarites* (Fl. Dak. Gr. *pl. 1. f. 9–11*); the fine lining is about .5 mm. apart as in the existing *Dammara robusta* Moore of Australia, but the texture is very thin and quite the opposite of the thick coriaceous leaves of *Dammara* and *Dammarites*.

ARISAEMA (?) MATTEWANENSE Hollick.

Arisaema Mattewanense Hollick, Trans. N. Y. Acad. Sci. 16: 130. *pl. 12. f. 7.* 1897.

Provisionally so referred by Dr. Hollick, as the fruit of some Araceous plant.

SALICACEAE.

SALIX Linn. Sp. Pl. 1015. 1753.

The willows are all extremely rapid growers and thrive in the wettest soil; they are thus apt to occur in localities favorable for fossilization. There are about 160 existing species widely distributed throughout the northern hemisphere and arctic zone, a few in the southern hemisphere; about 80 are American. There are about 46 fossil American species distributed as follows: Raritan 5, Island Raritan 4, Dakota 11, Woodbine 1, Montana 3, Vancouver 2, Laramie 4 (?), Ft. Union 1, Green River 5, Eocene 7 (?), Eolignitic 3, Tertiary 2, Miocene 5, Pleistocene 1 (?).

Heer records three from the Island of Sachalin and seven from the Tertiary of Greenland.

SALIX PROTEAEFOLIA FLEXUOSA (Newb.) Lesq. *Pl. 48. f. 12; pl. 52. f. 2.*

Salix flexuosa Newb. Ann. Lyc. N. Y. 9: 21. 1868; Ill. Cret. & Tert. Pl. *pl. 1. f. 4.* 1878; Later Ext. Fl. 56. *pl. 2. f. 4; pl. 13. f. 3, 4; pl. 14. f. 1.* 1898.

Salix protecaefolia flexuosa Lesq. Fl. Dak. Group, 50. *pl. 44, f. 4, 5.* 1892.

Dakota Group: Kansas. Cretaceous: Seacliff, Long Island (Hollick, '94) and Block Island (Hollick, '98).

The smaller leaf is similar to the smaller forms referred to the above species. It resembles a number of small lanceolate leaves of varied affinities such as Lesquereux's *Andromeda affinis*, the smaller forms of *Myrica longa* Heer from the Dakota (but has a narrower base), and *Laurus angusta* Heer as figured in Fl. Foss. Arct. 7: *pl. 57. f. 1b;* the latter is, however, considerably smaller than Heer's figures of this same species in the same work, v. 6², and also much smaller than the leaf which Lesquereux refers to this species in the Flora of the Dakota Group.

Were our specimen (*pl. 48. f. 12*) somewhat more linear it might be compared to *Eucalyptus Dakotensis*, but there is no doubt that it is a *Salix*. The larger leaves (*pl. 52. f. 2*) show the characteristic venation of this species.

Salix Mattewanensis sp. nov. *Pl. 51. f. 5.*

A small ovate-lanceolate leaf with an obtuse base and slender tapering tip, greatly resembling several modern willow leaves; secondaries regular, camptodrome.

Except for its small size it is very similar to *Salix membranacea* Newb. There is considerable resemblance to *Salix* sp. (Fl. Amboy Clays, *pl. 42. f. 6–8*) only the tip is more elongated. There is also some resemblance to such leaves as *Leguminosites constrictus* Lesq. and to several of the forms referred to *Cassia*.

Salix Meekii Newb.

Salix Meekii Newb. Ann. Lyc. N. Y. 9: 19. 1868; Later Ext. Fl. 58. *pl. 2. f. 3.* 1898. Hollick, Trans. N. Y. Acad. Sci. 16: 130. *pl. 13. f. 3, 4.* 1897.

S. cuneata Newb. Ill. Cret. & Tert. *pl. 1. f. 2, 3.* 1878.

S. protecaefolia lanceolata Lesq. Fl. Dak. Group, 50. *pl. 64. f. 6–8.* 1892.

Recorded by Hollick from the Matawan formation near Cliffwood, N. J.; not found by me.

POPULITES Lesq. Am. Jour. Sci. **46**: 93. 1868.

Founded by Lesquereux to include leaves from the Dakota Group which are apparently related to *Populus* but differing in their generally entire margin, cordate outline, and craspedodrome venation, the latter character apparently wanting in our species. Some of Lesquereux's species have since been transferred to the genera *Grewiopsis*, *Hamamelites*, *Menispermites*, and *Cissites*, leaving seven Dakota species and one species from the Upper Cretaceous of Vancouver Island.

The genus *Populus*, although containing the oldest known dicotyledon at Kome, besides ten Dakota species and two Potomac species according to Fontaine, is so essentially a later genus that I prefer to include our leaf in the related genus *Populites*, thus obviating too great definiteness of relation to the existing genus.

Populus contains about twenty-five species in the existing flora, all of which are confined to the northern hemisphere. Some twelve of these inhabit North America. The fossil species are numerous.

Populites tenuifolius sp. nov. *Pl. 49. f. 7.*

A leaf exceeding 10 cm. in length and nearly 12 cm. in width: margin in the upper part apparently entire or perhaps a trifle undulate; about 4 cm. of the right lateral margin is preserved and seems to be slightly crenate, but the indications are very faint and may be due to the wearing away of the material. The base is not preserved, but I judge it to have been cordate. The texture is extremely thin for so large a leaf. Secondaries four or five on each side, very thin, alternate, unbranched except the basal ones, leaving the midrib at an angle of about 45° and curving upward, branching near the margin much as in *Protophyllum Sternbergii*;* basal secondaries evidently much longer than the others, giving off numerous branches to the latero-basal portion of the leaf. Areolation ill-defined, angular.

I have been at a loss to correctly determine this leaf; it bears considerable resemblance to some of Lesquereux's species of *Protophyllum*, but inasmuch as the latter is a syn-

* Lesq. Fl. Dak. Group, *pl. 42. f. 1.*

thetic type of uncertain botanical affinities, with mostly coriaceous leaves, it has not been considered available. The only Raritan leaf with which our specimen may be compared is *Tiliaephyllum dubium*,* which it resembles in its cordate outline, delicate venation, and thin texture; like the Raritan leaf ours is represented by but a single specimen rather poorly preserved. It differs in being larger and in lacking the dentate margin, and was apparently equilateral with a straight midrib. In view of the uncertainty of Newberry's determination it is desirable that we should endeavor to get an idea of the true botanical affinity of our leaf, which it seems to me will place it among those leaves ancestral to the modern aspens or poplars. It resembles several species of *Populus*, although the latter are as a rule coriaceous or subcoriaceous, for instance *Populus Harkeriana* Lesq. from Staten Island† and the Dakota Group.‡ It may be compared with *Populus balsamoides* (?) var. *latifolia* Lesq.,§ although the latter is a Tertiary species; the margin is apparently similar and the venation is strikingly similar except at the margin.

It may also be compared with the Dakota species *Populites Lancastriensis* Lesq.‖ which it greatly resembles in size and outline; the secondaries are stouter and straighter in the latter and the basal one is less branched.

FAGACEAE.

QUERCUS Linn. Sp. Pl. 994. 1753.

About two hundred existing species of the northern hemisphere,¶ more than fifty of which occur in North America. The extinct American species number about 127, distributed

* Newb. Fl. Amboy Clays, 109. *pl. 15. f. 15.*

† Hollick, Ann. N. Y. Acad. Sci. 11 : 419. *pl. 36. f. 8.*

‡ Lesq. Fl. Dak. Group, 44. *pl. 46. f. 4.*

§ Lesq. Cret. & Tert. Fl. 158. *pl. 31. f. 4.*

‖ Lesq. Cret. Fl. 58. *pl. 3. f. 1.*

¶ Recorded by Ettingshausen from Tertiary of New Zealand. (Trans. N. Z. Inst. v. 23.)

as follows: Raritan 2, Dakota 20, Montana 2, Vancouver 6, Laramie 17, Livingston 3, Denver 9, Ft. Union 7, Tertiary of Yellowstone Park 7, Green River 7, Eolignitic 6, Eocene 12, Miocene 25, Payette 4, Pleistocene 6, Glacial 1, Atane 7, Patoot 7, Tertiary of Greenland 15.

Quercus Hollickii sp. nov. *Pl. 51. f. 1, 2.*

Leaves subcoriaceous, obovate, obtuse, gradually narrowing to the base; secondaries strong, equidistant and parallel, alternate, camptodrome, angle of divergence about 50°; basal one third of the margin entire, above rather irregularly dentate.

These specimens evidently represent a leaf about 9 cm. in length by about 4.5 cm. in greatest width.

I have been unable to refer this to any of the described species of *Quercus* although it resembles several; in outline it is similar to *Q. Wardiana* Lesq.* from the Dakota group, but the latter is 50 per cent. larger and with different venation. There is also a resemblance to Newberry's *Q. elliptica* † but the secondaries are straighter, more ascending and more regularly arched in our specimen. Again, it may be compared to the Tertiary *Q. Olafseni* Heer, but the latter has the leaves more oval, margin more dentate, secondaries craspedodrome and straighter, greatly resembling Lesquereux's *pl. 48. f. 4* from the Fort Union Beds; in the latter, however, some of the upper secondaries run directly to the dentate points of the margin. There is, further, a resemblance to *Q. Nevadensis* Lesq., from the Pacific Coast Miocene, which however has the secondaries straighter and subcraspedodrome.

Considerable similarity is to be noted with various leaves referred to *Celastrophyllum*, as for instance *C. grandifolium* Newb., which is common in the Raritan (localities not given); our leaf is considerably shorter and relatively wider, more obovate in outline, with a more tapering base, straighter midrib and more regular secondaries.

* Fl. Dak. Group. *pl. 7. f. 1.* 1892.
† Later Ext. Fl. *pl. 20. f. 3.* 1898.

QUERCUS HOLMESII Lesq. *Pl. 48. f. 13.*

Dryophyllum (*Quercus*) *salicifolium* Lesq. Ann. Rep. U S. Geol. & Geog. Surv. Terr. **1874**: 340. *pl. 8. f. 2.* 1876. Name preoccupied by *Quercus salicifolia* Newb.

Dryophyllum (*Quercus*) *Holmesii* Lesq. Cret. & Tert. Flora, 38. *pl. 4. f. 8.* 1883.

Quercus Holmesii Lesq. Fl. Dak. Group, 58. 1892.

Upper Cretaceous: Port McNeill, Vancouver Island. Dakota Group ?: San Juan River, S. W. Colorado.

There are a number of small-leaved oaks which resemble this species, including *Quercus Montanensis* Knowlton (Fl. Montana Form. *pl. 11. f. 10*), *Dryophyllum subfalcatum* Lesq. (*D. Bruneri* Ward) of the Laramie and the smaller forms with nearly simple margins of Newberry's Tertiary *Quercus consimilis.*

QUERCUS MORRISONIANA Lesq.

Quercus Morrisoniana Lesq. Cret. & Tert. Fl. 40. *pl. 17. f. 1, 2.* 1883. Hollick, Trans. N. Y. Acad. Sci. **16**: 131. *pl. 13. f. 11, 12.* 1897.

Recorded by Hollick from the Matawan formation near Cliffwood, N. J.; not found by me.

QUERCUS (?) NOVAE-CAESAREAE Hollick. *Pl. 51. f. 4.*

Quercus (?) *Novae-Caesareae* Hollick, Trans. N. Y. Acad. Sci. **16**: 131. *pl. 13. f. 9, 10.* 1897.

Hollick points out the resemblance of these leaves to those of *Quercus Myrtillus* Heer from Greenland and also to those of *Diospyros provecta* Velen. from Bohemia.

I have found several fragments at Cliffwood which belong here.

QUERCUS sp.

Quercus (?) *sp.*, Hollick, Trans. N. Y. Acad. Sci. **16**: 131. *pl. 14. f. 9.* 1897.

Of doubtful affinity. Hollick compares this fragment with *Quercus poranioides* Lesq. and with *Q. Thulensis* Heer, and

also suggests that it might be a fragment of *Ilex Masoni* Lesq. There are several similar fragments in my collection.

MORACEAE.

Ficus Linn. Sp. Pl. 1059. 1753.

The existing species number some six hundred shrubs and trees of the warmer parts of the globe everywhere, chiefly in Asia, Africa and the East Indian Islands. Two species enter the limits of the United States, occurring in Florida and the West Indies. About one hundred species of *Ficus* occur in America in the following formations: Potomac 2, Raritan 3, Island Raritan 5, Dakota 23, Woodbine 1, Montana 16, Vancouver 6, Laramie 21, Livingston 1, Denver 9, Ft. Union 5, Green River 5, Tertiary of Yellowstone Park 4, Eocene 6, Eolignitic 6, Miocene 7, Atane 3, Patoot 2, Greenland Tertiary 1.

Recorded by Ettingshausen from Tertiary of New Zealand (Trans. N. Z. Inst. v. **23**); now extinct there, though living in Australia.

Ficus reticulata (Lesq.) Knowlton. *Pl. 52. f. 5; pl. 53. f. 1, 4.*

Laurophyllum reticulatum Lesq. Ann. Rep. U. S. Geol. & Geog. Surv. Terr. **1872**: 425. 1873; Cret. Flora, 76. *pl. 15. f. 4, 5.* 1874.

Ficus laurophylla Lesq. Ann. Rep. U. S. Geol. & Geog. Surv. Terr. **1874**: 342. *pl. 5. f. 7.* 1876. Cret. & Tert. Fl. 49. *pl. 1. f. 12, 13.* 1878; Fl. Dak. Group, 85. 1892.

Ficus reticulata Knowlton, Bull. U. S. Geol. Surv. 152: 104. 1898.

Heretofore known from the Dakota Group of Kansas. The Cliffwood remains consist of the impressions of the under surface of leaves rather fragmentary, and indicate an oblong-lanceolate leaf 2–3.5 cm. in width, with an entire margin and rather stout midrib; secondaries branch at an obtuse angle, unequal, becoming marginal; venation some-

what irregular. There is some resemblance to the Greenland leaves which Heer (Fl. Foss. Arct. 7: *pl. 79. f. 4*) refers to *Diospyros brachysepala* A. Br.

FICUS WOOLSONI Newb. *Pl. 47. f. 7.*

Ficus Woolsoni Newb.; Hollick, Trans. N. Y. Acad. Sci. 12: 6. *pl. 2. f. 1, 2c.* 1892; Newb. Fl. Amboy Clays, 70. *pl. 20. f. 3; pl. 23. f. 1–6.* 1896.

This species is thus far only represented by a small fragment from Cliffwood, although common in the Raritan Clays at Sayreville and Woodbridge, and also reported from Kreischerville, Staten Island, by Hollick.

PROTEACEAE.

PROTEOIDES Heer, Phyll. Crét. Nebr. 17. 1866.

This extinct genus, which is supposed to be allied to the existing genus *Protea*, has some eight fossil American species as follows: Raritan 2, Dakota 4, Mill Creek 1, Vancouver 3. Many fossil species of Proteaceae have been described from the European Tertiary but considerable doubt has been expressed as to the real affinity of many of them, their resemblance to various species of Coniferae, Meliaceae, Sapindaceae and Myricaceae being pointed out.

