LAKE DRUMMOND, DISMAL SWAMP.

REPORT ON A BOTANICAL SURVEY OF THE DISMAL SWAMP REGION.

INTRODUCTION.

During the summer of 1898 a botanical survey of the Great Dismal Swamp in southeastern Virginia, and of adjacent parts of Virginia and North Carolina, was carried on by this Division. From May to November a great part of the region as defined below was traversed and, as far as possible, carefully explored. The work was pursued in the extensive area bordered on the north by the mouth of Chesapeake Bay and on the south by the lower reaches of the Neuse River. But only that portion of it included in and immediately adjoining the Great Dismal Swamp, especially on the northeast, east, and southeast, could be surveyed with any considerable care in the time allotted.

During the prosecution of the survey headquarters were made in the city of Norfolk, and thence excursions were made into the surrounding territory. The Great Dismal Swamp was traversed in several directions, and that part which borders on Lake Drummond was somewhat thoroughly explored. The outer strand was carefully studied from Willoughby Spit, on the south shore of the Chesapeake, to a point about 8 miles below Virginia Beach, on the Atlantic, much time being given to Cape Henry and its vicinity. The "trucking" area in the neighborhood of Norfolk was frequently visited. In North Carolina the neighborhood of Elizabeth City, of Edenton, and especially of Newbern, was repeatedly traversed. A short time was spent upon Ocracoke Reef, a little south of Cape Hatteras, and the results there obtained were published in an earlier number of the Contributions from the United States National Herbarium.[1]

Two main objects were kept in view during the progress of the investigation, one of which was largely economic in its bearing, the other purely scientific. First, it was sought to ascertain in what degree the character of the native vegetation of the region, varying to a certain extent on different soils, may serve as an indication of the quality and value of the soil. Second, a study was made of the ecological distribution of the vegetation—in other words, of the various local assemblages in which the different species and forms are combined to

[1] The Plant Covering of Ocracoke Island. Contr. Nat. Herb., vol. 5, No. 5 (1900).

form the plant covering of the region as a whole. As the character of the assemblage which occupies each limited tract is, of course, largely determined by conditions of the physical environment there prevailing, it is easily seen how closely related are these two lines of investigation. On its purely scientific side, the first is, indeed, merely an aspect of the second.

The study of the native growth upon different soils presupposes some knowledge of the soils themselves. To supply this knowledge a special chapter upon the soils of the region has been contributed to the present report by Mr. Frank Gardner, through the kindness of Professor Whitney, of the Bureau of Soils. Mr. Gardner made a careful personal examination of the soils of the Dismal Swamp itself, and has also studied other soils in the neighboring territory. Two principal types of soil, the most valuable of the region, were especially considered in this part of the investigation—the light, sandy soils in the neighborhood of salt water, which are devoted to market gardening or "truck" growing, and the rich soils that have been reclaimed from the wooded swamps by felling the timber and by drainage, upon which the principal crops are corn and potatoes.

The principal agricultural products of the region are detailed and briefly described by way of preface to that section of the report which deals with the problem of the relation between soils and the native growth upon them. It was found that the solution of this problem presents considerable difficulty in the country investigated, owing to the lack of important chemical differences in the agricultural soils. Water content of the soil, depending largely upon the fineness of its particles and upon the drainage, was found to be the principal element in determining the character of the native growth. As this factor varies greatly within narrow limits, it soon became evident that it would be impossible to map the soils of the region by the forest growth upon them, as was originally intended. Yet it is believed that such positive results as were obtained will be useful in the further prosecution of this interesting and important but by no means simple line of investigation, and that even the negative results are not without value. Both contribute toward determining just how far a farmer may rely upon the quality of the native growth on his land as an indication of its value for this or that crop. It is hoped that the inquiry may be resumed in some region in which the natural conditions will admit of obtaining more definite results.

The purely scientific section of this report is largely devoted to a description of the several assemblages which make up the plant covering of the region as it actually occurs. To supplement the descriptions, which necessarily convey but a limited conception of the actual relations and appearance of the vegetation, numerous photographs are reproduced. A discussion of the character of the environment and the most striking modifications which apparently adapt plants

thereto follows the description of each formation. Not only the gross adaptations, such as can be detected in the field with the unaided eye, but also peculiarities of minute structure which are to be regarded as fitting the plant to its surroundings, are here considered.

A more detailed description of the leaf anatomy of a number of the abundant or otherwise interesting species is presented in a succeeding chapter. Here the species are arranged in their systematic order, for convenience of reference. The anatomical descriptions are very far from being complete. In most cases merely the leaf is considered, and only those of its characters are mentioned which are believed to be directly related to the environment. A discussion of the broad geographical relationships of the flora of the Dismal Swamp region and a list of all species collected or noted complete the purely scientific portion.

As an indispensable preface to both the economic and the scientific sections, the first three chapters are devoted to the climate of the region, its geography and physiography, and its geology. Statistics of climate were obligingly communicated by the Chief of the United States Weather Bureau. Many of the data contained in the second chapter, and practically the whole of the third, were taken from manuscript of the text to the Norfolk folio of the Geological Atlas of the United States, to which access was had by the courtesy of the author, Mr. N. H. Darton, of the United States Geological Survey.

A list of all literature consulted in the preparation of the report is appended.

Of the photographs here reproduced, a considerable number were taken by the author. Others were made by Mr. Frederick V. Coville. A number of Dismal Swamp views were obtained from Mr. John G. Wallace, of Wallaceton, Va. Finally, an excellent series of photographs belonging to the Geological Society of America, several of which had previously been reproduced in Prof. N. S. Shaler's "General Account of the Fresh-Water Morasses of the United States," were kindly placed at our disposal by the Director of the United States Geological Survey. Professor Shaler's paper, a valuable contribution to knowledge of the geology, physiography, and vegetation of the region, was freely consulted and is often quoted in this report.

The author wishes to express his great indebtedness to the specialists to whom the determination of various groups is credited in the List of Species Collected. Mr. Theodor Holm, of Brookland, D. C., rendered valuable assistance in the preparation of the anatomical notes. Dr. E. L. Greene courteously extended the facilities of his valuable library. To Mr. C. D. Beadle, of the Biltmore Herbarium, Biltmore, N. C., I am indebted for data as to the northern limit of many Austroriparian plants. For various courtesies and much useful information I wish to express my obligations to the following gentlemen: Mr. T. R. Ballantyne and the late Maj. Charles Pickett, of Nor-

folk; Messrs. H. H. Kirn and J. T. Griffin, of West Norfolk; Mr. T. J. Barlow, of Portsmouth; Mr. Cannon, of the Albemarle and Chesapeake Canal Company; Mr. Wallace, of Wallaceton, Va., and Messrs. Willet, E. S. Meadows, and Cromwell, of Newbern, N. C.

CLIMATE.

The following data concerning the climate of the Dismal Swamp region have been communicated by the United States Weather Bureau.[1] Statistics are given from two stations in the region—Norfolk and Cape Henry, Va. The climate at Norfolk closely tallies with that of the Dismal Swamp itself, while at Cape Henry we find the more extreme meteorological conditions to which the strand vegetation of the region is exposed. In addition, data from the stations at Hatteras and at Wilmington, N. C., are presented. These points are considerably south of the Dismal Swamp region, but they are near enough to make a comparison of their climates with that of the more northern stations interesting and instructive.

TEMPERATURE.

THERMOMETRICAL RECORD.

The normal number of days per annum with a temperature above 6° C. (43° F.) is, at Norfolk, 295; at Hatteras, 365. During this period the normal sum total of daily temperatures above 6° C. (43° F.) is, at Norfolk, 3,359.4° C. (6,047° F.); at Hatteras, 3,749.4° C. (6,749° F.).[2]

The normal mean temperature of the six consecutive hottest weeks of the year is, at Norfolk, 26.3° C. (79.3° F.); at Hatteras, 25.9° C. (78.6° F.).[3]

Normal temperature.[4]

Station.		Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual.
Norfolk	°C.	4.6	6.0	8.3	13.4	19.1	23.9	25.8	24.8	21.7	15.9	10.2	6.0	15.0
	°F.	40.4	42.8	46.9	56.2	66.4	75.1	78.5	76.6	71.1	60.6	50.3	42.8	59.0
Cape Henry	°C.	4.5	6.6	7.3	12.6	18.0	22.8	25.0	24.7	22.1	16.5	11.0	6.6	14.8
	°F.	40.2	43.9	45.2	54.6	64.5	73.1	77.0	76.4	71.8	61.8	51.9	43.9	58.7
Hatteras	°C.	7.6	8.1	10.0	14.0	19.1	23.3	25.5	25.2	23.2	18.0	13.1	9.0	16.3
	°F.	45.7	46.6	50.1	57.2	66.4	74.0	77.9	77.4	73.7	64.5	55.6	48.2	61.4
Wilmington	°C.	8.3	9.9	12.2	16.4	20.9	24.8	26.5	25.7	23.1	17.5	12.6	9.0	17.2
	°F.	46.9	49.8	53.9	61.5	69.7	76.7	79.7	78.2	73.6	63.5	54.6	48.3	63.0

[1] For an account of the methods of computation and reduction employed by the Weather Bureau see Report of the Chief for 1891–92, p. 37; also for 1896–97, pp. 126, 127, and 279.

[2] The sum total of effective temperatures, as here defined, is the factor upon which Dr. Merriam bases the boreal limit of the transcontinental life zones in North America. See Nat. Geographic Mag., vol. 6, pp. 229 to 238 (1894), and Yearbook U. S. Dept. Agr. for 1894, pp. 211 to 213 (1895).

[3] The mean temperature of the six consecutive hottest weeks is the factor regarded by Dr. Merriam (loc. cit.) as most effective in determining the austral limit of species.

[4] All readings in these tables were taken in the shade.

Normal daily range of temperature.

Station.		Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual.
Norfolk	°C.	8.3	9.0	9.3	9.5	9.7	9.8	9.6	8.0	7.6	8.2	8.3	8.5	8.8
	°F.	15.0	16.2	16.7	17.1	17.4	17.6	17.2	14.4	13.6	14.8	14.9	15.3	15.8
Cape Henry	°C.	8.2	9.0	8.6	9.3	8.6	8.3	7.9	7.4	6.9	7.7	8.0	8.2	8.2
	°F.	14.8	16.0	15.5	16.8	15.4	15.0	14.2	13.3	12.4	13.8	14.4	14.8	14.7
Hatteras	°C.	7.0	7.1	7.2	6.9	6.4	5.7	5.5	5.1	5.3	5.7	6.3	7.1	6.3
	°F.	12.7	12.8	12.9	12.5	11.5	10.3	10.0	9.2	9.6	10.2	11.3	12.8	11.3
Wilmington	°C.	9.8	10.2	10.3	10.0	9.6	9.2	8.7	8.4	8.8	9.9	10.4	10.2	9.6
	°F.	17.6	18.3	18.6	18.1	17.3	16.5	15.6	15.1	15.9	17.9	18.7	18.4	17.3

Absolute maxima.

Station.		Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual.
Norfolk	°C.	26.6	27.2	31.1	35.0	36.6	39.0	39.0	37.2	37.7	31.6	34.0	24.0	39.0
	°F.	80.0	81.0	88.0	95.0	98.0	102.0	102.0	99.0	100.0	89.0	93.0	75.0	102.0
Cape Henry	°C.	25.5	26.6	29.4	35.5	36.1	39.0	38.3	39.4	35.5	31.6	27.2	24.4	39.4
	°F.	78.0	80.0	85.0	96.0	97.0	102.0	101.0	103.0	96.0	89.0	81.0	76.0	103.0
Hatteras	°C.	26.1	22.8	29.4	30.0	34.0	39.0	37.2	36.1	35.0	32.2	26.1	22.8	39.0
	°F.	79.0	73.0	85.0	86.0	93.0	102.0	99.0	97.0	95.0	90.0	79.0	73.0	102.0
Wilmington	°C.	26.6	27.2	30.6	33.3	36.1	37.7	39.4	37.2	35.5	33.3	28.3	25.5	39.4
	°F.	80.0	81.0	87.0	92.0	97.0	100.0	103.0	99.0	96.0	92.0	83.0	78.0	103.0

Mean maxima.[1]

Station.		Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual.
Norfolk	°C.	20.3	22.0	24.6	29.6	32.8	35.4	36.4	34.5	32.7	27.9	24.2	21.3	28.4
	°F.	68.5	71.6	76.2	85.2	91.0	95.7	97.5	94.1	90.8	82 3	75.6	68.6	83.1
Cape Henry	°C.	20.1	22.6	24.2	28.4	32.3	34.9	36.0	34.8	32.7	28.0	25.0	21.7	28.3
	°F.	68.1	72.6	75.5	83.2	90.2	94.8	96.7	94.6	90.9	82.6	76.9	69.3	82.9
Hatteras	°C.	19.2	20.4	20.6	23.4	27.4	30.7	31.0	30.7	29.7	26.6	23.6	21.2	25.2
	°F.	66.6	66.8	69.0	74.1	81.4	87.2	87.9	87.3	85.5	80.0	74.5	68.4	77.4
Wilmington	°C.	21.9	23.1	23.6	29.7	32.5	34.7	35.7	34.2	33.0	28.9	25.7	22.5	29.0
	°F.	71.4	73.6	77.5	85.4	90.5	94.5	96.2	93.6	91.4	84.1	78.3	72.5	84.0

Absolute minima.

Station.		Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual.
Norfolk	°C.	−14.4	−16.6	−10.0	−4.4	3.3	9.4	13.9	13.3	4.4	−0.5	−6.6	−14.4	−16.6
	°F.	6.0	2.0	14.0	24.0	38.0	49.0	57.0	56.0	40.0	31.0	20.0	6.0	2.0
Cape Henry	°C.	−14.4	−15.0	−11.1	−2.2	5.0	8.8	13.3	10.6	9.4	1.7	−4.4	−13.9	−15.0
	°F.	6.0	5.0	12.0	28.0	41.0	48.0	56.0	51.0	49.0	35.0	24.0	7.0	5.0
Hatteras	°C.	−10.0	−11.7	−3.3	−0.5	6.1	12.8	16.1	16.6	10.0	5.5	−2.2	−13.3	−13.3
	°F.	14.0	11.0	26.0	31.0	43.0	55.0	61.0	62.0	50.0	42.0	28.0	8.0	8.0
Wilmington	°C.	−12.8	−12.2	−6.6	−2.2	3.3	10.6	15.5	13.3	5.5	0.0	−5	−12.2	−12.8
	°F.	9.0	10.0	20.0	28.0	38.0	51.0	60.0	56.0	42.0	32.0	23.0	10.0	9.0

Mean minima.[2]

Station.		Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual.
Norfolk	°C.	−7.9	−6.8	−3.7	1.8	7.7	13.8	17.1	17.1	12.1	5.2	−1.8	−6.8	4.0
	°F.	17.8	19.7	25.4	35.2	46.0	56.8	62.8	62.8	53.8	41.4	28.8	19.7	39.2
Cape Henry	°C.	−7.5	−6.4	−3.9	1.7	7.5	13.3	17.1	16.8	13.0	6.0	−1.1	−6.4	4.2
	°F.	18.4	20.5	25.0	35.0	45.5	56.0	62.8	62.3	55.4	42.9	29.9	20.5	39.5
Hatteras	°C.	−4.5	−3.3	−0.5	3.9	10.4	16.1	18.8	19.0	15.8	8.7	2.1	−3.2	6.9
	°F.	23.9	26.0	31.0	39.1	50.8	61.0	65.6	66.4	60.4	47.7	35.8	26.3	44.5
Wilmington	°C.	−6.2	−4.2	−1.7	3.3	8.7	14.6	18.1	16.9	12.0	4.8	−1.7	−5.5	4.9
	°F.	20.8	24.4	29.0	37.9	47.7	58.3	64.6	62.5	53.7	40.7	29.0	22.0	40.9

[1] Obtained for each month by dividing the sum of the absolute maxima during the period covered by observations by the number of years. The annual mean maximum for each station represents the mean of the monthly mean maxima. The years during which measurements of temperature have been taken at the several stations are: Norfolk, 1871 to 1898; Cape Henry, 1874 to 1898; Hatteras, 1881 to 1898; Wilmington, 1871 to 1898.

[2] Obtained in the same manner as the mean maxima.

LATEST AND EARLIEST FROSTS.

The dates of the latest killing frost in spring and the earliest in autumn are unquestionably an important factor in the life history of plants of the temperate zones, especially of cultivated plants. These two dates form the most easily recognizable, although not the precise limits of the growing period of most plants, or, to speak more exactly, of their period of greatest physiological activity.

The average dates of latest and earliest killing frosts at the four stations are:

Station.	Latest frost in spring.	Earliest frost in autumn.
Norfolk	Mar. 26	Nov. 14
Cape Henry	Mar. 19	Do.
Hatteras	Feb. 25	Dec. 13
Wilmington	Mar. 15	Nov. 12

The absolute dates of latest and earliest frosts during the period covered by observations are:

Station.	Latest frost in spring.	Earliest frost in autumn.
Norfolk	Apr. 26, 1888	Oct. 10, 1895
Cape Henry	Apr. 19, 1875	Nov. 11, 1894
Hatteras	Apr. 5, 1881	Nov. 14, 1880
Wilmington	Apr. 21, 1897	Oct. 13, 1888

The following table gives the actual dates of latest and of earliest killing frost of each year during the period of observation:

Year.	Norfolk.		Cape Henry.		Hatteras.		Wilmington.	
	Latest.	Earliest.	Latest.	Earliest.	Latest.	Earliest.	Latest.	Earliest.
1873	.....	Nov. 14	.....	.....	.....	.....	.....	Nov. 14
1874	Apr. 13	Nov. 30	Mar. 25	Nov. 30	.....	.....	Mar. 14	Dec. 1
1875	Apr. 19	Nov. 18	Apr. 19	do	.....	.....	Apr. 19	Nov. 12
1876	Mar. 23	Oct. 15	Mar. 22	Nov. 27	.....	.....	Mar. 4	Nov. 26
1877	Mar. 20	Nov. 30	Mar. 20	Nov. 30	.....	.....	Mar. 18	Nov. 12
1878	Mar. 21	Oct. 21	Mar. 25	Dec. 6	.....	.....	Feb. 19	Nov. 1
1879	Mar. 6	Nov. 3	Mar. 6	Nov. 20	.....	.....	Apr. 4	Nov. 3
1880	Apr. 12	Nov. 16	Mar. 25	Nov. 16	.....	.....	Feb. 16	Nov. 16
1881	Apr. 7	Nov. 17	Mar. 29	Nov. 25	Apr. 5	.....	Mar. 8	Nov. 24
1882	Feb. 26	Nov. 15	Feb. 5	Nov. 30	Jan. 4	Nov. 26	Jan. 23	Nov. 20
1883	Mar. 23	Nov. 30	Mar. 25	Dec. 15	Mar. 23	Dec. 16	Mar. 23	Nov. 13
1884	Mar. 5	Nov. 21	Mar. 5	Dec. 18	Mar. 5	Dec. 19	Mar. 4	Oct. 24
1885	Apr. 11	Dec. 3	Feb. 24	Dec. 3	Feb. 21	Dec. 27	Mar. 24	Nov. 25
1886	Mar. 4	Nov. 8	Mar. 18	Nov. 14	Feb. 8	Dec. 2	Mar. 3	Nov. 8
1887	Apr. 20	Nov. 6	.....	.....	Jan. 13	Dec. 29	Feb. 28	Dec. 2
1888	Apr. 26	Nov. 28	.....	.....	Mar. 7	Dec. 14	Mar. 10	Oct. 13
1889	Mar. 12	Nov. 7	.....	Nov. 29	Feb. 25	.....	Feb. 26	Nov. 29
1890	Mar. 17	Nov. 1	Mar. 17	do	Mar. 16	Nov. 14	Apr. 20	Nov. 1
1891	Mar. 18	Nov. 18	Mar. 16	Nov. 10	Mar. 15	Nov. 30	Mar. 15	Oct. 29
1892	Mar. 22	Nov. 6	Mar. 22	Nov. 23	Mar. 19	Nov. 24	Apr. 16	Oct. 21
1893	Mar. 30	Nov. 16	.....	Dec. 7	Jan. 26	Nov. 25	Mar. 20	Nov. 17
1894	Mar. 28	Nov. 6	.....	Nov. 11	Mar. 28	Dec. 28	Mar. 31	Nov. 7
1895	Mar. 21	Oct. 10	Mar. 30	Nov. 21	Feb. 25	Nov. 22	Mar. 22	Nov. 21
1896	Apr. 4	Nov. 14	Mar. 24	Nov. 14	Mar. 14	Dec. 6	Apr. 5	Dec. 1
1897	Apr. 21	Nov. 19	Feb. 3	Nov. 24	Feb. 28	Dec. 24	Apr. 21	Nov. 13
1898	Apr. 6	Nov. 21	Mar. 6	Nov. 30	Feb. 2	Nov. 27	Apr. 8	Nov. 21

From these data we may gather the following general conclusions: The climate of the Dismal Swamp region is characterized by a mild winter, with normal positive temperatures of 4° to 6° C., and by a long and hot, but usually not extremely hot, summer. The normal daily variation in temperature is comparatively small. Even the normal annual range is only between 8° and 9° C., and the departure of the normal variation in any month of the year from that of any other month does not exceed about 2° C. The normal number of days in the year which have a temperature above 6° C. (43° F.), which is generally regarded as the minimum temperature for vegetative activity in most plants of the Temperate Zone, is, at Norfolk, about five-sixths of the whole. The sum total of temperatures above 6° C. during that period is for the latitude a considerable one, enough to permit the occurrence in the region of a number of tropical and subtropical forms and to place it in the warm temperate belt.[1] Likewise important as regulating the northward extension into this region of numerous warm temperate and tropical forms is the distribution of killing frosts, from which about eight months of the year are normally free.

SUNSHINE AND CLOUDINESS.[2]

Normal percentages of possible sunshine.

Station.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual.
Norfolk	46	45	49	52	52	52	52	49	53	58	53	52	51
Cape Henry	42	51	50	50	56	55	53	49	56	58	51	47	52
Hatteras	46	47	52	55	59	55	55	52	56	58	54	53	54
Wilmington	47	46	52	56	54	50	48	47	52	60	55	52	52

Normal hours of sunshine.[3]

Station.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual.
Norfolk	188.1	136.5	181.5	205.3	228.3	228.9	252.6	205.8	197.5	201.8	162.0	155.7	2,324.0
Cape Henry	129.8	154.7	185.8	197.4	245.8	242.1	237.1	205.8	208.6	201.7	155.9	140.7	2,305.4
Hatteras	144.7	143.7	193.4	216.0	256.2	238.9	243.1	216.9	208.3	203.0	167.4	160.6	2,392.2
Wilmington	149.6	141.3	193.4	219.3	253.6	215.8	211.0	195.4	193.3	210.5	173.7	160.0	2,296.9

Normal cloudiness.[4]

Station.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual.
Norfolk	5.4	5.5	5.1	4.8	4.8	4.8	4.8	5.1	4.7	4.2	4.7	4.8	4.9
Cape Henry	5.8	4.9	5.0	5.0	4.4	4.5	4.7	5.1	4.4	4.2	4.9	5.3	4.8
Hatteras	5.4	5.3	4.8	4.5	4.1	4.5	4.5	4.8	4.4	4.2	4.6	4.7	4.6
Wilmington	5.3	5.4	4.8	4.4	4.6	5.0	5.2	5.3	4.8	4.0	4.5	4.8	4.8

[1] Schimper (Pflanzengeographie, p. 445) regards the line which divides the cold temperate from the warm temperate belt as approximately coinciding with the isotherm of +6° C. (43° F.) for the coldest month. In the Dismal Swamp region the normal temperature falls slightly below this point in January.

[2] "Data as to sunshine are derived from the statistics of normal cloudiness and must be considered merely as a first approximation to the actual values of normal sunshine for these stations. For comparative purposes they may be used without serious error."—Mr. A. J. Henry, Division Climate and Crops, U. S. Weather Bureau, in litt.

[3] Based upon the same data as the above table but expressed in hours.

[4] From the Report of the Weather Bureau for 1896-97, pp. 286 to 288. The data are "computed from monthly means based on tridaily observations, November, 1870, to June 30, 1888; thereafter, frequent personal observations. Scale 0 to 10."

It thus appears that the percentage of possible sunshine and number of hours of sunshine are high as compared with other parts of the Atlantic slope in North America, although generally considerably lower than those recorded for stations west of the Mississippi River.

ATMOSPHERIC HUMIDITY.

Normal humidity in percentages of saturation.

Station.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual.
Norfolk	76	72	68	68	71	71	72	76	77	75	73	74	73
Cape Henry	77	74	73	72	73	74	76	78	76	74	71	74	74
Hatteras	84	81	79	80	82	83	83	82	81	81	79	82	81
Wilmington	73	71	69	68	72	74	76	80	78	75	72	73	73

The quantity of atmospheric water normally present in the Dismal Swamp region is not notably greater nor smaller than that which prevails in other parts of the northern and middle Atlantic slope in the United States, although falling considerably below the normal percentages of the coast from Charleston, in South Carolina, to Galveston, in Texas (78 to 82 per cent). The high percentage at Cape Hatteras is due to a local cause, the proximity at that point of the warm Gulf Stream and the cold Arctic Current. On the other hand, the humidity is of course far greater than in the arid and semiarid regions of the Western States (42.9 per cent at Yuma, Ariz.; 46.2 per cent at Pueblo, Colo., etc.). The distribution during the year is remarkably uniform, varying only to an extent of 9 per cent between the month of least and that of greatest normal humidity.

PRECIPITATION.

Rain.—The rain-bearing storms of this region usually approach from the west. The character of the rainfall (as to intensity) varies at different seasons. The winter and spring rains are usually light and long continued, while the summer and fall rains are more often heavy and of short duration, hence of the torrential type.

Normal precipitation, chiefly rain.

Station.		Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual.
Norfolk	cm	9.57	9.62	11.47	10.17	10.7	10.57	14.8	15.27	11.40	9.67	7.75	9.17	130.2
	in	3.83	3.85	4.59	4.07	4.28	4.23	5.92	6.11	4.56	3.87	3.10	3.67	52.08
Cape Henry	cm	10.6	8.9	12 8	11.15	10.17	9.87	14.07	13.85	11.37	9.47	8.92	9.67	130.85
	in	4.24	3.56	5.13	4.46	4.07	3.95	5.63	5.54	4.55	3.77	3.57	3.87	52.34
Hatteras	cm	14.77	1.17	15.25	11.8	11.5	11.42	16.07	15.87	16.1	15.42	12.95	13.67	166.02
	in	5.91	4.47	6.10	4.72	4.60	4.57	6.43	6.35	6.44	6.17	5.18	5.47	66.41
Wilmington	cm	9.85	8.07	9.87	7.4	10.4	14.25	18.1	18.67	16.05	9.6	6.12	7.45	135.85
	in	3.94	3.23	3.95	2.96	4.16	5.70	7.24	7.47	6.42	3.84	2.45	2.98	54.34

Average number of rainy days.

Station.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual.
Norfolk	12.7	11.0	11.6	10.7	11.2	10.4	12.4	12.7	9.4	8.9	9.9	10.4	131.3
Cape Henry	11.9	9.8	12.6	11.6	11.8	10.5	10.6	10.7	7.7	7.8	9.8	10.2	125.0
Hatteras	15.9	10.2	11.9	8.4	10.0	9.6	10.2	10.2	13.7	7.5	6.7	9.5	123.8
Wilmington	12.8	10.2	11.1	9.3	9.9	11.2	12.6	14.4	9.9	8.0	8.3	11.1	128.8

Snow.—The precipitation of snow during the winter is normally very small, both in quantity and in the number of days upon which snow falls. The snowfall during the winters of 1895–96 and 1896–97 was as follows:

Examples of snowfall.

Station.	1895–96.	1896–97.
Norfolk	14.2 cm. (5.7 in.)	31.2 cm. (12.5 in.)
Cape Henry	9.0 cm. (3.6 in.)	28.0 cm. (11.2 in.)
Hatteras	None.	None.
Wilmington	30.2 cm. (12.1 in.)	None.

The number of days in the year ended December 31, 1896, upon which snow fell to a depth of 2.5 mm. (0.1 inch) or more, was at Norfolk, 5; at Cape Henry, 9; at Hatteras, 0; at Wilmington, 2.

Precipitation thus means chiefly rainfall in the Dismal Swamp region, where the normal fall of snow in winter is too small to be of any noteworthy importance to the vegetation. The normal annual quantity of precipitated water is large as compared with that of most other temperate regions, although it is considerably less than at Cape Hatteras. The average number of days with rainfall during the year is more than one-third of the whole. The distribution of precipitation throughout the year, like that of atmospheric humidity, is remarkable for its uniformity. The normal variation in rainfall between the month of greatest (July) and that of least (November) amounts to only 7 centimeters at Norfolk and about 5 at Cape Henry. The variation in number of days on which rain falls between the month with most and that with least is likewise slight, being about four days at Norfolk and five at Cape Henry.[1]

Dew.—No data regarding the amount of dew deposited could be obtained, nor is this factor of primary importance to vegetation in a region which possesses such an abundant and equally distributed atmospheric humidity and rainfall.

[1] The Dismal Swamp region belongs to Schimper's "immerfeucht Gebiet" of the warm-temperate belt (Pflanzengeographie, p. 500), which is characterized by its rainfall being pretty equally distributed throughout the year. It is exceptional, however, in that its large forest trees (excepting Pinus and Chamaecyparis) are all deciduous. Most hygrophile forest in the division thus characterized by Schimper is evergreen.

WIND.

The normal wind direction in midsummer is almost exactly opposite to the normal direction in midwinter. In January the prevailing winds at Norfolk are from slightly west of north; at Hatteras from almost due north, and at Wilmington from considerably west of north. In July, on the other hand, the prevailing winds at Norfolk and at Wilmington are from somewhat west of south, and at Hatteras from almost exactly southwest.[1]

Average maximum velocity of the wind.

Station.		Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual.
Norfolk	ks	15.6	16.6	18.2	15.6	13.5	14.2	12.9	13.2	15.2	15.9	16.3	15.0	15.2
	mi	9.7	10.3	11.3	9.7	8.4	8.8	8.0	8.2	9.4	9.8	10.1	9.3	9.4
Cape Henry	ks	25.5	25.2	30.3	23.7	21.0	22.0	19.0	20.8	21.8	22.4	23.5	24.8	23.2
	mi	15.8	15.6	18.8	14.7	13.0	13.6	11.8	12.9	13.5	13.9	14.6	15.4	14.4
Hatteras	ks	25.0	24.5	25.2	24.2	20.1	21.3	18.5	19.7	17.3	18.4	19.8	24.0	21.4
	mi	15.5	15.2	15.6	15.0	12.5	13.2	11.5	12.2	10.7	11.4	12.3	14.9	13.3
Wilmington	ks	15.5	16.6	18.2	18.7	16.9	15.6	14.7	13.5	14.2	13.7	14.2	13.7	15.5
	mi	9.6	10.3	11.3	11.6	10.5	9.7	9.1	8.4	8.8	8.5	8.8	8.5	9.6

The rate of movement of currents of air is of great importance to vegetation, not only by reason of their direct mechanical effect upon the plant and upon its substratum, but also because transpiration increases with the velocity of the wind, other things being equal. The average maximum velocity of the wind varies greatly within the limits of the Dismal Swamp region, the ratio of velocity at Cape Henry, one of the most exposed points on the Atlantic coast of North America, to that at Norfolk being nearly as 5 to 3. The range in average maximum velocity from month to month does not greatly vary, as that in the month of greatest (March) exceeds that in the month of least (July) by about 30 per cent.

SUMMARY.

The climate of the Dismal Swamp region as a whole is highly favorable in all essential respects to the vigorous growth of what we may term, for the sake of convenience, "normal" plants; i. e., such as are not especially equipped to endure any kind of extreme conditions. It is characterized by a long growing period with a relatively high sum total of effective temperature, a mild winter, normally slight daily variations of temperature, abundant sunshine, heavy and well distributed rainfall, and a high and remarkably uniform percentage of atmospheric moisture. It is preeminently a forest climate, and the whole region was, in its primitive condition, densely forested. There still remain, especially in the depths of the Dismal Swamp, many trees of great size. On the outer coast, however, among the sand dunes, local qualities of the soil and extreme exposure to the wind

[1] See Rep. Chief U. S. Weather Bureau for 1896–97, charts 1 and 3.

neutralize these favorable conditions and occasion the presence of vegetation which is decidedly desert-like.