PROTEOIDES DAPHNOGENOIDES Heer. *Pl. 51. f. 6–9.*

Proteoides daphnogenoides Heer, Phyll. Crét. Nebr. 17. *pl. 4. f. 9, 10.* 1866. Newb. Fl. Amboy Clays, 72. *pl. 17. f. 8, 9; pl. 32. f. 11, 13, 14; pl. 33. f. 3; pl. 41. f. 15.* 1896. Lesq. Cret. Fl. 85. *pl. 15. f. 1, 2.* 1874. Hollick, Trans. N. Y. Acad. Sci. 11: 98. *pl. 3. f. 1, 2.* 1892; 12: 36. *pl. 2. f. 4, 9, 13.* 1893; Bull. Torrey Club, 21: 52. *pl. 177. f. 1.* 1894; Ann. N. Y. Acad. Sci. 11: 420. *pl. 36. f. 1–3.* 1898.

Remains of this species are common in the clays near Cliffwood, but very fragmentary. Previously recorded from the Dakota group at Decatur, Nebraska; Raritan at Woodbridge, Sayreville, etc., N. J.; the Mill Creek series at Mill Creek and the Cretaceous on Staten Island and Long Island.

BANKSIA Linn. f. Suppl. 15. 1781.

The existing species number about fifty and are confined to the Australian region. Two fossil species have been identified from American strata, but whether or not they are allied to the living *Banksiae* is not altogether certain.

BANKSIA PUSILLA Velen.

Banksia pusilla Velen. Fl. Boehm. Kreidef. 7 (32). *pl.* 1 (9). *f.* 14–17. 1883. Hollick, Trans. N. Y. Acad. Sci. **16**: 132. *pl.* 13. *f.* 7. 1897.

With the exception of *Banksia Helvetica* Heer, which Lesquereux records from the Eolignitic of Mississippi, this genus is not found elsewhere on this continent, although species referred to this and the allied genus *Banksites* occur in the European Tertiary. It is essentially a later genus, with upwards of fifty existing species which are all confined to the Australian region. The above species is very similar to *Santalum Americanum* Lesq. (Cret. & Tert. Fl. *pl.* 32. *f.* 7) of the western Tertiary.

NYMPHAEACEAE.

NELUMBO Adans. Fam. Pl. **2**: 76. 1763.

But two living species are known, *N. Nelumbo* (L.) Karst. of eastern Asia and *N. lutea* (Willd.) Pers. of eastern North America, giving emphasis to the well-known similarity of these two floras. The genus appeared in the middle Cretaceous and ranges to the Miocene Tertiary, increasing regularly in size. There are one Asiatic, seven European and nine American fossil species,* all of the American species, unless it be Heer's from Atane, being from a considerably higher horizon than our Cliffwood specimen.

Exceptions to the latter statement are unpublished species from Long Island and Martha's Vineyard, discovered by Dr. Hollick.

Nelumbo primaeva sp. nov. *Pl.* 43. *f.* 1.

This is undoubtedly a portion of a leaf of *Nelumbo* — too

* The living and fossil species are enumerated by Hollick in Bull. Torrey Club, **21**: 307. 1894.

small a fragment, however, for rigid determination. It represents a small-leaved species with leaves apparently about the same size as those of *Nelumbo Laramiensis* Hollick (*l. c. f.* in text); the cross venation is obliterated, however, and the primary veins are only eight in number instead of twelve, as is the case in *N. Laramiensis*.* *Nelumbo intermedia*,† of the Montana formation, is of about the same size, but has twelve or thirteen weak primary veins. *Nelumbo Dawsoni* Hollick, ‡ from the Canadian Belly River, is also a small leaf, but has eighteen primary veins. Dawson has described,§ but not figured, a small leaf from the Canadian Laramie, under the name of *Nelumbium Saskachuensis*, of similar size and with only seven primaries.

MAGNOLIACEAE.

MAGNOLIA Linn. Sp. Pl. 535. 1753.

There are about fifteen existing species of *Magnolia*, confined to eastern North America, eastern Asia and the Himalayan region. The fossil species are numerous, there being over forty from continental America besides those from Greenland. The distribution of the American fossil species is as follows: Raritan 7, Island Raritan 8, Dakota 11, Atane 4, Mill Creek 1, Woodbine 2, Montana 2, Vancouver 2, Laramie 7, Denver 1, Ft. Union 2, Eocene 6, Eolignitic 5, Miocene 5, Greenland Tertiary 6.

MAGNOLIA OBTUSATA Heer. *Pl. 47. f. 4.*

Magnolia obtusata Heer, Fl. Foss. Arct. 6²: 90. *pl. 15. f. 12; pl. 21. f. 3.* 1882. Lesq. Fl. Dak. Group, 201. *pl. 60. f. 5, 6.* 1892.

This leaf resembles greatly the smaller of the two figures which are figured respectively by each of the above authors.

* Dr. Hollick, who has seen a figure of this leaf, writes: "Very close if not identical with *Nelumbo Laramiensis*."

† Knowlton, Fl. Montana Form. (Bull. U. S. Geol. Surv. 163:) 53. *pl. 13. f. 3–5.* 1900.

‡ *Brasenia antiqua*, Daws. Trans. Roy. Soc. Can. 3: sec. 4, 15, *f.* 1886.

§ Daws. *ibid.*, 5: sec. 4, 35. 1888.

Previously recorded from the Atane schists of Greenland and the Dakota group of Kansas.

MAGNOLIA WOODBRIDGENSIS Hollick. *Pl. 53. f. 5; pl. 57. f. 2.*

Magnolia Woodbridgensis Hollick, in Newb. Fl. Amboy Clays, 74. *pl. 36. f. 11; pl. 57. f. 5–7.* 1896. Hollick, Trans. N. Y. Acad. Sci. **16**: 133. *pl. 14. f. 8.* 1897; Ann. N. Y. Acad. Sci. **11**: 60. *pl. 3. f. 2.* 1898.

While the fragments shown on *plate 53* have the venation entirely obscured, I have no hesitation in referring them to the above species, especially as I have found other smaller fragments with the characteristic venation of *Magnolia.*

Judging from the nearly parallel lateral margins of the fragment shown on *plate 57* it would seem to indicate a rather longer leaf than the typical *Magnolia Woodridgensis*, a leaf more like *Magnolia Boulayana* Lesq. or *Magnolia glaucoides* Newb. The incomplete nature of the specimen, however, and the total obliteration of the venation make it preferable to place it under *M. Woodbridgensis.* Leaf-blade apparently quite thick.

MAGNOLIA TENUIFOLIA Lesq. *Pl. 47. f. 10.*

Magnolia tenuifolia Lesq. Am. Jour. Sci. **46**: 100. 1868; Cret. Flora, 92. *pl. 21. f. 1.* 1874; Fl. Dak. Group, 198. *pl. 24. f. 1.* 1892.

Previously known from the Dakota Group at Decatur, Neb., Kansas, and Peace River, Northwest Territory.

Our fragment is very similar to *f. 1. pl. 24*, Fl. Dak. Group, of this species, except that the secondaries are somewhat straighter and more regular.

There is considerable resemblance to *Magnolia Capellinii* Heer, which is doubtfully recorded from Sayreville, N. J., Glen Cove, L. I., and Martha's Vineyard, as well as from the Dakota of the West and from Greenland.

Ours, while only a fragment, denotes a more elongated leaf than that of *M. Capellinii.*

LAURACEAE.

LAURUS Linn. Sp. Pl. 369. 1753.

As commonly restricted, the existing species are but two, of southern Europe, the Canary Islands and Madeira. The family is large and chiefly tropical. The fossil species are numerous, over thirty being found on this continent. It may be remarked, however, that there is considerable uncertainty in the generic diagnoses which are based upon nothing but leaf remains of the Laurineae. Remains referred to *Laurus* are common in the European Tertiary and Heer records one species from the Tertiary of Siberia, besides four at Atane, three at Patoot, and four in the Tertiary of Greenland. The American species are distributed as follows: Raritan 3, Island Raritan 4, Dakota 11, Mill Creek 1, Woodbine 1, Montana 3, Vancouver 1, Cret. of N. W. Terr. 1, Laramie 4, Livingston 1, Denver 3, Ft. Union 2, Tertiary of Yellowstone Park 2, Eocene 1, Eolignitic 4, Miocene 7.

LAURUS HOLLAE Heer. *Pl. 50. f. 7, 8; pl. 52. f. 7, 8.*

Laurus Hollae Heer, Fl. Foss. Arct. 6²: 76. *pl. 33. f. 13; 44. f. 5b; 45. f. 3.* 1882. Lesq. Fl. Dak. Group, 92. *pl. 12. f. 8.* 1892. Hollick, Trans. N. Y. Acad. Sci. **12**: 7. *pl. 2. f. 17.* 1892.

Previously known from the Dakota Group, Kansas; Cretaceous, Staten Island; Atane schists, Greenland. Ours are rather poor specimens for positive determination; as far as they go they agree admirably with the above species.

LAURUS PROTEAEFOLIA Lesq. *Pl. 47. f. 9; pl. 49. f. 6.*

Laurus proteaefolia Lesq. Bull. U. S. Geol. and Geog. Surv. Terr. **1**: 393. 1876; Ann. Rep. *ibid.* **1874**: 342. *pl. 5. f. 1, 2.* 1876; Cret. & Tert. Fl. 52. *pl. 3. f. 9, 10; pl. 16. f. 6.* 1883; Fl. Dak. Group, 92. 1892.

Lesquereux's specimens were from the Dakota Group at Morrison, Col., and Fort Harker, Kansas. The Cliffwood forms which Hollick refers to *Laurus plutonia* Heer are somewhat larger than the majority of Heer's figures of that species, and our remains which seem to be species of *Laurus*

are larger still and more ovate in form, with less ascending secondaries. They are intermediate in size among Lesquereux's figures of *L. proteaefolia*.

LAURUS PLUTONIA Heer. *Pl. 50. f. 9–11.*

Laurus plutonia Heer, Fl. Foss. Arct. 6²: 75. *pl. 19. f. 1d, 2–4; pl. 20. f. 3a, 4–6; pl. 24. f. 6b; pl. 28. f. 10, 11; pl. 42. f. 4b;* 7: 30. *pl. 58. f. 2; pl. 62. f. 1a.* Lesq. Fl. Dak. Group, 91. *pl. 13. f. 5, 6; pl. 22. f. 5.* 1892. Newb. Fl. Amboy Clays, 85. *pl. 16. f. 10, 11.* 1896. Hollick, Trans. N. Y. Acad. Sci. 12: 236. *pl. 6. f. 1.* 1893; Bull. Geol. Soc. Am. 7: 13. 1895; Trans. N. Y. Acad. Sci. 16: 132. *pl. 13. f. 5, 6.* 1897; Ann. N. Y. Acad. Sci. 11: 60. *pl. 4. f. 6, 7.* 1898.

Recorded from the Raritan, locality not given; Matawan, Cliffwood, N. J.; Dakota group, Kansas and Minn. (?); Cretaceous, Glen Cove, L. I., Martha's Vineyard and Block Island; Middle Cretaceous at Atane and Patoot, Greenland.

This is another species which was very common throughout eastern North America from Greenland to New Jersey during the Middle Cretaceous. The leaves were rather variable in outline, Newberry's Amboy Clay forms and those from Cliffwood which Hollick refers to this species being considerably broader than the majority of Heer's specimens. The leaves from the Dakota which Lesquereux identifies with this species are, on the other hand, smaller and agree fairly well with the leaves in our collections which seem to belong to this species. The latter agree closely with Heer's figures and differ considerably from Hollick's forms from this formation. About the same size as the Block Island leaf which Hollick refers to this species.

Laurus Hollickii sp. nov. *Pl. 52. f. 4.*

A small lanceolate Lauraceous leaf about 8 cm. long and 1.5 cm. in greatest width, which is at a point about half way between the apex and base, the blade tapering about equally in both directions; secondaries four or five on each side,

leaving the midrib at an angle somewhat less than 45° and curving upward with a long sweep, becoming nearly parallel with the margin, along which they form small shallow arches, the connecting branches to the secondary next above being small and transverse.

Species dedicated to Dr. Arthur Hollick, who suggested its Lauraceous affinity.

This species is quite similar to *Daphnophyllum Dakotense* Lesq. from the Dakota group, which Lesquereux compares with *Daphne protogaea* Ett.* Our leaf is somewhat narrower and the distal portions of the secondaries are straighter. There is also considerable resemblance in outline to various species of *Salix* and some of the lanceolate species of *Ficus*.

LAUROPHYLLUM Göpp. Tertiarfl. Java, 45. 1854.

An entirely extinct genus containing leaves supposed to be allied to *Laurus* and including five American species in the Raritan, Mill Creek and Upper Cretaceous.

LAUROPHYLLUM ANGUSTIFOLIUM Newb. *Pl. 47. f. 1, 5, 8, pl. 49. f. 1–5.*

Laurophyllum angustifolium Newb. Fl. Amboy Clays, 86. *pl. 17. f. 10, 11.* 1896.

Remains of leaves, which by their narrow elongated shape, thick midrib, and coriaceous texture are allied to this species of Newberry from the Amboy Clays at Woodbridge are very common at Cliffwood. The remains are very poor, however, consisting of larger or smaller fragments of the basal portions of leaves. The petiole (preserved in *f. 5*) is short and stout.

Newberry compares his leaves with some of Heer's *Myrica longa*, but the latter lack the straight narrowly ascending basal margins and are rather abruptly rounded. If Arctic analogues are necessary we may point out the resemblance to the Tertiary *Laurus Reussii* Ett. or to forms of *Laurus angusta* Heer from Atane (Fl. Foss. Arct. 6²: *pl. 43, f. 1c*).

* Fl. Bilin. pt. 2, 13. *pl. 34. f. 1–3.* 1868.

SASSAFRAS Nees & Eberm. Handb. Med. Pharm. Bot. 2: 418. 1831.

At the present day a monotypic genus of eastern North America, although inhabiting Europe before the Glacial period in both the Tertiary and Cretaceous ages. Numerous fossil leaves have been referred to this genus ranging from the Potomac formation upward. While some of these are undoubtedly ancestral *Sassafras* species, others are just as undoubtedly not related to *Sassafras;* for instance we would refer *Sassafras Harkerianum*, *S. obtusum* and *S. cretaceum obtusum* to *Cissites;* we would refer *S. dissectum*, *S. dissectum symmetricum*, *S. mirabile*, *S. papillosum*, *S. recurvatum*, *S. dentatum* and *S. grossedentatum* to *Platanus* or possibly to *Protoplatanus*. The two dozen or more ancient American species occur in the following formations: Potomac 3, Cheyenne Sandstone 3, Raritan 4, Island Raritan 2, Matawan 1, Dakota 14, Vancouver 1, Canadian Upper Laramie 2.

Heer describes two species from Atane, one of which is identical with a Dakota form; one species from Patoot; and one from the Tertiary of Greenland. Velenovsky identifies *S. acutilobum* in the Cenomanian of Bohemia, and several species have been described from the European Tertiary formations.

SASSAFRAS ACUTILOBUM Lesq. *Pl. 45. f. 1, 2.*

Sassafras acutilobum Lesq. Cret. Flora, 79. *pl. 14. f. 1, 2.* 1874; Cret. & Tert. Fl. 56. *pl. 5. f. 1, 5.* 1883; Fl. Dak. Group, 100. 1892. Newb. Fl. Amboy Clays, 87. *pl. 25. f. 1–10; pl. 26. f. 2–6.* 1896; Later Ext. Fl. 98. *pl. 7. f. 1.* 1898 > *S. cretaceum.* Hollick, Trans. N. Y. Acad. Sci. **12**: 236. *pl. 7. f. 1.* 1893. **16**: 132. *pl. 14. f. 13.* 1897. Velen. Fl. Böhm. Kreidef. 4: 2. *pl. 2. f. 1.* 1886.

S. recurvatum Heer, Fl. Foss. Arct. 6²: 74. *pl. 39. f. 4.* 1882; not Lesq.

There can be no doubt that this rather fragmentary leaf is referable to *Sassafras acutilobum* as commonly understood.

In outline it is almost identical with Lesquereux's typical leaf from the Dakota Group, the only differences being its slightly smaller size and somewhat wider median lobe. It is also very similar to the leaf from the Bohemian Cretaceous which Velenovsky refers to this species, the only difference being the less conical lobes. With Newberry's Amboy Clay forms there is a general resemblance to the more typical specimens. Hollick, ('97) found a small fragment in this (Clay Marl) formation which he thought might be referable to this species. With the question of the proper generic relations of this species we are not here concerned. In another place * I have expressed doubt as to the validity of its reference to *Sassafras*.

ACERACEAE.

Acer Linn. Sp. Pl. 1054. 1753.

There are about one hundred existing species of maples. The fossil species are also quite numerous, there being some twenty-six fossil American forms distributed as follows: Raritan 1, Island Raritan 1, Belly River 1, Laramie 5, Denver 1, Ft. Union 3, Green River 3, Eocene 3, Miocene 8, Pleistocene 3.

Heer records one from the Tertiary of Siberia, one from the Tertiary of Manchuria, three from the Island of Sachalin, two from Patoot, and five from the Tertiary of Greenland. Ettingshausen records maples in the Tertiary of Australia, Tasmania and New Zealand.

Acer paucidentatum Hollick.

Acer paucidentatum Hollick, Trans. N. Y. Acad. Sci. **16**: 132. *pl. 14. f. 2, 3.* 1897.

As remarked by Hollick this maple resembles several Tertiary species. *Acer* is only represented by fruit in the New Jersey Raritan, although a small leaf has been found in that formation on Staten Island.

Sapindus Linn. Sp. Pl. 367. 1753.

Sapindus is at the present day a chiefly tropical genus of about ten species of Asia and America. The only existing

* Bot. Gaz. 34: 438. 1902.

North American species are *S. marginatus* Willd., which ranges from Kansas to northern Mexico and eastward to Georgia and Florida; *S. Saponaria* Linn., of the Florida Keys, West Indies and Venezuela; and *S. Drummondii* H. & A. The American fossil species are numerous, there being twenty-one or more forms distributed as follows: Island 1, Matawan 1, Dakota 2, Denver 1, Upper Laramie 1, Eocene, Ky. 1, Brandon, Vt. 1, Green River 7, Fort Union 5, Tertiary of Yellowstone Park 2, Eolignitic 4, Miocene 1, Greenland 3.

Did we assume that these fossil leaflets should be of uniform size and form, as they are in our existing species of the Southwest, the number of fossil species would be greatly multiplied.

SAPINDUS MORRISONI Lesq. *Pl. 47. f. 2, 3.*

Sapindus Morrisoni Lesq. Cret. & Tert. Fl. 83. *pl. 16. f. 1, 2.* 1883; Fl. Dak. Group, 158. *pl. 35. f. 1, 2.* 1892. Heer, Fl. Foss. Arct. 6[2]: 96. *pl. 40. f. 1; pl. 41. f. 3; pl. 43. f. 1a, b; pl. 44. f. 7, 8.* 1882. Hollick, Trans. N. Y. Acad. Sci. **11**: *pl. 3. f. 5.* 1892; **12**: 235. *pl. 6. f. 3.* 1893; Bull. Torrey Club, **21**: 57. *pl. 179. f. 8.* 1894; Bull. Geol. Soc. Am. **7**: 13. 1895; Ann. N. Y. Acad. Sci. **11**: 422. *pl. 36. f. 4.* 1898. White, Am. Jour. Sci. III. **39**: 99. *pl. 2. f. 12.* 1890.

The Cliffwood forms are small leaves with a considerably inequilateral base and numerous somewhat ascending irregularly curved camptodrome secondaries. There is no question but what this is a species of *Sapindus;* it agrees quite well with Lesquereux's Cret. & Tert. Fl. *f. 2,* and Fl. Dak. Group, *f. 2,* and Hollick's specimen from Tottenville, Staten Island, all of which are rather smaller than the other figured leaves of this species. Hollick * identifies two fairly perfect leaves from this horizon with Velenovsky's *Sapindus apiculatus* from the Bohemian Cretaceous. These leaves are somewhat smaller than our specimens and less full at the

* Trans. N. Y. Acad. Sci. 16: 133. *pl. 13. f. 1, 2.* 1897.

base on the larger side, otherwise they are quite similar. They may be either small leaves of *Sapindus Morrisoni* or else new forms altogether. It may well be that the leaves referred to the widely distributed *Sapindus Morrisoni*, as indicated above, embrace more than one species.

This is another species which we could expect to find in the Raritan formation.

SAPINDUS APICULATUS Velen.

Sapindus apiculatus Velen. Fl. Böhm. Kreidef. **3**: 6 (53). *pl.* 7 (*22*). *f.* 1–8. 1884. Hollick, Trans. N. Y. Acad. Sci. **16**: 133. *pl.* 13. *f.* 1, 2. 1897.

As remarked under *Sapindus Morrisoni*, this might well be a small leaf of that species. Recorded by Hollick from the Matawan; not found by me.

CELASTROPHYLLUM Göpp. Tertiärfl. Java, 52. 1854.

This extinct genus includes leaves related to those of *Colastrus*. It has ten species in the Potomac, ten in the Raritan, one in the Island series, seven in the Dakota, two in the Matawan, one in the Atane beds and three in the Patoot beds.

Celastrophyllum elegans sp. nov. *Pl.* 43. *f.* 6.

A handsome ovate-lanceolate leaf about 6 cm. long and 10 mm. wide at its widest part which is about midway between the base and the apex; with a somewhat wedge-shaped base, an evenly rounded apex and a slightly undulating margin; there are eleven shallow indentations on each side, the lowest about 6 mm. from the base; petiole rather stout, 10 mm. in length; secondaries branch at an angle of somewhat more than 45° and are straight to within a short distance of the margin, curving and forming arches only about one millimeter from it.

Hollick refers a leaf from this formation to *Celastrophyllum Newberryanum;* ours is a narrower longer leaf with more regular secondaries. Compared with the Amboy Clay leaves of *C. Newberryanum* ours is a longer more slender leaf. *C. Newberryanum* was however an abundant and very variable leaf and some of Newberry's figures approach ours quite

closely, for instance, Fl. Amboy Clays, *pl. 49. f. 10.* Our leaf is also somewhat similar to some of the Amboy clay leaves which Newberry refers to *C. crenatum* Heer, though the latter is stouter and averages much larger.

C. grandifolium Newb. is of somewhat the same proportions but about three times as large. The Dakota species except *C. decurrens* are much smaller leaves. The Potomac species are mostly smaller broader leaves of rather obscure affinities.

CELASTROPHYLLUM NEWBERRYANUM Hollick.

Celastrophyllum Newberryanum Hollick; Newb. Fl. Amboy Clays, 101. *pl. 49. f. 1–27.* 1896; Trans. N. Y. Acad. Sci. 16: 133. *pl. 14. f. 1.* 1897.

This small-leaved *Celastrophyllum* is abundant in the upper Raritan beds at South Amboy and we would naturally expect it to extend upward into the Cliffwood beds, where it is recorded by Hollick.

RHAMNACEAE.

RHAMNUS Linn. Sp. Pl. 193. 1753.

About seventy-five existing species, mostly north temperate, a few tropical and a few south temperate; eleven inhabit North America. Thirty-three species are found fossil on this continent in the following formations: Island Raritan 2, Dakota 6, Montana 1, Laramie 10, Denver 6, Ft. Union 2, Green River 3, Eolignitic 2, Tertiary 1.

Heer records one from the Tertiary of Manchuria, one from the island of Sachalin, two from Atane, one from Patoot, and eight from the Tertiary of Greenland.

Rhamnus Novae-Caesareae sp. nov. *Pl. 50. f. 5, 6.*

These leaves are somewhat similar in outline and venation to what Hollick calls *Quercus (?) Novae-Caesareae* from this same locality, only our specimens are less perfect and considerably larger. Their true affinity seems to be with *Rhamnus*, and I have been unable to associate them with any of the

described species. Remains are fragmentary, but indicate a simple ovate-lanceolate leaf 7–10 cm. long by about 2.25 cm. wide, with ascending camptodrome secondaries and transverse tertiaries.

RHAMNUS INAEQUILATERALIS Lesq.

Rhamnus inaequilateralis Lesq. Fl. Dak. Group, 170. *pl. 37. f. 4–7.* 1892. Hollick, Trans. N. Y. Acad. Sci. **16**: 133. *pl. 13, f. 8.* 1897.

The Cliffwood forms are identical with the smaller of Lesquereux's leaves. Recorded by Hollick from the Matawan formation; not found by me.

PALIURUS Mill. Gard. Dict., ed. 7. 1759.

There are only two existing species, one confined to southern China and Japan, and the other to southern Europe and western Asia. The fossil species are numerous, some sixteen occurring on this continent; it is pertinent to remark, however, that in the absence of fruit *Paliurus* is practically indistinguishable from *Zizyphus* or *Ceanothus*.

Raritan 1, Island Raritan 3, Dakota 5, Mill Creek 2, Vancouver 1, Laramie 4, Canadian Upper Laramie 1, Denver 3, Ft. Union 2, Green River 2, Miocene 1.

Heer records one from the Tertiary of Siberia, one from the Island of Sachalin, one from Patoot, and three from the Tertiary of Greenland.

PALIURUS INTEGRIFOLIUS Hollick (?).

Paliurus integrifolius Hollick, Bull. Torrey Club, **21**: 57. *pl. 177. f. 5, 8, 12.* 1894; Trans. N. Y. Acad. Sci. **16**: 133. *pl. 14. f. 10.* 1897.

This reference of a fragment from near Cliffwood was only provisional. The specimen represents the basal fragment of a leaf which is rather large for *Paliurus* and lacks the lateral branches of the primaries which ought to be present in the left hand portion of the specimen. It might well represent the basal portion of some of the leaves from the Raritan formation which Newberry referred to *Cissites formosus* Heer. Not found by me.

MYRTACEAE.

EUCALYPTUS L'Her. Sert. Angl. 18. 1788.

There are about one hundred and forty existing species of great variety of form, foliage and blossom, confined to the Australian region, none occurring in New Zealand on the one hand or Asia on the other.* Nine fossil species have been referred to this genus from American strata, most of which are doubtfully determined owing to the uncertainty of leaf remains: Island Raritan 2, Dakota 3, Raritan 4, Laramie 1, Green River 1, Atane 2.

EUCALYPTUS GEINITZI Heer. *Pl. 53. f. 3.*

Myrtophyllum (*Eucalyptus?*) *Geinitzi* Heer, Fl. Foss. Arct. 3^2: 116. *pl. 32. f. 14–17; pl. 33. f. 6b.* 1874.

Eucalyptus Geinitzi Heer, Fl. Foss. Arct. 6^2: 93. *pl. 19. f. 1c; pl. 65. f. 4–9.* 1882. Lesq. Fl. Dak. Group, 138. *pl. 37. f. 20.* 1892. Newb. Fl. Amboy Clays, 110. *pl. 32. f. 2, 12, 15, 16.* 1896. Hollick, Trans. N. Y. Acad. Sci. **11**: 98. *pl. 2. f. 1.* 1892; **12**: 34. *pl. 2. f. 5.* 1892; 236. *pl. 6. f. 2.* 1893; Bull. Geol. Soc. Am. **7**: 13. 1895; Annals N. Y. Acad. Sci. **11**: 60. *pl. 4. f. 1–3.* 1898. White, Am. Jour. Sci. III. **39**: 98. *pl. 2. f. 8–11.* 1890. Heer, Kreide Fl. Moletein, 22. *pl. 11. f. 3, 4.*

This reference is only provisional, as the leaf is too fragmentary for certainty and the venation is entirely obliterated. I have thought I detected the characteristic venation at times but cannot be certain. Previously recorded from the Dakota, Kansas; the Raritan, Woodbridge, Sayreville, N. J.; and the Cretaceous of Staten Island, Long Island and Martha's Vineyard. Also recorded from Greenland and the continent of Europe.

Eucalyptus (?) **dubia** sp. nov. *Pl. 52. f. 1.*

This fragment is referred to *Eucalyptus* because of its resemblance to Newberry's Fl. Amboy Clays, *pl. 32. f. 6,*

* Although Ettingshausen records them from the Tertiary of New Zealand (Trans. N. Z. Inst. v. 23).

(*E.* (?) *angustifolia*). In all probability neither of these leaves is related to *Eucalyptus*.

The secondaries spring from the midrib at an angle of 45° to 50° and are approximately straight and parallel, about 1.5 mm. apart, some opposite, others irregular; intermediate tertiaries give alternate branches to each secondary. The venation is not characteristic of *Eucalyptus*, and resembles somewhat that of *Laurophyllum reticulatum* Lesq., but our specimen is a smaller, relatively narrower leaf. A second specimen shows a marginal vein connecting the secondaries about .5 mm. from the margin.

STERCULIACEAE.

Sterculia Linn. Sp. Pl. 1007. 1753.

Nearly one hundred existing species of the tropics of both hemispheres. American fossil species are some seventeen in number, distributed as follows: Potomac 1, Cheyenne Sandstone 1, Raritan 1, Island Raritan 2, Dakota 8, Cretaceous of British Columbia 1, Denver 1, Green River 1.

None have been recognized in the Atane beds of Greenland, although one species occurs at Patoot. One species has been recorded from the Island of Sachalin; the genus is present in the upper Cretaceous of Europe and some sixteen species have been described from the European Tertiary deposits, although the American Tertiary is practically barren of these plants.

Sterculia Cliffwoodensis sp. nov. *Pl. 43. f. 5.*

Sterculia sp. (?) Hollick, Trans. N. Y. Acad. Sci. **16**: 133. *pl. 14. f. 4–7.* 1897.

It is to be hoped that more and fuller remains may be discovered of this beautiful species. The present specimen indicates a trilobed leaf with entire margin and decurrent base; lobes diverging at an angle of about 45° or less, with nearly parallel margins and acute tips (?); the secondaries branch at a wide angle and their tips are joined by rather straight arches.

Lesquereux separates the Dakota leaves of *Sterculia* from *Aralia* merely on account of the "primary divisions and primary nerves from the top of the petiole." This character, which I do not consider diagnostic, would refer this leaf to *Aralia* as the lateral primaries branch from the midrib a considerable distance above its base. The venation is somewhat similar to the Dakota *Sterculia reticulata* Lesq. (Fl. Dak. Group, *pl. 34. f. 10*), and also to that of *Aralia transversinervia* Sap. & Mar. described by Hollick from Oakneck, Long Island (Bull. Torrey Club, **21**. 54. *pl. 176. f. 1.* 1894) which leaf he does not consider an *Aralia*.