GEOGRAPHY AND PHYSIOGRAPHY.

GENERAL GEOGRAPHY OF THE REGION.

The territory embraced in this report under the designation "Dismal Swamp Region" lies, roughly, between parallels 36° and 37° N. latitude and meridians 75° 50′ and 76° 35′ W. longitude. It covers a considerable part of the Coastal Plain[1] area in southeastern Virginia and northeastern North Carolina. It is bounded on the north by the mouth of the James River (Hampton Roads) and of Chesapeake Bay, on the east by the Atlantic Ocean, on the south by Albemarle Sound, and on the west approximately by the western border of the Great Dismal Swamp. The region, therefore, comprises the whole of Princess Anne and Norfolk counties and the eastern portion of Nansemond County in Virginia and the whole of Currituck, Camden, Pasquotank, and Perquimans counties in North Carolina.

Owing to the limited time which could be devoted to the survey, not every part of the area thus defined was thoroughly explored. The southern or North Carolina portion was only superficially and partially examined, the counties of Currituck and Camden having been traversed merely by railway. On the other hand, a large part of Princess Anne and Norfolk counties, Va., as well as of that section of Nansemond County which lies within the borders of the Dismal Swamp, was explored with considerable care.

The greatest length of the region, from Willoughby Spit south to Albemarle Sound, is nearly 96.5 kilometers (60 miles). Its greatest width, along the Virginia-North Carolina boundary, is about 65 kilometers (40 miles). Approximately the area embraces 6,200 square kilometers (2,400 square miles).[2] The whole is a flat or slightly undu-

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[1] In order that the term "Coastal Plain," as here employed, may be perfectly clear to readers, I may be allowed to quote from Mr. N. H. Darton's manuscript the following definition:

"The central and southern portions of the Atlantic slope of the United States embrace four provinces of very distinct characteristics. From the westward there is, first, the plateau province, which comprises broad basins, occupied by upper Paleozoic rocks. The second is the Appalachian province, consisting of high, longitudinal ridges, due in greater part to sharply folded middle and lower Paleozoic rocks. Third, the Piedmont Plateau province, a region of undulating plains, extending from the Blue Ridge with a gradual declivity eastward, and underlain by crystalline rocks. And, fourth, the Coastal Plain, a province bordering the ocean, deeply invaded by tide-water estuaries and underlain by gently east-dipping unconsolidated strata from early Cretaceous to Recent age."

[2] This figure would be considerably smaller if we subtract the area of the numerous salt-water bays and lagoons which extend inland, especially on the north and east.

lating plain, varying in elevation from mean tide level to 6.6 meters (22.2 feet) above that level, except at some points along the outer coast, where the drifting sands form dunes that rise to a considerably greater height. The elevation of by far the greater part of the area is from 3 to 6 meters (10 to 20 feet). The maximum altitude, leaving out of consideration the sea dunes, is reached in the heart of the Dismal Swamp, from which point there is a gentle terrace-like slope toward sea level on the north, east, and south. Along the western margin of the great swamp occurs a more or less sharply defined ancient sea beach, the Nansemond escarpment, which varies in height from 1½ to 15 meters (5 to 50 feet)[1] and constitutes the natural western boundary of the Dismal Swamp region.

Numerous waterways traverse this flat plain, most of which have their source in or near the Dismal Swamp, and flow northward into the James River and Chesapeake Bay and southward and southeastward into Currituck and Albemarle sounds. These are the Nansemond and its tributaries, Elizabeth River and its branches, and Lynnhaven River with its numerous ramifications on the northwest, north, and northeast, and North Landing, Northwest, North, Pasquotank, Little, and Perquimans rivers on the east, southeast, and south. Near their sources most of these water courses are small fresh streams of sluggish, dark-brown water, rich in finely divided organic matter, but they soon widen out into estuarine channels in which tidal action is distinctly perceptible, and whose waters, in the streams flowing into the James and Chesapeake Bay, become first brackish and then salt. The brooks which are tributary to these rivers are in most cases more or less overgrown with palustrine vegetation and their current is usually almost imperceptible.

PROMINENT PHYSIOGRAPHIC FEATURES.

The principal physiographic features of the nonaqueous surface of the region are more or less intimately connected with and dependent upon the character of the plant formations which cover them, although this, in turn, is of course primarily due to conditions of soil and of drainage. The several areas which may be described in some detail, proceeding from the coast line toward the interior, are: (1) The beach and the dunes, (2) the salt marsh, (3) the plain, (4) the swamps.

THE BEACH AND THE DUNES.

This area follows the shore from the mouth of the Nansemond River around Cape Henry and down the outer Atlantic coast, as well as part way around the deep, irregular indentations of the shore line which are formed by Elizabeth and Lynnhaven rivers and their

[1] Shaler, 10th Ann. Rep. Geol. Surv., pp. 255 to 339 (1890).

VIEW ON THE HEADWATERS OF NORTHWEST RIVER, DISMAL SWAMP.

THE HELIOTYPE PRINTING CO., BOSTON.

branches. It varies in width from a mere strip 2 or 3 meters wide (as along the estuaries) to nearly 1 kilometer (over ½ mile) at Cape Henry. Its surface everywhere consists of finely divided, wave-deposited, and often wind-blown whitish sand.

In the more sheltered coves and along the rivers and bayous the beach is ordinarily smooth and gently sloping, with a contour unbroken by abrupt elevations. The sands of the more exposed portions of the coast, on the other hand, are piled up by the wind so as to form dunes which are sometimes much the highest land of the region.

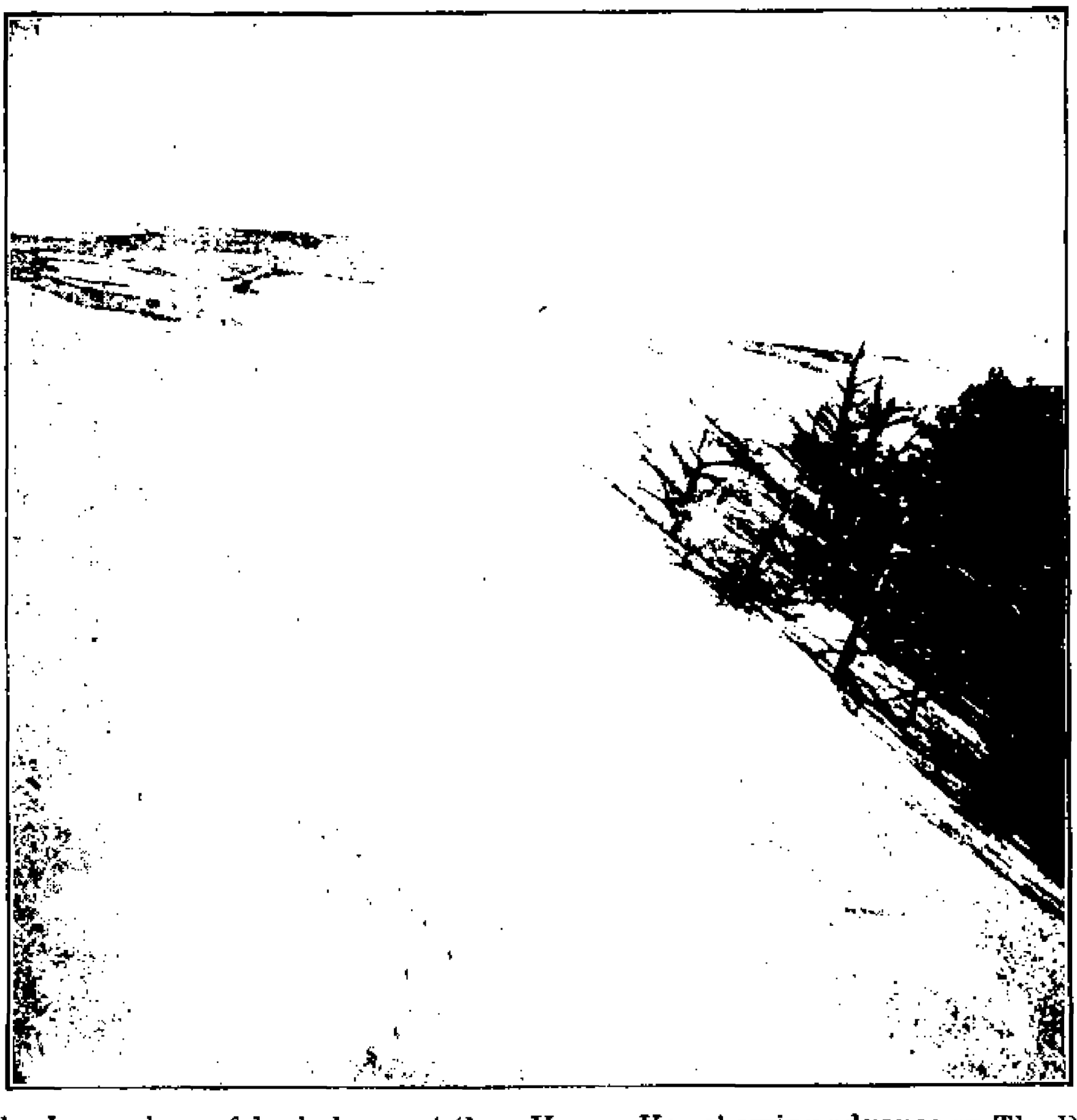

FIG. 51.—Inner slope of high dunes at Cape Henry, Va., showing advance on The Desert.

This area of sand hills reaches its culmination at Cape Henry, where the summit of the highest dune is roughly estimated to be 25 meters (80 feet) above mean tide level.[1] Thence along the south shore of Chesapeake Bay west to Willoughby Spit and along the Atlantic strand to a point 24 kilometers (15 miles) southeast of Cape Henry the dunes gradually decrease in size and finally disappear. Whether sand hills of any size occur between the Virginia-North Carolina boundary and Cape Hatteras was not ascertained.

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[1] The highe t contour noted on the Norfolk folio of the Geological Atlas of the United States is 50 feet, but higher contours lying inside this are indicated. A century ago B. H. Latrobe (see below) estimated the height of the highest dune to be not "less than 100 feet above high-water mark."

The lesser dunes on this coast appear usually to originate about tufts of marram grass (*Ammophila arenaria*), although *Uniola paniculata*, *Panicum amarum*, and other plants are likewise effective as the nuclei of accumulations. As a rule the outermost dunes are the lowest, being only breast high or lower. The height of the hills increases with greater or less regularity to the innermost, normally the highest, line of dunes. The last are often forested, although at Cape Henry, where they attain their maximum elevation, they are devoid of vegetation excepting a few plants of marram grass (*Ammophila arenaria*).

FIG. 52.—Incursion of the sand on inland vegetation near Cape Henry, Va.

The outermost and innermost dunes usually form regular chains, broken here and there by the wind, but conforming mainly to the contour of the coast. The middle dunes also exhibit a tendency to form rows parallel to the shore line, but this tendency is often modified and obscured so that there frequently appears a total lack of order in their arrangement. The outer or seaward slope of the dunes is very gentle, and is usually more irregular than the abrupt landward declivity, whose angle, e. g., in the highest dunes at Cape Henry, is about 45 degrees.

At and near Cape Henry the dune area is unmistakably advancing

inland, while elsewhere along this coast such a movement is less evident or not to be detected (fig. 51). From the summit and the steep inward face of the highest dunes at Cape Henry project the tops of old cypress trees, some of which still bear a few living leaves (fig. 52). The sand is pouring down upon the floor of a tract of swampy forest (locally known as "The Desert,") and the leaves and branches of many of the trees have been more or less perfectly denuded by sand-laden winds (fig. 53). Between these high inner dunes and the beach are to be seen dead trunks of large pine trees standing amid the barren sands.

The Desert itself occupies an ancient dune area, and bears witness to the fact that, while at present the aeolian sands are gaining upon

FIG. 53.—Incursion of the sand on inland vegetation near Cape Henry, Va.

the forest, in times past a contrary process has had place (fig. 54). This forest area covers an area of alternate elevations and depressions, the former bearing a growth of oaks, pines, and a more or less xerophilous undergrowth, the latter a palustrine forest of cypress (Taxodium), black gum (*Nyssa biflora*), red maple (*Acer rubrum*), etc., with here and there small, shallow pools containing aquatic vegetation. The ridges which traverse The Desert conform generally in direction to that of the present coast line.

Very interesting, as showing how little conditions have altered at Cape Henry within the past one hundred years, is the following description of the dunes as they appeared about 1799 to B. H. Latrobe:[1]

These easterly winds, blowing during the driest and hottest season of the year,

[1] Trans. Am. Phil. Soc., vol. 4, pp. 439 to 443 (1799).

carry forward the greatest quantity of sand, and have amassed hills, which now extend about a mile from the beach. The natural level of the land, elevated little more than 10 feet above high-water mark, has a very gentle declivity to the east. It is now a swamp of about 5 miles square (25 square miles). The soil below the surface is a white, loamy sand; and if the water falling upon or rising in it had a free discharge to the ocean it would probably be perfectly dry. This, however, the sand hills prevent, and the water is discharged into the sea to the southward and into the mouth of the Chesapeake to the northward by small creeks, which find vent from the westerly extremes of the swamp. Lynnhaven Creek is the most considerable of these drains. The swamp, or, as the neighboring inhabitants call it, The Desert, is overgrown with aquatic trees and shrubs. The gum (*L. styraciflua*), the cypress, the maple (*A. rubrum*), the tree improperly called "sycamore" (*Platanus occidentalis*), the *Magnolia virginiana*, the wax myrtle (*Myrica cerifera*),

FIG. 54.—The Desert from the high dunes at Cape Henry, Va.

and the reed (*Arundinaria tecta*) are the principal. Of these many thousands are already buried in the sand, which overtops their summits and threatens the whole forest with ruin. Their destruction is slow, but inevitable. Upon the extreme edge of the sand hills, toward the swamp, the wind, opposed by the tops of the trees, forms an eddy. The sand carried along with it is precipitated, and runs down the bank into the swamp. Its slope is very accurately in an angle of 45 degrees. By gradual accumulation the hill climbs up their trunks; they wither slowly, and before they are entirely buried they die. Most of them lose all their branches, and nothing but the trunk remains to be covered with sand: but some of the cypress retain life to the last. * * *

Since the establishment of the light (about sixteen years ago) the hills have risen about 20 feet in height, and have proceeded into the Desert about 380 yards from a spot pointed out to me by the keeper. * * * The height of the hill at the

swamp is between 70 and 80 feet perpendicular. It is higher nearer the sea, the inner edge being rounded off, and I think at its highest point it can not be less than 100 feet above high-water mark.

If the hills advance at an equal ratio for twenty or thirty years more, they will swallow up the whole swamp and render the coast a desert indeed, for not a blade of grass finds nutriment upon the sand [sic].

This is even to-day a very good picture of the Cape Henry sand hills and the forest behind them. The advance of the sand must have proceeded at a much less rapid rate during the past century, however, than during the sixteen years before Latrobe's visit.

Other evidences are not lacking of a subsidence and consequent re-

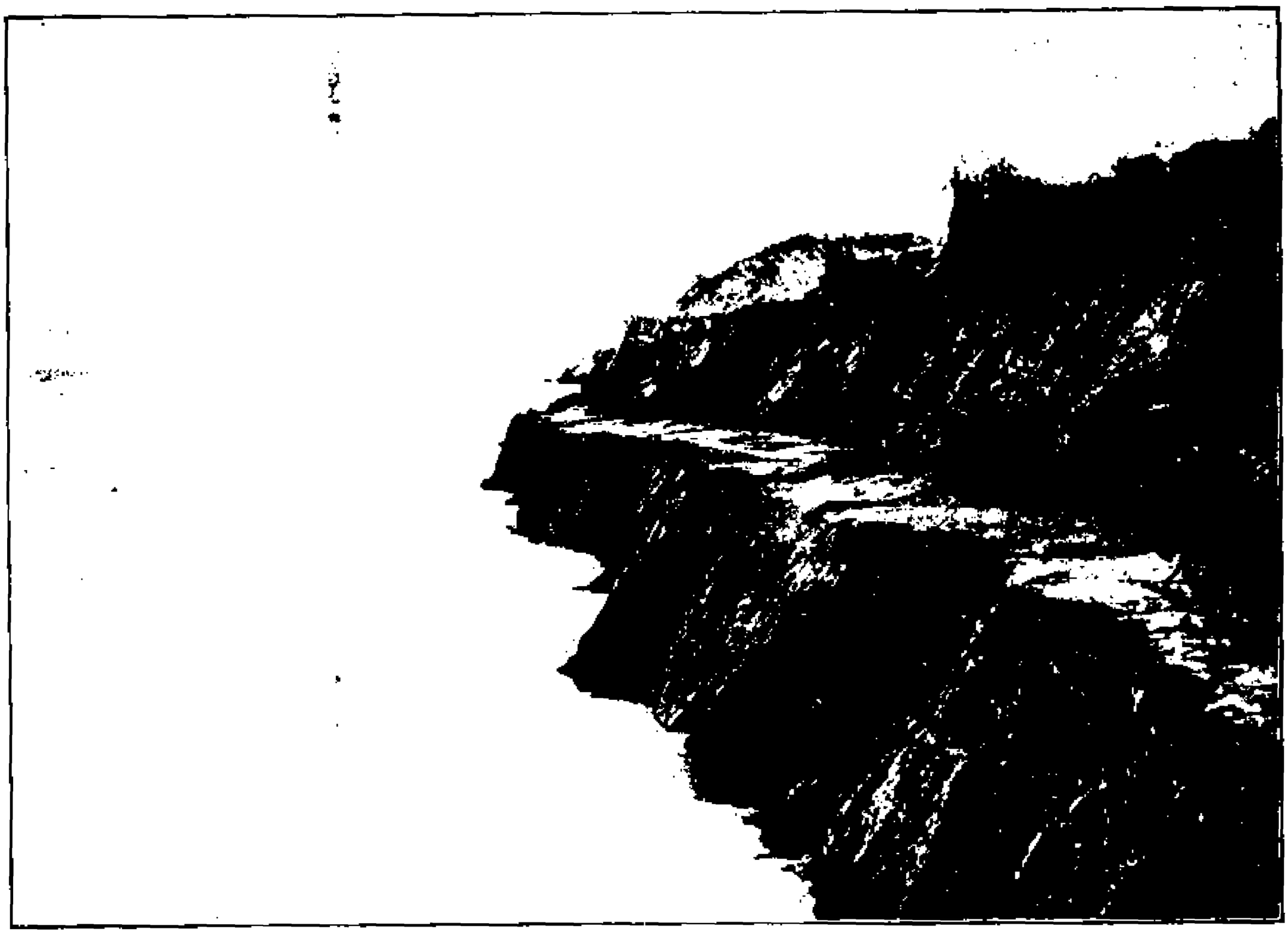

FIG. 55.—Terrace along the shore near Virginia Beach; sand above, clay below.

cession of this coast line. In the low terrace of Columbia clay (fig. 55) which outcrops along the beach from Cape Henry southward, sometimes several meters above high-tide limit, sometimes between the levels of high and low tide, stumps *in situ* (usually of the cypress) are frequently to be seen. Such stumps are said to be abundant beneath the waters of Albemarle Sound.

This topographical feature, which exactly coincides with a plant formation, is almost everywhere developed along creeks and rivers as far upstream as the influence of brackish water makes itself felt, and in sheltered bayous and lagoons where the slope of the shore is very gentle. Along streams the salt marsh consists usually of a

narrow strip on each side of the channel, while in lagoons (notably the upper part of Back Bay) it sometimes takes the form of a meadow of considerable width. While the largest salt marshes are found just inside the beach and dune area of the outer coast, the narrow belts which fringe tidal streams penetrate deeply into the inland plain, where they are always at once recognizable by their peculiar vegetation.

The presence and extent of salt marshes along the shores of Currituck and Albemarle sounds was not ascertained. At the head of Back Bay, which eventually opens into Currituck Sound, extensive brackish meadows occur. On the other hand, this formation does not exist about Edenton Bay, on the north shore of Albemarle Sound. The latter sound, fed as it is by numerous fresh-water streams, some of which are of considerable size, is rarely at all brackish.

Above the limit of saline water the larger streams are bordered by marshes which resemble the salt marsh, but are occupied by fresh-water vegetation.

THE PLAIN.

The greater part of the territory east and north of the Great Dismal Swamp, together with that south of the swamp and immediately bordering Albemarle Sound, constitutes what may be termed "The plain." It was in all probability originally everywhere covered by a forest of short-leaf pine (*Pinus taeda*), in which hard-wood species (oaks, sweet gum, etc.) held a secondary place. Since the settlement of the region, however, conditions have been greatly altered. Much of it has been deforested and occupied by cultivated crops and by dwellings. In the remaining forest much of the pine has been cut down, and as a result deciduous species play a much more important part in its composition than was probably the case before the advent of civilization. Even then the pine forest was interrupted, especially along water courses, by areas of wooded swamp and of salt marsh. To-day it is for the most part broken up into scattered tracts of comparatively small extent, between which intervene areas of cleared land.

The general surface of this plain is flat or slightly undulating. Elevations that can be termed hills do not occur. To the drainage system and the differences in the plant covering, rather than the orography, is attributable what little of variety its physiognomy exhibits.

THE SWAMPS.

The Great Dismal Swamp and the lesser outlying morasses of the region constitute the most northeastern extensive outpost of that immense body of palustrine forest which covers so large a part of the Coastal Plain of the southeastern United States, and which extends up the Mississippi River and its larger tributaries to southeastern Missouri and southern Illinois and Indiana.

"The Dismal Swamp," to quote Professor Shaler, "belongs altogether to that group of inundated lands where the lack of drainage is due to an original deficiency of slope, combined with the flow-retarding influence of vegetation on the movement of water from the land."[1] North of the mouth of the Chesapeake the inclination of the plain is usually sufficiently great to permit the ready off-flow of the rainfall, while the climate is unfavorable to the development of certain types of vegetation (especially the large cane, *Arundinaria macrosperma*), that are particularly effective in retaining the surface water.

The total area of the Dismal Swamp is estimated at about 3,900 square kilometers (1,500 square miles), which comprises all extensive bodies of hygrophile forest lying between Elizabeth River and the mouth of the James on the north, and Albermarle Sound on the south. More than one-half of this area lies in North Carolina, the Virginia State line passing not far south of Lake Drummond. An additional 1,800 square kilometers (700 square miles) is computed to have been reclaimed by drainage from the original area of the great swamp. A large part of this land was deprived of its excess of water by the digging of the Dismal Swamp Canal, close upon a century ago. The canal traverses the swamp east of its center, and has had the effect of partially draining the region east of it, while retaining in the portion to the west much water that formerly escaped into the sounds. Consequently the western section of the swamp is probably wetter than it was a hundred years ago. Much of the land east of the canal is now in cultivation or is susceptible of cultivation after much less preparation than the western part of the swamp would require.

The outlines of the morass are very irregular, particularly on its eastern margin, where the reclamation of extensive tracts has cut off from the principal swamp some areas of hygrophile forest, especially along the upper waters of the rivers, which were once continuous with it. Occupying scattered depressions over the whole region, beyond what could ever have been the limits of the Great Dismal Swamp itself, are lesser tracts of similar character, which exhibit the same peculiarities, but on a smaller scale.

The Dismal Swamp is traversed by contour lines of from 1½ to 6 meters (5 to 20 feet) elevation, and a great part of its area is thus more elevated than the major portion of the plain lying to the east and northeast. The surface of Lake Drummond, nearly if not quite the highest point in the swamp, is normally 6⅔ meters (22.2 feet) above sea level.

This interesting body of water (Pl. LXV, frontispiece), lying approximately in the center of the Dismal Swamp, is about 5 kilometers (3 miles) in greatest diameter, and is of quite regular shape, as the shore line forms long curves uninterrupted by promontories, and there are no islands. The depth of water, which is said not to have

[1] Shaler, loc. cit., p. 313.

exceeded 2 meters (about 6 feet) in any portion originally, has been increased by the digging of canals and other artificial causes until the normal greatest depth is about 4½ meters (15 feet). In November, 1898, however, the depth was considerably less than 2 meters (6 feet) in almost every part of the lake, much of the water having been recently drained off through the feeder of the Dismal Swamp Canal. The water was then lower than it had ever before been known to be.

The water of Lake Drummond, like that of the wooded swamps of the Coastal Plain generally, is of a deep brown hue and is rather turbid. When taken up in small quantity the color is much like that of sherry. This brown color is doubtless due to the great amount of finely divided

FIG. 56.—Cypress stumps on the margin of Lake Drummond.

vegetable matter with which it is impregnated. The people of the countryside ascribe to the swamp water tonic properties, which they believe to be derived from the bark and wood of the "juniper," or white cedar. Despite this large percentage of organic matter held suspended in its water, the floor of the lake is in large part covered with a fine white sand.

The peculiarity of the aspect of Lake Drummond is enhanced by the multitude of gray old cypress stumps, worn by weather and water into a thousand fantastic shapes, that encircle the basin, standing in the shallow water near the shore (fig. 56). During very high water many of these stumps are completely submerged. A few small trees are still alive, relics of what must once have been a noble forest of cypress.

The lake is entirely surrounded by low, swampy woods. At two or three points, where the ground is slightly higher, are small clearings, the remains of old lumber camps. In a very few places, notably at the mouth of the Jericho Canal, soil is being deposited, and marshy flats, occupied chiefly by herbaceous vegetation, extend a little way into the lake. The total present area of these flats, when the water of the lake is at its normal level, is perhaps a hectare ($2\frac{1}{2}$ acres).

In spite of the slight differences of elevation already mentioned, the surface of the Dismal Swamp exhibits very little diversity, the variations from the highest ground to the lowest being insignificant to the eye, although sufficient to induce some alterations in the plant covering. A great part of the swamp is covered with standing water, which varies in depth at different seasons, but rarely, even in the wettest parts, exceeds 6 decimeters (2 feet), and is usually from 2 to 15 centimeters (1 to 6 inches). The several ditches or small canals that have been cut through the Dismal Swamp ordinarily contain about a meter (3 or 4 feet) of water. Usually in the early fall a considerable part of the swamp is sufficiently dried off for a number of weeks to be traversed dry shod, but in its normal condition the greater part is very wet.

The origin of the Dismal Swamp and of its central body of water, Lake Drummond, offers an interesting problem in historical geology, and one that has been much discussed, but it is outside the province of this paper.

Col. William Byrd, a commissioner appointed by one of the colonial governors of Virginia to fix the boundary between that colony and North Carolina, gives an entertaining account of the Dismal Swamp as he and his party of surveyors found it at that early day. I quote from "The History of the Dividing Line: Run in the Year 1728," one of the papers comprised in the "Westover Manuscripts of William Byrd, esq., of Westover," published at Petersburg, 1841. On their first day in the swamp Mr. Byrd's party were "blessed with pretty dry ground for 3 miles together. But they paid dear for it in the next two, consisting of one continuous frightful pocoson, which no creatures but those of the amphibious kind had ventured into before. This filthy quagmire did in earnest put the men's courage to a trial, and though I can not say it made them lose their patience, yet they lost their humor for joking. They kept their gravity like so many Spaniards, so that a man might have taken his opportunity to plunge up to the chin without danger of being laughed at."

"The ignorance of the borderers" concerning the Dismal Swamp is much complained of, "notwithstanding they had lived their whole lives within smell of it. * * * At the same time they were simple enough to amuse our men with idle stories of the lions, panthers, and alligators they were like to encounter in that dreadful place. * * * The surveyors pursued their work with all diligence, but still found the soil of the Dismal so spongy that the water oozed up into every

footstep they took. To their sorrow, too, they found the weeds and briers more firmly interwoven than they did the day before. But the greatest grievance was from large cypresses, which the wind had blown down and heaped upon one another. On the limbs of many of them grew sharp snags, pointing every way like so many pikes, that required much pains and caution to avoid. These trees, being evergreens [sic] and shooting their large tops very high, are easily overset by every gust of wind, because there is no firm earth to steady their roots. Thus many of them were laid prostrate, to the great encumbrance of the way."

GEOLOGY.

It will be expedient to leave the description of the most recent superficial deposits of the Dismal Swamp region to the following chapter on "Soils," and to devote this section of the paper to a brief description of the underlying strata, so far as their character and extent have been determined, merely enumerating the uppermost deposits. The series of events which has created the surface topography and the arrangement of the underlying geological formations which we find in the Dismal Swamp region to-day has formed the subject of numerous publications, and will be described in the text of the Norfolk folio of the Geological Atlas of the United States, soon to be issued by the United States Geological Survey. While the present distribution of the vegetation of the region is undoubtedly in part a result of its past geological mutations, the subject is too extensive to be entered upon in this report, even were the data at hand for its proper presentation. Consequently we shall confine ourselves to a statement of existing conditions.

The most recent surface formation of the Dismal Swamp region consists, in the region designated as The Plain, of a soil usually loamy, but varying from almost pure sand, with an insignificant content of humus in the highest and best-drained portions, to a mixture of sand, silt, and considerable organic matter in the lower-lying lands. In the beach and dune area the surface formation consists entirely of fine white sand of marine origin. In the swamps, on the other hand, notably in the Great Dismal itself, occur heavy deposits of peat—vegetable matter in various stages of decomposition—which in many places reach a thickness of 3 meters (10 feet) and are sometimes 4½ meters (15 feet) thick. Toward the margins of the Dismal Swamp these vegetable deposits gradually decrease in thickness. Great numbers of trunks of large trees have been buried in the peat, and are often so well preserved as to be valuable for all purposes to which newly felled timber can be put.[1] The surface of the salt marshes is covered with a thin layer of brownish or gray silt, mixed with considerable decaying organic matter and saturated with water which contains usually 2 to 3 per cent of sodium chloride. Under this a layer of stiff, blue clay often occurs.

[1] See N. B. Webster, Amer. Naturalist, vol. 9, pp. 260 to 262 (1875).

Beneath these various surface deposits are extensive layers of sands, clays, gravels, marls, and matter of organic (chiefly vegetable) origin, which slope gradually to the southeast and which have an aggregate thickness of more than 525 meters (1,750 feet). These in turn rest upon the strata of crystalline rocks which are exposed farther west, but in the Dismal Swamp region are everywhere deeply buried.

The formations above the rock floor represent all geological periods from Lower Cretaceous to Recent. The greater part of them were deposited unconformably, the general level of the Coastal Plain having suffered numerous oscillations during the time in which they were laid down. The following table of the several formations, giving their period, general character, and thickness wherever the last was ascertainable, is quoted verbatim from Mr. Darton's forthcoming paper:

Period.	Formation.	Character.	Thickness in meters (and feet).
Recent	Alluvium, etc. (unconformity).	River mud, marsh, beach sand, dune sand, etc.	0–18 (60).
Pleistocene	Columbia (unconformity)	Sandy loams, sands, and clays	3–9 (10–30).
Neocene	Lafayette (unconformity)	Gravel, orange sands, loams	7.5–12 (25–40).
	Chesapeake (unconformity)	Fine sands, clays, and diatomaceous deposits.	10.5–169.5 (35–565).
Eocene	Pamunkey	Glauconitic sands, marls, and clays.	9?–90 (30–300).
Cretaceous	Marine deposits (unconformity).	Clays and sands	0–150 (500).
	Magothy (unconformity)	Sands?	?
	Potomac (great unconformity).	Sands and clays	60–288? (200–960).
	Crystalline rocks	Granites, gneisses, etc	

The formations occupying the surface in the Dismal Swamp region are the Chesapeake, Lafayette, Columbia, and Recent. Marine fossils are abundant in the Chesapeake formation, fossil shells being present in some deposits in such quantities as to afford marls valuable for agricultural purposes. The inorganic matter which constitutes the bulk of all the formations consists of the detritus of rocks in the Appalachian and Piedmont provinces[1] to the west, which was carried seaward by streams during past ages, just as is happening to-day.

The Columbia formation, a comparatively thin layer of sands and sandy loams, forms the surface of almost every part of the Dismal Swamp region where very recent deposits (dune and beach sand, marsh silt, swamp peat) have not been laid down upon it. This sheet varies in thickness from 6 to 10 meters (20 to 35 feet). The formations lying beneath the Columbia are naturally exposed only in the valleys of the larger rivers, especially the Elizabeth, the James (Hampton Roads), and the Nansemond. A section through part of the Columbia deposits is exposed on the outer ocean beach, where it forms a low bench of clay, either above high tide or between the levels of ebb and flood (fig. 55). The materials belonging to this formation, which compose

[1] See footnote, p. 331.

the subsoil of much of the region, vary considerably at different points, and comprise gravel, coarse sand (sometimes quicksand), fine sand, silt, and red, yellow, and blue clays, besides various mixtures of sand, silt, and clay.[1]

In the greater part of the Dismal Swamp region water stands quite near the surface of the soil, so that the roots of all except the smallest herbaceous plants can readily penetrate to a depth at which water is abundant. All deep-lying water of the region, so far as has been ascertained, has a salty taste.

SOILS.

By FRANK D. GARDNER, *Assistant, Division of Soils.*

THE SALT MARSHES.

The soil of the salt marshes is usually a brown silt containing much partially decomposed vegetable matter, beneath which stiff clay is often present as a subsoil. Great moisture is the normal condition of this soil, and at high tide it is subject to overflow. As the water which then covers it is strongly brackish, the soil of salt marshes is characterized by a much higher percentage of common salt (NaCl) than is present in ordinary soils.

THE SAND STRAND.

The soil of the beach and dune area, like that of the salt marshes, possesses no agricultural value. It is an almost pure marine sand, whitish in color. Near the tide limit particles of carbonate of lime ($CaCO_3$) are somewhat abundantly intermixed, a result of the decomposition of seashells. Farther back, however, accumulation of lime is prevented by the dissolving action of rain water impregnated with carbonic oxide (CO_2). Humus is almost entirely wanting, except on the innermost, fixed dunes. Here the growth of trees permits a sufficient accumulation of vegetable matter to give the soil a grayish color. Elsewhere the sparseness of the vegetation, the ready permeability of the sand, the mechanical effect of the wind, and the rapid oxidation brought about by wind and sunlight are conditions which interfere with the accumulation of dead vegetable and animal matter.

Common salt, sodium chloride, is present in considerably larger quantity near the shore than is normally the case in inland soils. The presence of the salt is easily accounted for by the frequency with which spray is blown landward by the wind.

That the percentage of sodium chloride, as well as of calcium carbonate, which exists in dune sands at any considerable distance

[1] The Columbia formation is described by W. J. McGee, Am. Journ. Sci., ser. 3, vol. 35, pp. 120 to 143, 328 to 330, 367 to 388, 448 to 466, 1888; and by N. H. Darton, Bul. Geol. Soc. America, vol. 2, pp. 431 to 450, 1891.

beyond the reach of the tides, is normally too small to have much influence upon vegetation is indicated by the researches of Massart on the Belgian coast. The following analysis of sand-strand soil is given in his paper:[1]

Hygroscopic water	0.22
Free water	.28
Substances soluble in water	.02

SOLUBLE IN NITRIC ACID.

Iron oxide	.14
Alumina	.13
Calcium carbonate	.14
Magnesium	.14
Carbon dioxide	.12

SOLUBLE IN SULPHURIC ACID.

Alumina	.30
Phosphoric acid	Traces.
Insoluble	98.81
	100.00

Despite its excessive permeability, the soil is here rarely dry except at and very near the surface. Even on the dunes one can easily reach moist sand with his hands. Near tide level, as everyone knows, the shallowest depression soon fills with water. It is probable that only the smallest plants of this strand formation ever have difficulty in reaching a sufficient supply of water with their roots. Abundant deposition of moisture in the form of spray, rain, and dew, and the resistance to evaporation offered by the superficial layer of the sand, as well as by the abundant atmospheric humidity, are factors which sufficiently account for this, at first glance, somewhat anomalous condition. A further physical peculiarity of sand which is of interest in connection with the vegetation is the rapidity with which the surface layer absorbs a great amount of heat, while the moist underlying portion remains always cool. On the other hand, sand gives up its heat with equal rapidity. Consequently it receives after nightfall a heavy precipitation of dew.

THE PLAIN—TRUCK SOILS.[2]

GENERAL OBSERVATIONS.

That part of the Dismal Swamp region which belongs neither to the strand, the salt marshes, nor the wooded swamps we have designated

[1] Mém. Soc. Roy. Bot. de Belgique 32, pt. 1 (1893); quoted from Swaelmen's "Le boisement de la côte belge" (1888).

[2] In the following publications of the Department of Agriculture Professor Milton Whitney has quite fully described the peculiarities of the so-called "truck" soils that occur along the Atlantic coast in the United States: Yearbook for 1894, pp. 129 to 143 (1895); Bul. No. 5. Div. Agr. Soils, pp. 15, 16, pls. 12 to 18 (1896); Bul. No. 13, Div Agr. Soils, pp. 8 to 11 (1898).

The Plain. It comprises the great bulk of those soils which are at present of the highest agricultural value. The lighter, sandier soils, which chiefly occur near tide water, are largely devoted to truck farming, the principal industry of the region. The ideal truck soil is light in texture, well drained, and easily worked, and has but a small natural content of organic matter. By a happy coincidence it is precisely this type of soil which usually borders tide water, not along the outer shore, where the sterile beach and dunes occur, but along the numerous bayous and estuaries which intersect the coastal plain in so bewildering a fashion. The value of the truck lands is thus enhanced by the protection against late and early frosts which the neighborhood of the sea affords, and by the ease with which their products can be shipped to a distance by water.

These three conditions are almost essential to profitable market gardening on a large scale when the object is, as here, to force vegetables to early maturity, in order that they may reach the large Northern cities well in advance of the home-grown product. Inland soils can rarely compete with those lying in the immediate vicinity of salt water: (1) Because they are usually too heavy, containing too high a percentage of silt or of clay in proportion to their sand content. The consequence is that they retain too much water and are slower to warm up at the beginning of the season, while also they become cold earlier in the fall than do lighter soils. For these reasons they are much more liable to the effects of late or of early frosts than soils near the coast. All these soil conditions are obstacles to the quick development of early vegetables. (2) Because they are too far from the sea, with its moderating influence upon temperature in spring and fall and with its facilities for cheap transportation.

It must not be understood, however, that there is any single type of soil which meets the requirements of all truck crops alike in the fullest degree. A soil that is light, sandy, and without a stiff clay bottom to a depth of 4 or 5 feet is admirably adapted to sweet potatoes and melons, but is less suitable for potatoes, strawberries, and peas, while distinctly unfitted for cabbage and spinach. In such land a ten or twelve days' drought will burn out potatoes.

In the fine truck region about Norfolk two well-defined types of soil are recognized by some farmers. One is a light loam, possessing only a thin clay bottom, beneath which there is often a bed of quicksand. This type is best suited for growing strawberries, and yields excellent cabbages, although it is not the finest kind of soil for the latter vegetable. The second is characterized by a sandy soil 12 to 18 inches deep, with a subsoil of clay sometimes stiff enough to be used for brick making. Potatoes and tomatoes are said never to rot in such soil, as frequently happens when they are put into that of the first type. This is also considered a superior soil for cucumbers.

Certain of the truck crops, especially those which are sown in the

spring, require for their early maturity a very light, dry soil, containing not more than 9 per cent of clay. Such are watermelons, muskmelons or cantaloupes, sweet potatoes, cucumbers, asparagus, and, when early maturity is very important, Irish potatoes. On the other hand, fall-planted crops are better adapted to heavier land, having a clay content of from 6 to 12 per cent. Spinach and cabbage are good examples of this class, and, as a general thing, strawberries, tomatoes, peas, and beans give somewhat better results on the heavier truck lands.

By some truck growers two principal types of land are distinguished near Newbern, N. C.: (1) A light yellow loam, excellent for peas and tomatoes, and for Irish potatoes, which have a fine white color when raised in this soil; (2) "gall-berry" land, which is richer in organic matter, and consequently black in color. The surface soil is sandy, clay is encountered in some quantity 2 to 3 feet below the surface, and a solid clay bottom occurs at a usual depth of 5 or 6 feet. Soil of this kind is warm and easily worked, but needs to be well drained, else it will "drown out" in very wet seasons. At all times it is decidedly more retentive of moisture than is the yellow loam. Gallberry land is considered by some "truckers" as unexcelled for strawberries, and for Irish potatoes, which are said to be better in size and flavor, although less attractive in color, than when grown in the yellow loam.

It can be said of this region that the natural drainage is almost everywhere deficient. Even the coastwise soils, which seem quite light and dry in their original condition, are nevertheless found to require at least cross furrowing before they are in fit condition for raising truck crops. On most of the large farms a system of tile drainage or of open ditches, intersecting every field, is employed.

Another point is that the very light soils near the coast, which are best fitted for forcing vegetables to early maturity, are all but worthless in their primitive condition. Only by the heavy application of fertilizers can they be made to yield good crops. The annual outlay for fertilizers is an item that should be well considered by anyone who contemplates truck farming. Some idea of the amount of money thus expended may be gained from the fact that on one farm near Norfolk $16,000 to $17,000 is paid out each year for commercial fertilizers. On the larger farms $60 to $75 worth of fertilizers per acre is used.

The cultivated truck soils are often slightly acid, although far less so than are swamp lands. This is believed to be due rather to artificial than to natural conditions. The long-continued use of fertilizers is held responsible by some truck growers for the sourness of their land. Whatever its cause, the result is frequently injurious to the crops, especially Irish potatoes, which are liable to rot in sour land. Application of lime, usually in the form of burnt shells, is a remedy

which is found efficacious in most cases. Those who deny that this treatment is beneficial have probably been too impatient, and have not allowed sufficient time for the chemical changes by which the acid is neutralized.

DESCRIPTIONS AND ANALYSES OF SAMPLES.

The descriptions and analyses of a series of samples taken from typical soils of The Plain will show better than any general discussion which are and which are not best suited to truck and other crops. Four samples from Newbern, N. C., are added to those from the Dismal Swamp region for purposes of comparison.

Beginning at the north and taking the samples as they occur in geographic order, going south, we have first sample No. 1599, which is a subsoil at from 12 to 30 inches, from Ballantine's farm near Eastern Branch, Norfolk, Va. It contains 14.35 per cent of clay, and while considered a good truck soil, is too heavy in texture to be as early as some other soils of the region.

Sample No. 1601 is also a subsoil at from 12 to 30 inches from the same farm, but is from land that needs drainage. Its texture is better suited for early truck than is No. 1599, because it contains little more than half as much clay. If drained it should make good early truck land.

Sample No. 1593, from the farm of William Wise, and No. 1595, from Henry Kirn's farm, are subsoils at from 9 to 30 inches, both from near West Norfolk, Va. They represent what is known as the finest type of early truck land, and it will be well to note carefully their texture. They are quite similar and contain about 8 per cent of clay and from 20 to 25 per cent of silt, the rest being largely medium and fine sand.

No. 1579, from the thirty-fifth milepost, Currituck County, N. C., represents the subsoil characteristic of the clay lands in that vicinity. It contains about 25 per cent of clay and is therefore much too heavy for truck. It would do well for corn, wheat, and pasture land.

No. 1570 is a sample from Camden, Camden County, N. C. It is a light sandy soil well suited to medium and late truck.

No. 1571 is also from Camden and represents the texture of the clay at 4 feet in depth, which underlies all of the Elizabeth City lands.

No. 1566 is a subsoil at from 9 to 30 inches and is from the farm of Dr. E. F. Lamb, Elizabeth City, Pasquotank County, N. C. This soil is well suited to truck.

Nos. 1519 and 1520, subsoils at from 7 to 24 and 24 to 30 inches, respectively, are very similar in texture. They are too heavy for any but late truck. Owing to their proximity to the river they are exceptionally free from frost.

No. 1540 is from 2 miles south of Chapanoke, Perquimans County, N. C. It is a heavy, stiff, close, tenacious, wet subsoil underlying a deep black loam. It contains over 25 per cent of clay and is therefore not suited to truck. It would make good grass and wheat land.

No. 1542 is a subsoil from one mile south of Chapanoke, N. C., and is much lighter in texture than the preceding sample. It would probably be well adapted to truck.

No. 1558 is from No. 4, Leigh's farm, near the point, Durants Neck, Perquimans County, N. C. It is a subsoil of from 9 to 30 inches, and contains 22 per cent of clay and 30 per cent of silt. It is too heavy for truck, but is well suited to corn, wheat, and cotton.

No. 1534 is a subsoil at from 5 to 30 inches, and is from the farm of S. S. Woods, at Hertford, Perquimans County, N. C. It contains 64 per cent of clay and 70 per cent of fine sand, and would be well adapted to early truck.

No. 1524, from 1¼ miles north of Edenton, Chowan County, N. C., is from Dr. Hoskin's place. It is a subsoil at from 5 to 30 inches. It contains less than 3½ per cent of clay, and would therefore be called sand. It is excellent for early truck.

No. 1522, from the farm of J. G. Wood, of Edenton, N. C., is a subsoil at from 8 to 30 inches, and contains about 16 per cent of clay. It is overlaid by a loam soil, but is rather too heavy for truck. It would probably make good cotton land.

No. 1517 is a subsoil at from 5 to 30 inches, and is from the farm of J. L. Rhems, of Newbern, N. C. The soil is a light sandy loam and well adapted to truck.

No. 1510 represents the type of earliest truck land on Hackburn & Willett's farm, Newbern, N. C. Its texture is too light for cabbage, but is excellent for potatoes. Crops ripen from four to eight days earlier on these lands than on the heavier cabbage lands, and, with proper attention, two weeks earlier than at Norfolk.

No. 1514 is also from Hackburn & Willett's farm, and represents the subsoil at from 14 to 30 inches of the cabbage and spinach land. This type of land averages from 200 to 225 barrels of cabbage per acre.

No. 1515 represents the texture of the subsoil below 3 feet, underlying both the early truck and cabbage lands.

The subsoils are given here because it is upon their texture that the character of crops is mostly determined. The complete mechanical analyses of all the foregoing samples are found below.

TABLE A.—*Mechanical analyses of subsoils.*

No.	Locality.	Description.	Gravel (2-1 mm.).	Coarse sand (1-0.5 mm.).	Medium sand (0.5-0.25 mm.).	Fine sand (0.25-0.1 mm.).	Very fine sand (0.1-0.05 mm.).	Silt (0.05-0.01 mm.).	Fine silt (0.01-0.005 mm.).	Clay (0.005-0.001 mm.).
			P. ct.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
1599	Virginia	Ballantine	0.00	2.67	25.17	5.12	10.16	31.45	8.88	14.35
1601	do	do	0.00	0.27	42.12	12.96	6.63	20.20	4.79	8.88
1595	West Norfolk, Va	Henry Kirn	0.00	1.42	23.27	38.25	7.51	15.14	5.90	7.15
1593	do	Wm. Wise	0.00	0.64	24.00	41.03	5.71	11.54	7.33	8.40
1579	35th milepost, North Carolina.		0.00	0.00	0.00	0.55	24.11	33.33	11.06	24.72
1570	Camden, N. C		0.00	2.46	5.17	19.79	33.53	19.69	7.11	10.35
1571	do		0.00	0.00	2.28	3.15	46.50	20.54	5.64	16.82
1520	Elizabeth City, N. C	W. M. Baxtor	0.00	0.00	4.98	8.87	44.97	19.20	5.88	13.62
1519	do	do	0.00	0.00	2.07	4.75	39.16	30.04	6.27	14.37
1566	do	Dr. E. F. Lamb	0.00	0.00	4.94	6.11	43.61	25.73	7.27	9.20
1540	Chapanoke, N. C., 2 miles south.		0.00	0.00	1.49	6.32	20.35	36.78	7.43	25.58
1542	Chapanoke, N. C., 1 mile south.		0.00	0.00	7.68	41.77	13.05	18.92	5.03	12.37
1558	Durant Neck, N. C	Leigh farm	0.00	0.00	0.00	0.20	38.03	29.54	8.17	22.15
1534	Hertford, N. C	C. S. Wood	0.00	0.00	6.37	68.34	9.67	7.55	2.35	6.47
1522	Edenton, N. C	J. G. Wood	0.00	1.13	6.11	20.58	27.82	18.37	7.79	15.85
1524	do	Dr. Hoskin	0.00	0.00	4.74	36.16	38.71	10.27	4.18	3.40
1517	Newbern, N. C	J. L. Rhems	0.00	3.91	22.60	29.03	22.38	7.03	3.16	10.32
1510	do		0.00	0.30	6.04	49.63	32.39	6.24	1.93	2.80
1514	do	Hackburn & Willett.	0.00	2.04	10.57	10.65	22.75	30.22	8.95	13.12
1515	do	do	1.19	8.09	29.69	16.11	11.43	14.36	2.53	13.55

THE WOODED SWAMPS.

The data for the following discussion were obtained in the Dismal Swamp proper, although what is said of the great morass will apply with equal force to the soils of other forested swamps in the region.

ORGANIC MATTER.

The accumulation of partially decomposed vegetable matter in this area is quite remarkable, being more than 3 meters (10 feet) in depth over considerable areas. With Congo-red test paper it shows a strongly acid reaction. It is the product of many centuries of vegetation, laid down little by little with practically no disturbance, so that there is only the slightest trace of soil in much of it. Upon ignition at a low red heat 94 per cent of it passes off as combustible material. Two leading types of vegetable deposits are easily distinguishable—those of the "Juniper" or "light" Swamp and those of the "Black Gum" or "dark" Swamp.

The first, a true peat, is found in the extensive tracts which are or were covered with the "juniper" or white cedar. Here the maximum thickness of the deposits appears to be about 3 meters (10 feet). Decomposition has progressed very little in this case. The peat consists of a reddish-brown mass of stringy consistency and is composed in great part of the wood, bark, and leaves of the "juniper." Owing to the antiseptic quality of the water, logs and even stumps *in situ* are so well preserved in this peat that when exhumed they often make valuable timber. When juniper land is cleared and drained the surface peat has a strong tendency to "cake" and harden beneath the sun's rays until it resembles charred wood. Consequently, juniper land is considered practically worthless, and its successful cultivation would undoubtedly entail a very heavy preliminary outlay.

While peat is used in the northern countries of Europe as fuel, all attempts to bring it into use in this country have been failures. Peat has a very great power of holding water. Being much like a sponge in texture, it will hold from two to ten times its own dry weight of water. Wet peat upon losing its water and becoming dry usually contracts to one-half or even less of its former volume. In New England peat is used in the compost heaps, and in this way becomes a manure of considerable value. The amount of plant food it contains is often small, but varies much with the nature of the vegetation from which it originated. The peat of the Dismal Swamp being largely from trees ought to be fairly valuable. Its greatest usefulness, however, will probably be in the physical effect that it will produce in the soil. Many soils are sadly deficient in humus, and for supplying this peat will do quite well. It is a question if much of this peat of the swamp could not be economically used on the very sandy truck farms, many of which are located within a short distance of the swamp. The principal part of the transportation could be cheaply made by water. The value of peat for this purpose could be experimentally determined at a very small outlay.

The second type of deposited vegetable matter has been laid down in those portions of the morass, especially around Lake Drummond,

BRUSHES OF PALM LEAF AND GRASS.

which bear a forest of black gum, cypress, and red maple (Pl. LXVII). In places the beds reach a thickness of 3, or even, according to Prof. N. B. Webster,[1] of 4½ meters (10 to 15 feet). The color is black. Decomposition has here progressed further than in the "juniper" deposits, and the black gum type is to be regarded as a form of humus, rather than of peat. When cleared and drained, black gum lands afford a rich, mellow top soil, which differs markedly from the stub-born juniper lands in being tractable and easily worked.

The following are determinations of the percentage of organic or combustible matter in such soil at each of three depths:

Per cent organic matter in soils.

Depth.	Virgin soils.	Soil cultivated 20 years.	Soil cultivated 50 years.
cm. 0–50 in. 0–20	13.10	6.90	5.10
cm. 50–100 in. 20–40	3.30	2.40	2.10
cm. 100–150 in. 40–60	1.90	1.40	1.00

This table shows that the largest part of the organic matter occurs in the upper 20 inches and that it decreases in amount for each succeeding 50 centimeters (20 inches) in depth. It furthermore shows, as one would naturally suspect, that the virgin soil contains more organic matter than that under cultivation, and that the longer the time of cultivation the smaller the content of organic matter. This holds true for each of the three depths, although the maximum change is in the upper 20 inches. Yet, even where cultivation has been continued for fifty years, the soil still has enough organic matter to give it a black color. In some places this black color extends into the second 20 inches, but is usually absent, the second and third 20 inches being ordinarily of a yellowish color. This abundance of organic matter is of great importance since it (1) furnishes a large amount of nitrogenous plant food, (2) increases the water-holding capacity of the soil, and (3) by its black color increases the power of the soil to absorb heat. The increased power to absorb heat is no doubt more than overcome by the cooling tendency of the increase in water content, due to the organic matter. From the standpoint of the early trucker this reduction in temperature would be a serious objection, because it would retard the maturity of his crops and throw them on the market when prices are usually much reduced. Aside from this objection, however, the organic matter is of great value.

ACIDITY.

The virgin soil is invariably very acid, doubtless because of the enormous accumulation of vegetable matter and the consequent

[1] Am. Naturalist, vol. 9, p. 260 (1875).

retardation of the drainage. Aeration of the soil is necessarily very imperfect under such conditions. It is the experience of farmers in the region that new fields when brought under cultivation are much benefited by liberal applications of lime. Even after being cultivated for twenty years the soils are still slightly acid and would doubtless be improved by further treatment with lime. Lime neutralizes the acids, and this is undoubtedly the principal advantage of its use on swamp soils. It is usually applied here in the form of burnt shells, about one ton per acre being the amount used on the swamp soils. The total cost of adding to the land this quantity of lime is estimated at about $4.50 per ton.

Portions of the swamp on which "juniper" abounds are of very little value agriculturally, and since even the waters flowing from these parts of the swamp are strongly acidified it may be that the presence of large amounts of acid is one of the causes of this non-productiveness. Whatever the cause of the acidity, it is gradually reduced when the soil is drained and exposed to the air, so that decomposition can proceed.

CLAY CONTENT.

The distribution of the clay content of these soils, as shown by the following table, is very interesting:

Per cent of clay in soils.

Depth.	Virgin soils.	Soil cultivated 20 years.	Soil cultivated 50 years.	Mean.
cm. 0-50 / in. 0-20	11.60	11.10	7.80	10.17
cm. 50-100 / in. 20-40	23.35	18.65	18.40	20.13
cm. 100-150 / in. 40-60	16.65	16.50	12.35	15.17
Mean....	17.20	15.42	12.85	.....

It will be seen that the per cent of clay at 0 to 50 centimeters (20 inches) is in each soil less than at either of the other depths, while at 20 to 40 inches it is greatest. This is a very fortunate distribution of the clay content for this particular region. The mean clay content of 10 per cent at 0 to 50 centimeters gives a texture that is very easy of cultivation and one that can be cultivated very soon after rains without injury to the structure of the soil. On the other hand, when taken in connection with its high per cent of organic matter and the character of the succeeding 20 inches in depth, it is sufficiently heavy to be adapted to a fairly wide range of crops.

The mean clay content of 20 per cent at 50 to 100 centimeters (20 to 40 inches) is just twice that of the surface 20 inches and gives a texture sufficiently heavy to be subject to but little leaching. This will prevent any considerable loss of plant food that is now present or that

VIEW IN THE BLACK GUM SWAMP.

may in the future be added in the way of fertilizers. It also gives a stratum with sufficient capillary power to draw water from a considerable depth below, which would be of great value in times of drought.

The mean clay content of 15 per cent at 100 to 150 cm. is just midway between that of the first and second 50 cm., and is not sufficient in quantity to prevent a fairly free lateral movement of the ground water at this depth. This is very important, since the success of underground drainage depends largely upon the free lateral movement of ground water at about the depth at which tile drains are usually laid. The whole of the Dismal Swamp area will require thorough underdrainage before it can be brought to a high state of cultivation, hence the importance of the texture of the soil at this depth. The clay content of a soil, when coupled with its organic matter, is the controlling factor in relation to its structure and water capacity.

TEXTURE.

The table on page 358 gives a complete mechanical analysis of eleven samples of soils from the Dismal Swamp, one from West Norfolk, and one from Illinois. As may be seen from the mean of the first nine analyses, the soils of the swamp to a depth of 1.5 meters (5 feet) contain, on an average, approximately 50 per cent of fine sand, the particles of which range from one-fourth to one-tenth of a millimeter in diameter. The next largest separation is that of clay, of which we have already spoken. These analyses show that the soils would properly be classed as sandy vegetable loam. The light texture of the upper 20 inches makes the soil easy of cultivation, and fields that have been in crops annually for fifty years are still in the best of mechanical condition.

Only two samples were taken below 3 meters (10 feet) in depth, and those show considerable difference in texture. No. 3928 was material taken from the bottom of the canal by the dredge, and had been exposed to the weather upon the canal banks for some time. It is not at all improbable that the rains had carried away most of its silt and clay, which may account for the small amounts of these separations shown in the analysis. Sample No. 3933, however, has a much less amount of fine sand and much more of medium and coarse sand.

Sample No. 302 is black prairie soil from Illinois, where underground drainage is practiced on a large scale in preparing land for the production of corn, grass, and wheat. A comparison of its texture with that of the soils of the Dismal Swamp shows the latter to have half as much clay as the former, and approximately one-fourth as much fine silt and silt. For thorough drainage in the prairie soils the lines of tile drains are seldom laid nearer than 150 feet from each other, and, judging from the comparative texture of the two soils, successful drainage could be accomplished in the swamp soils by having

the lines of drains 300 feet apart. In fact, experience shows that open ditches 4 feet deep and 300 feet apart afford ample drainage for the swamp soils from which the above analyses were made. Underground tile drains could be used at intervals equally great with as good success, and would have many advantages over the open ditches, which will be spoken of under the head of drainage.

Sample No. 357 is from the finest truck land near West Norfolk, and is here introduced for comparison with the swamp soils in order that we may judge of their fitness for early trucking. Excepting the organic matter, the two soils are very similar in texture when we compare them at corresponding depths. The swamp soil has approximately five times as much organic matter as the truck soil, which, together with its slightly greater amounts of clay, silt, and very fine sand, gives it an appearance very different from the latter.

The slightly heavier texture, together with the high per cent of vegetable matter, very much increases the water-holding power of the swamp soil, and as a result makes it colder in the early season. This promises crops of larger growth, but they will be much later in maturing, and since earliness is the chief factor on which the success of the trucker depends, this soil can not be expected to compete successfully with that about West Norfolk in truck crops, except in case of a few crops where earliness brings no particular advantage, as in the case of late potatoes, cabbage, and celery. These crops could certainly be grown at less expense for fertilizers and no greater expense for cultivation and marketing than those of the famous truck areas. When drained and put in a good state of cultivation, there is no doubt that a large portion of the swamp area would be well suited to the growth of celery. With a minimum amount of drainage, the borders of the swamp might be used for the growing of cranberries and the water from the interior used to flood them.[1]

For special crops, to which the swamp soil is adapted, much of it could doubtless be economically used. In order to succeed, it would of course require good business ability and a knowledge of the requirements, management, and marketing of the crop to be grown. There is no doubt that the swamp soils, under proper treatment, will prove very valuable for those crops to which the environment as a whole is favorable. When thoroughly drained, swamp soils in general are among the most productive and lasting. With the present demand for lands, it is a question if it would prove profitable to deforest and drain the whole of the swamp area, though it could be done at a moderate expense. The value of the timber removed would, in part at least, pay the expense of its removal. By drainage sufficient to lower the water 12 to 18 inches below the surface fire could be used as a means of destroying the timber, and at times of drought considerable por-

[1] The cultivation of celery in the region, as well as the possibilities of cranberry growing, are discussed under the head of "Agricultural products."

tions of the peat could no doubt be burned if so desired. After drainage the change in the character of the area would be very great. The peat would contract to a very much smaller volume in losing water, and would oxidize to a considerable extent.

WATER.

The water of Lake Drummond and, in fact, all water in the swamp is amber in color, and, after very heavy rains or unusual agitation, is quite turbid. For the most part it is slightly acid, and when issuing from areas where the juniper abounds, is markedly so. The water often tastes of the wood of cypress or juniper, and is said to have remarkable preservative properties. It is noticeable that there are none of the offensive odors in the Dismal Swamp which are so common about fresh-water swamps or ponds elsewhere, e. g., in the prairie region. Formerly the water from the swamp was barreled and used in ship voyages across the ocean. The movement of the water in the swamp is very slow, being greatly impeded by the dense growth and the great accumulation of peat. When the land is cleared of vegetation, however, it is easily drained. The subsoil, being sandy, admits of quite rapid movement of the water.

DRAINAGE.

The labor expended in the past in draining areas around the periphery of the Dismal Swamp would, if directed with regard to the best present-day systems of drainage, have sufficed to drain the whole of the area. The old drainage systems now in use were planned by each owner for himself, without any relation to a general scheme of drainage. There are many miles of open ditches, most of which were completed before the middle of the present century. Their construction was made at an enormous outlay, and the annual expense of removing the vegetation and soil that accumulates in them each year is considerable. At least 90 per cent of these open ditches could as well be replaced by underground drains of tile, only the larger or main ditches being left open. By means of underground drains the annual expense of clearing ditches would be done away with. The additional cost would be that of the tile only, and, indeed, this would be partially offset by the smaller amount of excavating required. A ditch to receive tile needs to be no wider than is required for the digger to work advantageously, and its sides may be perpendicular, while a ditch which is to remain open must be several feet wide at the top in order that the sides shall not cave and fill the ditch. This greater width may more than double or treble the amount of excavation required, which would largely offset the cost of tiles and, in the case of small tiles, might exceed their entire cost. Then, again, the tile drains can be laid in any direction,

without conforming to the shape of the fields, and better drainage may be secured with shorter ditches than would be the case with open ones which have to follow the borders of fields. This also may reduce the amount of excavating.

By the use of tiles all open ditches excepting main ones are done away with. Instead of many small fields, bounded on all sides by deep ditches, entailing much turning with teams and implements in the process of plowing and cultivating the crop, the whole farm may be in a single field. The small fields are accessible at one point only by means of a bridge. The ditches occupy much land and afford a harbor for weeds and noxious plants, which have to be cut down annually and removed at much expense.

A farm of 800 acres on the west side of the Dismal Swamp canal has open ditches every 400 yards one way and every 100 yards the other. This makes each of the small fields contain about 8 acres. There would be 100 of these fields in the whole farm, and the length of ditches would therefore be 50,000 yards, or 28 miles. Assuming that the width of land taken up by a ditch and its borders is 1 rod, which is about the average, 56 acres would thus be occupied and would produce nothing but weeds. This amounts to 7 per cent of the farm.

The whole of the swamp is susceptible of drainage. As it has an adequate fall for an artificial flow of waters and a subsoil sufficiently sandy to admit free movement of water, the tiles need not be nearer to each other than 300 feet. The vegetable matter in the soil would prevent the banks of the necessary open ditches from caving badly.

During the last two years the Dismal Swamp canal has been considerably deepened, and all locks except one at each end have been removed. The water, therefore, now stands some 6 feet lower than it formerly did, and this will afford ample outlet for all of the district west of it. By running tributary ditches west from the canal at intervals of every 2 miles and extending them back to near the Nansemond Escarpment, a distance of about 10 miles, the whole of this area could be easily drained. These tributary ditches should be 8 or 10 feet wide where they enter the canal and of a depth of 2 or 3 feet below the level of low water in the canal. It might be advisable to have here and there smaller ditches tributary to these main ones, owing to some local peculiarity in the lay of the land, but most likely the entire remainder of the drainage could be done by tiling.

It is somewhat a question if, with the present demand for agricultural lands, it would pay to deforest and drain these swamp lands to be used in producing corn, as the redeemed portions are at present largely employed. It would hardly seem probable that this region could compete with the corn States of the Ohio and Mississippi valleys, where the land is easily brought under cultivation and the best methods and machinery are used in its production. Nevertheless, as

far as experience goes, the swamp soils are capable of producing as large yields of corn as are the prairie soils of the Mississippi Valley, and the climatic conditions as a whole are more favorable than is the case in the latter territory. Owing to its close proximity to the ocean the Dismal Swamp has a longer growing season. Then again the normal monthly rainfall for the summer months is about 30 per cent greater than in the Mississippi Valley. The following table shows the normal monthly precipitation in inches for the two region compared:

Comparison of precipitations.