In outline this leaf resembles *Sterculia lugubris* Lesq. except that the primaries are not basal; whether the lobes were produced to the length they are in that species is of course conjectural. Our fragment is also somewhat similar in outline to the fragment (Fl. Amboy Clays, *pl. 26. f. 2*) referred by Newberry to *Aralia quinquepartita* Lesq., in which however the venation is unfortunately obliterated. Hollick's *Sterculia* sp. (*l. c.*) probably belongs here; his *f. 4* is the fragment of a much smaller leaf, but his larger fragments (*f. 5–7*) might well be the acutely tipped lobes of our leaf, the venation of the two corresponding very well.

Our leaf also has somewhat the appearance of *Aralia Jorgensenі* Heer (Fl. Foss. Arct. **7**: *pl. 101. f. 1*) but the sinuses are not quite so deep. It might further be compared to *Aralia Wellingtoniana Vaughanii* Knowlton from the Woodbine formation of Texas (Dakota). The latter is trilobed, the lobes slender and entire; not figured, however. (Knowlton; Hill, Ann. Rep. U. S. Geol. Surv. **21**: 318. 1901.)

Sterculia Snowii bilobata var. nov. *Pl. 43. f. 7.*

Sterculia Snowii is known from the Dakota Group of Kansas and New Mexico and the Cheyenne Sandstone at Belvidere, Kansas. The specimen from the Matawan here figured, in its outline approximates *Liriophyllum Beckwithii* Lesq., from the Dakota Group, but the venation is radically differ-

ent. We have supposed its relationship to be with *Sterculia Snowii* not only because the latter already has a remarkable bilobate form (var. *disjuncta*), but also because we can readily imagine a leaf like the leaf of *S. Snowii* shown on Fl. Dak. Group, *pl. 33. f. 3* with a deeper sinus which would then make it correspond with our specimen.

This reference is far from satisfactory; it would seem that if this is a variety of *S. Snowii* the latter ought to be present as well or at least in the Raritan, although it has not as yet been discovered, except a doubtful specimen from Tottenville, Staten Island (Hollick, Ann. N. Y. Acad. Sci. **11**: 422. *pl. 37. f. 4.* 1898). Although Lesquereux in his Report on the Clay Deposits of New Jersey (1878) recognized undetermined species of *Sterculia* at three different localities, no decisive remains of this genus have thus far come to light in the Raritan formation in New Jersey. Dr. Hollick, to whom a sketch of this leaf was sent, is disposed to compare it with Fl. Dak. Group, *pl. 21. f. 5*, which Lesquereux refers to Heer's *Cissites formosus*. Inasmuch as Lesquereux's determination is doubtful, because the secondary system is quite unlike that of *Cissites* in looping along the margins and more like that of *Sterculia*, I prefer to consider it more nearly related to the latter, at least provisionally. It may also be compared with *f. 3* of *Aralia concreta* Lesq., as figured by him in Cret. & Tert. Fl. *pl. 9*. *Sterculia limbata* Velen., the Bohemian representative of *S. Snowii*, has sometimes 4-lobed, 4-veined leaves.

STERCULIA MUCRONATA Lesq. *Pl. 43. f. 3.*

Sterculia mucronata Lesq. Fl. Dak. Group, 182. *pl. 30. f. 1–4.* 1892.

In the absence of the apical and basal portions, and because of the obliteration of the venation, it is with considerable hesitation that I refer this small bilobed leaf to the above Dakota Group species. That it is referable to *Sterculia* is I think probable, but just which species to associate it with is doubtful. It is about the same size as Lesquereux's smaller

specimens (*f. 3, 4*), but differs in having the midrib branch at some distance above the base. Both ancient and modern *Sterculia* leaves vary considerably, and *Sterculia Snowii* has a bilobed form.

There is considerable resemblance to the smaller leaves from the Raritan at Woodbridge, which Newberry refers to *Sassafras acutilobum* Lesq. (Fl. Amboy Clays, *pl. 25. f. 2, 5, 6, 10*). Leaves of the living *Sterculia diversifolia occidentalis* Benth., from interior Australia, contained in the Meisner Herbarium, are very similar to *Sterculia mucronata*.

ARALIACEAE.

Aralia Linn. Sp. Pl. 273. 1753.

The genus *Aralia* has never been precisely defined for the paleobotanist, the custom being to follow precedent and refer a variety of polymorphic leaves of synthetic types to this genus — leaves having a variety of affinities, Platanoid, Sassafroid, etc., as well as leaves allied to *Cissus* and *Hedera*. The existing flora includes some twenty-seven species of North America and Asia, six of which are American; only one of these, however (*A. spinosa* L.), is arborescent. The ancient flora contains numerous leaves that have been referred to this genus, besides several that have been referred to the allied genus *Araliaephyllum*. The distribution of the American fossil species is as follows:* Potomac 1, and 4 sp. of *Araliaephyllum*, Raritan 8, Matawan 6, Island Raritan 5, Dakota 13, Mill Creek 3, Laramie 3, Denver 1, Ft. Union 5, Tertiary of Yellowstone Park 3, Green River 1, Eocene 4, Miocene 5, Atane beds 2, Patoot beds 1, Greenland Tertiary 2.

Velenovsky enumerates two species from the Cenomanian of Bohemia, *A. decurrens* being apparently identical with *A. Saportanea* of the Dakota, and the other, *A. coriacea*, reappearing at Martha's Vineyard. From the European Tertiary some thirty-two species are recorded, none occurring in the existing flora of Europe.

*Ettingshausen (Trans. N. Z. Inst. 19: 449) records *Aralia* in the Tasmanian Tertiary.

Lesquereux (Fl. Dak. Group, 249) characterizes these leaves as follows: "Base decurrent, primary nervation palmately trifid and supra-basilar," but he repeatedly fails to conform to his definition. Thus his *A. acerifolia*, *A. tenuinervis*, *A. dissecta* and *A. subemarginata* lack the decurrent base, as do also five of Newberry's Raritan forms. The primaries are generally subbasal and are basal in Lesquereux's *A. quinquepartita*, *A. notata*, *A. dissecta* and *A. Masoni*. I have been at a loss to distinguish between *Sterculia* and *Aralia* in the Matawan material; no mutually exclusive characters can be gathered from the published descriptions or figures, and as it would be useless to attempt a revision without an examination of all the collected material, I have been forced to follow the pernicious precedent above alluded to.

ARALIA TOWNERI Lesq.

Aralia Towneri Lesq. Bull. U. S. Geol. & Geog. Surv. Terr. **1**: 394. 1876; Ann. Rep. *ibid.* **1874**: 349. *pl. 4. f. 3.* 1876; Cret. & Tert. Fl. 62. *pl. 6. f. 4.* 1883; Fl. Dak. Group, 132. *pl. 23. f. 3, 4; pl. 31. f. 1.* 1892. Hollick, Trans. N. Y. Acad. Sci. **16**: 132. *pl. 14. f. 11, 12.* 1897.

Described originally from the Dakota Group of Kansas, Hollick has doubtfully referred two fragments from the clays near Cliffwood to this species. These fragments are so incomplete that the form of the leaf is more or less conjectural. The secondaries are straighter than in Lesquereux's specimens and branch from the primaries at a wider angle. At the same time they seem to differ from my specimens from this formation which I have referred to *Aralia Ravniana* Heer.

ARALIA RAVNIANA Heer. *Pl. 46. f. 7; pl. 53. f. 2; pl. 57. f. 1.*

Aralia Ravniana Heer, Fl. Foss. Arct. 6[2]: 84. *pl. 38. f. 1, 2.* 1882.

The specimens from Cliffwood figured above are identical with Heer's *Aralia Ravniana* from the Atane schists at

Igdlokunguak, Greenland, except that the basal primary forks a considerable distance from its base. I was at first disposed to refer them to *Aralia Towneri* Lesq., particularly as Heer compared his leaves with that species and Lesquereux suggested * that the two were identical.

While the occurrence of two such large-leaved species of *Aralia* in the Matawan formation may seem anomalous, especially as they had much in common, I fail to see their identity. *Aralia Towneri* was a palmately five-lobed leaf with a decurrent base and obtuse lanceolate lobes. *Aralia Ravniana* on the other hand was probably a six- or seven-lobed leaf of large size, for while in no case is the apex preserved, I cannot conceive that such a leaf as the discovered fragments evidently represent could have had an undivided terminal lobe. If they had, they would differ from all other species of *Aralia* in its size, and from lobed leaves in general. They would have had a lobe wider than long, with an area greater than the balance of the leaf, the deep lateral sinuses almost cutting it off from the rest of the blade. In the specimen figured at *pl. 57, f. 1* (one fourth natural size) the midrib more than half way to the tip gives off a strong lateral branch which it seems reasonable to suppose formed the midrib of a lateral lobe. Furthermore, *A. Ravniana* differs from *A. Towneri* in having stouter primaries, narrower sinuses, more ovate lobes, the basal ones widely spreading, and the base but slightly or not at all decurrent. If we may judge from the obsolete venation, it was a more coriaceous leaf.

ARALIA PALMATA Newb. *Pl. 44.*

Aralia palmata Newb. Fl. Amboy Clays, 117. *pl. 39. f. 6, 7; pl. 40. f. 3.* 1896.

It is easier perhaps to criticise others than to escape criticism oneself, at the same time in considering the leaves which seem referable to *Aralia* in our collections from near Cliffwood and in comparing them with the Raritan forms referred

* Cret. & Tert. Fl. 105.

to this genus by Newberry, we are struck with the range of variability, not only within each species as defined by him, but in the whole group, and the thought forces itself upon us that perhaps it would be an advantage to cut down the total number of species. Newberry has described seven species from the Woodbridge horizon alone and only one from the higher beds at South Amboy. The occurrence of a variety of *Aralia*-like leaves in the Matawan shows that the imperfection of the record is probably responsible for their absence in the intervening beds: and it seems rather incredible that each form represents an ancient species that flourished on the New Jersey coast in Cretaceous days.

The leaves before us, while not uniform, seem to more nearly represent *Aralia palmata* than any other known form. Our *f. 5* may be compared with Newberry's *f. 6*. While it is about one sixth smaller, other fragments from Cliffwood indicate a somewhat larger size; the lobes are a trifle more slender and the main sinuses somewhat deeper. The lower margins were sometimes undulate and the latero-basal lobes short. The lobation was, however, somewhat variable, as it was also in Newberry's leaves. Our *f. 6* might be compared with a variety of forms, such as *Ficus* (?) *Alaskana* Newb. (Later Ext. Fl. *pl. 51. f. 1*) and *Hedera obliqua* Newb. or *Hedera primordialis* Newb. of the Amboy Clays. It has the secondaries straighter than is usually the case in this genus; in its tertiary venation it agrees with Newberry's *f. 3* of *Aralia palmata*. The secondaries were distant and were joined at their tip by widely arching loops.

Other species with which our leaves may be compared are *Cissites ingens* Lesq. and *Liquidambar integrifolium* Lesq. (Cret. and Tert. Fl. *pl. 14. f. 3*).

ARALIA GROENLANDICA Heer. *Pl. 45. f. 4.*

Aralia Groenlandica Heer, Fl. Foss. Arct. 6²: 84. *pl. 38. f. 3; pl. 39. f. 1; pl. 46. f. 16, 17.* 1882 (*f. 17* is *Aralia Ravniana*); *pl. 39. f. 3* of *Sassafras recurvatum* Lesq. is in all probability this species. Lesq. Fl. Dak.

Group, 134. *pl. 54. f. 1–3.* 1892. Hollick, Bull. Geol. Soc. Am. 7: 13. 1895. Newb. Fl. Amboy Clays, 116. *pl. 28. f. 4.* 1896.

A widespread species recorded from the Atane schists, Greenland; Dakota Group, Kansas; Raritan, Woodbridge, N. J.; and the Cretaceous at Martha's Vineyard.

If Newberry has correctly identified Fl. Amboy Clays, *pl. 28, f. 4*, as the above species then our fragment undoubtedly belongs to the same species. It is the same size as Newberry's leaf; the angle of divergence of the lateral primaries is a trifle greater however, and the primary venation is stronger, agreeing with Lesquereux's and Heer's leaves in the latter particular. Both the New Jersey leaves are smaller than the Dakota and Greenland specimens and have relatively narrower lobes. Unfortunately the basal portion of the Cliffwood leaf is gone, so we do not know whether or not there was an extra pair of laterals springing from the base of the midrib. This is a feature of all the leaves which Lesquereux has referred to this species, but is wanting in Heer's *pl. 38, f. 3*, and is also wanting on one side in the Raritan leaf.

The leaf which Newberry describes as a new species (*l. c.* 117. *pl. 28. f. 3*), under the name of *Aralia patens*, should in all probability be considered as a form of his *A. Groenlandica* with deeper sinuses and more divergent lobes, as he suggests. Our leaf might also be compared with Cret. & Tert. Flora, *pl. 5. f. 1*, which Lesquereux considers *Sassafras acutilobum;* it is also much the same form of leaf as *Sterculia aperta* Lesq., but larger; and there is considerable resemblance to the leaf which Heer refers to *Sassafras Ferretiana* Mass. (Fl. Foss. Arct. 7: *pl. 97. f. 5*).

Aralia Mattewanensis sp. nov. *Pl. 43. f. 2; pl. 46. f. 6.*

A palmately four- or five-lobed leaf; lobes oblanceolate in outline (tips missing), with rather narrow sinuses nearly to the base; primaries rather stout; a majority of the secondaries branch at a wide angle and are nearly straight to within a short distance of the margin, along which they arch. Leaf coriaceous, if we may so judge from the obsolete venation.

These leaves have a distant resemblance to Lesquereux's *Cissites formosus* Heer (Fl. Dak. Group, *pl. 21. f. 5*) but bear no resemblance to the Amboy Clay leaves which Newberry refers to that species. Our leaves also suggest some forms of *Aralia* such as *A. quinquepartita* Lesq., but the base is apparently not decurrent and the primaries branch from the midrib at the same place, the lateral ones at nearly right angles.

Aralia Brittoniana sp. nov. *Pl. 45. f. 3.*

I have been unable to identify this with any known species of *Aralia* and therefore add another to the long list of diversified leaves of this genus which have been found in the Raritan and Matawan formation. In size and outline it resembles *Aralia acerifolia* Lesq. of the Fort Union beds of the West, but the secondaries are stronger and more regular. The specimen denotes a leaf which was trilobed with an evident tendency to produce an extra latero-basal lobe on each side: with a broadly truncated base which curves upward for about half the distance to the tip to form a point above which the margin is concave; lobes presumably acute; terminal lobe broad with moderately convex sides; sinus to below the middle, rounded; primary and secondary venation strong, but tertiary venation entirely obsolete; lateral primary could not have branched far from the base and forms an angle of about 45° with the midrib, leaving room for a secondary below; secondaries regular, leaving the primaries at a wide angle and running straight to within a short distance of the margin and then curving to join the secondary next above. Our only specimen was evidently not bilaterally symmetrical.

ERICACEAE.

Andromeda Linn. Sp. Pl. 393. 1753.

At the present time a monotypic genus of the north temperate and subarctic zone. Many fossil leaves have been referred here, some twenty-five species in this country alone.

The generic determination of Ericaceous leaves is always however a matter of extreme uncertainty, which is fully shared by the following distributed American forms: Raritan 6, Island Raritan 1, Dakota 9, Woodbine 1, Montana 1, Laramie 2, Livingston 1, Denver 1, Green River 2, Eocene 2, Miocene 1, Pleistocene 2, Atane 2, Greenland Tertiary 5.