Place.	Number years.	Apr.	May.	June.	July.	Aug.	Sept.	Total.
Norfolk, Va	26	4.3	4.2	4.4	5.8	6.3	4.7	29.7
Peoria, Ill	41	3.2	3.8	3.7	4.0	3.0	3.5	21.2
Keokuk, Iowa	24	3.2	4.1	4.5	4.1	2.8	3.5	22.2

The month of August in the Mississippi Valley is most frequently the dry month that cuts short the crop. From the table it will be seen that on an average Norfolk, which is but a few miles north of the swamp, has more than twice as much rain in August as have the places in the Mississippi Valley. Furthermore, the water table is so near the ground surface and the subsoil is so light in texture that with good methods of cultivation drought is almost unknown in the Swamp region. This insures a good crop every year, while in the Mississippi Valley there is a shortage in the corn crop on an average once in every three years, due to insufficient moisture in the soil. This gives a great advantage to the swamp lands.

Again, the Dismal Swamp is at the very door of a magnificent seaport where produce can be loaded on ships for transportation to almost any point in the world. Since the transportation canal runs through the swamp produce could be taken almost immediately from field to boat and transported in this way to any of our Eastern cities, Baltimore, New York, Philadelphia, or Boston. The expense of transportation would be considerably less than by rail from the Mississippi Valley to any of these cities.

Upon careful study it will be found that the location, climate, and soil of the swamp are such as to give it many advantages, even for the production of a great staple like indian corn. The soil, being sandier than that of the prairies, is more easily cultivated. On the other hand, when we consider the superior facilities for transportation, it is clear that there is much to be said in favor of more intensive farming on land reclaimed from the Dismal Swamp. Potatoes, cabbage, and celery are crops that do well on such land; and, with proper management, they could undoubtedly be made profitable here.

SOIL ANALYSES.

TABLE B.—*Mechanical analyses of soils and subsoils.*

No.	Locality.	Description.		Moisture in air-dry sample.	Organic matter.	Gravel (2–1 mm.).	Coarse sand (1–0.5 mm.).	Medium sand (0.5–0.25 mm.).	Fine sand (0.25–0.1 mm.).	Very fine sand (0.1–0.05 mm.).	Silt (0.05–0.01 mm.).	Fine silt (0.01–0.005 mm.).	Clay (0.005–0.0001 mm.).
			Inches.	*P.ct.*	*P.ct.*	*P.ct.*	*P.ct.*	*P.ct.*	*P.ct.*	*P.ct.*	*P.ct.*	*P.ct.*	*P.ct.*
3921	1 mile west of Wallaceton, Va.	Virgin soil	0-20	1.72	13.10	T.	1.28	2.75	34.15	19.78	10.01	5.21	11.60
3922			20-40	1.24	3.30	T.	.20	1.45	34.05	20.23	10.93	4.83	23.35
3923	Edge of swamp.		40-60	.96	1.90	....	.15	2.00	47.30	19.25	7.95	3.03	16.65
3929	Wallaceton, Va., 300 yards west of Dismal Swamp Canal.	In corn for 20 years continuously.	0-24	1.32	6.90	T.	.95	7.75	50.53	8.68	7.70	4.42	11.10
3930			24-44	1.22	2.40	T.	1.13	5.63	50.13	9.15	7.61	3.96	18.65
3931			44-60	1.00	1.40	T.	.63	4.88	58.10	8.78	4.82	2.82	16.50
3924	Wallaceton, Va., 100 yards east of Dismal Swamp Canal.	In corn for 50 years continuously.	0-21	.84	5.10	T.	1.15	7.25	54.45	8.20	10.68	3.16	7.80
3925			21-40	.97	2.10	T.	.90	6.40	48.38	6.15	12.13	3.35	18.40
3926			40-60	.97	1.00	T.	.50	3.25	67.95	8.80	2.80	1.05	12.35
	Mean of above.			1.14	6.13	T.	.77	4.60	49.45	12.11	8.29	3.65	15.16
357	West Norfolk, Va.	Finest truck land, 9–18 inches.		.56	1.66	0.04	.46	18.26	53.83	5.84	6.03	4.39	8.78
302	Champaign, Ill.	Prairie soil		....	....	1.04	1.98	6.85	6.23	5.82	28.38	15.46	30.00
3928	Wallaceton, Va., 1 mile north.	Sand dredged from canal, 10–14 feet.		.17	.20	....	.40	1.73	79.00	16.25	.82	.07	.15
3933	Lake Drummond, Virginia.	Sand bored from bottom of feeder 12 feet deep.		.48	2.12	T.	6.79	30.69	15.07	15.32	6.03	3.46	11.62

THE PLANT COVERING OF THE REGION: ITS PHYSIOGNOMY AND ECOLOGY.

One of the most important functions of plant geography is the description of the vegetation of each floral region as it actually occurs in nature, apart from the systematic relationships of the species and the historical-geographical affinities of the whole flora. A word picture is given of the facies or physiognomy of the plant covering as a whole, and of the various assemblages of species—formations and associations—which occupy the different soils, overlying the several geological formations. In the Dismal Swamp region, owing to the uniformity of its geology and the comparatively slight physical and chemical differences of its soils, the principal factor in effecting a differentiation of the plant formation is the nature of the drainage. Only the plant growth of areas bordering immediately upon salt water is affected to any great extent by the chemical composition of the soil. Elsewhere it is chiefly a question of whether the substratum possesses a greater or less water content.

In order to an intelligible description of the physiognomy, a classification of the several plant assemblages of the region is necessary. The following arrangement appears to be, on the whole, the most simple and logical. It must not be supposed that the natural limits of the formations and associations are sharply defined. On the contrary, between neighboring assemblages there is usually a debatable ground, which might be reckoned to either. Thus the forests of the plain pass by insensible gradations into the xerophile woods of the inner strand on the one hand, into hygrophile forest or wooded swamp

on the other. Between the dry sand strand and the wet salt marsh there is almost invaribly a neutral belt, and so in most other cases. Nevertheless, the plant formations are well-marked features of the landscape, that can be recognized by any traveler. Indeed, next to the water courses, the plant formations are the most important elements in the landscape of the flat Coastal Plain.

In the following discussion of the plant formations of the Dismal Swamp region, their physiognomy and taxonomic composition, with special regard to abundant and conspicuous species, are first described. Then follows, under the head of each formation, or formation class, a sketch of the more prominent ecological characteristics, preceded by a discussion of the life conditions. What may be termed biological forms—in contradistinction to systematic forms—and, in general, the more obvious adaptations to environment, are briefly treated. The ecology of the sand strand and of the palustrine forest is discussed at greatest length, because in these formations life conditions are extreme, and adaptations thereto are numerous and easily detected. This is likewise the case with the salt marsh and the aquatic formations, but here most of the biological, like the taxonomic forms, are of wide distribution on the surface of the globe, and have been described in many other publications. Hence it has seemed advisable to treat these formations more briefly. The sand strand and the salt-marsh formations of the North Carolina coast were described in an earlier paper;[1] and as the species, especially of the salt marsh, are largely those that occur on the Virginia coast, climatic and other conditions of the environment being likewise nearly identical, the following descriptions of the formations in Virginia may be regarded as in part supplemented in the paper cited:

The following is a synopsis of the formations and associations which are easily recognizable in the plant covering of the Dismal Swamp region:

Maritime formations.
- Salt-marsh formation.
  - Spartina stricta association.
  - Juncus roemerianus association.
  - Typha association.
  - Spartina patens association.
  - Baccharis-Hibiscus association.
- Sand-strand formations.
  - Beach and outermost dunes—Ammophila-Uniola association.
  - Middle (open) dunes.
    - Dry soil—Myrica association.
    - Wet soil, dune marshes—Juncus dichotomus association.
  - Inner (wooded) dunes.
    - The high dunes—Quercus virginiana association.
    - The strand pine woods.

[1] T. H. Kearney, Contributions from the National Herbarium, vol. 5, No. 5.

Inland formations.
Nonhygrophile formations—The wooded or artificially deforested plain.
Forest formations.
Mixed forest.
Pine barrens.
Cleared-land formations (noncultural).
Arboreous (trees that have survived the forest).
Shrubby (thickets and hedges).
Herbaceous.
Cultural formations.
Field crops.
Garden vegetables.
Cereals.
Cotton.
Forage plants.
Other crops.
Cultivated trees.
Orchards.
Shade trees.
Weeds.
Cultivated land.
Waysides.
Ruderal plants.
Fresh-water formations.
Hygrophile forest.
Black gum swamp.
Open or light swamp.
Juniper forest association.
Ericaceae (shrubby) association.
Canebrake (Arundinaria) association.
Woodwardia-Sphagnum association.
Fresh-water marsh formations.
Reed-marsh formation.
Along rivers—Typha-Sagittaria association.
Edge hygrophile forest—Scirpus-Erianthus association.
Low marsh formation—Rynchospora-Elecocharis association.
Aquatic.

MARITIME FORMATIONS.

SALT-MARSH FORMATIONS.

What may be designated the "creek marsh" is a conspicuous element in the topography of the region. It occurs usually as a narrow strip bordering tidal streams up to the point where the water ceases to be brackish, but not infrequently covers wider areas in lagoons and bayous. The vegetation of the creek marsh is chiefly reed-like and very dense. The species composing it are halophile or salt-loving plants, most of which are only occasional in other situations. They are also limnophile, i. e., prefering a clay or mud bottom. Toward the upper limit of saline water the salt-marsh area becomes gradually narrower, and its species fewer, while plants characteristic of fresh-water marshes mix with the halophytic species, finally replacing them

entirely. Thus, just above that point on the Nansemond River near Suffolk where the water begins to be normally fresh, *Spartina polystachya* and *Scirpus americanus* are the only remaining salt-marsh species, and such normally fresh-water plants as *Sagittaria lancifolia*, Pontederia, *Polygonum hydropiperoides*, *Typha latifolia*, and *Zizania aquatica* form the bulk of the association at the water's edge. It is probable that the last-named group of species can endure brackish water at times, while, on the other hand, as Contejean has shown,[1] most "salt-loving" plants are not really dependent upon the presence of salt in their substratum. It is probable that some salt-marsh species find the silty or clayey soil of the marshes, which is rich in

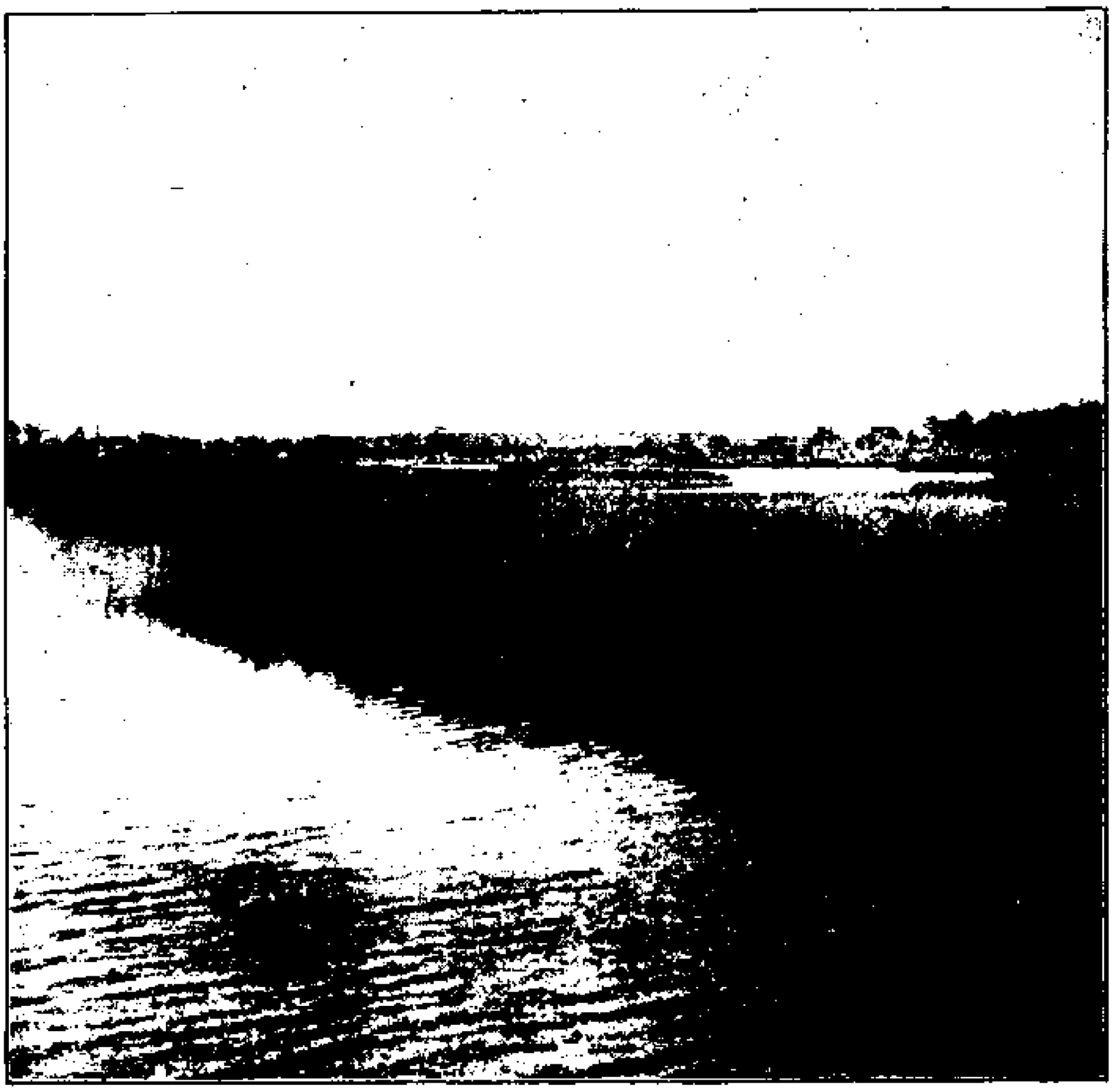

FIG. 57.—Salt marsh covered with *Spartina stricta maritima*.

organic matter, more indispensable than the sodium chloride which it contains.

Several associations of species, in each of which one species almost always strongly predominates, may be distinguished in the salt-marsh formation, although here as elsewhere sharp lines can rarely be drawn. The most important of these will be noted.

Spartina stricta association.—This assemblage, in which thatchy grass, *Spartina stricta maritima*, is often the only, and always by far the most important species, occupies the immediate edge of the water along creeks and estuaries, sometimes as a mere fringe, sometimes covering areas of considerable width (fig. 57). It prefers places

[1] Géographie Botanique, p. 94.

where the tidal range is marked, so that a large section of the stem is under water at flood, and here it grows usually to a height of about 1 meter (3 to 4 feet). Its papery lower leaf sheaths, persistent at the base of the stout culms, form a close-fitting envelope which serves admirably as a protection against the water (fig. 58). The color of the Spartina is a fine bright green, turning to brown as the end of the growing season approaches. Among the secondary members of the association the succulent, almost leafless, annual glasswort (*Salicornia herbacea*) is most important. It is especially conspicu-

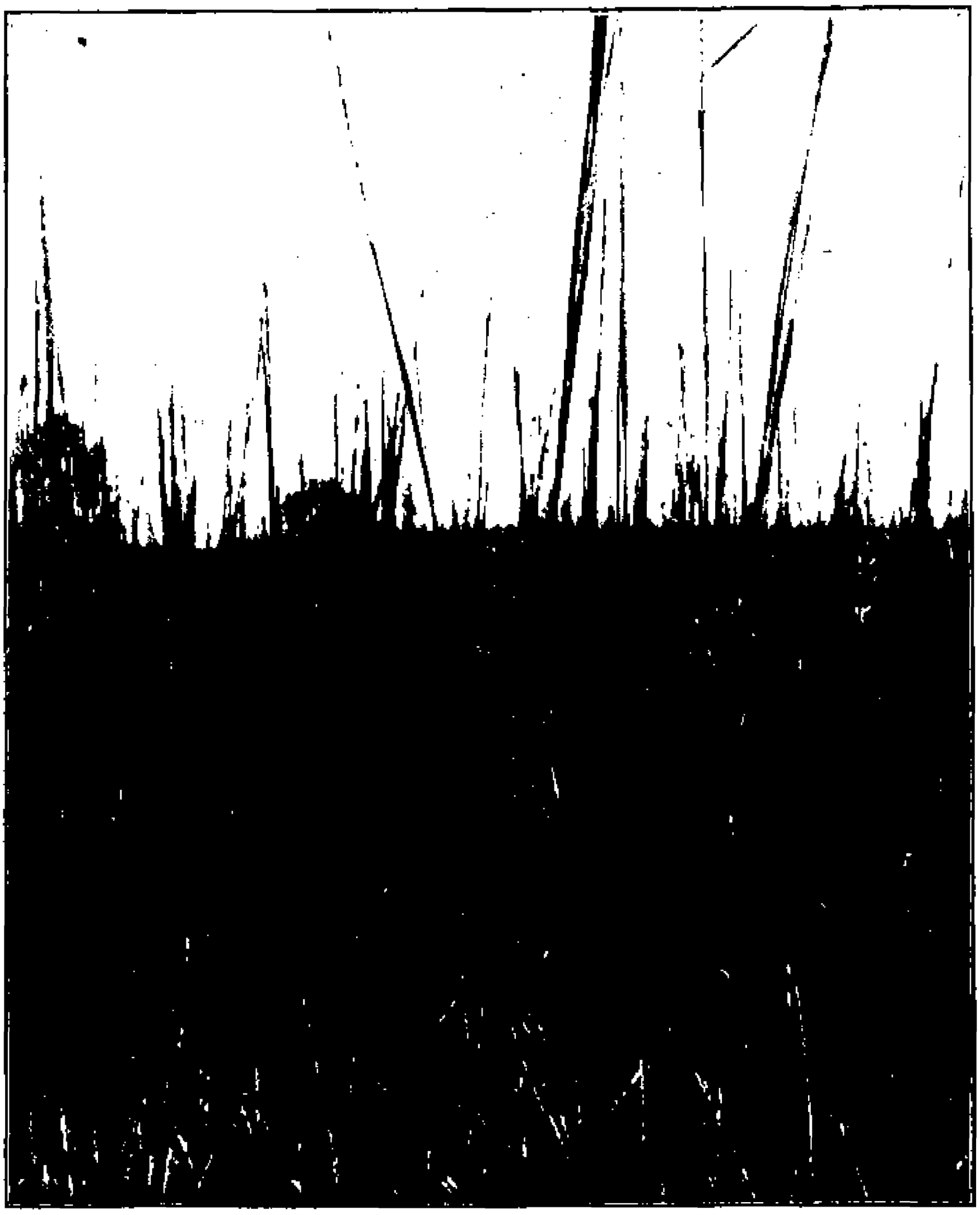

FIG. 58.—*Spartina stricta maritima.*

ous when, as often happens in the fall, the whole plant becomes bright red.

Juncus roemerianus association.—The rush which gives character to this association is perhaps the most abundant salt-marsh plant of the region. It usually occurs just inside the growth of *Spartina stricta*, to which its dark green, almost black, color offers a striking contrast, especially in early summer. The serried stems and leaves of this Juncus, mostly 1 meter or so high, terete, stiff, and sharp-pointed, form a dense growth wherever the plant occurs, usually

covering wider areas than the Spartina and extending up to dry land. It is a plant which prefers situations that are not deeply inundated at high tide, and are left bare of superficial water, although saturated, when the tide goes out. Consequently, it is able to shelter a larger number of associates, and among its stems a majority of the salt-marsh species of the region find a congenial habitat.

Most abundant of these is the shrubby *Iva frutescens*, whose stems usually grow as high as or higher than those of *Juncus roemerianus*. Conspicuous in the autumn are the white rays of a slender, weak-stemmed, perennial Aster (*A. tenuifolius*). Less showy, but more abundant, is the usually stout annual *Aster subulatus*. *Lythrum lineare* and *Limonium carolinianum* are frequent. *Spartina patens* (a small form) and *S. polystachya* sometimes grow among the *Juncus*, and *Typha latifolia* frequently occurs in this association. At one point below Virginia Beach a somewhat peculiar assemblage of species occupies tiny pools among the Juncus growth—*Monniera* (*Herpestis*) *monniera*, *Lippia* sp. (with the leafy and flowering branches remarkably strict and slender), *Eleocharis mutata*, *Eleocharis glaucescens*, *Paspalum distichum*, etc.

Typha association.—The common cat-tail of the region is a not quite typical form of *T. latifolia*, which sometimes covers rather wide strips in nearly pure association, especially near the upper limit of brackish water along streams. Indeed, the same form is even more abundant in the fresh-water marshes, and appears to be to some extent indifferent to the presence or absence of considerable salt. It grows usually to a height of about 2 meters (6 feet).

Spartina patens association.—Very different in appearance from the other coarse-looking marsh grasses is a small, slender form of *Spartina patens* (*juncea*), which here and there forms a dense meadow-like, dark-green covering of the salt marsh, interrupting the *Juncus roemerianus* association. It is usually only 3 to 6 decimeters (1 to 2 feet) high. On Lynnhaven Bay and its branches, where this association appears to be most abundant, the grassy marsh is dotted in midsummer with the pink stars of *Sabbatia stellaris*. *Fimbristylis spadicea* occurs in some quantity, and occasional bushes of *Baccharis halimifolia* and clumps of *Panicum virgatum* vary the monotonous aspect of this association.

Other grass-like plants occasionally predominate in the salt-marsh vegetation, but are not of primary importance. *Scirpus americanus*, 6 decimeters (2 feet) or so high, sometimes forms a nearly pure association, conspicuous amid other marsh growth for its bright-green color. *Spartina polystachya*, not infrequent in other marsh associations, rarely forms small assemblages alone, for example, near the limit of navigation on the Nansemond River. It does not appear to grow so tall here as farther south, 1½ to 2 meters (5 to 7 feet) being its usual height. *Phragmites communis* is not uncommon near the

heads of bayous, but rarely makes a dense growth to the exclusion of other species.

Baccharis-Hibiscus association.—A number of species are most at home in the wet soil at the inner edge of the salt marshes, whence they stray out into the *Juncus roemerianus* or other associations. Most important of these is *Baccharis halimifolia*, a handsome shrub usually 1½ to 2½ meters (5 to 8 feet) high. In the fall this plant is one of the showiest in the region, its snow-white pappus making a brilliant contrast to the dark-green foliage.[1] No less beautiful is *Hibiscus moscheutos* (locally, "wild cotton") with its large whitish or deep rose-colored flowers, a species very characteristic of the marsh borders. *Solidago sempervirens* is abundant. Only occasional in Virginia, although common farther south along the coast, is the sea ox-eye (*Borrichia frutescens*), an interesting, Helianthus-like composite, with straggling stems 3 to 6 decimeters (1 to 2 feet) long and thickish leaves, whose exceedingly dense covering of hairs gives a glistening appearance to the seemingly smooth surface. The large clumps of *Panicum virgatum*, "switch grass," are sometimes a conspicuous feature of the marsh borders. *Kosteletzkya virginica*, a malvaceous plant with showy rose-purple flowers, is frequent and characteristic. *Willugbaeya* (*Mikania*) *scandens*, *Rumex verticillatus*, *Pluchea camphorata*, and *Atriplex hastata* are less important.

The small marshes which occupy depressions among the sand dunes contain, as would be expected, some species that are normally salt-marsh plants. The greater part of their vegetation is composed, however, of fresh marsh and of sand-strand species. For convenience, they will be described under the head of "Sand-Strand."

The general aspect of the salt-marsh vegetation is somber and monotonous, despite the occasional presence of bright-colored flowers. This is due to the overwhelming predominance of a few species of reed-like and grass-like plants. Especially from autumn to early spring, when most of these are discolored and brownish, the color tone is a dull one.

ADAPTATIONS TO ENVIRONMENT IN THE SALT-MARSH VEGETATION—LIFE FORMS.

In regarding those conditions of the physical environment which most probably affect the structure and habit of salt-marsh plants, three points present themselves at once. These are:

1. Liability to partial submersion at high tide.
2. A soft, more or less mobile substratum.
3. The presence of a relatively high percentage of common salt (sodium chloride) in soil and water.

[1] Although perhaps best developed at the edges of salt marshes, this plant is abundant in other situations, as along roadside ditches, sometimes at a considerable distance from salt water. It is also common among the dunes, in moist pine woods behind them, etc. It seems to be more dependent upon sea air than upon saline soil.

The modifications of structure which can be attributed with some degree of assurance to the action of these and other factors may be referred to three principal categories:

1. Structures preventing free access of water to submerged parts. The most striking adaptation of this class is the persistence of the basal sheaths in grasses and grass-like plants. This is beautifully exemplified in *Spartina stricta maritima*, the bases of whose culms are tightly enveloped by the closely imbricated, large papery sheaths.

2. Structures serving to hold the plant fast in the watery, incoherent soil. These take the form in most cases of long rootstocks, creeping through the mud and sending up erect leafy and flowering branches at frequent intervals. Of such character are the underground parts of the great majority of salt-marsh plants. Often, as in Typha, *Spartina polystachya*, Phragmites, and other large plants with a considerable weight to be supported, the rhizomes are very long and large. Annual plants, which are few in the salt marshes (*Aster subulatus* and *Salicornia herbacea* being the only common species), have less need of firm anchorage in the soil.

3. Structures serving to reduce the evaporation of water from the leaves, which would otherwise be excessive, as the chiefly herbaceous salt-marsh vegetation, unsheltered by large, woody plants, is directly exposed to the drying effect of the wind and to the strong light and heat of the sun. The necessity for such protection is the greater because, as is well known, roots absorb water with difficulty when it contains any considerable percentage of salts in solution, owing to the decreasing force of endosmosis when the degree of concentration of the external water approaches that of the cell sap. In order to compensate the reduced absorbing activity of the roots it is obvious that the escape of water from the upper part of the plant, especially from the leaves, where it is normally greatest, must be correspondingly checked.[1]

[1] To the plants of the salt marshes, growing in a soil that is impregnated with salt (in solution) and subject to partial or total inundation twice a day by brackish water, it is of the utmost importance that the supply of water grudgingly yielded to them by the substratum should be guarded in every possible way. But even were it easier for salt-marsh plants to absorb water, it would not be to their benefit to take it up in great quantities, for this would result in an increased accumulation in the cells of sodium chloride, which would tend to exert a disturbing and even harmful influence upon the processes of assimilation and metabolism. Some plants endure the presence of greater quantities of salt than do others, but none can continue to live after a certain limit of accumulation has been reached. Even if salt-marsh plants can, as has been suggested (Diels, in Jahrb. f. Wiss. Bot., vol. 23, p. 316. For a criticism of Diels's experiments and conclusions, see W. Benecke, Jahrb. f. Wiss. Bot. 36, 179 to 196. 1901), decompose a considerable quantity of sodium chloride by means of the organic acids in their cells and reunite its elements into less harmful combinations, a limit to this process would soon be reached if the transpiration current were as unimpeded as in most plants of ordinary, moderately moist inland soils. Consequently the difficult absorption of water, which is usually regarded as an adverse condition, would appear to be positively beneficial in the case of salt-marsh plants.

Among modifications that are probably effective in diminishing transpiration may be cited:

(*a*) Thickening of the cuticle and epidermis walls, which is exhibited, often to a high degree, by nearly all plants of the salt marsh. This thickening is often conspicuous when species of the salt marsh are compared with nearly related species from other localities, or even when individuals of the same species, respectively inhabiting the salt marsh and some other habitat, are placed side by side. A more or less pronounced roughening of the cuticle is also frequently to be detected. Its probable service to the plant will be discussed presently.[1]

(*b*) Hairy covering sufficiently dense to be of service as a protection against excessive transpiration occurs only in *Borrichia frutescens*, which has both leaf surfaces very densely covered with two to four celled hairs (each epidermis cell being thus extended by tangential division); on the under leaf surface of *Hibiscus moscheutos*, and possibly on the stellate-pubescent leaves of *Kosteletzkya virginica*, in which species, however, the hairiness is far less dense.

(*c*) Stomata, protected by being situated in furrows of the leaf surface, which are in some cases partially closed by hairs, in species of Spartina, etc.; and correlated with this—

(*d*) Leaf becoming conduplicate or involute, thus concealing the ventral surface, where all or most of the stomata lie, especially in the species of Spartina and in certain sedges.

(*e*) Leaf vertical in *Juncus roemerianus*, *Fimbristylis spadicea*, and *Typha latifolia;* nearly vertical in species of Spartina and other grasses, and in Baccharis, *Aster* spp., *Iva frutescens*, and other dicotyledons with isolateral leaves.

(*f*) Transference of the normal functions of leaves in large part to the (erect) stems, in *Juncus roemerianus*, *Scirpus americanus*, and *Salicornia herbacea*.

(*g*) Small size of the leaves, and hence of the transpiring surface, without transfer of function to the stems, in *Aster subulatus*, *Aster tenuifolius*, *Sabbatia gracilis*, *Lythrum lineare*, *Lippia* sp., *Monniera* (*Herpestis*) *monniera*, and many other species.

(*h*) Succulency: of stem (accompanied by reduction of the leaves to mere scales), *Salicornia herbacea;* of leaves (moderate), Borrichia, *Solidago sempervirens*, *Aster* spp. (in *A. subulatus* the stems are also somewhat succulent). Succulent plants lose their water much more slowly than do others, since the water tissue, the strong development of which causes the thickening of the succulent parts, gives up its supply reluctantly. This is in some cases due to the presence of a

[1] Page 389.

mucilaginous slime in the cells of the water tissue, which greedily absorbs and tenaciously retains much water.[1]

(*i*) Presence of a considerable quantity of mineral salts, especially sodium chloride, in solution in the cell sap. It is well known that the rapidity of evaporation from a given liquid surface decreases in proportion to the density of the liquid. Consequently a plant organ which holds in its cells more than the ordinary quantity of dissolved mineral substances loses by transpiration less than the ordinary amount of vapor of water. We have here another instance of the fact that while the presence of much salt in the soil is generally regarded as a circumstance wholly adverse to plant life, certain species are able to use this substance in such a way as to neutralize its own injurious action.

(*j*) Development of compact palisade tissue, usually on both surfaces of the (in such cases) isolateral leaf, in nearly all the species.

4. Adaptations to exposure to the mechanical action of the wind. The most noteworthy are (a) the prevailing biological form, i. e., the grass-like, which offer little resistance; and (b) the development of considerable mechanical tissue, notably in the grass-like monocotyledons, where this sometimes takes the form of strong peripheral groups of stereome (i. e., in the stem and leaves of *Juncus roemerianus*).

Specialized modifications for dissemination of the seeds are not numerous in the salt-marsh plants. The glumes of species of Spartina appear to be fitted to some extent to float upon the water, as is the fruiting calyx of Salicornia, with its spongy thickening. The bristles of Typha, the callus hairs of Phragmites, and the bristly pappus of the Asters, Solidago, and Baccharis, are of course adapted to carriage by the wind. Burs, winged fruits, and edible fruits appear to be almost entirely wanting.

SAND-STRAND FORMATIONS.

In Virginia, as in other parts of the world, the well-marked topographical division known as the sand strand is occupied by a sparse vegetation, in open formation, i. e., the individual plants mostly grow far enough apart to leave much of the soil visible among them. For this reason the strand sand contains an unusually small amount of underground parts of plants, and is consequently the more easily blown about by the wind. In the Dismal Swamp region this formation comprises three rather clearly defined belts. These are: (1) the beach

[1] Compare Volkens, Flora der Ägyptisch-Arabischen Wüste, p. 43. 1887. It has been suggested (Massart, Mém. Soc. Roy. Bot. de Belgique, 32, pt. 1, pp. 18, 19. 1883.) that the frequency of succulent plants among the salt-marsh vegetation is due to the fact that such plants obtain most of their water, not when the soil is covered with salt water at high tide, but when rain falls during the ebb. If this could be demonstrated, the necessity for tissue adapted to holding water for considerable and indefinite periods would be evident.

and low outer dunes, bearing a particularly sparse, almost entirely herbaceous, growth, composed of very few species; (2) the higher middle dunes (white dunes or sea dunes), with their summits often crowned with small thickets, and with a more abundant and diversified herbaceous vegetation, especially in the depressions among them; and (3) the innermost, highest dunes (gray or land dunes), which are almost always covered with pine forest.[1] In the third belt may best be included the flat, dry pine woods that almost always occur immediately behind the dunes.

BEACH AND OUTER DUNES.

The outermost line of dunes is usually only 2 meters or so above high tide, and the sloping beach between it and the water is commonly devoid of plant growth, although often strewn with sea wrack (*Zostera marina*) which has been cast up by the waves. Sometimes, however, a few plants of sea rocket (*Cakile edentula*) and of saltwort (*Salsola kali*) are found here. Rarely *Ammodenia* (*Honkenya*) *peploides* occurs. The beach is the area characteristically occupied in the Tropics by the Pes-caprae formation, which is composed of such plants as *Ipomoea pes-caprae* and *Spinifex squarrosus*.[2]

The outer line of dunes, usually less than breast-high and constantly shifting, is inhabited by certain hardy, strong-rooting plants, which send up numerous stems from their branching root stocks. Marram grass (*Ammophila arenaria*), growing usually to a height of about 6 decimeters (2 feet), is the most abundant of these (fig. 59), but not rarely gives place to small colonies of the handsome sea oats (*Uniola paniculata*) (commonly 6 to 9 decimeters, 2 to 3 feet, high), which entirely replaces Ammophila not far south of this region (fig. 60). An aromatic composite, *Iva imbricata*, forms roundish clumps of stout, nearly erect stems (usually about 6 decimeters, 2 feet, high), and is the only noteworthy bright green plant of the outermost dunes (fig. 61).

Another grass similar in habit to *Uniola paniculata* is *Panicum amarum nanus*, which is not uncommon on the outermost dunes. Its strong, widely branching rhizomes send up numerous leafy branches, but few that bear flowers. In this respect, also, it resembles Uniola and Ammophila. Each of these three grasses seems generally to grow only where the others are absent. It is not uncommon to see one small dune held by Ammophila alone and its nearest neighbor bearing only Uniola or Panicum.

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[1] At Cape Henry the very high innermost dunes are not forested, and are almost entirely bare of vegetation, the only growth being a few plants of *Ammophila arenaria*.

[2] See Schimper, Indomalayische Strandflora, pp. 77 to 84. See also p. 385 below.

FIG. 59.—Marram grass (*Ammophila arenaria*) on the dunes near Cape Henry, Va.

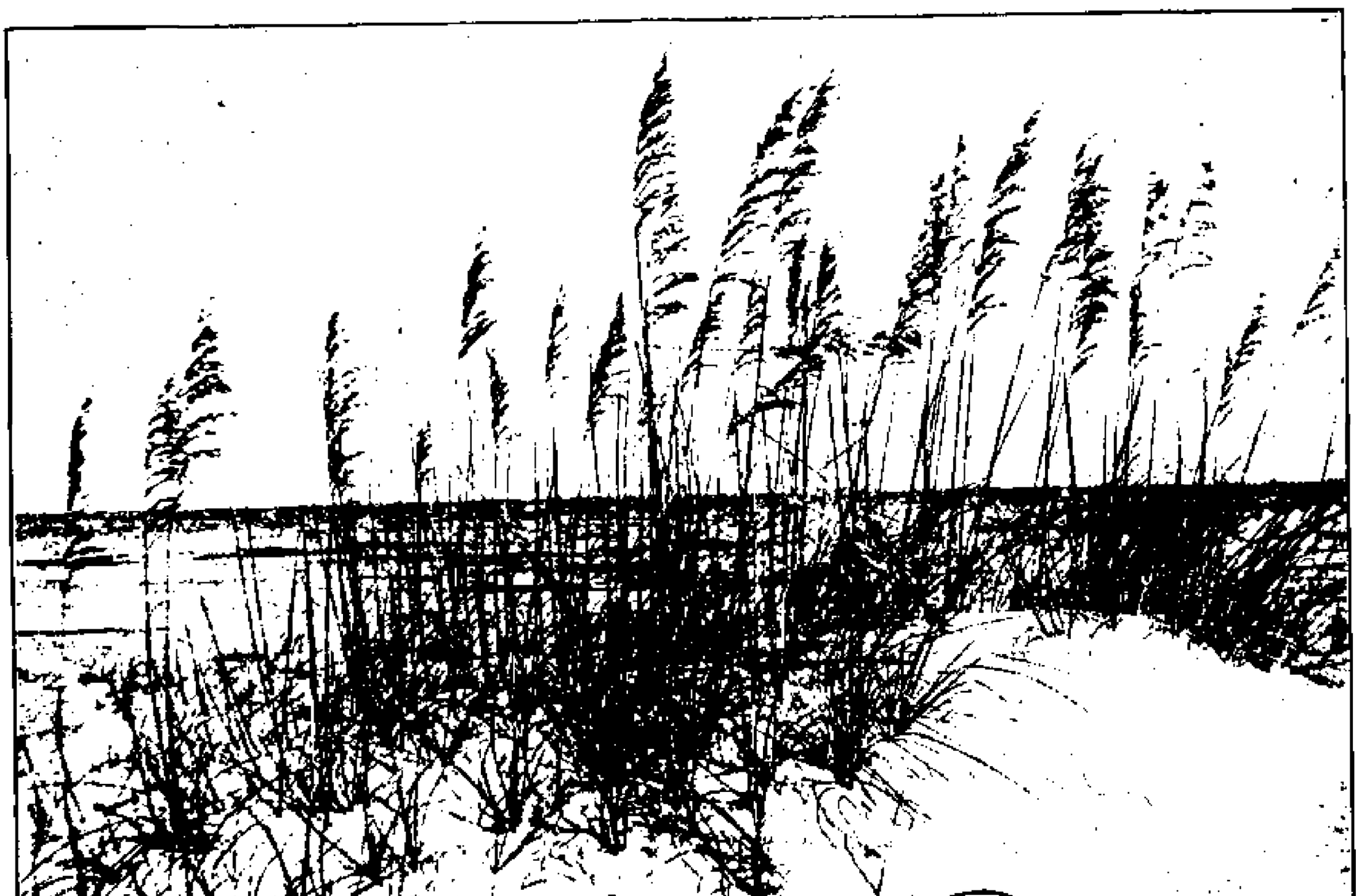

FIG. 60.—Sea oats (*Uniola paniculata*) on the dunes near Cape Henry, Va.

Cakile edentula and *Salsola kali*, both succulent annuals, attain their best development on the exterior line of dunes. The former, especially, sometimes forms large mats, with decumbent branches as much as 9 decimeters (3 feet) long and a strong taproot penetrating vertically into the sand to a maximum depth of 2 feet (6 decimeters). A stout, low-stemmed Xanthium[1] was observed only at Cape Henry, where it formed part of this association. *Oenothera humifusa*, *Euphorbia polygonifolia*, *Cenchrus tribuloides macrocephalus*, *Mollugo verticillata*, and other species which are most at home in the second belt sometimes stray to the outermost dunes. Depauperate specimens of *Myrica carolinensis*, only 3 decimeters (1 foot) or so

FIG. 61.—*Iva imbricata* on the dunes near Cape Henry, Va.

high, sometimes occur here, as do occasional specimens of other woody plants. But these are to be regarded as, in a way, accidental cases.

MIDDLE (OPEN) DUNES.

Myrica association.—Here *Cakile edentula* and *Salsola kali* frequently occur, but are not characteristic. *Uniola paniculata* and *Iva imbricata* are absent, while, on the other hand, *Ammophila arenaria* and *Panicum amarum mimus* are almost or quite as much at home as on the outermost dunes (fig. 62). In sheltered, flat places Ammophila sometimes makes a comparatively dense, almost meadow-like growth, often associated with scattered depauperate shrubs—*Myrica carolinensis*, *Quercus virginiana maritima*, *Rhus copallina* (fig. 63). The higher sand hills are often occupied by dense thickets of *Myrica*

[1] Apparently an undescribed species, nearest the European *X. italicum* Murr.

carolinensis, usually 1½ to 2 meters (5 or 6 feet), but frequently 3 meters (9 feet), high, often unaccompanied by other woody species

FIG. 62.—Meadow-like growth of Ammophila near Oceanview, Va.

(fig. 64). This plant, which is more or less at home in the drier portions of the forested plain, is, however, most characteristic as a dune

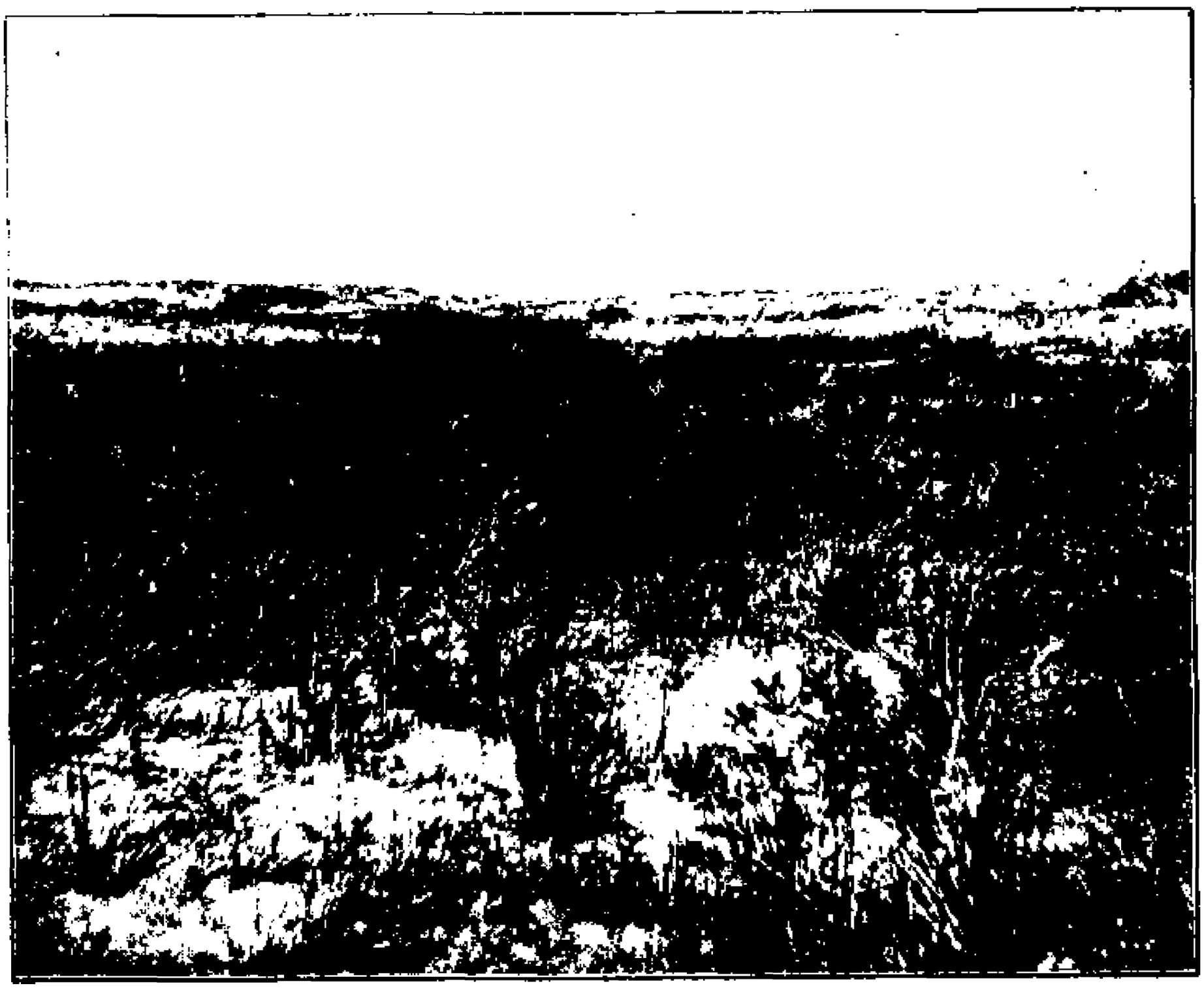

FIG. 63.—Ammophila with *Myrica carolinensis* at Cape Henry, Va.

plant, and is noteworthy as the shrub which usually occurs nearest the beach.

Other shrubs which occur on the open dunes are *Prunus angustifolia* (*chicasa*), *P. serotina*, *Diospyros virginiana*, *Salix fluviatilis* (*longifolia*), *Quercus virginiana* (*virens*), *Baccharis halimifolia*, and occasionally *Cephalanthus occidentalis* and *Platanus occidentalis*. Of these each of the two species of Prunus, as well as the Salix and Cephalanthus, sometimes form small thickets, excluding other shrubs. The occurrence of such normally water-loving plants as Baccharis, Salix, Platanus, and Cephalanthus on the summits of the dunes is a

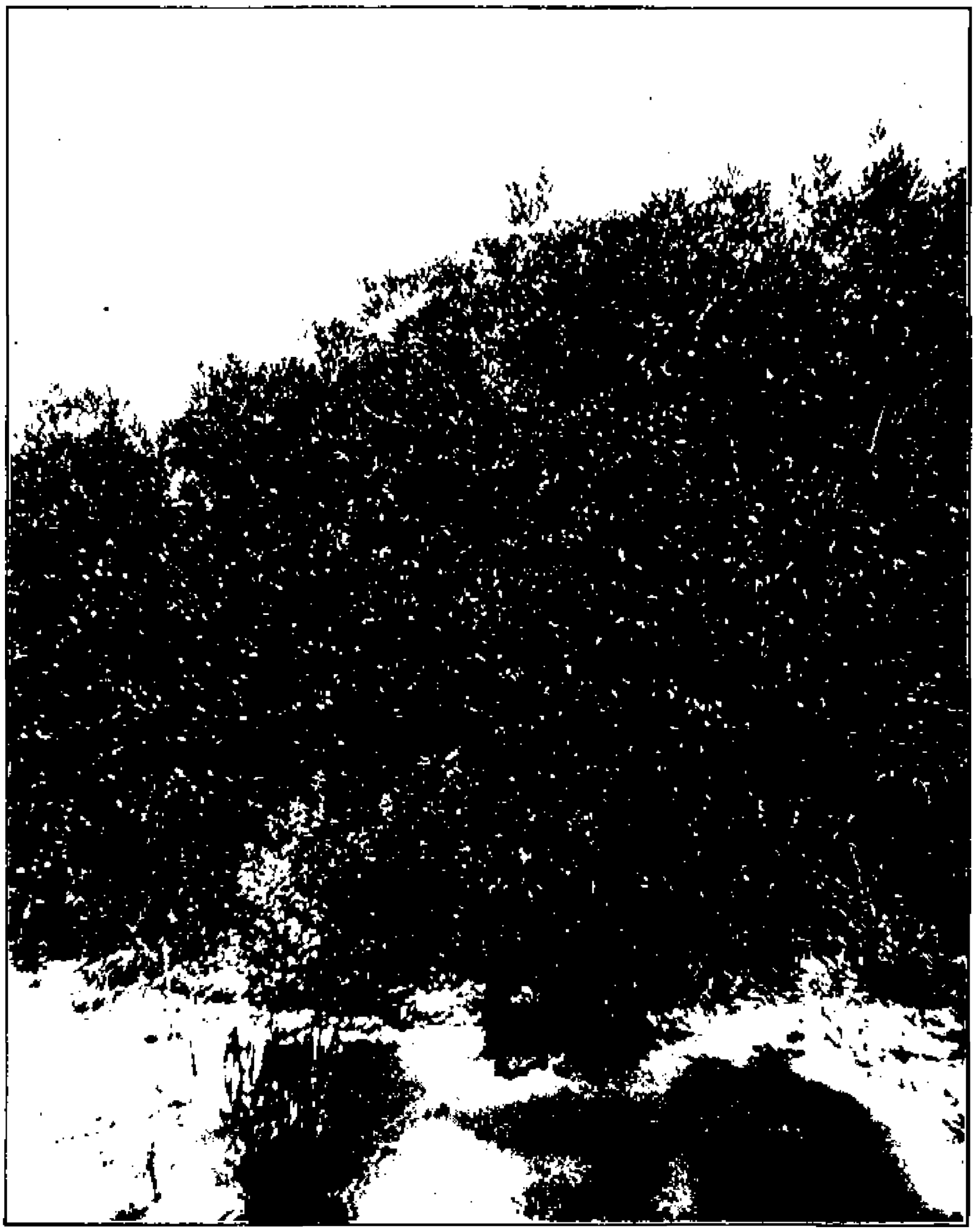

FIG. 64.—Thicket of "myrtle" (*Myrica carolinensis*) on a dune at Cape Henry, Va.

striking indication of the abundant water content of the sands. Only a few meters distant, in soil of precisely the same character, such a plant as *Prunus angustifolia*, which is usually confined to the driest soils, may be seen growing vigorously. The live oak (*Quercus virginiana*) hardly occurs as a tree on the Virginia coast, nor does it form thickets (fig. 65). Among the open dunes it is a straggling shrub with gnarled stems usually 1½ or 2, sometimes 3, meters (5 to 10 feet) long,

usually strongly inclined landward—an evidence of the force of the winds. *Baccharis halimifolia* on the dunes usually grows at the edge of the Myrica thickets.

While the open dunes are not forested, scattered small trees often grow upon or among them. Most frequent, and usually advancing farthest toward the beach, is the loblolly pine (*Pinus taeda*), which here sometimes attains a height of 13 meters (45 feet) and a diameter of 7 or 8 decimeters ($2\frac{1}{2}$ feet) (fig. 66). Other species that attain the dignity of trees are the black cherry (*Prunus serotina*), with its leaves thicker than is normally the case inland; the persimmon (*Diospyros virginiana*), which ripens fruit abundantly; the Spanish oak (*Quercus*

FIG. 65. Live oak (*Quercus virginiana*) on the middle dunes near Oceanview, Va.

digitata), and rarely the holly (*Ilex opaca*). All show the effect of the wind in the position of their trunks, which lean in a landward direction, their numerous dead branches (especially upon the windward side), and the position of their ragged crown of foliage (almost altogether on the leeward side of the stem).

A striking characteristic of the middle-dune vegetation, as of nearly all plant formations of the southern coastal plain, is the strong development of woody lianas or climbing plants. These either support themselves upon the shrubs, especially in the Myrica thickets, where they often form almost impenetrable tangles (comparable to the

Barringtonia formation of the East Indian strand),[1] or trail along the ground, finding no support. These trailing stems are sometimes very long, e. g., *Tecoma radicans*, 3½ meters (12 feet), and *Vitis rotundifolia*, 9 meters (30 feet). These species occur also in the inland forests, where they usually climb high and their stems attain

FIG. 66.—*Pinus taeda* among the sand dunes near Oceanview, Va.

a considerable thickness, while among the dunes they are ordinarily of small diameter. Most abundant are two species of grape—the

[1] This formation is described as follows by Schimper (Indomalayische Strandflora, p. 68):

"Directly behind the strip of sand, where decaying algae and numberless shells and pieces of coral indicate the zone of tidal action, rises a wall of foliage composed of various trees and shrubs and rendered almost impenetrable by *Cassytha filiformis*, *Guilandina bonducella*, species of Canavalia, and other slender climbing plants. This constitutes the outer limit of a narrow forest and shrub formation, stretching like a hem along the coast, which I shall call the Barringtonia formation, after a genus of Myrtaceae, which is represented there by several arborescent species."

summer grape (*Vitis aestivalis*) and the muscadine (*V. rotundifolia*)—and a green brier (*Smilax bona-nox*). Hardly less important are *Smilax rotundifolia* and *S. glauca*, the yellow jessamine (*Gelsemium sempervirens*), and the scarlet woodbine (*Lonicera sempervirens*). The Virginia creeper (*Parthenocissus quinquefolia*) and the trumpet creeper (*Tecoma radicans*) are frequent, but less abundant, while the poison ivy (*Rhus radicans*) is comparatively rare among the dunes. Some of these climbers, Tecoma, Lonicera, and Gelsemium, are very showy when in blossom. *Smilax glauca* sometimes entirely covers the lesser dunes, associated only with small

FIG. 67.—*Panicum amarum* among the middle dunes near Cape Henry, Va.

herbaceous plants, such as *Hudsonia tomentosa*, *Lechea maritima*, and *Diodia teres*. Similar in habit to the strand form of these lianas is a peculiar form of the dewberry (*Rubus villosus*),[1] whose long, prickly stems trail over the ground, sometimes to the length of nearly 2 meters (6 feet).

One of the most characteristic plants of the middle-dune formation is *Panicum amarum* (fig. 67), which is quite different in habit from its variety *minus*, and resembles the typical form of *P. virgatum*. It is a large, glaucous grass of coarse texture, forming tufts of consider-

[1] *R. canadensis* of authors, not of Linnaeus (fide Prof. L. H. Bailey).

able size, usually about a meter (3 feet) high (fig. 68). The somewhat one-sided panicles bend in a graceful manner. The large form of *Spartina patens* (*juncea*) sometimes grows on and among the dunes.

The other predominant herbaceous plants are mostly small, and are best developed in the depressions and on the sides of the dunes. Short-rooted annual or biennial species, with prostrate stems forming mats, such as *Oenothera humifusa*, *Euphorbia polygonifolia*, *Triplasis purpurea*, *Mollugo verticillata*, and *Diodia teres*, are abundant, the last

FIG. 68.—*Panicum amarum* among the dunes near Oceanview, Va.

attaining an unusual size. Depauperate *Linaria canadensis* (mostly 8 to 12 centimeters (3 to 5 inches) high) is conspicuous in spring with its bright blue flowers, but disappears by midsummer. It is probably a winter annual.[1] *Gnaphalium purpureum*, a biennial species, is not

[1] The small size and early maturity of this species is what would be expected from its lack of special adaptations to the strand environment. It is in this respect similar to many annuals of the deserts, as described by Volkens (Flora der ägypt-arab. Wüsten, pp. 20, 40) and Coville (Contr. U. S. Natl. Herb. 4:44, 45).

uncommon. A reduced form of the annual *Erigeron canadensis*, sometimes only 5 to 8 centimeters (2 or 3 inches) high, and with thicker leaves than in other situations, is especially abundant in rather moist sand. *Lechea maritima* and *Hudsonia tomentosa* (both perennial and suffrutescent) usually grow together, but the latter often covers small areas unassociated with other species (fig. 69). A small Cyperus with hard tubers, *C. grayi*, and two or three species of Panicum (*P. scribnerianum*, *P. angustifolium*) often grow with these Cistaceae, the first, however, sometimes in pure associations. *Physalis heterodus*, with long, radiant, prostrate stems, is occasional in open places.

Monarda punctata is abundant, particularly at the edge of the

FIG. 69.—*Hudsonia tomentosa* on the dunes near Virginia Beach (*Pinus taeda* in background).

Myrica thickets, where *Cenchrus tribuloides macrocephalus*, a canescent form of *Solanum nigrum*, and *Physalis viscosa*[1] are most at home. In the shelter of the bushes of *Myrica carolinensis* a number of species occur which do not properly belong to the dune flora and are not especially adapted to that environment. Such are *Phytolacca decandra*, typical *Erigeron canadensis*, *Eupatorium capillifolium* (*foeniculaceum*), and *Chenopodium anthelminticum*, the last, however, not rarely occurring away from the shade and protection of the thickets. These plants will much more rapidly when uprooted than do most of the true dune plants.

[1] This plant, which was seen in Virginia only at Cape Henry, is common along the North Carolina coast.

The dune marshes.—In small, nearly level tracts or basin-like depressions among the dunes, with a subsoil denser than the surface sand, rain water is often held for days, forming shallow pools; and here the soil, even at the surface, is normally wet. In such places a marsh vegetation finds opportunity for development, and contrasts with other vegetation of the open dunes in that it grows densely, or, in other words, in closed formation. The prevailing species are mostly not halophile plants, although *Scirpus americanus* and *Fimbristylis spadicea* are often abundant. On the other hand, species normally not halophile, especially two rushes, *Juncus scirpoides* and *J. dichotomus*, usually dominate the association and give a dull brown color to the whole. *Panicum virgatum* and *Andropogon glomeratus* are not infrequent. In the wet sand at the edges depauperate *Erigeron canadensis* (with thickish leaves), diminutive *Sarothra gentianoides*, and *Diodia virginiana* usually occur. Depauperate Myrica bushes frequently occur sparsely.

Sometimes, as in a marsh at Cape Henry, a considerable variety of inland palustrine species associate together, notably *Eragrostis refracta*, *Lycopodium inundatum*, *Drosera intermedia*, *Fimbristylis autumnalis*, *Rynchospora cymosa*, *Centella asiatica*, *Hydrocotyle umbellata*, etc. South of Virginia Beach a similar marsh contained, in addition to these, *Rhexia mariana*, *Eupatorium rotundifolium*, *Cyperus haspan*, *Panicum sphagnicola*, *P. agrostoides*, and cranberry (*Oxycoccus macrocarpus*), the last with stems 2 meters (nearly 7 feet) long, creeping among and almost hidden by other plants.

Such marshes are really part of the fresh-water vegetation of the region, but are placed here for the sake of topographical continuity, and because of the occurrence in them of a few halophile or halophile species. They form a transition from the sand strand to the salt marsh on the one hand and to the low fresh-water marshes on the other. They may well be termed "neutral ground."[1]

THE INNER (WOODED) DUNES.

The high dunes.—These are usually the highest of the dunes, and in most cases bear an open forest of small short-leaf pine (*Pinus taeda*), usually 6 to 9 meters (20 to 30 feet) high and 3 decimeters (1 foot) or less in diameter. Sometimes a small growth of deciduous trees and shrubs, notably black cherry (*Prunus serotina*),[2] persimmon (*Diospyros virginiana*), *Xanthoxylum clava-herculis* (sometimes 6 meters, 20 feet, high), *Sassafras sassafras*, *Juniperus virginiana*,

[1] Massart describes the vegetation of dune marshes along the Belgian coast as "in all things similar to that which inhabits marshes in the interior of the country." Mém. Soc. Roy. Bot. de Belgique, vol. 32, p. 10 (1893). For a reproduction of a photograph of one of these marshes see the same author (loc. cit., pl. 1).

[2] The largest specimen observed was about 9 meters (30 feet) high and 3 decimeters (1 foot) in diameter.

etc., mingle with or take the place of the pine. At Cape Henry occur thickets of laurel oak (*Quercus laurifolia*), mostly 3 to 3½ meters (10 to 12 feet) high.

The ground being shaded and protected from the wind by the trees, a small amount of humus collects on the surface of the inner dunes, giving the soil a gray color (hence "gray dunes," one of the terms by which they are known in Europe).[1] Here, among the pines, the live oak (*Quercus virginiana*) attains its best development on the Virginia coast, although in this region it is never of arboreous size and shape. *Quercus virginiana* assumes on the wooded dunes a compact, rounded, symmetrical form, with nearly horizontal branches, very different from its aspect among the open dunes. The largest specimen seen was about 8 meters (25 feet) high, about 8 meters in greatest spread of branches, and the diameter of the largest stem 3 decimeters (1 foot) above the ground was nearly 6 decimeters. The live oak grows scatteringly among the pines, not forming thickets. In the dull, dark color of its foliage it resembles *Myrica carolinensis*.

On the summit and outer slope of the fixed dunes *Ammophila arenaria* is still abundant, sometimes carpeting the ground to the exclusion of other herbaceous vegetation; but apparently flowers are rarely if ever produced in this situation. Doubtless it was this grass which contributed most to the original fixing of these dunes and their preparation for other vegetation; and one might fancy that the plant is reluctant to yield its sway to less hardy species. *Panicum amarum mimus* and *Cyperus grayi* are common on the fixed dunes. With the latter *C. cylindricus*, of similar habit, frequently occurs. But the most characteristic herb of these dunes is *Galium hispidulum*, which has slender yellow rootstocks branching and creeping through the sand in every direction at a depth of usually 2 to 4 centimeters (1 or 2 inches), while sending up at frequent intervals clusters of leafy and flowering stems, commonly only 8 or 10 centimeters (3 or 4 inches) high.

Quite different is the type of vegetation normally occupying only the inner slope of the forested dunes, but occasionally extending over the crest and down the outer slope. Here prevails a dense low undergrowth of chiefly woody species, some of which do not venture farther into the strand formation. In a typical place *Sassafras sassafras* and *Xanthoxylum clava-herculis*, the latter attaining here a height of only 3 to 6 decimeters (1 to 2 feet), were particularly abundant. *Smilax bona-nox*, *S. glauca*, *Vitis aestivalis*, *Tecoma radicans*, and *Parthenocissus quinquefolia* formed dense tangles among the low shrubs. At other points *Ilex opaca*, *Rubus cuneifolius*, *Aralia spinosa*, *Callicarpa americana*, and even *Acer rubrum* and *Nyssa sylvatica*, enter into this association.

[1] Warming, Ökologische Pflanzengeographie, p. 243.

The strand pine woods.—Many of the species just enumerated form the chief undergrowth of the dry, flat pine woods, which often border the dune area on its inner side (figs. 70, 71). They form the transition to the forested plain beyond, but can be more conveniently classed with the fixed dunes. The principal tree is loblolly pine (*Pinus taeda*). *Aralia spinosa* (1 to 3 meters, 3 to 10 feet, high), *Xanthoxylum clava-herculis* (attaining a height of 6 meters, 20 feet), and *Callicarpa americana* are more characteristic of this formation than of any other in the region. *Gelsemium sempervirens*, *Tecoma radicans*, and other lianas are abundant, Tecoma in places ascending the trunks of all the small pine trees, and giving to such areas a peculiar and striking appearance. Where the strand forest is somewhat

FIG. 70. Strand pine woods at Oceanview, Va.

moist, *Baccharis halimifolia* is often the principal element of the undergrowth. In very dry soil, in openings among the trees, sand blackberry (*Rubus cuneifolius*), starved specimens of black locust (*Robinia pseudacacia*), and Chickasaw plum (*Prunus angustifolia*) sometimes form small, low thickets.

The herbaceous species that occur in this association are chiefly such as characterize the drier parts of the inland forest generally. *Opuntia opuntia* and *Yucca filamentosa*, however, appear to be more at home here than elsewhere. Compositae (species of Solidago, Eupatorium, Elephantopus, Erechtites, and Chrysopsis), Leguminosae (species of Meibomia (Desmodium) and Lespedeza), *Danthonia sericea*, *Uniola laxa* (*gracilis*), and *Convolvulus americanus* are worthy

of mention. In somewhat boggy soil occur *Galium claytoni*, *Panicum ciliatum*, *Polytrichum commune*, and small quantities of peat moss (forms of *Sphagnum cymbifolium* and *S. recurvum*, occasionally *S. henryanum*). In one diminutive sphagnum bog the moss, both living and dead, was only 20 to 25 centimeters (8 to 10 inches) high. The surface had, at noonday, absorbed much heat from the sun and

FIG. 71.—Innermost dunes encroaching on the strand pine woods (of *Pinus taeda*) near Virginia Beach.

was perfectly dry, while the lower part was wet and quite cold. The substratum was the prevailing sand.

SAND STRAND OF LYNNHAVEN BAY.

The Sand Strand of Lynnhaven Bay and its ramifications is less exposed to the wind than the shores of the Chesapeake and the open Atlantic, and is therefore without typical dunes. Its plant associations are somewhat different from those of the outer Sand Strand, containing, as would be expected, a larger admixture of inland forms. The narrow strip of beach lies in most places in front of an abrupt bank, which is often 3 to 5 meters (10 or 15 feet) high. The summit of this bank is commonly covered with trees, and it forms the edge of the inland forest, but shelters a plant association somewhat different from any other in the region. The prevailing pine is often *Pinus echinata*, which attains a better development here than elsewhere in the region, being frequently 18 meters (60 feet) high and 8 decimeters (2½ feet) in diameter near the base. At other points *Pinus taeda* predominates. Other characteristic trees are *Quercus minor*, which grows to a consid-

erable size, and a small growth of *Q. digitata*, *Diospyros virginiana*, and *Hicoria glabra*.