ANDROMEDA PARLATORII Heer. *Pl. 50. f. 1–4.*

Andromeda Parlatorii Heer, Phyll. Crét. Nebr. 18. *pl. 1. f. 5.* 1866. Lesq. Cret. Flora, 88. *pl. 23. f. 6, 7; pl. 28. f. 15.* 1874; Fl. Dak. Group, 115. *pl. 19. f. 1; pl. 52. f. 6.* 1893. Newb. Fl. Amboy Clays, 120. *pl. 31. f. 1–7; pl. 33. f. 1, 2, 4, 5.* 1896. Heer, Fl. Foss. Arct. **3**: 112. *pl. 32. f. 1, 2.* 1875; **6**[2]: 79. *pl. 21. f. 1b, 11; pl. 42. f. 4c.* 1882. Hollick, Bull. Torrey Club, **21**: 54. *pl. 175. f. 2, 5.* 1894; Ann. N. Y. Acad. Sci. **11**: 420. *pl. 37. f. 7.* 1898. White, Am. Jour. Sci. III. **39**: 97. *pl. 2. f. 4.* 1890.

Prunus ? Parlatorii Lesq. Am. Jour. Sci. II. **46**: 102. 1868.

This species is recorded from the following localities: Dakota Group: Kansas, Nebraska, and New Ulm, Minn. Cretaceous: Sea Cliff, L. I., Tottenville, Staten Island and Martha's Vineyard. Raritan: common at nearly every locality opened. Greenland: Atane beds at Atanekerdluk, Isunguak and Igdlokunguak.

Newberry (*l. c.*) is inclined to doubt the reference of all these leaves to *Andromeda*, pointing out that generic determinations of most Ericaceous leaves are always doubtful. Heer compares his Greenland specimens to Ettingshausen's *Laurus cretacea* from Niederschöna. In our *f. 4* the finer reticulation is very minute and five- or six-sided.

MYRSINACEAE.

MYRSINE Linn. Sp. Pl. 196. 1753.

Fossil American species occur in the following formations: Raritan 3, Island Raritan 3, Dakota 2, Green River 1, Atane 1, Greenland Tertiary 2.

The family is a large one of the tropics of both hemispheres. In the recent monographic revision by Carl Mez (Engler, Pflanzenreich, Heft 9, 1902) nine hundred and thirty-three species are enumerated distributed among thirty-two genera and nine fossil genera are enumerated. Four species, all arborescent, enter the United States, one of them a true *Myrsine*, the others referred to the genera *Icacorea* (*Ardisia*) and *Jacquinia*. They range from southern Florida through the West Indies, Central America, Mexico and northern South America.

MYRSINE CRASSA Lesq. *Pl. 52. f. 6.*

Myrsine crassa Lesq. Fl. Dak. Group, 114. *pl. 52. f. 2, 3.* 1892.

The single leaf which I have referred to this Dakota species was lost after the hurried sketch which is here reproduced was made and the reference can therefore be only provisional unless additional specimens are discovered.

The outline and venation suggest this species although it is a somewhat smaller leaf. I was at first inclined to refer it to *Liriodendropsis*, which it greatly resembles, but in the absence of the apex our reference of it to this species of *Myrsine* is warranted.

OF UNCERTAIN AFFINITIES.

DEWALQUEA GROENLANDICA Heer (?). *Pl. 57. f. 3.*

Dewalquea Groenlandica Heer, Fl. Foss. Arct. 6^2: 87. *pl. 29. f. 18, 19; pl. 42. f. 5, 6; pl. 44. f. 11;* **7**: 37. *pl. 62. f. 5, 6.* Newb. Fl. Amboy Clays, 129. *pl. 41. f. 2, 3, 12.* 1896. Hollick, Ann. N. Y. Acad. Sci. **11**: 423. *pl. 36. f. 7.* 1898.

Obscure leaf-remains of uncertain botanical affinities; included by Heer in the Ranunculaceae. Leaves (or leaflets) with very tapering base, thick midribs, and short petioles; apparently rather coriaceous in texture and with the venation entirely obliterated. They agree fairly well with the figures of this species as cited above. This is another species which

occurs in the New Jersey Raritan (localities not given); on Staten Island; and in the Atane and Patoot beds of Greenland. The genus was founded by Saporta & Marion* and embraces several European species of which *Dewalquea insignis* reappears in both the Atane and Patoot beds of Greenland, and on Staten Island; while *D. Haldemiana* reappears in the Patoot beds, in Utah, and on Staten Island. The Dakota group furnishes two additional species.

PODOZAMITES MARGINATUS Heer. *Pl. 46. f. 1–3.*

Podozamites marginatüs Heer, Fl. Foss. Arct. 6²: 43. *pl. 16. f. 10.*

Similar remains are common in the Raritan (three species). Hollick (Bull. Torrey Club, **21**: 62. *pl. 180. f. 4*) records a fragment from Glen Cove, Long Island, and also from Chappaquidick Island, Mass. (Bull. N. Y. Bot. Gard. **2**: 401. *pl. 41. f. 8, 9.* 1902).

The genus was founded by Fr. Braun, in Münster, Beitr. Petrefacten-Kunde (Heft. 6. 28. 1843) and is chiefly Upper Triassic (Rhetic) and Jurassic, becoming decadent in the Cretaceous. The latter has yielded, however, seventeen species on this continent (including Greenland), nine of which existed as late as the mid-Cretaceous, all described from rather fragmentary and somewhat doubtful leaf-remains.

Our specimens would appear to be fragments of *Podozamites marginatus?* Heer, which occurs at Woodbridge in the Raritan clays (Fl. Amboy Clays, 44. *pl. 13. f. 5. 6*); originally described by Heer from Atane, Greenland.

Phragmites (?) **Cliffwoodensis** sp. nov. *Pl. 46. f. 5.*

A terminal, sharply pointed fragment of a monocotyledonous leaf, 12 cm. long and 5.5 mm. broad, finely parallel-veined.

The remains of *Phragmites* usually consists of leaf fragments or rhizomes, all of rather doubtful affinity, although a single palet of *P. Oeningensis* A. Br. is described by Heer from Greenland.

* Mem. Cour. & Sav. Étrangers Acad. Belg. 37: 55. 1873.

The Matawan remains are too small to be definitely referred to *Phragmites*, and may be compared to those referred to *Poacites*, *Cyperites*, etc.

CHONDRITES FLEXUOSUS Newb. (?)

Chondrites flexuosus Newb. Fl. Amboy Clays, 34. *pl. 1. f. 1, 4.* 1896.

Obscure remains from near Clifford (not figured), of doubtful botanical affinities, may be compared with the above species which occurs at Sayreville, Woodbridge, etc., in the Raritan clays.

Carpolithus juglandiformis sp. nov. *Pl. 46. f. 8.*

Has a superficial resemblance, but no botanical affinity with some of the fruits referred to the genus *Cycadeospermum*. Is evidently not a seed-bearing scale but seems to have been a small nutlet which has been compressed and transformed into lignite; bears considerable resemblance to *Juglans costata* (Presl) Brongn. as figured by Lesquereux (Cret. & Tert. Fl. *pl. 39. f. 5*) from the Green River group at Florissant, Colorado.

Carpolithus Cliffwoodensis sp. nov. *Pl. 48. f. 6.*

This specimen resembles a number of seeds figured by Heer from the Arctic regions, as for instance *Lamprocarpites nitidus* (Fl. Foss. Arct. 6[2]: *pl. 8. f. 12–14*) and *Carpolithes najadium* (*ibid.* 1: *pl. 27. f. 15, 15b*), although with the exception of *f. 14* our specimens are about twice the size of any of those of Heer.

Carpolithus dubius sp. nov. *Pl. 48. f. 7.*

This appears to be a thick, inequilateral, oblong scale. It is about 2 mm. in thickness and the surface is irregularly roughly lined. Botanical affinity vague.

CARPOLITHUS VIRGINIENSIS Font. (?) *Pl. 48. f. 5.*

Carpolithus Virginiensis Font. Potomac Flora, 266. *pl. 134. f. 11–14; pl. 135. f. 1, 5; pl. 168. f. 7, 7a.*

1889. Ward, Ann. Rep. U. S. Geol. Surv. 19^2: 693. *pl. 169. f. 16.* 1899.

Without a comparison of specimens this reference is only provisional, although from the published figures our specimen is almost exactly like the detached specimens from the Potomac formation described as above. Fontaine considers them as probably belonging to some species of *Baieropsis*, a Lower Cretaceous genus which does not occur in New Jersey; nor is it at all likely to have persisted as late as the Middle Cretaceous. Remains are abundant in the Potomac formation attached to stems; also found detached in the Lower Cretaceous of the Black Hills; and in the Kootanie at Great Falls, Montana. Remains indicate a small, smooth, and hard nutlet.

CARPOLITHUS DRUPAEFORMIS Hollick.

Carpolithus drupaeformis Hollick, Trans. N. Y. Acad. Sci. **16**: 134. *pl. 11. f. 4, 4a.* 1897.

Apparently the seed of some drupaceous fruit as the name indicates. Recorded by Hollick from the Matawan formation near Cliffwood, N. J.; not found by me.

STROBILITES INQUIRENDUS Hollick.

Strobilites inquirendus Hollick, Trans. N. Y. Acad. Sci. **16**: 130. *pl. 11. f. 1.* 1897.

Remains of doubtful affinity, possibly a distorted and somewhat macerated cone. Recorded by Hollick from the Matawan formation near Cliffwood, N. J.; not found by me.

PITYOXYLON HOLLICKI Knowlton.

Pityoxylon Hollicki Knowlton; Hollick, Trans. N. Y. Acad. Sci. **16**: 134. *f. 1, 2.* 1897.

Recorded by Hollick from the Matawan formation near Cliffwood, N. J.; not found by me.

Description of Plates.

PLATE 43.

Fig. 1. *Nelumbo primaeva* sp. nov.
Fig. 2. *Aralia Mattewanensis* sp. nov.
Fig. 3. *Sterculia mucronata* Lesq.
Fig. 4. *Moriconia cyclotoxon* Deb. & Ett.
Fig. 5. *Sterculia Cliffwoodensis* sp. nov.
Fig. 6. *Celastrophyllum elegans* sp. nov.
Fig. 7. *Sterculia Snowii bilobata* var. nov.

PLATE 44.

Aralia palmata Newb.

PLATE 45.

Figs. 1, 2. *Sassafras acutilobum* Lesq.
Fig. 3. *Aralia Brittoniana* sp. nov.
Fig. 4. *Aralia Groenlandica* Heer.

PLATE 46.

Figs. 1–3. *Podozamites marginatus* Heer.
Fig. 4. *Arisaema cretaceum* Lesq.
Fig. 5. *Phragmites* (?) *Cliffwoodensis* sp. nov.
Fig. 6. *Aralia Mattewanensis* sp. nov.
Fig. 7. *Aralia Ravniana* Heer.
Fig. 8. *Carpolithus juglandiformis* sp. nov.

PLATE 47.

Figs. 1, 5, 8. *Laurophyllum angustifolium* Newb.
Figs. 2, 3. *Sapindus Morrisoni* Lesq.
Fig. 4. *Magnolia obtusata* Heer.
Fig. 6. *Quercus* sp.
Fig. 7. *Ficus Woolsoni* Newb.
Fig. 9. *Laurus proteaefolia* Lesq.
Fig. 10. *Magnolia tenuifolia* Lesq.

PLATE 48.

Figs. 1–4. *Moriconia cyclotoxon* Deb. & Ett.
Fig. 5. *Carpolithus Virginiensis* Font. (?).
Fig. 6. *C. Cliffwoodensis* sp. nov.
Fig. 7. *C. dubius* sp. nov.
Figs. 8–11. *Dammara Cliffwoodensis* Hollick.
Fig. 12. *Salix proteaefolia flexuosa* (Newb.) Lesq.
Fig. 13. *Quercus Holmesii* Lesq.
Figs. 14, 19. *Cunninghamites squamosus* Heer.
Figs. 15, 16, 17, 20. *Sequoia Reichenbachi* (Gein.) Heer.
Fig. 18. *Sequoia Reichenbachi* (Gein.) Heer. (?).
Figs. 21–22. *Sequoia gracillima* (Lesq.) Newb.

PLATE 49.

Figs. 1–5. *Laurophyllum angustifolium* Newb.
Fig. 6. *Laurus proteaefolia* Lesq.
Fig. 7. *Populites tenuifolius* sp. nov.

PLATE 50.

Figs. 1–4. *Andromeda Parlatorii* Herr.
Figs. 5, 6. *Rhamnus Novae-Caesareae* sp. nov.
Figs. 7, 8. *Laurus Hollae* Heer.
Figs. 9–11. *Laurus Plutonia* Heer.

PLATE 51.

Figs. 1, 2. *Quercus Hollickii* sp. nov.
Fig. 3. Undetermined.
Fig. 4. *Quercus* (?) *Novae-Caesareae* Hollick.
Fig. 5. *Salix Mattewanensis* sp. nov.
Figs. 6–9. *Proteoides daphnogenioides* Heer.

PLATE 52.

Fig. 1. *Eucalyptus* (?) *dubia* sp. nov.
Fig. 2. *Salix proteaefolia flexuosa* (Newb.) Lesq
Fig. 3. Undetermined.
Fig. 4. *Laurus Hollickii* sp. nov.
Fig. 5. *Ficus reticulata* (Lesq.) Knowlton.
Fig. 6. *Myrsine crassa* Lesq.
Figs. 7, 8. *Laurus Hollae* Heer.
Fig. 9. *Quercus* sp.

PLATE 53.

Figs. 1, 4. *Ficus reticulata* (Lesq.) Knowlton.
Fig. 2. *Aralia Ravniana* Heer.
Fig. 3. *Eucalyptus Geinitzi* Heer.
Fig. 5. *Magnolia Woodbridgensis* Hollick.

PLATE 54.

Boulders of clay on beach near Cliffwood, N. J., yielding plant remains.

PLATE 55.