Myrica carolinensis, *Rhus copallina*, *Symplocos tinctoria*, *Persea pubescens*, and *Quercus digitata* form in places small dense thickets at the foot of the bank. Spanish moss (*Tillandsia usneoides*), with stems sometimes a meter (nearly 4 feet) long, drapes the branches of oaks and pines, especially *P. echinata*. Of lianas, *Smilax bona-nox*, *Tecoma radicans*, and *Rhus radicans* are most common. In the flat, open pine groves, which occasionally occur at the foot of this bank just above high tide, red fescue grass (*Festuca rubra*) forms a somewhat dense sod, with scattered symmetrical clumps of *Panicum virgatum* and considerable numbers of *Yucca filamentosa* and *Opuntia opuntia*. In the pine woods at the summit of the bluff woody undergrowth is often scarce, and there occurs a scanty herbaceous growth comprising *Tragia urens*, *Jatropha stimulosa*, *Meibomia* (*Desmodium*) *stricta*, *Sporobolus asper*, *Chrysopsis graminifolia*, *Galium hispidulum* (abundant), *Uniola longifolia*, *Helianthemum canadense*, and species of Panicum (of the *dichotomum* type). In some places *Rubus trivialis*, with trailing stems, is abundant.

On the narrow strip of sandy beach and the open face of the bluff above it two Leguminosae, in habit similar to *Rubus trivialis*, occur. These are *Phaseolus helvolus* and *Bradburya* (*Centrosema*) *virginiana*, the latter with numerous large, showy, lilac-colored flowers. The principal branches of their stems lie flat upon the ground, radiating in every direction, but do not attach themselves to the soil by roots at the nodes. The longest branches observed measured 15 decimeters (Phaseolus) and 18 decimeters (Bradburya). Both are twining plants when able to find supporting objects. *Festuca rubra* is occasional on the beach. Other plants of this strand are common species of the outer beach—Ammophila, *Panicum amarum*, *P. amarum minus*, *Salsola kali*, *Cakile edentula*, *Hudsonia tomentosa*, *Lechea maritima*, *Spartina patens* (*juncea*), *Cenchrus tribuloides macrocephalus*, etc.

Of the plants mentioned as occurring among the dunes, the following are strand species in the strictest sense, seldom or never entering into any other formation:

Ammophila arenaria,
Uniola paniculata,
Panicum amarum,
P. amarum minus,
Spartina patens (the large form),
Cenchrus tribuloides macrocephalus,
Cyperus grayi,
Quercus virginiana (*virens*),[1]
Ammodenia (*Honkenya*) *peploides*,
Cakile edentula,
Euphorbia polygonifolia,
Lechea maritima,
Hudsonia tomentosa,
Oenothera humifusa,
Physalis viscosa,
Galium hispidulum,
Diodia teres,[2]
Iva imbricata.

Other species which occur on the strand reach their best development farther inland. It will be observed that the percentage of such inland plants is comparatively small seaward from the crest of the fixed dunes.

ADAPTATIONS TO ENVIRONMENT IN THE STRAND VEGETATION—LIFE FORMS.

Under the headings of climate, topography, and soils of the Dismal Swamp region, the various factors that constitute the physical envi-

[1] Almost always a strand plant in Virginia and North Carolina.
[2] Rare, except as a strand plant, in the Dismal Swamp region.

ronment of the strand vegetation were discussed in a very general way. Of these factors, the most important in their effect upon plant growth are probably to be referred to two categories. To the first belong the movements of the atmosphere, so far as their mechanical effects upon the vegetation are concerned, whether direct, or indirect, i. e., through their action upon the substratum. The second comprises all such factors as tend to bring about excessive transpiration, and consequently necessitate protective modifications.

MODIFICATIONS DUE TO THE MECHANICAL ACTION OF THE WIND.

Exposure to frequent strong winds laden with fine particles of sand is the more or less probable cause of certain modifications in the vegetation, especially that of the open dunes. Three principal results of such exposure may be mentioned:

Direct effect on the external form of the plant.—This is evident in individual trees and large shrubs of the open dunes, which are marked by their trunks usually leaning in a direction opposite to that of the prevailing winds, the branches on the wind-exposed side being often entirely denuded, leaving the crown of foliage to leeward of the trunk; by their gnarled and twisted stems and branches, the latter often rigid and comparatively short; and frequently by their torn and ragged-looking foliage (especially in such inland species as *Platanus occidentalis* and *Taxodium distichum*, when straying into this area).

Indirect or histological effect.—This often appears in the development of much strengthening tissue (stereome, wood), and in a considerable thickening of the cuticle and epidermis cell walls of the leaves, giving the surface a hard, resistant, polished texture. The latter is especially notable in the evergreen leaves of *Quercus virginiana*, and in the whole surface of the larger grass-like plants, *Uniola paniculata*, *Ammophila arenaria*, *Panicum amarum*, etc. It is a modification chiefly important to the plant as a protection against excess of light and of transpiration, but is perhaps also useful as a protection against the impact of strong, sand-laden winds.[1]

Effect through redistribution of soil.—The wind blowing upon the incoherent surface soil keeps it in almost constant motion, and often shifts great masses of it in a short time. Consequently some plants are being uprooted, while others are quickly buried beneath the sand. This action is, of course, most violent in winter. Large dunes that have been cut open by the wind exhibit dead roots and rootstocks (of Smilax, Ammophila, etc.) far below the surface. To the necessity of adapting themselves to the mobile soil in cooperation

[1] How strongly the wind may act upon plants not protected in some such way is evident in the tattered older leaves of the banana, which usually become segmented by the splitting through to the midribs of the tissues between the parallel lateral nerves.

with other factors are due some of the interesting life forms which strand plants exhibit. The most notable of these are:

1. Long, branching rootstocks, which send up numerous leafy or flowering branches. These are either slender and creep near the surface of the sand, as in Ammophila,[1] *Galium hispidulum* (longest more than 9 decimeters—3 feet), and *Scirpus americanus*, which last grows in moist sand and has rootstocks usually rather stouter than those of the others; or the rhizomes are stout and descend obliquely or almost vertically deep into the sand, as in *Uniola paniculata* (one rootstock was actually traced 6 decimeters (2 feet), and was probably a meter or more in length), *Panicum amarum*,[2] and *Iva imbricata*, which has rootstocks at least 9 decimeters (3 feet) long.

Physalis viscosa resembles *Galium hispidulum* in habit, but in this case it is from slender branched roots, having a maximum length of over 12 decimeters (4 feet), that the low, leafy, and flowering shoots originate. Such habit of growth is immensely serviceable to strand plants, as it goes far toward securing them from being uprooted, and likewise protects them from burial by the sand. For, while by an occasional movement of the sands the above-ground stems may be completely overwhelmed, the subterranean parts continue to grow forward and to send up new branches, which unfold leaves and flowers.[3] The more deeply penetrating rootstocks are also useful to the plant by insuring it a constant supply of water.

Shrubs and small trees among the dunes often develop greatly elongated roots, although these are not to be compared in length with the roots, enormously extended in proportion to the stem length, that have been detected in many desert plants.[4] This was particularly observed in *Pinus taeda*, of which small specimens showed a stem less than 1 meter (3 feet) high, but had roots at least 5 meters (over 16 feet) long. An individual of *Xanthoxylum clava-herculis* was even more remarkable, having a stem less than three decimeters (1 foot) and roots 4½ meters (15 feet) long.

2. Stems trailing over the ground, but usually not attached to it by

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[1] The longest rootstock of this grass which was examined measured 3 meters (10 feet), while the thread-like, much-branched roots are sometimes considerably over a meter (4 feet) long. In other localities a much greater extension of the rootstock has been observed.

[2] In *Uniola paniculata* and *Panicum amarum* the roots, as well as the rootstocks, are stouter than those of Ammophila.

[3] "The species of the genera Agropyrum and Ammophila [after burial in the sand] present a curious arrangement. At each of the nodes of their long stolons creeping beneath the surface of the soil, a small branch, often forked at apex, is developed, which grows vertically upward and whose length depends upon the thickness of the stratum it must traverse; its growth only ceases when it reaches the surface, whether that be near or distant. The leaves developed upon these ascending branches are always directed toward the light, in spite of the burial of the plant." Massart, Mém. Soc. Roy. Bot. de Belgique, vol. 32, pt. 1, p. 31. 1893.

[4] Compare Volkens, Flora der ägyp.-arab. Wüste, pp. 24, 25, and Coville, Contr. U. S. Natl. Herb., vol. 4, p. 47.

secondary roots).—This mode of growth is exemplified in *Rubus villosus* (*canadensis*) and *R. triviālis*, in most of the woody lianas (when unable to find supporting objects), and in two herbaceous species of Leguminosæ, *Phaseolus helrolus* and *Bradburya* (*Centrosema*) *virginiana*.[1]

3. The radiant form, which may be regarded as a phase of the preceding, is exhibited by certain—chiefly annual—species (fig. 72), possessing a well-defined vertical taproot, which is either slender (as in *Mollugo verticillata*, *Euphorbia polygonifolia*, *Diodia teres*) or rather

FIG. 72.—*Diodia teres* on the middle dunes near Oceanview, Va., illustrating the radiant form.

stout (as in *Lechea maritima*, *Oenothera humifusa*, *Meibomia arenicola*, *Cakile edentula*). In this form the stem branches at the surface of the ground, and the branches, lying flat upon the sand (only the

[1] The Pes-caprae vegetation form, which has creeping stems sending numerous secondary roots into the soil, may, perhaps, be regarded as a further development of this habit. It is a form very characteristic of the tropical strand, but hardly not represented on the Virginia coast. Farther south, near Cape Hatteras, humble representatives of it occur on the edges of the salt marsh. On the coast of Georgia the species which gives a name to this form, *Ipomœa pes-caprae*, reaches its northern limit in America.

lower in Cakile), radiate in all directions like the spokes of a wheel. *Oenothera humifusa* is a particularly characteristic representative of the radiant form, one specimen observed having 21 branches from 3 to 9 decimeters (1 to 3 feet) in length. In Lechea it is the sterile, leafy, basal shoots that assume this form. The root in this species is comparatively long (about 3 decimeters) and vertical. In Meibomia the longest branches sometimes measure 9 decimeters (3 feet) in length. It is possible that the radiant form, as well as the preceding, is also useful to the plant by retarding evaporation from the area of sand thus shaded, consequently insuring a supply of water near the surface of the soil between rains. As the under side of the stems and leaves of plants which have this habit of growth are effectually protected against light and heat radiated from the surface of the sand, and to a large extent from exposure to the air, their rate of transpiration must be proportionately much less than in plants not possessing this habit.

4. *The roselle form.*—"Rosette plants," which have most of their leaves at the base of the stem and appressed to the soil, are protected in the same manner as plants of the radiant form. They are rare on the strand of Virginia and North Carolina, but are not uncommon on the coast of northern Europe. Two (probably) winter annuals, *Gnaphalium purpureum* and *Linaria canadensis*, have their basal leaves arranged in a flat rosette. In the latter species these are borne on short horizontal branches.

5. *The cushion or hassock* ("*Polster*") *form.*—This life form, which is so strikingly developed in the high Andes, in Australasia, and elsewhere, is hardly to be included among those of the Virginia strand, unless one refers here the peculiar mode of growth of *Hudsonia tomentosa*, which has numerous short, erect branches. These are densely clothed with appressed, scale-like leaves, and stand closely together. The roots of the Hudsonia are small (the longest about 15 centimeters, 6 inches, long), and afford the plant but a weak anchorage in the soil. Consequently the species grows most abundantly in the sheltered hollows among the dunes.

6. *The sod form* ("*Rasenform*").—This is represented by *Festuca rubra* alone, and does not occur in the dune area proper.

7. *The thicket form.*—This life form, closely analogous to the two preceding, characterizes several of the shrubby species, notably *Myrica carolinensis*. Farther south along the coast *Ilex vomitoria*, *Quercus virginiana*, and other species form strand thickets.[1] By this mode of growth the individual plants are in large measure protected against the sun and the wind, and the habit may well be interpreted as an adaptation against excessive transpiration, as well as against the mechanical force of the wind. The compact, rounded

[1] Kearney, Contr. U. S. Nat. Herb., vol. 5, p. 272.

form, with numerous short, rigid branches, already described as being sometimes assumed by the live oak, may have similar advantages.

8. *Plants with subterranean storage.*—Bulbs, tubers, and other strong, local thickenings of underground parts, which are greatly developed in most arid regions, are not frequent among the dunes. *Cyperus grayi* and *C. cylindricus* have corm-like thickenings at the bases of the stems. Woody, tuber-like swellings occur on the root-stocks of the species of Smilax, and were also observed on the roots in young plants of the live oak. The possession of a subterranean food reservoir is unquestionably an advantage to a plant which is liable to burial by the sand.

9. *Annuals.*—In very arid regions annual plants often avoid the long period of drought by completing their course of life in a few weeks of the growing season, and are therefore designated as "ephemeral."[1] On the strand annuals are numerous in species and individuals, but there is no dry season, properly so called, to be guarded against, so the different species reach the acme of their development at different seasons. The annual life habit is probably more serviceable to dune plants as a protection against being uprooted or buried. This is an ever-present danger in the sand-strand formation, and one to which species with a long life period are of course most liable. Besides the radiantly growing species already enumerated, the following annuals are frequent: *Festuca octoflora*, *Aira praecox* (in woods behind the dunes), *Cenchrus tribuloides macrocephalus*, *Sarothra gentianoides*, and depauperate *Erigeron canadensis*, the last two preferring moist sand in the hollows.

PROTECTION AGAINST EXCESSIVE TRANSPIRATION.

A number of causes render it necessary that strand vegetation should be guarded against too great loss of water by transpiration from the leaves, just as plants of truly arid regions must be similarly protected. The environmental factors which induce such peculiarities of structure are, however, somewhat different in the two cases. Here, as in most maritime regions, atmospheric humidity is abundant and pretty equally distributed throughout the year. Furthermore, there is no lack of water in the dune sands at a usual depth of only 15 to 30 centimeters (6 to 12 inches) below the surface, so that all except the smaller (chiefly annual) herbaceous plants could readily obtain an abundant supply at all times, were it not for another factor, the presence in the soil of certain salts, particularly sodium chloride.

The life conditions of the strand which are probably the most effective causes of protective modifications of this nature may be stated as follows:

1. Strong insolation, and much light reflected from the surface of the white sand.

2. Heat, often intense, during most of the growing season. The

[1] Compare Volkens's Fl. der Ägypt.-arab. Wüste, pp. 20, 40.

superficial layer of sand becomes greatly heated and very dry when exposed to the sun, although the soil beneath remains always cool and moist.

3. Exposure to almost constant and often strong currents of air, which keep the atmospheric envelope of the plant always changing, hence never saturated, and thus stimulate transpiration.

4. Presence in the soil of sodium chloride, in relatively large quantity. As has already been remarked, it is only in that portion of the sand strand which is very near the waves that sodium chloride exists in quantity sufficient greatly to affect vegetation.

Modifications of structure that probably serve the plant by protecting it against the excessive transpiration that the factors just enumerated tend to induce are rather numerous in the sand-strand vegetation. Some characters are almost certainly adaptations to this end, while the value of others is more doubtful. As a rule it is the leaf structure rather than the whole form and habit of the plant that is most obviously concerned. Among the most noteworthy peculiarities and modifications are:

(1) Those which effect a reduction of the transpiring surface. The most important of these are:

(*a*) Leaves small or narrow, as in *Helianthemum canadense*, *Lechea maritima*, *Salsola kali*, *Mollugo verticillata*, *Oenothera humifusa*, *Diodia teres*, *Linaria canadensis*, and especially *Hudsonia tomentosa* and *Sarothra gentianoides*. The last two species have scale-like leaves.

(*b*) Leaves with the power of becoming conduplicate or involute. This character is conspicuous in many of the grasses, notably *Panicum amarum*, *Spartina patens*, *Uniola paniculata*, and *Ammophila arenaria*, in which most of the stomata lie on the leaf surface thus protected, while the cuticle and epidermis walls are much more strongly thickened on the exposed (dorsal) surface, which is hard and polished. In Panicum and Ammophila the leaves are strongly involute on dry, sunny days, but become nearly plane in wet weather. The leaf margins of *Quercus virginiana* and of *Rubus cuneifolius* are somewhat revolute when the leaf is exposed to strong sunlight. This serves in some degree to protect the dorsal (under) surface, in which lie the stomata.

(2) Position of the leaves. These are nearly vertical in many of the grass-like plants. In *Smilax glauca*, also, when exposed to strong insolation, the leaves assume a nearly vertical position, thus opposing the glaucous under surface to the light and giving the plant a very characteristic appearance. The same phenomenon occurs, but in a less degree, in *Rubus cuneifolius*, which similarly opposes its tomentous lower leaf surface to a strong light.

(3) The surface protected by various outgrowths or modifications of the epidermis.

(*a*) Thickening of the cuticle of the epidermis cells, which is particularly noticeable in the large grasses and some of the woody plants with mostly evergreen leaves, as *Smilax* spp., *Quercus virginiana*, *Gelsemium sempervirens*, etc., but is common to nearly all the strand species. A surface which exhibits great thickening of the cuticle is usually not otherwise protected. Where a dense covering of hairs or other means of protection exists the cuticle is apt to be comparatively thin, e. g., in *Oenothera humifusa*. The polished surface which usually accompanies such thickening may possibly be useful to the plant by reflecting some of the light rays which fall upon the leaves. A rough surface of the cuticle, due either to wrinkles or to warts, characterizes some species of this formation, e. g., *Lonicera sempervirens* and *Galium hispidulum*. In the latter plant the thick cuticle is both strongly wrinkled and papillose. It has been suggested that such roughening is useful by diverting some of the incident light rays.

(*b*) A thin coating of wax, giving the surface a glaucous appearance. *Panicum amarum* is glaucous all over, while *Smilax glauca* and *Lonicera sempervirens* have the lower leaf surface conspicuously wax-coated.

(*c*) A dense covering of hairs. These may be simple, in which case they are often elongated, and form a villous or tomentous covering: on both surfaces of the leaf in *Oenothera humifusa* (stomata about equally numerous on both surfaces), *Hudsonia tomentosa*, and *Lechea maritima;* only on the under leaf surface in *Rubus cuneifolius*. Other species have hairs that are irregularly branched, as *Physalis viscosa*, or stellate and scale-like, as on the leaves of *Helianthemum canadense* and the lower leaf surface of the live oak (*Quercus virginiana*). Short, stout, thick-walled, unicellular hairs also line the walls of the furrows on the ventral (upper) leaf surface (where most of the stomata are placed) in such grasses as *Uniola paniculata*, *Ammophila arenaria*, and *Spartina patens*, thus preventing a rapid movement of the air about the stomata. Similar hairs also occur on the dorsal leaf surface of *Lonicera sempervirens* and on both surfaces in *Galium hispidulum*, but probably not in sufficient numbers to be of service in reducing transpiration. As noted above, the cuticle is usually thin where the surface is protected by a dense coat of hairs.[1]

(4) Modifications of the internal structure of the leaves. In the few species of the Sand Strand formation whose leaves are orthotropic (vertical) or approximately so, there is a tendency to isolateral structure of those organs. In other words, the two faces of the leaf, ventral and dorsal, are alike or nearly alike. Thus the leaves of *Smilax*

[1] The bicellular hairs of Lechea and Hudsonia, of a type apparently peculiar to the family Cistaceae, are described and figured (for *Lechea maritima*) in the chapter on Anatomy. Such hairs, together with glandular and stellate ones, also occur in *Helianthemum canadense*, the third representative of this family in the sand strand of the Dismal Swamp region.

glauca are partially, and those of *Lechea maritima* are almost perfectly, isolateral. In *Galium hispidulum* the epidermis is nearly alike on both faces (stomata present, but in relatively small number, on the ventral face also), while the mesophyll is differentiated. But this is much more commonly the case in the Salt Marsh formation, the leaves of most plants of the Sand Strand being plagiotropic (more or less nearly horizontal) in position and bifacial or dorsiventral in structure. In two important points leaves of the latter type exhibit adaptations that help to protect against excessive transpiration, first, in the arrangement of the chlorophyll tissue, and second in that of the stomata.

(*a*) Chlorenchyma. In by far the greater number of plants of this formation whose leaves are strongly bifacial (and such is the case with almost all the dicotyledons) there is a sharp differentiation of the chlorophyll tissue into palisade and pneumatic tissue. The first consists normally of cells which are high (their diameter much greater at right angles to than parallel to the surface) and form a very compact tissue, usually without intercellular spaces. In most of the plants with which we are here concerned the palisade tissue forms a single layer, but in some there are two or even three layers. It is widely believed that this arrangement of the layer or layers of chlorophyll tissue which lie nearest that surface of the leaf (the ventral) which is exposed to the strongest light serves, among other purposes,[1] as a means of diminishing transpiration. This compact tissue prevents the access to the more open tissue beneath of a large proportion of the light and heat rays which strike the plant.

The more open pneumatic tissue or spongy parenchyma which is thus protected consists, usually, of nearly isodiametric cells. These are often irregular in form and have their neighboring walls separated by numerous air spaces. It is obvious that if such tissue lay directly beneath the epidermis of the upper surface of the leaf, the loss of water from that organ would be much greater.

(*b*) Stomata. Corresponding to the arrangement of the palisade tissue upon the ventral or upper, and of the open pneumatic tissue upon the dorsal or lower side of the leaf, in most of the strand plants of this region the stomata are either all, or by far the greater number of them, situated in the lower (dorsal) surface. The pores, as well as the air chambers into which they open, are thus shielded by the entire thickness of the leaf from the direct access of the incident rays. This is conspicuously true of the woody plants of the Sand Strand, e. g., *Smilax bona-nox*, *Quercus virginiana*, *Myrica carolinensis*, *Gelsemium sempervirens*, *Lonicera sempervirens*, etc.

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[1] The controlling factor in the strong development of palisade tissue is, however, intense light and the consequent opportunity for a great increase of assimilatory activity. For a brief discussion of this question, which has been ably treated by Stahl, Hinriches, Wagner, and others, see Haberloudt Pflanzenanat., 2te Aufl. 252–255.

In most of the grasses, on the other hand, the stomata are most numerous on the ventral or upper face, e. g., *Ammophila arenaria*, *Panicum amarum*, *Uniola paniculata*, *Spartina patens*. But here they are doubly or triply protected by the involution of the leaf blades, by their position in furrows, and often by the presence of stout hairs lining the wall of the furrows. Furthermore, the approximately vertical position assumed by such involute leaves diminishes the angle at which they are encountered by the light rays.

(*c*) The mestome or fibro-vascular bundles of the stems and leaves in many strand plants are more or less completely enveloped by massive groups of very thick-walled stereome. This undoubtedly serves in great degree to protect the ascending and descending fluids from evaporation.

(5) Succulency. As was stated in the discussion of the Salt Marsh formation, succulency is largely due to a strong development in the interior of the organ, whether stem or leaf, of thin-walled, often colorless parenchyma, which is believed to perform the function of a water-storage tissue. This modification is especially characteristic of desert plants, notably Cactaceae, but is also not infrequent among strand plants, especially in the salt marshes.[1] Succulent species of the sand strand are either—

(*a*) Stem succulents, with leaves much reduced and a partial or complete assumption by the stem of the functions of transpiration and assimilation, e. g., *Opuntia opuntia*, or—

(*b*) Leaf succulents, with well-developed, functionally active, fleshy leaves, but often exhibiting, at the same time, some degree of succulency in the stem, e. g., *Cakile edentula*, *Iva imbricata*, *Euphorbia polygonifolia*, and, to a minor extent, *Yucca filamentosa* (bases of the leaves).

It is well known that fleshy plants, while holding a larger supply of water in their tissues than do nonsucculent species, also give up their water less readily, and are therefore excellently adapted against excessive transpiration.

(6) Excretion of aromatic, volatile oils. It has been suggested[2] that plants which excrete essential oils are thereby protected to some extent against loss of water. By evaporation of these oils an envelope of aromatic air is formed about the plant, which, according to Tyndall,

[1] Massart (Mem. Soc. Roy. Bot. de Belgique, 32, pt. 1, p. 18) notes that succulents are much more frequent in the salt marshes than on the sand strand of Belgium. This he attributes to the effect of the strong, sand-laden winds that blow over the beach and dunes and riddle the soft, unprotected tissues of fleshy plants. He remarks that on the sea-cliffs of Normandy succulent plants, being less exposed to this danger, are more numerous.

[2] Haberlandt, Physiologische Pflanzenanatomie, p. 325, ed. 2, p. 436; Volkens, Flora der ägypt.-arab. Wüste, p. 46; Warming, Ökolog. Pflanzengeog., p. 195.

is less pervious to heat rays than is ordinary atmosphere. How effective this may be is yet very doubtful,[1] but it is not to be denied that such aromatic plants are much more abundant in dry soils and climates where the water supply of the plant needs to be jealously guarded than where other conditions prevail. On the dunes the principal species thus characterized are *Myrica carolinensis*, *Iva imbricata*, *Chenopodium anthelminticum*, and *Monarda punctata*.

(7). Formation of a sand envelope around the roots. About the root fibers of certain grasses (notably *Aristida* spp.) of the North African deserts, Volkens[2] observed the presence of a cylinder composed of sand grains that cohere with each other and adhere closely to the root hairs by means of a viscous excretion from the latter. In the deserts of Arizona and in other arid sandy wastes the same phenomenon occurs. This Volkens believes to be a protection against excessive loss of water in its passage through the axial vascular strand of the root. In *Ammophila arenaria* and *Uniola paniculata*, on the Virginia coast, it was observed that sand grains cling tightly to the persistent root hairs, often adhering even when the plant is uprooted and roughly handled, although no viscous excretion was detected. Some protection may thus be afforded the plants in question against loss of water in its course through long roots, although the adaptation is obviously much less perfect than in grasses of the deserts.

(8) Development of tunicated bases of the stems (especially in Gramineae). The persistence of the bases of old sheaths at the foot of the culms in Gramineae, as pointed out by Hackel, is a character especially noticeable in grasses of arid regions. It is believed to afford protection against transpiration from the base of the culm, which rests in the frequently much-heated surface sand. The enveloping sheaths, therefore, perform the same function as do the homologous dry outer scales of many bulbs, and are said to be further useful in some cases as a reservoir for water, which is held between the closely appressed sheaths. In *Uniola paniculata*, *Ammophila arenaria*, and *Panicum amarum*, among dune grasses, the tunic sheaths may serve the former purpose, but do not form a dense enough covering to be useful for storage of water, even were there necessity for such a structure in strand plants of this moist climate.

The strand plants of this region generally differ from xerophytic formations elsewhere in their lack of those specialized structures which enable the plant to reserve water against a period of drought.[3]

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[1] Pfeffer (Pflanzenphys. 2te Auflage 1:501) considers this absorption "as hardly of high importance" for protection against loss by water.

[2] Flora der ägypt.-arab. Wüste, p. 25.

[3] E. g., the water hairs of species of Mesembryanthemum in the Sahara (Volkens, Flora der ägypt.-arab. Wüste, p. 53) and the cup-like leaf bases of species of Tillandsia and other tropical epiphytes (Schimper, Die epiphytische Vegetation Amerikas, pp. 73, 74, etc., 1888).

Succulency of subaerial organs was the only kind of water-storage apparatus detected in this vegetation.

Owing to the possession of various protections against excessive loss of water, most strand plants are very slow to wilt when detached from the soil.

PROTECTION AGAINST EXCESSIVE LIGHT.

Several of the modifications described as protecting against too great transpiration are perhaps equally valuable to the plant by preventing the injurious action of too strong and long-continued light. In the present state of our knowledge, however, it is often not possible to distinguish between the operation of these two factors and the resulting modifications of the organism.

The development of thorn-like branches (as in *Prunus angustifolia*); of prickles (*Smilax* spp., *Rubus* spp., *Aralia spinosa*, *Zanthoxylum clava-herculis*); of spines (*Opuntia opuntia* and the leaf tips of *Yucca filamentosa*) is in all probability a consequence of the physical conditions (great heat and strong light) which render necessary protection against excessive loss of water. It is hardly conceivable, however, that these structures are themselves of any use to the plant as a protection against such conditions. Prickly and thorny plants are most abundant on the inner slope of the fixed dunes and in the woods behind them, where the heat is more intense and the soil is drier than anywhere else in the Dismal Swamp region.

POLLINATION.

No important observations were made in regard to the pollination of the flowers of strand plants. Anemophilous fecundation, however, undoubtedly predominates. The species which can safely be referred to one or the other method of pollination are as follows:

Anemophilous: All Gramineae, Cyperaceae, Juncaceae, Myrica, Quercus, Chenopodium. *Iva imbricata*, Xanthium.

Self-fertilizing: *Lechea maritima.*

Entomophilous: *Oenothera humifusa*, *Monarda punctata*, *Gelsemium sempervirens*, *Tecoma radicans*, *Lonicera sempervirens.*

DISSEMINATION OF SEEDS.

Structures, especially developed in or about the fruits, which are useful to the plant in the dissemination of its seeds occur in many of the strand plants, although they are doubtless in most cases a heritage from inland ancestors rather than modifications acquired after residence upon the strand. The majority of these are adaptations to transportation by the wind, although other methods are not lacking. The various structures may be classified as follows:

(1) Adaptations to wind transportation.

(*a*) Specific gravity small in proportion to size, as in the spikelets of Gramineae (*Spartina patens*, *Uniola paniculata*, *Ammophila*

arenaria), and in the indehiscent siliques of Cakile and the fruits with corky ridges of *Diodia virginiana*.

(*b*) Development of special structures which serve as sails: Represented by the wings in *Salsola kali* and *Tecoma radicans*, and hairs (pappus) in *Baccharis halimifolia* and *Eupatorium capillifolium*.

(*c*) Tumble-weed structure: The entire panicle breaks off near the base of the culms in *Eragrostis pectinacea* and *E. refracta*, and rolls over the ground, its progress being facilitated by the horizontally spreading branches, which act as sails, thus behaving like the prolongation of the rhachides in Spinifex.[1] The breaking off of the panicle is expedited by the slenderness of the lowest internodes of the culm.

(2) Adaptations to transportations by animals.

(*a*) Edible character of fruit: Species with fleshy fruits are rather numerous on the dunes, although *Physalis viscosa* is the only strictly maritime species thus characterized. Others are *Diospyros virginiana*, *Prunus serotina*, *P. angustifolia*, *Rubus cuneifolius*, *R. villosus* (*canadensis*), *Lonicera sempervirens*, *Vitis rotundifolia*, and *V. aestivalis*.

(*b*) Apparatus for attachment to the hair of animals, as in the burs of *Xanthium* sp. and of *Cenchrus tribuloides macrocephalus*.

GENERAL ASPECTS OF THE STRAND VEGETATION.

The general facies of the strand vegetation is somber and monotonous. Bright hues, whether of the vegetative or the floral organs of plants, are comparatively infrequent and contribute but slightly to the general effect. This prevailing lack of vivid color is due partly to the sparseness of the plant covering, which leaves the exposed soil as one of the chief color elements in the landscape, and partly to the various protective arrangments already detailed, which more or less conceal the green coloring matter. *Iva imbricata* is almost the only bright-green plant of the open dunes. On the other hand, Myrica (resinous) has a brown-green color, Oenothera (villous) is almost white, Hudsonia (tomentous) is gray, Ammophila (thick cuticle) is silvery green, *Panicum amarum* (glaucous) is blue green, and Cakile (succulent) is yellowish. Myrica gives the prevailing color to the middle dune area. Gaily tinted flowers are those of *Lonicera sempervirens* and *Tecoma radicans* (red), *Linaria canadensis* (blue), and *Oenothera humifusa*, *Hudsonia tomentosa*, and Gelsemium; the last three, being yellow, are less conspicuous amid the sands. Owing to the paucity of individuals, however, even the brilliantly colored flowers add little brightness to the aspect of this formation.

Poverty of species, as well as of individuals, characterizes the strand vegetation of this as of other regions. Only about 50 species, belong-

[1] See Goebel, Pflanzenbiolog. Schilderungen, Theil 1, pp. 135 to 138 (1889); Schimper, Indo-malayische Strand-flora, p. 81.

ing to 40 genera and 26 families, are properly strand plants in the Dismal Swamp country. Of the total number, no less than 12 are Gramineae. Mosses and saprophytic, fleshy fungi are either wanting or are present in such small numbers as to play an insignificant part in the associations. Some lichens occur upon trees and shrubs, but do not, as in parts of northern Europe, cover the ground on the fixed inner dunes. Parasites, epiphytes, and saprophytes are biological forms which are not represented by the higher plants of the true strand formation (either marsh or sand strand). Their absence could almost be predicated from a knowledge of the life conditions.

A few introduced weeds, such as *Capriola* (*Cynodon*) *dactylon*, *Rumex acetosella*, and *Solanum nigrum*, invade the Sand-Strand formation, but in numbers so small as to be unimportant. Broadly speaking, the flora of the strand is an indigenous one, and a majority of its species are endemic to Atlantic North America.