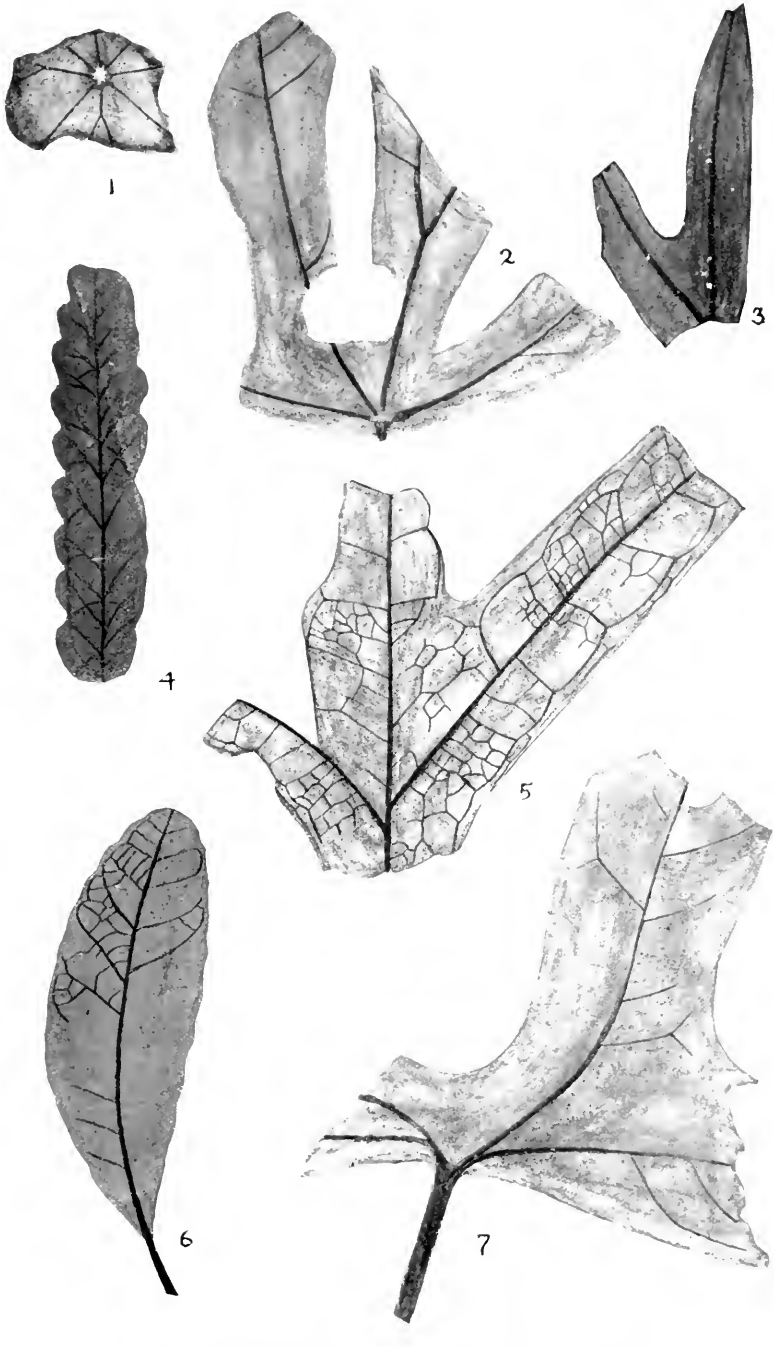
Showing how face of bluff near Cliffwood, N. J., is obscured by landslips.

PLATE 56.

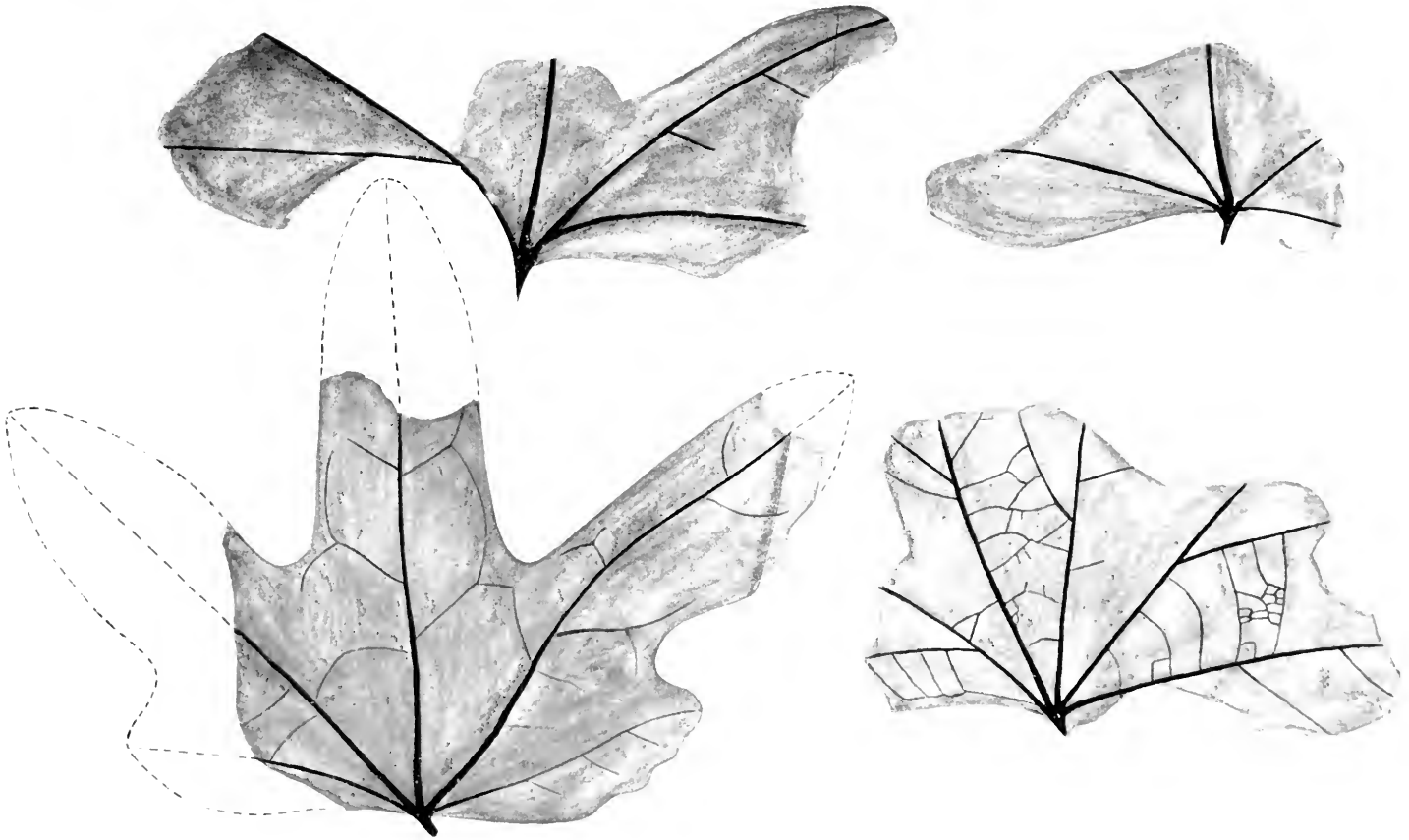
View of bluff near Cliffwood, N. J., showing alternating layers of sand and lignite.

PLATE 57.

Fig. 1. *Aralia Ravniana* Heer. Cliffwood specimen restored, ¼ natural size.
Fig. 2. *Magnolia Woodbridgensis* Hollick.
Fig. 3. *Dewalquea Groenlandica* Heer. (?)



NELUMBO, ARALIA, STERCULIA, MORICONIA, CELASTROPHYLLUM.



ARALIA PALMATA Newb.

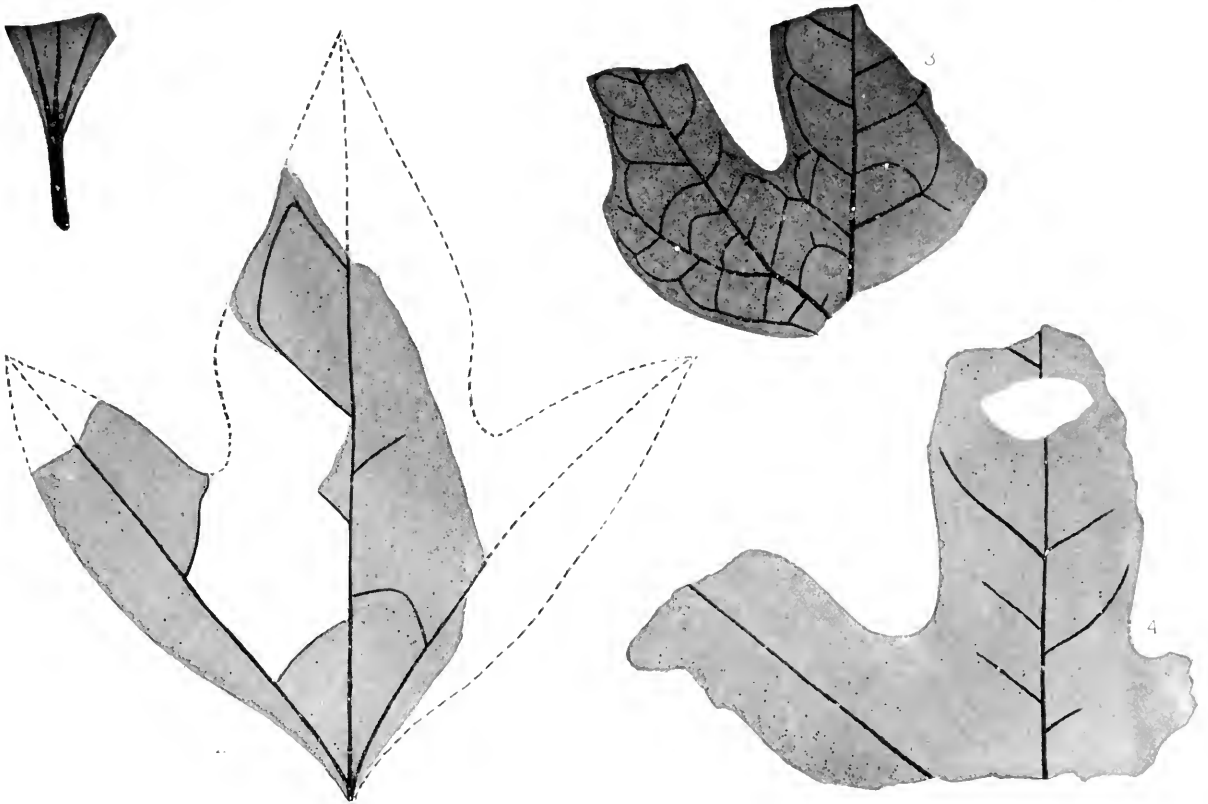
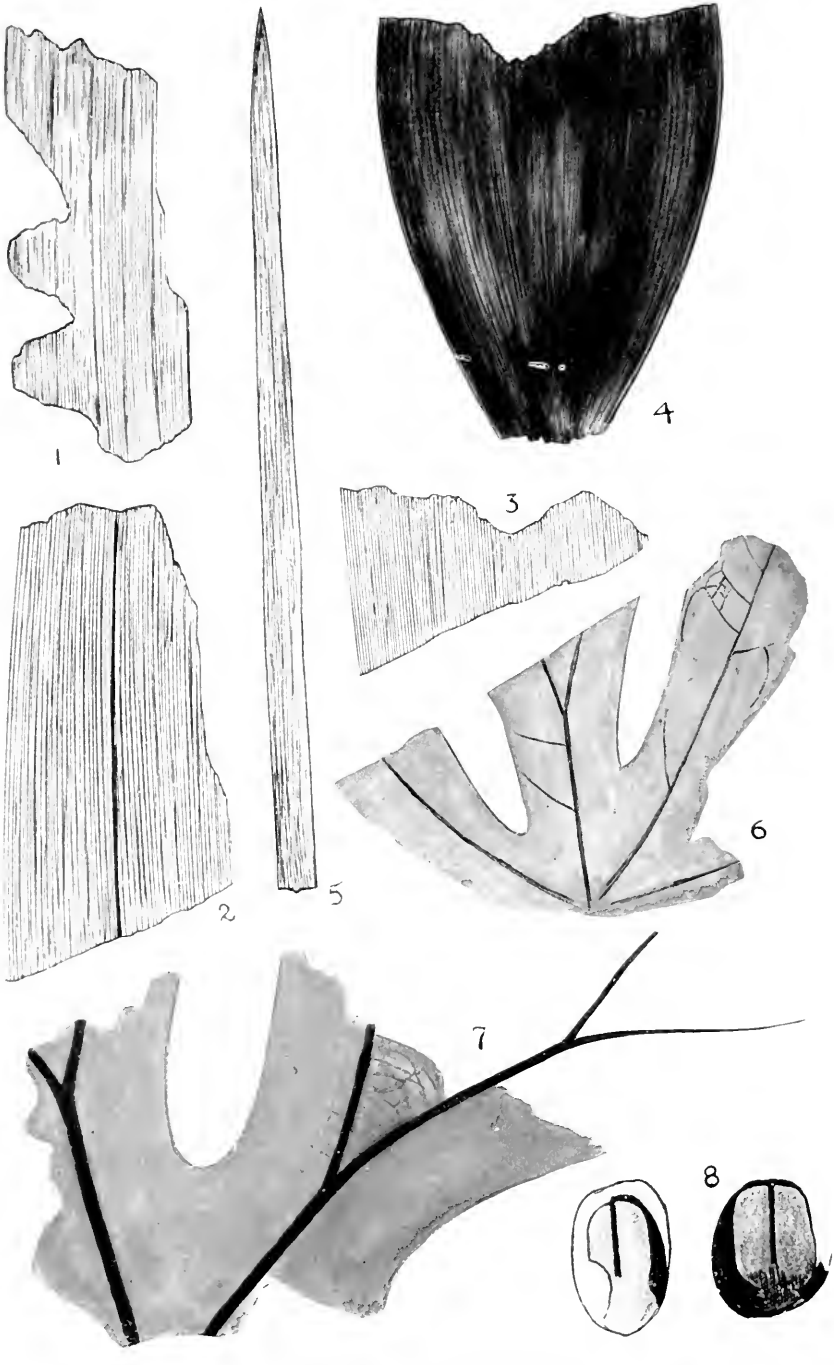
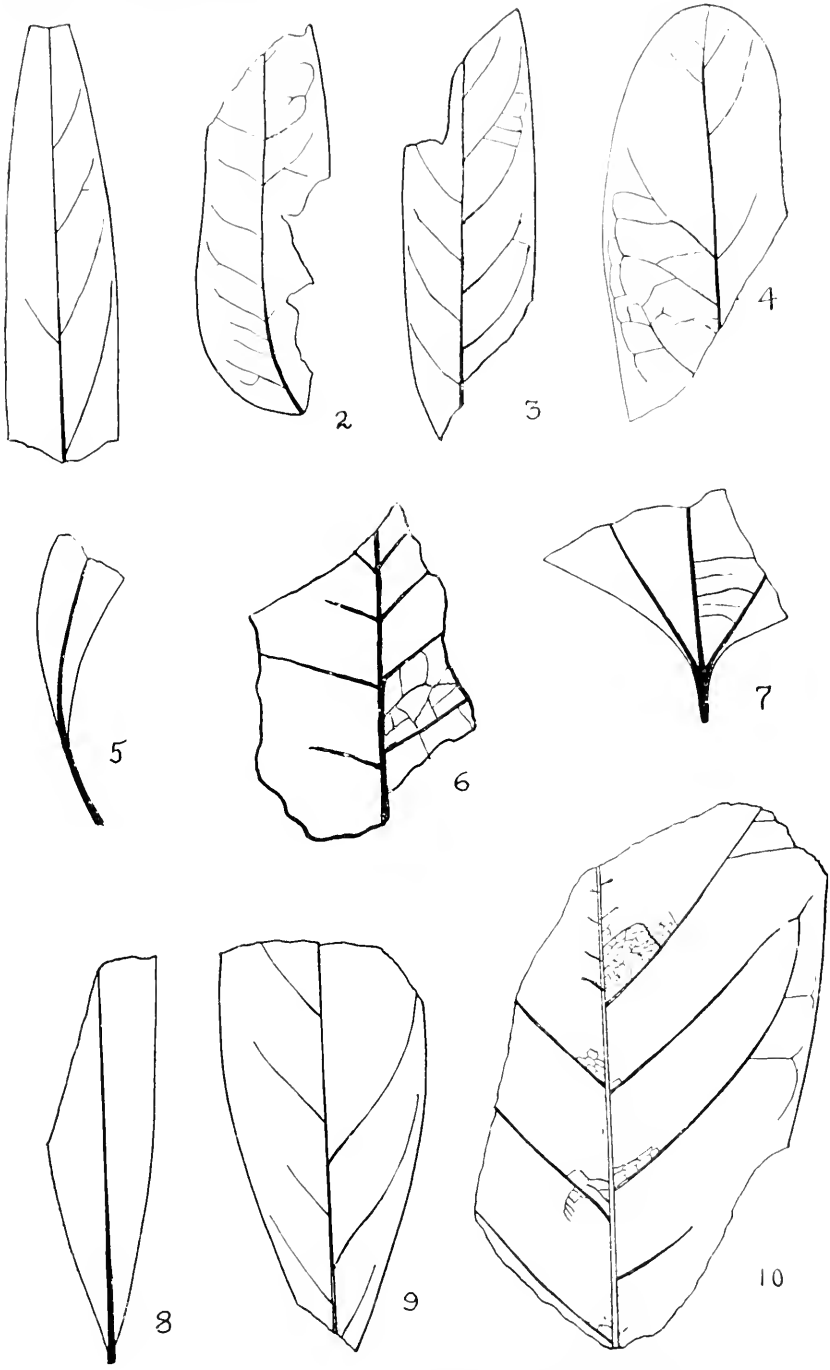