NONHYGROPHILE INLAND FORMATIONS.

The nonhygrophile inland formations occupy that great body of land in the Dismal Swamp region which is neither wooded swamp, river marsh, salt marsh, nor sand strand. The major part of it lies north, east, and southeast of the Dismal Swamp proper. A small portion of the country west and northwest of the morass (near Suffolk) was visited in the course of this survey and is here included; but the Nansemond escarpment is to be understood as fixing the western limit of the Dismal Swamp region, and the higher land west of it is not treated in this report. Eastward and northeastward the wooded plain extends to the strand and salt-marsh areas bordering the Chesapeake and the Atlantic. South of the swamp, along Albemarle Sound, the same group of formations occurs, but was explored only near Edenton, N. C. Newbern, on the Neuse River, in North Carolina, which was twice visited, is considerably south of the Dismal Swamp region, but supplemental data obtained there are intercalated as being useful for comparison. The aquatic and palustrine vegetation of small marshes, ponds, and streams, intimately connected topographically with the wooded plain, are treated, for the sake of ecological continuity, under the heading of "Low Marsh formation."[1]

The whole area thus defined was probably in its natural condition covered with forest growth, but very much of it—more than one-half—has been divested of its original plant covering, and is now cultivated or in various stages of return to the forested condition. Cultivated fields, abandoned fields, roadsides, and waste ground have each their more or less distinctive plant covering, and will therefore be treated as separate plant formations.

The chief and almost the only factor regulating the ecological distribution of the inland vegetation is drainage. Quality of soil, depending upon whether sand, silt, or clay predominates, is chiefly important

[1] P. 439, below.

as affecting water conditions. Chemical differences play here a very subordinate part, and are practically limited to the possible action of humic acids in the more swampy soils.

FOREST FORMATIONS.

MIXED FOREST.

The forest which still covers large areas of the Coastal plain is usually a mixture of coniferous and of deciduous trees. Where the original conditions have not been disturbed, the loblolly pine (*Pinus taeda*) is still the dominant species, as it probably was originally in almost every part of the region where this formation prevails. Not infrequently, especially near the strand, *Pinus taeda* is still almost the only tree in tracts of considerable extent. Generally, however, hardwood species are largely intermixed, especially where the original growth of pine has been cut away. In the latter case it almost invariably follows that the various deciduous trees, which often form a low undergrowth in the pine woods, spring up into tall trees when the removal of the pines gives them the needed space for development. On stiffer soils, especially away from the sea, hardwoods of several species frequently constitute the strongly predominant or, even in small areas, sole element of the forest grow h. Generally, however, the mixture of deciduous and of evergreen trees (pine) is so intimate that it is altogether inexpedient to attempt the delimitation of two distinct formations, one of evergreen, the other of deciduous forest, as is elsewhere often practicable. The better plan will be to present a discussion of this forest formation as a whole, and then descriptions of a series of small local areas, showing the actual association of species in each case with reference to the special conditions of soil. The data for such descriptions were in every case recorded on the spot, with notebook in hand.

Pinus taeda, the hard, short-leaf, loblolly, or old-field pine, as it is variously designated, is unquestionably the species which, as a proper tree,[1] is most abundant in this association. In its present condition this pine is most frequently a small tree, 8 or 10 meters high and 3 decimeters or less in diameter near the base (fig. 73). In this condition it is doubtless usually "second growth" on land from which the original forest has been cleared. On the innermost dunes and immediately behind them, as we have seen, the pine is also usually a small tree, but here it is for the most part the original growth that remains. Physical conditions are, in most cases, responsible for the small size of the trees in this situation, the soil being light and poor in plant food and the shelter from wind being slight. Farther inland,

[1] The sweet-gum (Liquidambar) is perhaps more abundant, if individuals below tree size (height of about 6 meters) are taken into account.

however, forested areas are frequently met with where the original growth of pine seems not to have been disturbed, and here the trees are often of rather imposing size, attaining a height of over 30 meters and a diameter, considerably above the base, of more than 6 decimeters. As a rule, however, trees of this size are seen only in limited tracts, on soils comparatively heavy and moist.

The renewal of the pine forest was somewhat carefully studied, and it was found that where the growth of pine has been removed deciduous trees usually take its place, except on the lightest, most sandy soils. On the other hand, abandoned fields, especially when first occupied by broom sedge (*Andropogon virginicus*), are gradually colonized by seedling pines. Inhabitants of the region who have observed the alternation of pine and of deciduous growth in their immediate neighborhood confirm this view. Exceptions occur, however. Sometimes in open pine woods young growth of the pine is abundant. Not rarely two adjacent fields, once cultivated but now left to nature, will show, the one a growth of seedling pines, the other

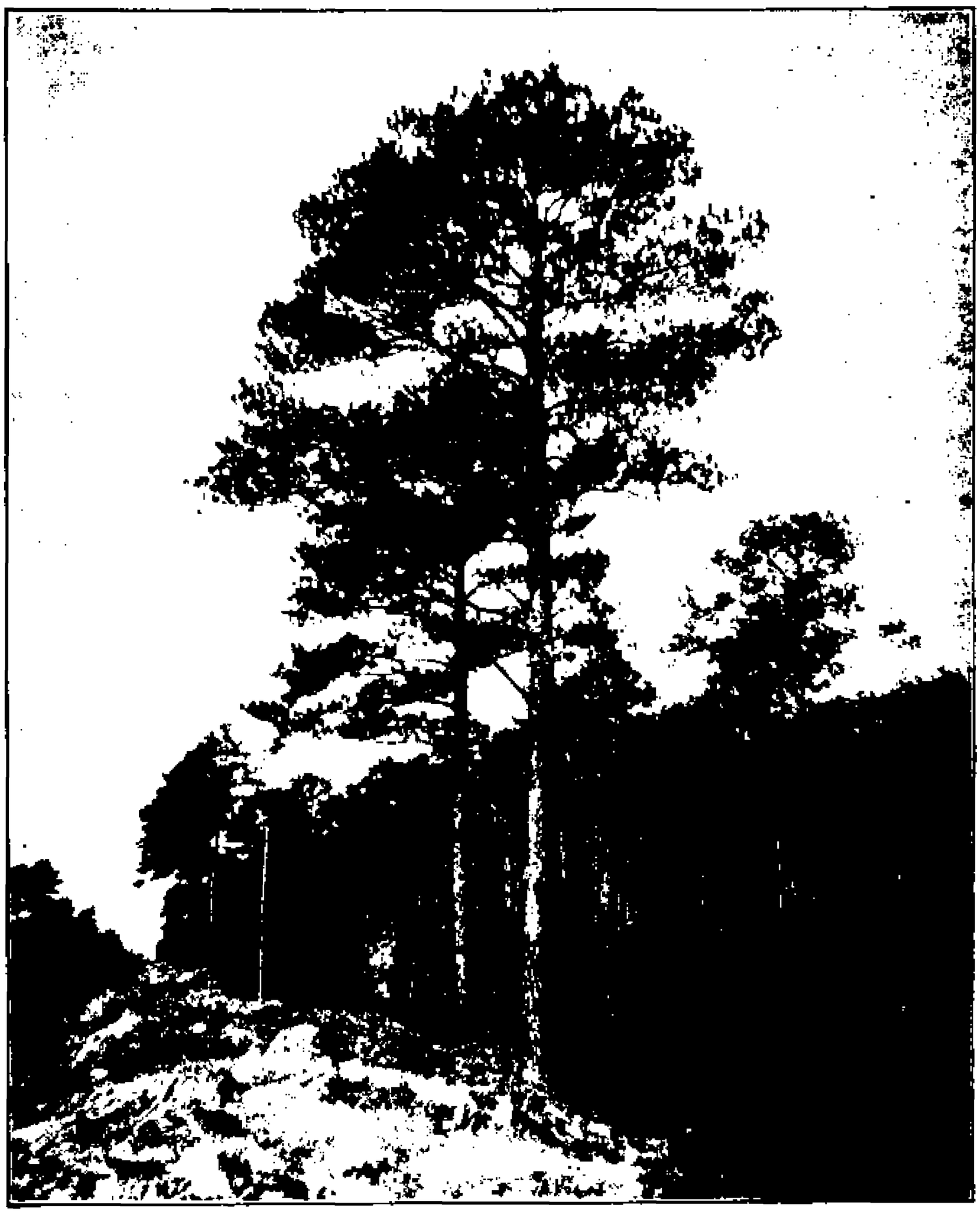

FIG. 73.—*Pinus taeda* along the Dismal Swamp Canal.

of young hardwoods. In such cases it was usually impossible to detect any corresponding difference in soil or drainage, and the result appeared to be due to what, for lack of a better word, we must term accident.[1]

The characteristic pine of the region is *P. taeda*. *P. echinata* (*mitis*) is not rare, but is comparatively an unimportant tree, seldom forming even groves. *P. palustris* (*australis*) was not observed, although it is known to occur sparingly in the region. It was formerly more common, but has been so eagerly sought on account of its valuable wood that to-day it is no longer noteworthy as an element of the forest formation.

FIG. 74.—Sweet gum (*Liquidambar styraciflua*) near Norfolk, Va.

The most important deciduous-leaved species in this formation is the sweet gum (*Liquidambar styraciflua*), a handsome tree always conspicuous because of its star-shaped leaves and the corky thickening of its branches (figs. 74, 75). A number of oaks are abundant and conspicuous, notably the water oak (*Quercus nigra*), the white oak (*Q. alba*), the cow oak (*Q. michauxii*), the Spanish oak (*Q. digitata*), the post oak (*Q. minor*), and the willow oak (*Q. phellos*). Less common are the red oak (*Q. rubra*), the quercitron (*Q. velutina*), and the laurel oak (*Q. laurifolia*). The beech (*Fagus americana*) most abounds where the subsoil is particularly rich in clay or silt and therefore retentive of moisture. The red maple (*Acer rubrum*) is often abundant, but does not usually grow to considerable size outside the swamps. The mocker-nut hickory (*Hicoria alba*) and the tulip tree (*Liriodendron tulipifera*), although frequent, are less abundant than the preceding species. Dogwood (*Cornus florida*), sourwood (*Oxydendrum arboreum*), holly (*Ilex*

[1] In some instances the seeding of pines in one field and not in a neighboring one may be accounted for by the position of the nearest pine forest and the prevailing direction of the winds. But many cases can not be so explained.

opaca), persimmon (*Diospyros virginiana*), and black gum (*Nyssa sylvatica*) are abundant, but do not usually occur as trees of even medium size. Other species of more or less importance in places are the black walnut (*Juglans nigra*), the pignut (*Hicoria glabra*), the red cedar (*Juniperus virginiana*), the red mulberry (*Morus rubra*), the hackberry (*Celtis occidentalis*), and the American elm (*Ulmus americana*). Chinquapin (*Castanea pumila*), sweet bay (*Persea pubes-*

FIG. 75.—Sweet gum (*Liquidambar styraciflua*) at Wallaceton, Va.

cens), sassafras (*Sassafras sassafras*), and black cherry (*Prunus serotina*) are commonly shrubs, and only here and there attain the size of small trees. The scurfy hickory (*Hicoria villosa*) and the redbud (*Cercis canadensis*) were observed only west of the Dismal Swamp, and there the yellow pine (*Pinus echinata*) and the post oak (*Quercus minor*) seem to be more abundant than they are east of the great morass.

All of these species, but especially the sweet gum and the oaks, also

occur as undergrowth in the pine woods, mingling with species that are true shrubs. When an opening is afforded them, through the removal or thinning of the pine growth by fire or the ax, the hard woods grow up, often into stately forest trees. The sweet gum (Liquidambar) is not rarely 30 meters high and 1 to 1½ meters in diameter near the base. It grows to its largest size on the moister, heavier soils, but forms an abundant undergrowth in lighter, drier land. The beech not rarely forms small groves, excluding other trees, especially in low ground. Here it is frequently 25 meters high and 1 meter in diameter. The white oak, the red oak, the cow oak, and the willow oak are often lofty trees, with wide-spreading branches and trunks 1 meter through near the base. In other parts of eastern North America the different oaks are usually rather constant in their liking for dry or for wet soils, but like most of the forest trees they lose this selective power to a great extent in the Austroriparian area, especially very near the coast. Even here, however, it may be said, in a general way, that the cow oak, the water oak, the willow oak, and, in a minor degree, the white oak, prefer heavy soils with a large water content, while the Spanish oak, post oak, quercitron, and laurel oak are most at home on a drier, better-drained substratum of coarser texture.

Mingled with the young trees, which usually form the major part of the undergrowth, whether the forest is chiefly pine or chiefly hard wood, is a great variety of shrubs, large and small. Indeed, the abundance and density of the woody lower growth almost everywhere in the Dismal Swamp region is perhaps the most salient feature of its vegetation. Besides the species already mentioned as sometimes reaching the size of small trees, the following are worthy of note:

The wax myrtle, *Myrica carolinensis*, is abundant in pine woods which have a light soil, sometimes constituting almost the sole undergrowth, but usually mixed with sweet gum, dogwood, etc. *Vaccinium corymbosum*, *Rhus copallina*, *Aralia spinosa*, *Oxydendrum arboreum*, *Sassafras sassafras*, and *Diospyros virginiana* are likewise usually predominant in drier, sandy soils, while service berry (*Amelanchier botryapium*), "honeysuckle" (*Azalea canescens*), "shin-leaf" (*Symplocos tinctoria*), and "gallberry" (*Ilex glabra*) grow most abundantly upon a comparatively heavy moist substratum. *Callicarpa americana*, *Zanthoxylum clava-herculis*, and *Baccharis halimifolia* are important elements of the undergrowth only in the woods near the strand. The American laurel (*Kalmia latifolia*), storax (*Styrax grandifolia*), and sparkleberry (*Vaccinium arboreum*) are comparatively rare and local. The last-mentioned species was seen only west of Suffolk, where it reaches almost the size of a tree (5 meters high). A number of species which attain their best development in the wooded swamps are also frequent in the lower-lying parts of the nonpalustrine forest. Such are *Leucothoë racemosa*, *Aronia arbutifolia*, and *Clethra alnifolia*.

Mingled with these larger shrubs are numerous undershrubs and half shrubs. Such are *Vaccinium stamineum*, *V. vacillans*, *V. virgatum tenellum*, and *Gaylussacia frondosa* in the higher, drier woods. In moist low pine woods *Rubus hispidus* sometimes carpets the ground with its slender, trailing, prickly stems. *Arundinaria tecta*, usually 3 to 6 decimeters high, often forms a close covering in moist ground in open pine woods, excluding other growth almost entirely.

In this, as in other formations of the Coastal plain, woody climbers or lianas are almost everywhere abundant in the drier parts, forming dense tangles among the undergrowth. Where moisture is more abundant their large stems climb high on the trees. Hence most of the species having this life form show transitions in the inland forest from their typical habit on the dunes to that which they assume in the wooded swamps. One of the most abundant and generally distributed species is *Smilax rotundifolia*. *Rhus radicans*, *Vitis rotundifolia*, *V. aestivalis*, *Parthenocissus quinquefolia*, *Tecoma radicans*, and *Gelsemium sempervirens* are also very common. *Smilax glauca*, *S. bona-nox*, and *Lonicera sempervirens* are unimportant in number of individuals as compared with their abundance in the maritime vegetation, while *Bignonia crucigera* and *Berchemia scandens* are in this formation hardly to be regarded as more than waifs from the swamps. As illustrating the abundance and luxuriance of the liana form in this part of the Coastal Plain, it is worth mentioning that near Edenton, N. C., a large tulip tree (Liriodendron) afforded support to two specimens of Tecoma (one with a stem diameter of 8 centimeters), three specimens of Decumaria (one of them 4 centimeters through), one specimen of *Rhus radicans*, and one of Bignonia, all firmly attached to the trunk from near the ground, while a large *Smilax rotundifolia* joined forces from the top of a neighboring small tree.

The habit of the lianas is most various. In dry, comparatively open woods, where pine is almost the only timber, they usually trail upon the ground (*Vitis rotundifolia*, *V. aestivalis*, *Smilax bona-nox*, *Tecoma radicans*, *Gelsemium sempervirens*), or have long underground stems sending up occasional leafy and flowering branches (*Rhus radicans*). These are forms which the species usually assume on and near the dunes. Where the undergrowth is heavy they form dense tangles among the bushes (especially species of Vitis and Smilax.) While in lower moist ground where the growth of shrubs and small trees is rather scanty, and a transition to palustrine forest is therefore to be recognized, the lianas assume the high-climbing form (notably Gelsemium, *Vitis* spp., *Smilax rotundifolia*).

Owing to the density of the woody growth in most parts of this forest formation, herbaceous plants have a comparatively limited space for development. In the drier, more open pine woods, however, where woody undergrowth is sometimes sparse, the ground is often covered with grasses (*Danthonia sericea*, *D. spicata*, *Aristida*

purpurascens, *Stipa arenacea*, *Andropogon* spp.), with Compositae (*Eupatorium* spp., *Elephantopus nudatus*, *Solidago odora*, *Ionactis* (*Aster*) *linariifolius*, *Sericocarpus linifolius*, *Helianthus atrorubens*, *Chrysopsis* spp., etc.), and with Leguminosae (species of Meibomia, Lespedeza, Galactia, Cracca (Tephrosia), Stylosanthes, *Bradburya* (*Centrosema*) *virginiana*, etc.). Other plants characteristic of such situations and the neighboring open spaces are: Vernal-flowering species, *Hieracium venosum*, *Iris verna*, *Linaria canadensis*, *Viola pedata*, and *Carduus spinosissimus*, the last being especially frequent at the edge of pine woods bordering salt marshes; flowering in summer, *Tragia urens*, *Jatropha stimulosa*, *Opuntia opuntia* (*vulgaris*), *Helianthemum canadense*, *Linum medium*, *L. floridanum*, *Polygala incarnata*, *Monarda punctata*, *Koellia mutica*, *K. hyssopifolia*, etc. Woods with a growth of this character are more frequent near the strand and along the larger streams.

In heavier moist soils, *Atamosco* (*Zephyranthes*) *atamasco*, with its beautiful large flowers opening in the spring, is locally gregarious, sometimes carpeting the ground with a sheet of white. *Nothoscordum bivalve* (*striatum*) and *Hypoxis hirsuta* (*erecta*) are in flower at the same season. It is rather remarkable that these three species, which are among the most noteworthy bulb-forming plants of the Dismal Swamp region, are all inhabitants of comparatively moist soil. Other vernal flowering species of rather damp soils in or near the edges of woods are *Mitchella repens*, *Asarum virginicum*, *Podophyllum peltatum*, *Smilacina racemosa*, etc. In autumn appear *Eupatorium coelestinum*, *E. semiserratum*, *E. serotinum*, *Gentiana elliottii*, *Lobelia puberula*, *Prenanthes alba*, *Erechtites hieracifolia*, *Panicum rostratum*, and *P. verrucosum*.

Pteris aquilina is here often very abundant in moist soils, although in regions where the surface is more broken it prefers dry slopes. Other ferns that are occasional in woods whose soil is still moister are species of Osmunda, Woodwardia, etc., but these belong properly to the wooded swamps. *Polystichum* (*Dryopteris*) *acrostichoides* is not infrequent.

Owing to the poverty in humus of the lighter, sandy soils, saprophytic fungi are there scarce. In the moister forests, however, they are often somewhat abundant, although seemingly less so than in many other forest regions of eastern North America. Of vascular saprophytes *Monotropa uniflora* was the only species noticed, although others probably occur. Parasitic leaf fungi are abundant, while vascular parasites are few. *Conopholis americana* is the most noteworthy holoparasitic phanerogam. Mosses and hepaticae, epiphytic and terrestrial, are by no means so abundant as in the wooded swamps. Except in "The Desert," near Cape Henry, where *Tillandsia usneoides* occurs on beeches, post oaks, and yellow pines, the only epiphytes are lichens (especially *Usnea* spp., on pines, etc.) and *Polypodium*

polypodioides (*incanum*). The last is common, however, only in the recesses of the Dismal Swamp.

The aspect of the inland forest, where its primitive condition has been preserved, is usually that of a more or less compact assemblage of woody plants, forming, in typical examples, a series of three layers—the first of undershrubs, the second of tall shrubs and young trees, and the third of fully developed trees. Lianas may, as we have seen, enter copiously into any one or all of the layers, according to conditions which vary within short distances. More than three well-defined and approximately coordinate layers are rarely to be distinguished in the nonpalustrine forest formation; for, wherever herbaceous phanerogams, or mosses, or saprophytic fungi are present in considerable numbers, the layer of undershrubs, and often that of high shrubs, is correspondingly reduced.

As has already been pointed out, conditions of soil, especially of soil moisture, are often very different in the nonpalustrine forest, at points only a slight distance apart. A few steps serve to take us from a spot where the soil is dry, sandy, and almost devoid of humus to one where it is moist, contains a high percentage of silt, and is well stocked with humus. Every such difference of soil is accompanied by a corresponding change in the character of the vegetation. But, owing to the wide range of adaptability to difference in soil which is exhibited by most of the important woody plants of this formation, and the insensible gradations from the driest and lightest to the wettest and heaviest soils, it is not practicable to distinguish associations which have a general distribution in the region, and can be recognized as such at different points, although more extended study may render possible such segregation. Nevertheless, it is important that we should have a more exact conception of the physiognomy and constitution of the formation, and for this reason a number of limited tracts of the nonhygrophile forest, lying as far apart as possible in space and in character, will be described at some length. In each case the elements of the description were jotted down in a notebook on the spot, and it should therefore afford an accurate picture of actual conditions.

While there is much that the several examples have in common, as should be the case in the parts of a single formation, there are also more or less important distinguishing characters. Thus, in one spot *Pinus taeda* is almost the only tree, while in another deciduous species strongly predominate. Here young plants of Liquidambar form the principal undergrowth, there it is composed largely of Myrica or of different oaks. Lianas are abundant in one bit of woodland, while quite unimportant in another. Herbaceous plants may find plenty of space for development in a tract of open forest, while only a few meters distant they are crowded out by a dense growth of undershrubs. None of the following cases can be taken as a type of the

virgin forests of the region. Everywhere conditions have been somewhat altered by man, especially in the removal of more or less of the original growth of pine:

1. Near the western branch of the Elizabeth River. Soil sandy, but with a stiff subsoil, consequently almost always moist. Forest of small pines (*P. taeda*), mostly 10 to 15 meters high, which are apparently giving place to hard woods, mostly sweet gum (Liquidambar) and oaks (*Quercus nigra*, *Q. phellos*, *Q. alba*). Black gum (*Nyssa sylvatica*) is also abundant among the pines, and is sometimes nearly as tall. Undergrowth dense, consisting largely of small red maple (*Acer rubrum*), *Oxydendrum arboreum*, *Rhus copallina*, *Gaylussacia frondosa*, *Clethra alnifolia*, Sassafras, *Aralia spinosa*, and much *Arundinaria tecta*.

2. Near the Southern Branch of the Elizabeth River. Soil gray, sandy, with about an inch of top mold, moist. Forest of small pines, chiefly 6 to 10 meters high, mixed with Liquidambar (the largest 22 meters high and 6 decimeters in diameter), *Quercus nigra*, *Q. digitata*, and *Oxydendrum arboreum*. Undergrowth rather dense, low, chiefly *Rhus copallina*, small Liquidambar, and *Ilex glabra*, with various other shrubs and young trees. In open spots species of Panicum, especially *P. laxiflorum*, are very abundant. Nearer the river the soil is drier and sandier, and *Myrica carolinensis* forms the major part of the undergrowth.

3. Near Kempsville, a typical inland locality east of Norfolk. Soil rather heavy (sand and silt), grayish in color, with about 5 centimeters of black top mold, very moist. Pines largely replaced by hardwoods—*Acer rubrum*, Liquidambar (the largest 30 meters high and 1 meter in diameter near the base), Liriodendron (occasionally very large), *Fagus americana*, *Quercus phellos*, *Q. michauxii*, *Q. alba*, *Q. velutina*, *Nyssa sylvatica*, *Carpinus caroliniana*. Undergrowth dense, consisting of small individuals of the deciduous trees, together with Oxydendrum, *Azalea canescens*, *Pyrus angustifolia*, *Aralia spinosa*, *Xolisma ligustrina*, etc. Lianas abundant and occasionally climbing high—*Smilax rotundifolia*, *Vitis rotundifolia*, *Rhus radicans*, *Parthenocissus quinquefolia*, and *Tecoma radicans*.

4. Lynnhaven Station. Soil a rather stiff, grayish loam with 2 or 3 centimeters of top mold. Trees almost exclusively *Pinus taeda*, 15 to 20 meters high and standing rather closely. Undergrowth largely of *Myrica carolinensis* (averaging 5 meters in height), with *Ilex glabra*, *Cornus florida*, Liquidambar, *Quercus phellos*, *Q. velutina*, *Q. nigra*, *Q. alba*, *Q. minor*, *Q. digitata*, *Acer rubrum*, *Ilex opaca* (one tree 12 meters high and 3 decimeters in diameter), *Persea pubescens*, *Nyssa sylvatica*, etc. Lianas not very abundant and chiefly low—*Smilax rotundifolia*, *Gelsemium sempervirens*.

5. Lynnhaven Station, about one-half kilometer from the preceding locality. Soil sandier, drier, with almost no humus. Pines low (8 meters or so) and more scattered. Undergrowth sparser and with less variety of species—Liquidambar, *Quercus digitata*, Myrica, Sassafras, *Rhus copallina*, *Prunus angustifolia*, *Rubus villosus*. Ground thinly covered with grasses, *Stipa avenacea*, etc., and other scattered herbs—*Chrysopsis graminifolia*, *Helianthus atrorubens*, etc.

6. Deep Creek, near the northeastern edge of the Dismal Swamp. Soil to a depth of 2 decimeters (8 inches) a moist, rich, brown loam, then stiffer, grayish, containing much silt. Small pines 12 to 18 meters (40 to 60 feet) high constitute hardly one-half of the forest, which includes *Quercus alba* (sometimes as tall as the pines), Liquidambar, *Nyssa sylvatica*, *Acer rubrum*, and, less important, Fagus, Liriodendron, *Ilex opaca*, *Quercus nigra*, *Quercus michauxii*, and Oxydendrum. Among the undergrowth, young hard wood trees with *Kalmia latifolia* and *Symplocos tinctoria* are most abundant, while *Ilex glabra*, *Aralia spinosa*, Arundinaria, Clethra, *Vaccinium corymbosum*, *Hamamelis virginiana*, *Leucothoë axillaris*, *Amelanchier botryapium*, etc., are common. Lianas are chiefly low, climbing over the bushes—Gelsemium, *Smilax rotundifolia*, *Vitis rotundifolia*,

and *Bignonia crucigera*. *Mitchella repens* and *Rubus hispidus* creep over the surface of the ground.

7. Near Edenton, south of the Dismal Swamp, near the edge of a tract of woodland. Soil sandy, and comparatively dry, with but slight content of humus. Trees, a few small scattered pines, with Liriodendron, *Quercus digitata*, and a low, open shrubby growth of Diospyros, *Rhus copallina*, Liquidambar, Oxydendrum, *Aralia spinosa*, Gelsemium, etc. Herbaceous growth abundant, of grasses (chiefly *Andropogon scoparius*); Compositae (*Eupatorium* spp., *Elephantopus nudatus*, *Chrysopsis graminifolia*, etc.); and, particularly conspicuous, various Leguminosae (*Cracca spicata*, Bradburya, *Stylosanthes biflora*, *Chamaecrista nictitans*, *Galactia volubilis*, species of Meibomia and of Lespedeza, *Crotalaria purshii*, etc.

8. Near Suffolk, west of the Dismal Swamp, top of a bluff about 9 meters (30 feet) high, on Cohoons Creek. Top soil to a depth of 15 centimeters (6 inches), a sandy, grayish-brown loam. Subsoil, for 7½ decimeters (30 inches), a fluffy, yellowish, sandy loam. Woodland open, the trees mostly 9 to 15 meters (30 to 50 feet) high, but some of the pines and white oaks attaining a height of 18 to 20 meters (60 to 70 feet). About half of the trees are *Pinus taeda*, the rest *Quercus minor*, giving place some little distance back from the stream to *Q. alba*, with *Q. velutina*, *Q. laurifolia*, *Q. nigra*, *Juniperus virginiana*, *Cornus florida*, *Castanea pumila* (9 meters, 30 feet, high), *Sassafras* (about 6 meters, 20 feet, high), *Vaccinium arboreum* (about 4½ meters, 15 feet, high), *Hicoria villosa*, *Fagus americana*. All these plants are treelike in habit. Woody undergrowth is scanty, and in places the ground is quite bare between the trees. Small patches of *Opuntia opuntia* (*vulgaris*) and scattered plants of *Jatropha stimulosa*, *Stylosanthes riparia*, *Ruellia ciliosa*, *Asarum virginicum*, *Aristolochia serpentaria*, etc., also occur. Altogether the association is much like that upon the wooded bluffs along Lynnhaven Bay.

PINE BARRENS.

This formation, so characteristic of the Austroriparian area of the Lower Austral life zone in North America, is not present in its typical form in the region east, west, or north of the Dismal Swamp, but is first encountered along Albemarle Sound, e. g., near Edenton, N. C. There occur open pine forests, with comparatively little woody undergrowth, but with a more or less close carpet of grasses and other herbaceous plants covering the ground.

Where the soil, always sandy and comparatively poor in organic matter, is dry, grasses such as species of Andropogon, Panicum, and Danthonia prevail, mingled with forms belonging to numerous other families, particularly Leguminosae and Compositae. Worthy of mention are *Stylosanthes biflora*, *Psoralea pedunculata*, *Meibomia stricta*, *Elephantopus nudatus*, *Eupatorium linearifolium*, *Aster gracilis*, *Polygala mariana*, *Koellia hyssopifolia*, *Gratiola pilosa*, *Linum medium*, etc.

In somewhat moister but otherwise very similar soil sedges (species of Rynchospora), *Eupatorium rotundifolium*, *Rhexia mariana*, *Ascyrum stans*, *Bartonia virginica*, *Spiraea tomentosa*, *Ilysanthes gratioloides*, *Monniera acuminata*, etc., are characteristic. In small depressions, along streams, diminutive marshes are frequent, and here grasses give place almost entirely to sedges -*Rynchospora inexpansa*,

R. corniculata, *Cyperus pseudovegetus*, *Eleocharis tortilis*, *Carex verrucosa*, as well as *Juncus setaceus*, *Habenaria cristata*, *Trachelospermum difforme* (a thin-stemmed liana), etc. In such spots woody undergrowth and lianas play a more important part than in the dry pine woods.

As we go farther south the Pine Barren formation becomes more and more the predominant element in the plant covering, and the number of species composing it increases proportionately. Moreover, the long-leaf pine (*Pinus palustris*) becomes more important in the forest growth. Near Newbern, N. C., for example, the drier, more open soil is occupied by grasses, in places by the characteristic wire grass (*Aristida stricta*) and the odd and handsome *Campulosus aromaticus* (*Ctenium americanum*) as well as a variety of other plants—*Linum floridanum*, *Ludwigia virgata*, *Hypericum pilosum*, *H. virgatum*, species of Lespedeza and Meibomia, *Rhynchosia tomentosa*, *Indigofera caroliana*, *Zornia bracteata*, *Eupatorium pinnatifidum*, *E. rotundifolium*, *Lacinaria liatris graminifolia*, *Solidago petiolaris*, etc.

Still greater is the diversity of species in the lower, marshy places. Here a variety of sedges, especially *Rynchospora* spp., *Carex verrucosa*, *Dichromena colorata*, and *Fuirena squarrosa* constitute the groundwork, while the pattern is formed of *Hypericum galioides* (flowers bright yellow), *Polygala lutea* (orange), *Aster paludosus* (blue), *Trilisa paniculata*, and *Carphephorus tomentosus* (purple), *Solidago pulverulenta* and *S. pilosa* (golden yellow), *Rhexia ciliosa* and *R. glabella* (rose-purple), and many others. In still wetter spots the superb *Habenaria blephariglottis* with large white and *H. cristata* with orange-colored flowers are abundant, and *Sarracenia flava* is occasional. Here also *Lycopodium alopecuroides* and often species of Sphagnum (*S. imbricatum* var., *S. brevicaule*) are abundant.