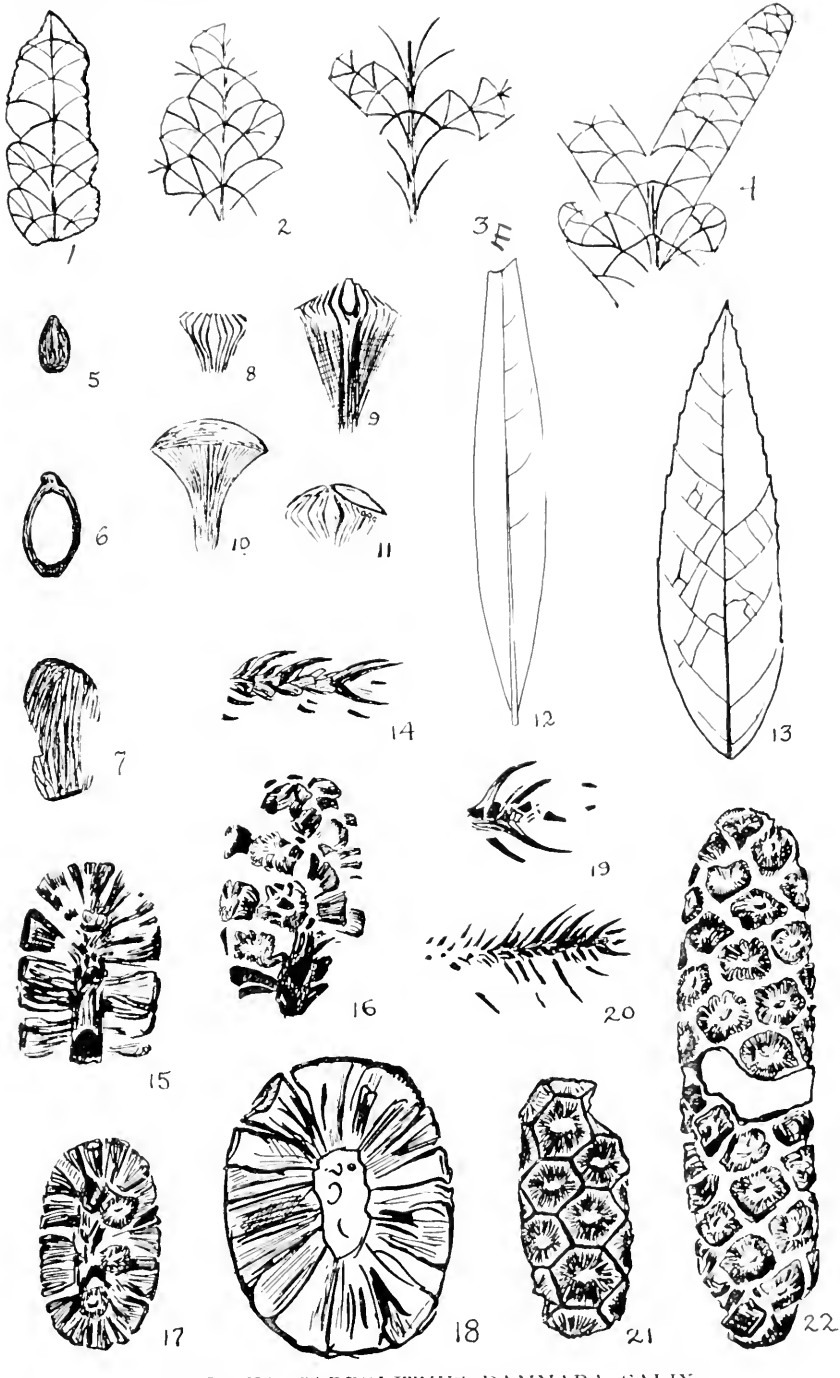
Fig. 1, 2. SASSAFRAS ACUTILOBUM Lesq. Fig. 3. ARALIA BRITTONIANA Berry.
Fig. 4. ARALIA GROENLANDICA Heer.



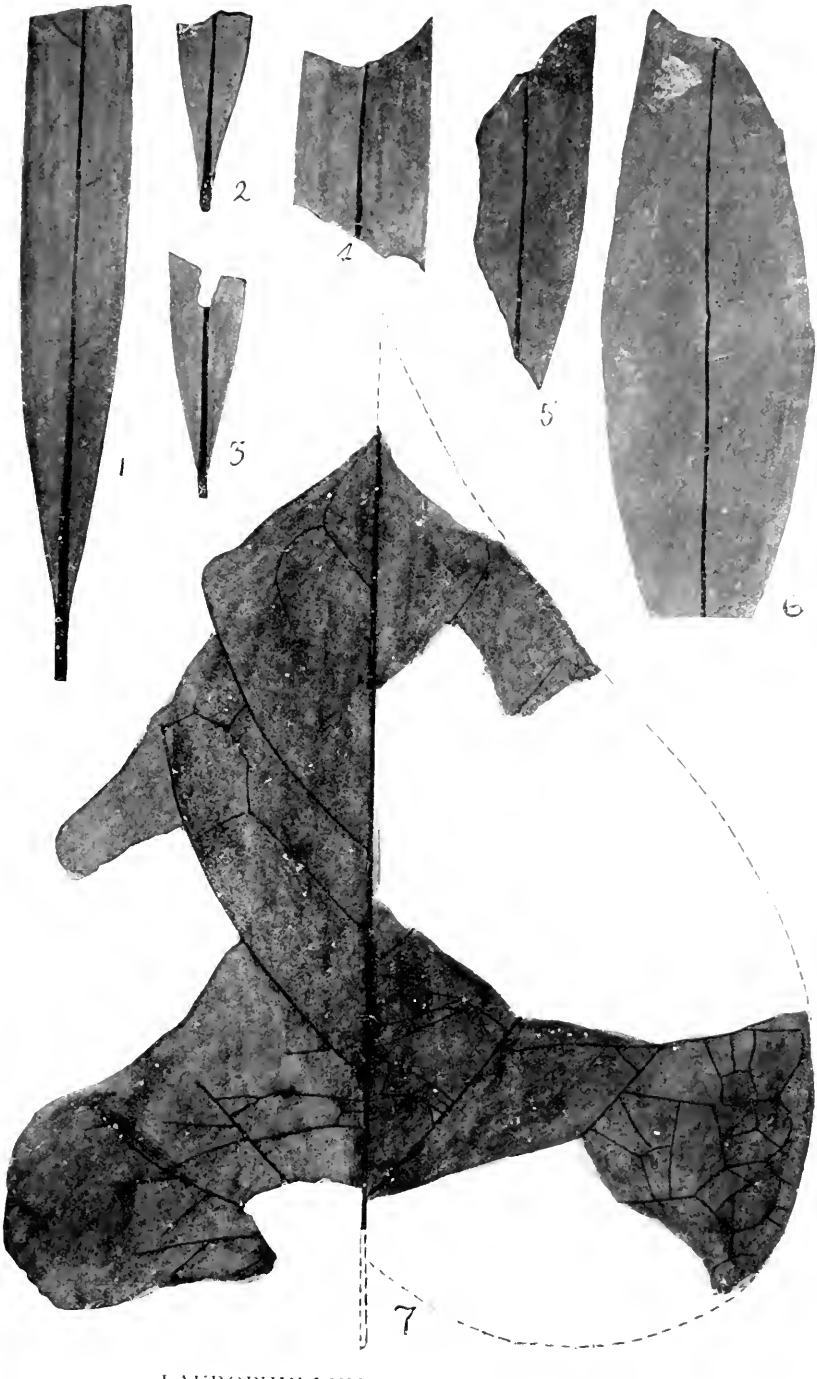
PODOZAMITES, ARISAEMA,
PHRAGMITES (?), ARALIA, CARPOLITHUS.



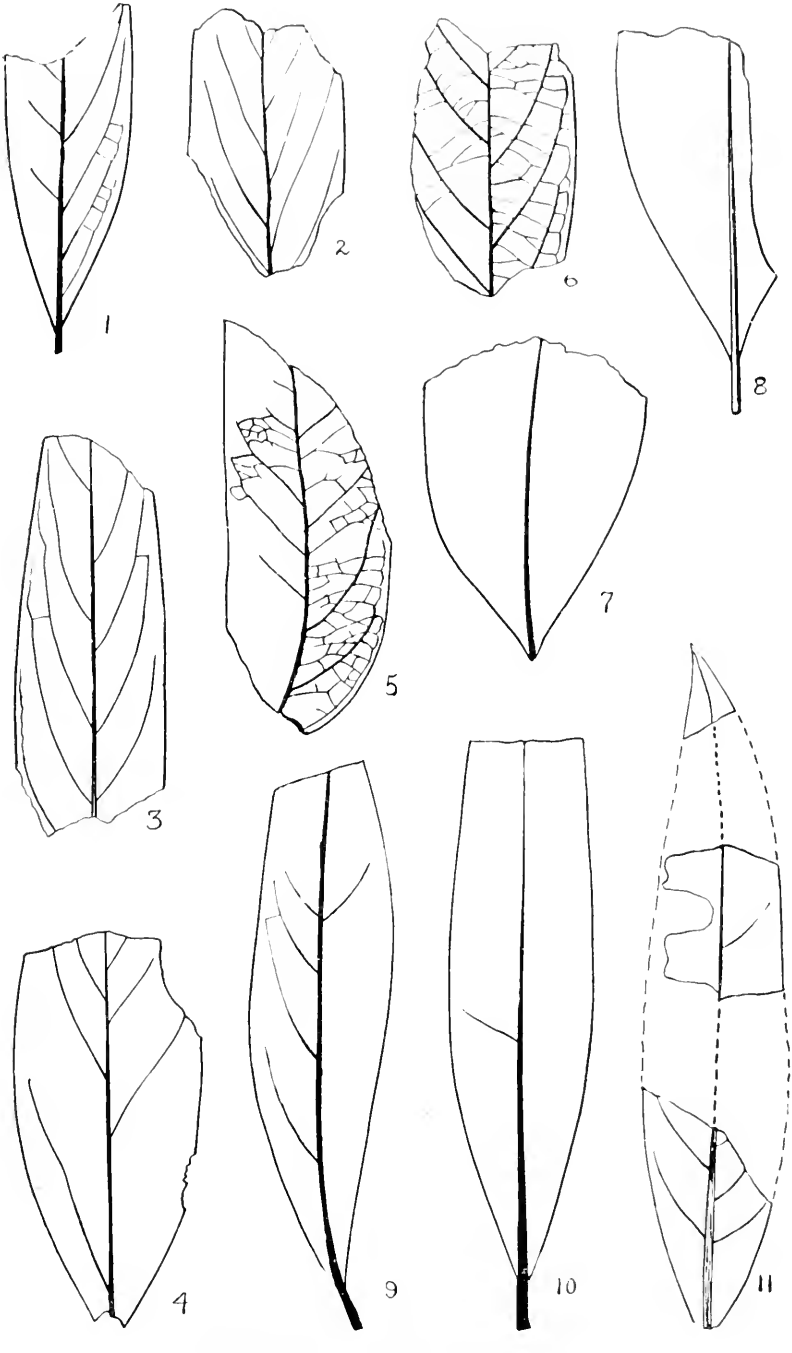
LAUROPHYLLUM, SAPINDUS, MAGNOLIA,
QUERCUS, FICUS, LAURUS.



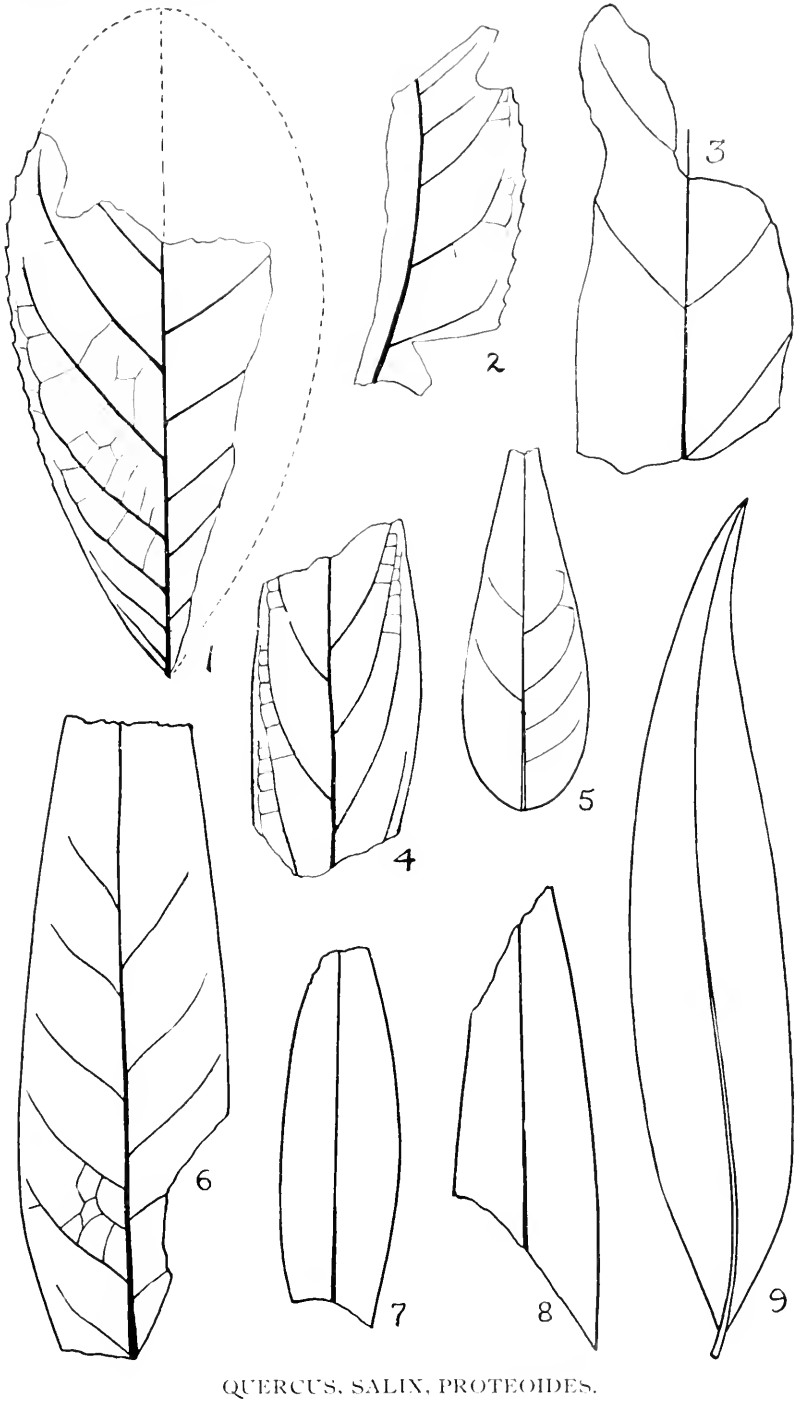
MORICONIA, CARPOLITHUS, DAMMARA, SALIX, QUERCUS, CUNNINGHAMITES, SEQUOIA.



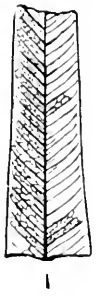
LAUROPHYLLUM, LAURUS, POPULITES

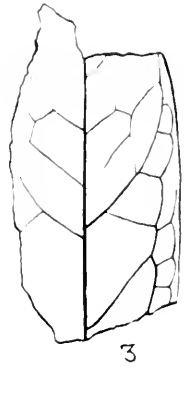


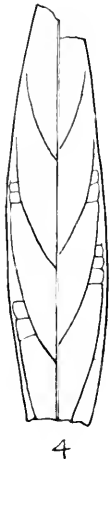
ANDROMEDA, RHAMNUS, LAURUS.

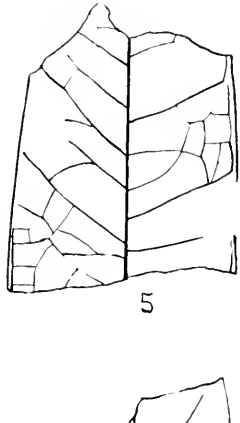


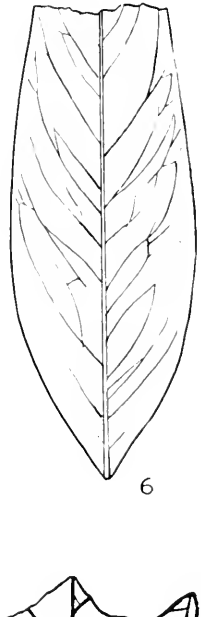
QUERCUS, SALIX, PROTEOIDES.

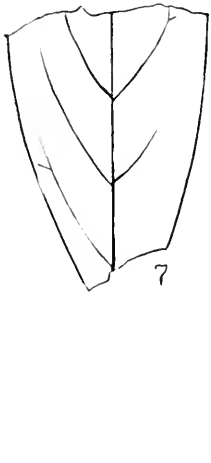


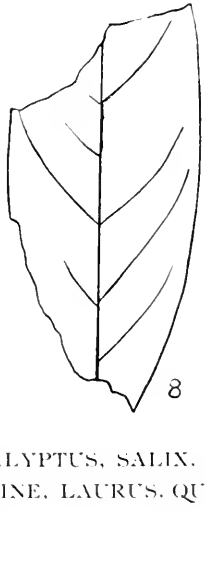


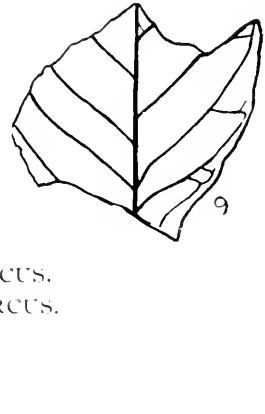




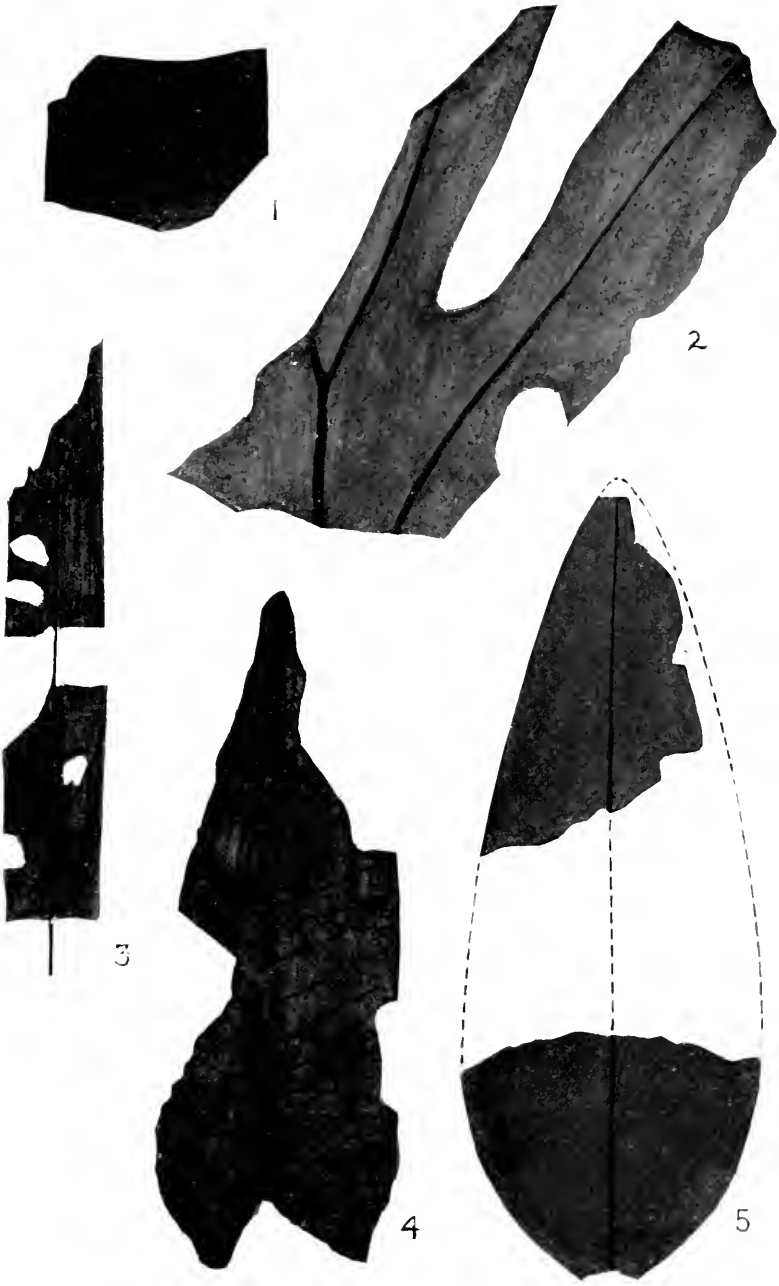




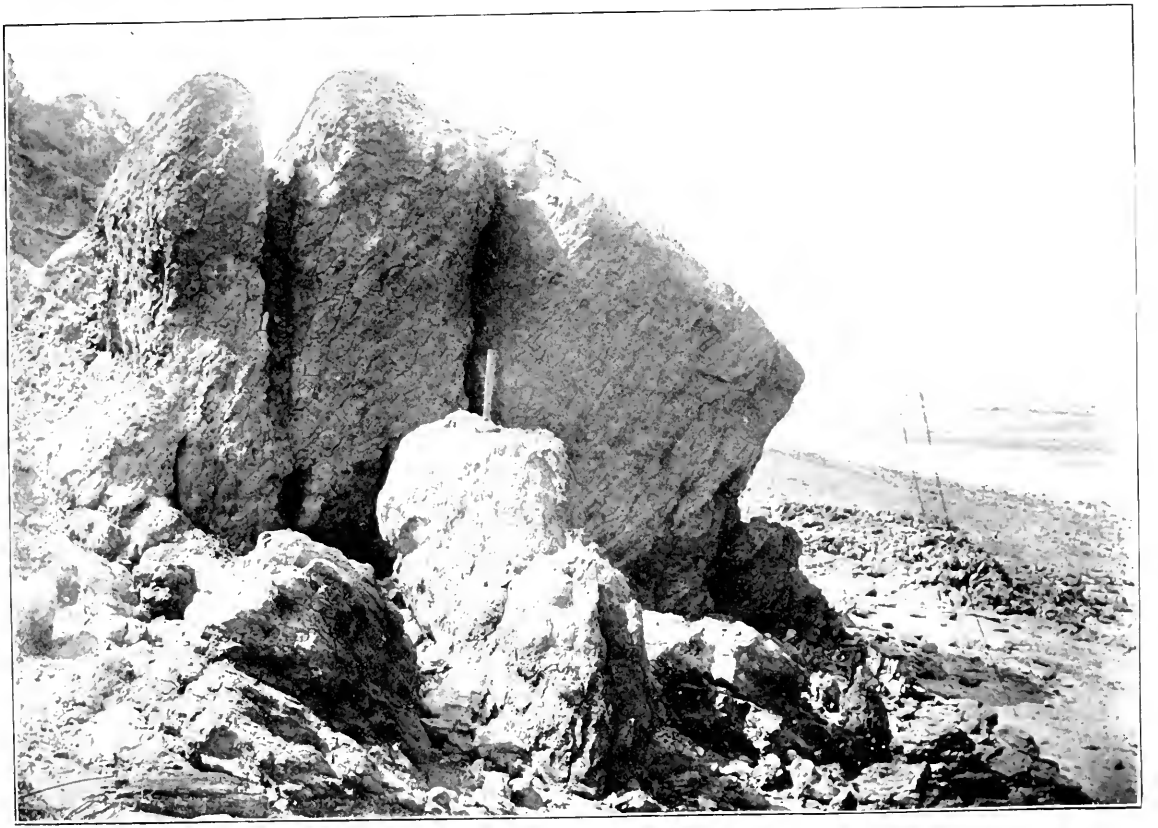




EUCALYPTUS, SALIX, FICUS,
MYRSINE, LAURUS, QUERCUS.

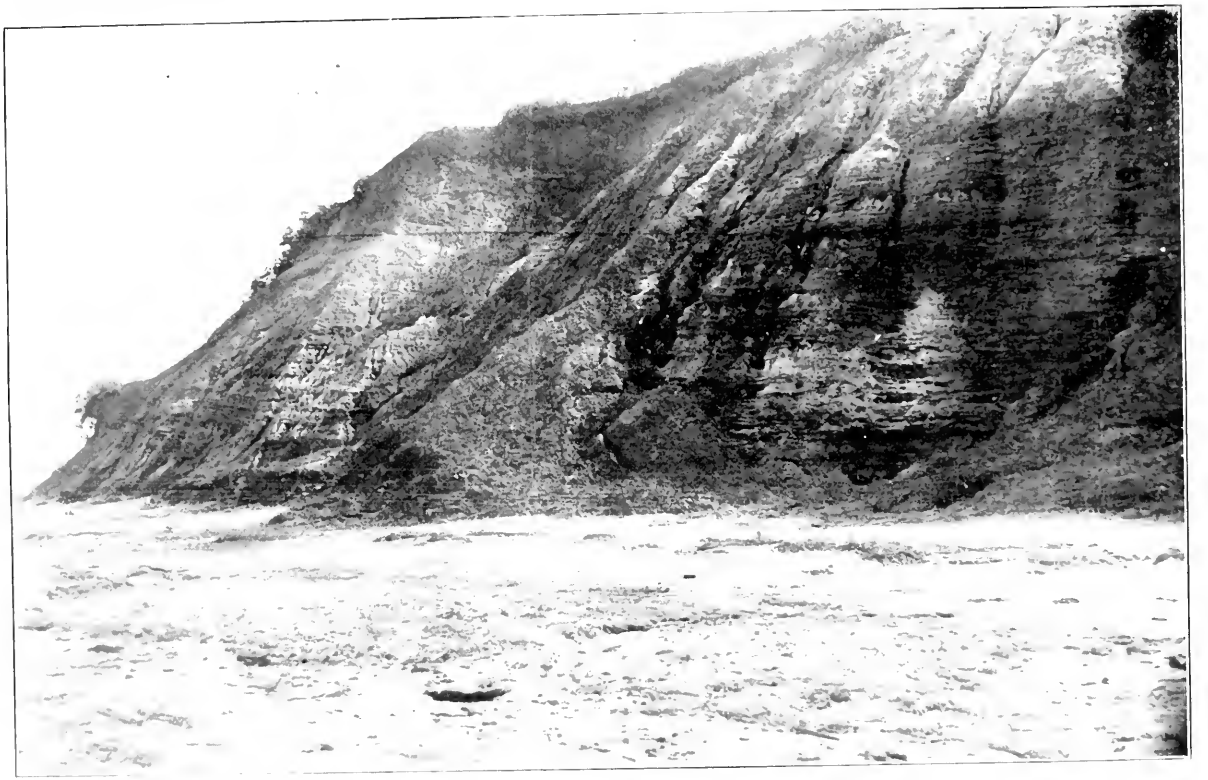


FICUS, ARALIA, EUCALYPTUS, MAGNOLIA.

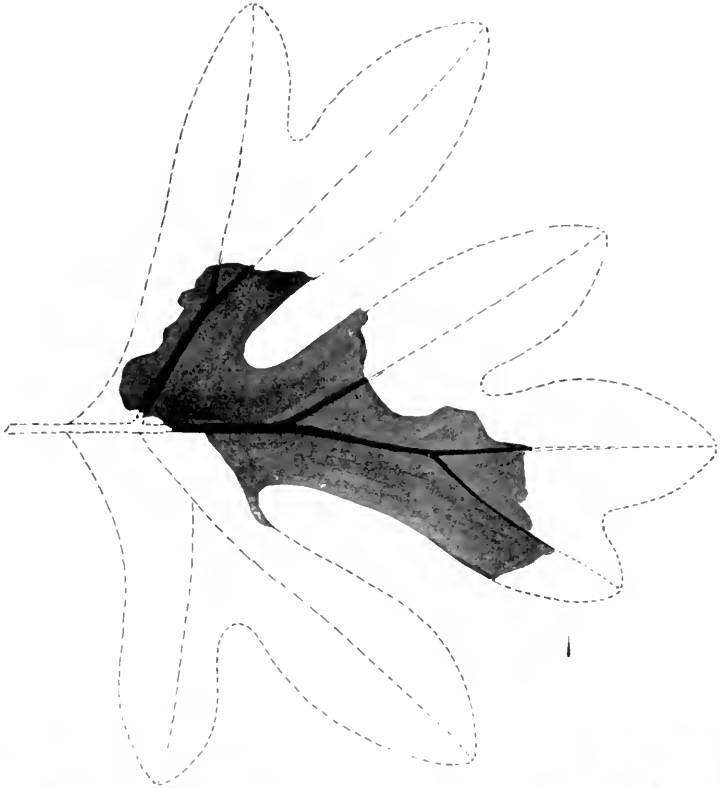


Boulders of clay, yielding plant remains, on beach near Cliffwood, N. J.

Bluff near Cliffwood, N. J., showing how its face is obscured by landslips



Bluff near Cliffwood, N. J., showing alternating layers of sand and lignite.



3.

ARALIA. MAGNOLIA, DEWALQUEA