The showy flowers of a great variety of herbaceous plants are the characteristic feature of the pine barrens. They are much less conspicuous in the mixed forests. One is especially impressed with the floral wealth of this formation in early autumn, when the gay colors of many Compositae are everywhere a feature of the landscape.

CLEARED-LAND FORMATIONS—NONCULTURAL.

ARBOREOUS ASSOCIATIONS.

Where the original forest growth is artificially removed individual trees or small groves are often left standing, and, finding more room for lateral growth than in the crowded forest, they assume forms that are not commonly met with there. Such survivals of the forest are especially frequent on roadsides and about dwellings in the country. In the case of indigenous species it is, of course, often difficult to distinguish between trees which originally belonged to the forest and those which have been planted by man. Therefore, all

native trees which occupy such habitats can best be included in this formation, unless it is clear that they owe their occurrence directly to human agency.

The commonest and at the same time the most handsome shade tree of the region is the willow oak (*Quercus phellos*), which is often planted about farmhouses and along the streets of towns, but also undoubtedly occurs as a remnant of the aboriginal plant covering, especially in low ground. This oak is frequently of great size, and, where its environment permits, of beautifully symmetrical form, with wide-spreading branches and rounded crown. Other species of oak, notably the water oak (*Q. nigra*), the red oak (*Q. rubra*), the white oak (*Q. alba*), and the quercitron (*Q. velutina*), are frequent on plantations. The beech (*Fagus americana*), the sweet gum (*Liquidambar styraciflua*), the tulip tree (*Liriodendron tulipifera*), and, more rarely, the mockernut hickory (*Hicoria alba*) grow to be magnificent trees when left standing in the open. The sassafras (*Sassafras sassafras*), the persimmon (*Diospyros virginiana*), and the chinquapin (*Castanea pumila*) occasionally attain arborescent size at roadsides. Here, as in other parts of North America, the red cedar (*Juniperus virginiana*) seems to be most at home along country roads, and is consequently a conspicuous feature of the landscape.

SHRUBBY ASSOCIATIONS—THICKETS AND HEDGES.

Fence rows, especially upon land that is not thoroughly cultivated, are commonly occupied by a low, woody growth, consisting of such normally arboreal species as the sweet gum (Liquidambar), the black cherry (*Prunus serotina*), and various oaks; of shrubs, e. g., persimmon (Diospyros), sassafras, sumac (*Rhus copallina*), chicasa plum (*Prunus angustifolia*), common blackberry (*Rubus* sp.), etc.; and of lianas, especially species of greenbrier (Smilax), the muscadine grape (*Vitis rotundifolia*), the yellow jessamine (*Gelsemium sempervirens*), the trumpet creeper (*Tecoma radicans*), and the poison vine (*Rhus radicans*). Where the soil is comparatively rich and moist the elder (*Sambucus canadensis*) often predominates, and is an exceedingly common plant along roadside ditches. The same association usually occupies the embankments of railways, except in the immediate vicinity of towns. Some of these plants, notably Sassafras, Diospyros, and Rhus, are abundant in old fields, and even among standing crops if these are not well cultivated.

Prunus angustifolia is common in dry, sterile soil at roadsides or in clearings and occasionally forms small dense thickets, growing to an average height of 1 to 1½ meters (4 or 5 feet), but is sometimes 3½ meters (12 feet) high, with a trunk 15 centimeters (6 inches) in diameter. The short thorny branches and the rather small and thickish leaves give the plant a distinctly xerophytic stamp. Where the Prunus

grows closely other vegetation is almost entirely excluded. The sand blackberry (*Rubus cuneifolius*) is one of the most characteristic plants of similar situations and is likewise obviously xerophytic in its organization. Other woody species of sandy roadsides are *Crataegus uniflora*, and, with stems prostrate, *Rubus trivialis* and Gelsemium. With these are usually associated herbaceous plants—*Bradburya virginiana* with its showy purple flowers, *Stylosanthes biflora* and *S. riparia*, *Galactia volubilis*, various Compositae, *Monarda punctata*, *Gymnopogon ambiguus*, *Festuca octoflora*, etc.

Along roadside ditches, especially near the sea, *Baccharis halimifolia* (sometimes 2½ meters, 8 feet, high) and *Rosa carolina* are commonly associated.

HERBACEOUS ASSOCIATIONS.

Often entering into the above-described associations of shrubby plants, but more frequently forming more or less nearly pure herbaceous assemblages in old fields and roadsides where woody plants play a subordinate rôle, are various species, notably of Compositae and grasses. One of the most abundant of these is the broom sedge (*Andropogon virginicus*), which frequently forms a close covering in abandoned fields. With it are generally mingled small scattered shrubs and, notably, seedling pines (see above, p. 397).

Senecio tomentosus is, in spring, one of the most common and showy plants of the region. It is particularly abundant in low, rather moist ground, in fields and on waysides. Its tufts of white tomentous leaves are hardly less conspicuous in contrast with the surrounding vegetation than are its golden-yellow heads. In moist sandy soil, especially near the sea, a characteristic species is *Cirsium spinosissimus*, a vernal flowering thistle with low, stout stems and large heads of pale yellow flowers. Exceedingly abundant at the same time of the year, but preferring the driest sand, is a small winter annual, *Linaria canadensis*. The bright blue flowers of this plant are conspicuous, notwithstanding their small size. Another vernal flowering species, bluets (*Houstonia coerulea*), is commonly associated with the Linaria. Two annual grasses, *Festuca myurus* and *F. octoflora*, and the small yellow clover, *Trifolium dubium*, are abundant in places. In late spring and early summer the sulphur-yellow heads of a cichoriaceous plant, *Sitilias* (*Pyrrhopappus*) *carolinianus*, are locally conspicuous at waysides. The Japan clover (*Lespedeza striata*) is another very abundant plant in such places; and likewise, in early summer, *Daucus carota* and *Achillea millefolium*.

In late summer and autumn large Compositae are the predominant herbs in fields and roadsides. The most characteristic and perhaps the most abundant herbaceous plant of the region is the hog weed or dog fennel (*Eupatorium capillifolium*) (fig. 76). Even in May the bright green, finely divided, Anthemis-like root leaves of this plant

are conspicuous. By midsummer the stems are 3 to 6 decimeters (1 or 2 feet) high, wandlike and very leafy. In early autumn the large plume-like, greenish or purplish panicles of numerous small heads are seen everywhere, waving gracefully in the wind and making every fence corner a place of beauty. The plant when full grown has stout stems 6 to 12 decimeters (2 to 4 feet) high. It is nowhere more abundant and showy than along the banks of the Dismal Swamp canal, where it is associated with vast quantities of *Panicum proliferum* and *P. crus-galli*. Other species of Eupatorium with white flowers are abundant, notably *E. linearifolium* and *E. rotundifolium*, the latter preferring rather moist soil. Asters, especially *A. ericoides*, with numerous small, white-rayed heads, are prominent in the land-

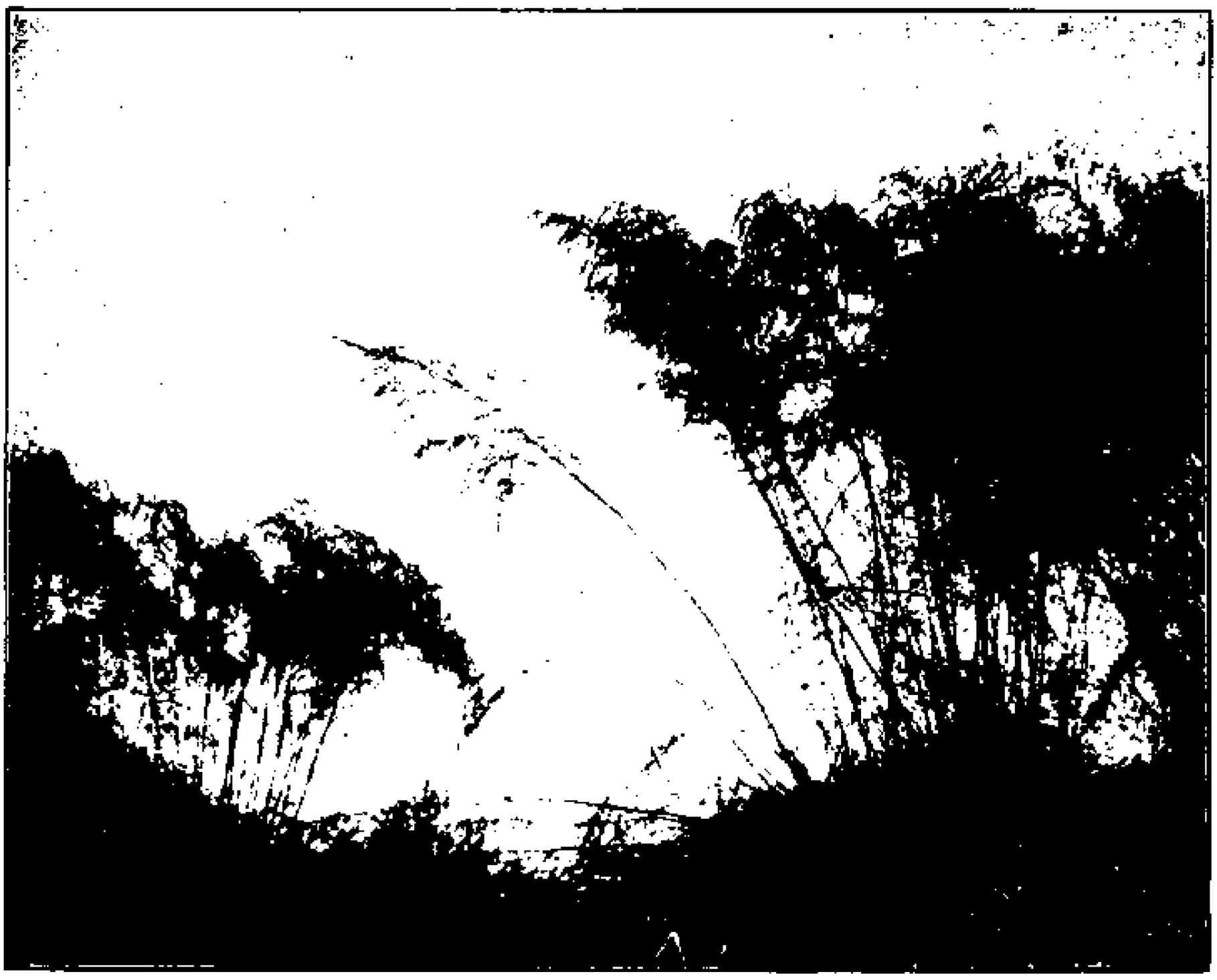

FIG. 76.—*Eupatorium capillifolium* on roadside near Wallaceton, Va.

scape. Golden-rods are likewise conspicuous, *S. canadensis* being the common roadside species. *Erigeron canadensis* and *Ambrosia artemisiaefolia* are exceedingly abundant. A very common plant along ditches in fields, less frequently covering the ground in low woods, is a tall, wandlike grass, *Erianthus contortus* (fig. 77), which in autumn is hardly inferior to *Eupatorium capillifolium* as a character plant of this formation.

Near towns and along the more-traveled highways, ruderal plants, introduced weeds, usually conquer the indigenous growth, but this is not always the case. For example, on the outskirts of even the larger seaport cities waste land is frequently occupied by an association of *Baccharis halimifolia*, *Eupatorium capillifolium*, and *Andropogon virginicus*.

CULTURAL FORMATIONS.

FIELD CROPS.

An extended account of the agricultural products of the region would not be in place here, but will be presented in another section of this report. Yet some discussion of the cultural formations is necessary to a complete description of the plant covering. The valuable bodies of cultivated land that have been reclaimed from the wooded

FIG. 77.—*Erianthus contortus* along a ditch near Portsmouth, Va.

swamps are included in this subdivision of the subject, because it is, of course, impossible to regard them as any longer forming a part of the hygrophile vegetation.

Garden vegetables.—The principal field crops of the region east of the western border of the Dismal Swamp are, first and foremost, certain table vegetables and fruits, which are cultivated on a large scale, this being well known as one of the principal market-garden or "trucking" areas along the Atlantic coast. Of these plants, Irish potatoes hold the first place in quantity grown, with cabbages second, and

strawberries third. Next in importance stand peas, beans (string and lima), tomatoes, and spinach. Sweet potatoes are much cultivated, and so are kale, asparagus, lettuce, cantaloupes, radishes, squash, and watermelons. Celery is raised in small quantity on the heavier swamp lands.

These "truck" crops are chiefly grown in the light, sandy soils, near salt water, although some of them, especially potatoes and, to a less extent, strawberries, are successfully cultivated on the stiffer, moister soils farther inland. Different vegetables occupy the land and mature at different seasons—e. g., kale and spinach in winter; radishes and asparagus in early spring; peas, cabbage, and potatoes in early summer; tomatoes and cantaloupes in midsummer; and sweet potatoes in early fall. Frequently two vegetables are cultivated together in the same field, or even in the same rows—e. g., cabbage and strawberries. Often second crops of some of the early vegetables are matured in autumn, notably peas and potatoes. After the removal of the earlier truck crops, indian corn is frequently planted on the land, although this cereal does not succeed as well on the light coastwise soils as on the heavier swamp soils inland. In the southern part of the region cotton is sometimes planted after the maturing of early truck crops. Frequently the land is allowed to lie idle during a great part of the summer, when it becomes occupied by a heavy spontaneous growth of grasses, notably crab grass (*Panicum sanguinale*), the principal uncultivated forage plant of the country.

The aspect of land thus occupied by extensive fields of garden vegetables is striking to the unaccustomed eye. Especially noteworthy in this respect are fields of strawberries, asparagus, and kale.

Cereals.—The principal cereal of the region is indian corn, which is much cultivated as a second crop upon land which was occupied earlier in the season by garden vegetables; but it is grown to best advantage upon the soils, rich in organic matter, which have been reclaimed from the Dismal Swamp. Here corn often grows to a height of 3½ meters (12 feet) without the use of fertilizers, and yields 15 to 30 hectoliters (40 to 80 bushels) of grain per acre. The effectiveness of this crop as an element of the landscape needs no comment.

Oats are frequently grown, especially in upland soils, at some distance from the coast, but never in great quantity. Small fields of rye and barley are occasionally seen. Rice, the upland variety, is cultivated to a considerable extent in the Albemarle Sound region of North Carolina. Wheat has been successfully grown, especially upon the swamp soils, but is no longer an important factor in the agricultural resources of the region.

Cotton.—Cotton is not cultivated to an important extent in Virginia, but is a staple crop in eastern North Carolina. Around Edenton it is grown largely upon warm, loamy upland soils. Near Newbern it is frequently sown upon land which had produced crops of vegetables

earlier in the season. It would be quite superfluous to describe the appearance of fields of this beautiful plant, or to expatiate upon its prominence as a feature of the plant covering.

Forage plants.—Timothy (*Phleum pratense*) is cultivated with considerable success, but not to any great extent, on land cleared from the Dismal Swamp. Crimson clover (*Trifolium incarnatum*) grows well upon higher, lighter soil. The forage crop *par excellence* of the region is the cowpea (*Vigna catjang*), which is planted either alone or with indian corn, and usually after some truck crop has been gathered. Fields of German millet (*Chaetochloa italica*) are frequent. Orchard grass (*Dactylis glomerata*) is occasionally planted, and red clover (*Trifolium pratense*) makes excellent growth, especially on the heavier inland soils. Such grasses as perennial rye grass (*Lolium perenne*), orchard grass (Dactylis), blue grass (*Poa pratensis*), meadow fescue (*Festuca elatior*), velvet grass (*Holcus lanatus*), and legumes, e. g., vetches (*Vicia sativa*, *V. angustifolia*), clovers (*Trifolium repens*, *T. pratense*), and the black medick (*Medicago lupulina*), grow luxuriantly at the edges of roadside ditches, especially along the shell roads, where lime is abundant in the soil.

Other field crops.—Peanuts are not a staple crop in the region north and east of the Dismal Swamp. West of the swamp, however, this is one of the most important agricultural products. About Edenton, N. C., the peanut is, next to cotton, the principal crop, being grown usually upon the same type of warm, light, loamy soil which is preferred for the cultivation of cotton.

Tobacco is occasionally sown in small patches by the negroes, and is said to grow well upon light soils suitable to truck. South of the Dismal Swamp region, near Newbern, N. C., it is a more important crop, wrapper leaf being the usual type there cultivated.

Sorghum is grown here and there near Norfolk, usually in small quantity on farms, for home consumption.

CULTIVATED TREES.

Fruit trees.—Few orchard fruits are well adapted to conditions in this region. Apples are frequent, and a variety of summer apple does very well on the heavier soils. Peaches, cherries, and pears are occasionally planted, but rarely in large numbers. The fig is a favorite for planting about dwellings, and grows thriftily.

Shade and ornamental trees.—In addition to the indigenous trees already described, which occur at roadsides and about dwellings in the country, having survived the destruction of the forest, there are a number of species, some native, others introduced, which have evidently been conveyed by artificial means to the stations which they now occupy.

At Fortress Monroe, in the city of Norfolk, and elsewhere, live oaks

are sometimes planted, and attain a good size, which is never the case in their natural habitat in this region (the strand). The buttonwood (*Platanus occidentalis*) is occasionally planted about country farmhouses. The silver poplar (*Populus alba*), and the paper mulberry (*Broussonetia papyrifera*) are favorite introduced shade trees, and are both pretty well naturalized. The osage orange (*Toxylon pomiferum*) is sometimes set out for hedges, attaining a height of 40 feet and a diameter near the base of the stem of 10 inches. In gardens in the towns the crape myrtle (*Lagerstroemia indica*) is abundantly planted, and grows to be an exceedingly ornamental small tree. The fig (*Ficus carica*) usually accompanies it. Less common in this latitude is the Chinaberry (*Melia azedarach*). *Albizzia julibrissin*, likewise a small tree, was not seen north of Edenton, but is there commonly naturalized near the town.

WEEDS.

The associations of largely indigenous species already described, which take possession of abandoned fields and country roadsides are not to be confused with the weed formation proper, which consists largely of species which have immigrated from other regions, especially from the Old World. This formation occupies cultivated land, especially near the towns, waysides along the principal lines of travel, and vacant lots, wharves, etc., in the cities and villages, as well as barnyards and inclosures generally in the country. An enumeration of all the weeds of the region would be out of place here; only the more conspicuous species will be mentioned in the following discussion.

Of cultivated land.—Chickweed or wintergreen (*Alsine media*) is one of the most abundant of weeds in truck land about Norfolk, being especially troublesome in strawberry fields during the cooler part of the year. Squirrel tail (*Hordeum pusillum*) is a very common vernal weed in the fields of garden vegetables, as are *Coronopus didymus* and sheep sorrel (*Rumex acetosella*), the last being one of the most characteristic weeds of the strawberry fields. Species of dock (*Rumex crispus*, *R. obtusifolius*), wild radish (*Raphanus raphanistrum*) and the mouse-ear chickweed (*Cerastium viscosum*) are likewise noteworthy among weeds, especially in spring. The broom rape (*Orobanche minor*) is exceedingly common among red clover in the country about Norfolk and Portsmouth, and is also parasitic upon the roots of other plants, notably the vetch (*Vicia sativa*). It is conspicuous in clover fields and on roadsides toward the beginning of summer.

From midsummer to early autumn a different group of weeds appears. Compositae such as the cocklebur (especially *Xanthium strumarium*), ragweed (*Ambrosia artemisiaefolia*), horseweed (*Leptilon canadense*), and dog fennel (*Eupatorium capillifolium*) are prominent. In the black corn lands along the eastern border of the Dismal

Swamp, cocklebur (*Xanthium strumarium*), morning-glory (*Ipomoea purpurea*), and *Sida spinosa* are the most abundant weeds. Near Newbern the small crow-foot grass (*Dactyloctenium aegyptiacum*) and *Eclipta alba* infest cornfields. Nut grass (*Cyperus rotundus*) with tuber-bearing underground shoots is especially frequent in gardens, where it is becoming very troublesome. Near Newbern it is considered the worst weed of the countryside. Bermuda grass (*Capriola dactylon*) is very common, and is in places a great nuisance in cultivated land.

Of waysides.—In the spring squirrel-tail grass (*Hordeum pusillum*) occupies almost every roadside, especially near the larger towns. The buttercup (*Ranunculus bulbosus*) covers pastures and waysides with a sheet of golden yellow. Peppergrass (*Lepidium virginicum*) is a common weed. The common garden honeysuckle (*Lonicera japonica*) is abundantly naturalized at roadsides, flowering profusely in May and filling the air with its fragrance. Vetches (*Vicia sativa*, *V. angustifolia*, *V. hirsuta*) are important elements of this part of the plant covering. A dock (*Rumex conglomeratus*) is common in roadside ditches. The wild onion (*Allium vineale*), chess (*Bromus secalinus*), and corn cockle (*Agrostemma githago*) are particularly conspicuous weeds toward the end of spring.

In early summer the wild carrot (*Daucus carota*) is in most places the predominant roadside weed. Round-leaved mint (*Mentha rotundifolia*) and fennel (*Foeniculum foeniculum*) are locally abundant in midsummer. The horse nettle (*Solanum carolinense*) and plantains (*Plantago rugelii* and *P. lanceolata*) are very common. Towards autumn native species gain the upper hand at most waysides; dog fennel (*Eupatorium capillifolium*), horseweed (*Erigeron canadensis*), rag weed (*Ambrosia artemisiaefolia*), knotweed (*Polygonum pennsylvanicum*), and sprouting crabgrass (*Panicum proliferum*) are most abundant; but such introduced species as Spanish needles (*Bidens bipinnata*), wormseed (*Chenopodium anthelminticum*), barn-yard grass (*Panicum crusgalli*), and yard grass (*Eleusine indica*) are also common. Bermuda grass (*Capriola dactylon*) is very common on country waysides, as well as along the streets and in the lawns of towns.

Ruderal plants.—These occupy waste ground in towns and about wharves, and the inclosures of country dwellings. Of course no sharp line divides this from the two preceding categories of weeds. Jimson weed (*Datura lævis*) is common, especially in barnyards and similar places. *Sagina decumbens* often grows between the bricks of city sidewalks. Lamb's quarters (*Chenopodium album*), wormseed (*C. anthelminticum*), and pigweed (*Amaranthus retroflexus* and *A. spinosus*), as well as other unsightly plants, occupy vacant lots. Vervain (*Verbena officinalis*), *Lycopus europæus*, and low mallow (*Malva rotundifolia*) occur about wharves. In Newbern *Erigeron*

linearifolius and the cosmopolitan tropical smut grass (*Sporobolus indicus*) are common street weeds.

ADAPTATION TO ENVIRONMENT IN THE NONHYGROPHILE INLAND VEGETATION—LIFE FORMS.

In the case of the group of formations just described little need be said in regard to adaptions to the environment. We are here dealing with what is, in a certain sense, neutral ground, lying between two different types of formation which have extreme life conditions, the Sand Strand on the one hand and the Hygrophile Forest on the other. Where the transition is toward the Sand Strand the vegetation possesses characteristics which have already been detailed under that heading. On the other hand, where conditions approach those prevailing in the Hygrophile Forest the plant covering becomes correspondingly modified, and the modifications can be most conveniently discussed in connection with that formation. Generally speaking, in the Wooded Plain conditions of soil and drainage vary greatly within such narrow limits, and most of the characteristic species show themselves to be so little choice in regard to habitat, that any attempt to discuss epharmonic modifications in the vegetation as a whole would be altogether unprofitable, even were it practicable. Very limited areas could be taken up in detail with a full description in each case of the physical conditions of the environment and the structure of the organisms forming the plant covering. Or, on the other hand, certain species of peculiar interest possessing well-marked epharmonic characters, e. g., *Senecio tomentosus*, *Isoetes stans*, could be described at length. But neither mode of treatment would give a satisfactory idea of the ecology of the formation as a whole. It is more expedient to emphasize the heterogeneity of the formations of the Wooded Plain and to point out that the characteristics of the more xerophilous portions are similar to those already discussed under the heading of "Sand Strand," while the moist, low-lying areas exhibit the features which distinguish the forested swamps, to be described later on. It may be said, in a broad way, that the general aspect of the vegetation indicates exposure to a considerable degree of heat and light. These influences are largely counteracted, however, by the presence of abundant moisture in the air and soil, the absorption of water by the roots of plants being unhindered by the presence of any considerable quantity of sodium chloride, as in the maritime formations, or by that poverty of the soil in oxygen which distinguishes the swamps.

The nonpalustrine forest, as well as the drier portions of the wooded swamps, are exposed to forest fires, which occur at frequent intervals, especially in the autumn, and often sweep over considerable areas. However, the absence of a marked period of drought prevents this being an important factor in the life of plants, as is the case in other regions. No modifications of the plants that could be attributed

to fire were observed in the Dismal Swamp region.[1] Forest fires are here sometimes accidental, but are often purposely started in order to produce in the following spring a more extensive development of young shoots of the cane (Arundinaria), which are eagerly grazed by cattle. The tendency of these fires is to destroy the older timber (especially the pines), and thereby effect a more vigorous shrubby growth. Certain herbaceous plants, notably the fireweed (*Erechtites hieracifolia*) and other Compositae, multiply rapidly upon land that has been ravaged by fire.

CLASSIFICATION OF LIANAS.

As nearly all the lianas, or climbing plants, both xerophilous and hygrophilous, which occur in the Dismal Swamp region are represented in the mixed forest formation of the Wooded Plain, there can be no better place than this for an enumeration of the species that possess this life form, so conspicuous and important in the region. The lianas may be classified[2] according to their mode of climbing, as follows:[3]

1. Clambering without development of local sensitiveness and not twining (Kletterpflanzen); in our two plants by means of hooked prickles:

* *Polygonum arifolium.* * *P. sagittatum.*

2. Climbing by negatively heliotropic aerial roots:

Decumaria barbara. *Tecoma radicans.*
Rhus radicans.

3. Twining:

* *Dioscorea villosa.*
* *Clitoria mariana.*
* *Bradburya (Centrosema) virginiana.*
* *Galactia volubilis.*
* *Falcata comosa (Amphicarpaea monoica).*
* *Apios apios (tuberosa).*
* *Rhynchosia tomentosa.*
* *Strophostyles helvola.*
Berchemia scandens (volubilis).
Gelsemium sempervirens.
* *Vincetoxicum (Gonolobus) carolinense.*
Lonicera sempervirens.
* *Willughbaeya (Mikania) scandens.*

4. Climbing by tendrils, consisting of:

(*a*) Modified leaves—

Smilax spp.[4] (metamorphosed stipules).
Clematis crispa (metamorphosed petioles).
Bignonia crucigera (metamorphosed leaflets, ending in adhesive thickenings).

(*b*) Modified shoots—

Vitis spp.
Parthenocissus (Ampelopsis) quinquefolia.[5]
* *Melothria pendula.*
Ampelopsis arborea (Cissus stans).

[1] Warming (Lagoa Santa, 250 to 263 and 466 to 469) describes the devastating fires to which the vegetation of the Brazilian "Campos" is exposed, and mentions certain important changes in the plant life of that region which he believes to have been brought about through the long-continued operation of this factor.

[2] The classification is that of Schenck, Beiträge zur Biologie und Anatomie der Lianen, I Theil, Biologie pp. 5 to 8, (1892).

[3] The names of herbaceous species are marked with an asterisk.

[4] Also mostly provided with hooked prickles.

[5] Tendrils ending in adhesive disks.

FRESH WATER FORMATIONS.

HYGROPHILE FOREST.

By far the greater part of the Hygrophile Forest of the region is embraced within the limits of the Great Dismal Swamp proper. That extensive morass has already been described, as to its physical characteristics, in the subdivision on geography and physiography, and the description need not be repeated in this place. As was there mentioned, certain smaller outlying tracts of swampy forest border the sluggish rivers which for the most part arise in the Great Dismal itself. There are also similar areas, of various size, scattered through parts of the region still more remote from the principal swamp, noteworthy being a considerable portion of "The Desert" at Cape Henry. The vegetation of these outlying swamps is very similar to that of the Great Dismal, and does not require to be separately treated.

Two principal formations are to be distinguished in the Hygrophile Forest: (1) The Black Gum or Dark swamp, covered with heavy deciduous forest; and (2) the Light, Open, or Juniper swamp, originally in great part covered with an evergreen forest of white cedar or "juniper" (*Chamaecyparis thyoides*), but now, in many places almost destitute of trees and bearing a growth of shrubs, of cane (*Arundinaria macrosperma*), and of ferns and peat moss. The first is in great part a virgin formation; the second, while composed entirely of indigenous species, owes its present condition largely to the work of man. Other associations, belonging to the fresh-water marsh and the aquatic formations, are subordinate elements in the plant covering of the swamps. They will be described under the formations to which they ecologically belong.

BLACK GUM SWAMP.

This, the local name of the heavy deciduous forest, indicates the predominance of the black gum (*Nyssa biflora*). (Plate LXVII.) The formation is also known in the region as "Dark swamp." Its larger trees are such as lose their foliage in the autumn, even the prevailing conifer, the bald cypress (*Taxodium distichum*), being deciduous. The only evergreen species among the large trees is the short-leaf pine (*Pinus taeda*), and that is comparatively scarce and unimportant. Such deciduous forest alone occupies the low, flat banks of the rivers above mentioned, and it is likewise characteristically developed within the Great Dismal Swamp proper, especially in the central portion about Lake Drummond. Fine tracts of it extend for 10 kilometers or more northwest of the lake, and cover large areas near the eastern periphery of the swamp. Indeed, areas occupied by this type of vegetation intervene between tracts of "Light swamp" in almost every part of the Great Dismal.

This is generally the wettest of the palustrine forest, and in no

small part of it water 3 to 10 decimeters (1 to 3 feet) deep, or even more, stands upon the surface of the ground during a great part of the year. At all seasons the soil is nearly or quite saturated. Here organic matter accumulates upon the surface in enormous quantities, and we have, as Lesquereux pointed out, a living example of that process of coal formation which was so active in many parts of the globe during the Carboniferous period.[1] On the eastern margin of Lake Drummond the stratum of black, spongy humus is at least 3 meters (10 feet) deep, and perhaps considerably more. Underlying these deposits are beds of sand and silt, often containing great numbers of fossil marine shells, probably of Pliocene age.[2]

The most abundant tree of the deciduous forest is probably the black gum (*Nyssa biflora*), although the red maple (*Acer rubrum*) is almost equally so. This maple seems to be increasing in the swamps more rapidly than any other tree, as thousands of its seedlings cover the ground wherever there is no standing water. Cypress (*Taxodium distichum*), while still fairly abundant in parts of the swamp, was formerly much more so. Especially at the margin of Lake Drummond, a belt of old cypress stumps, many of great size, is evidence of what must once have been a fine forest of this tree (fig. 56). The value of the wood of the cypress, which has been assiduously sought after in the swamp for a hundred years or more, is responsible for its present relative scarcity. Taxodium reproduces itself very slowly, so that an area once gleaned for merchantable timber is regarded by lumbermen as permanently exhausted. Except upon small tracts of marshy land at the edge of Lake Drummond, where seedlings are quite plentiful,[3] there is very little evidence that this tree will regain its former importance in the Dismal Swamp. Nevertheless, it is still the largest tree of the region, specimens 35 meters (120 feet) high and 12 or even 15 decimeters (4 or 5 feet) in diameter above the swollen base being not infrequent.

The black gum (*Nyssa biflora*) is often nearly as tall (sometimes 30 meters, 100 feet), but smaller, usually 3 to 6 decimeters (1 to 2 feet) through above the enlarged base. Red maple (*Acer rubrum*) grows to a height of 20 to 25 meters (70 to 80 feet), but the trees are almost always small, not much exceeding 3 decimeters (1 foot) in diameter. In many parts of the swamp cotton gum (*Nyssa uniflora*), locally

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[1] Lesquereux, Torfbildung im grossen Dismal Swamp: Zeitschr. der deutsche geologische Gesellch., vol. 4, pp. 695 to 697.

[2] Shaler, Tenth Ann. Rept. U. S. Geol. Surv., p. 315 (1890).

[3] Shaler, in an interesting paper upon the bald cypress (Mem. Mus. Compar. Zool Harvard, 16, No. 1, pp. 1 to 15, 1887), suggests that Taxodium propagates in some vegetative manner. That the wood of this tree can send out leafy shoots after being felled was shown by a number of cypress posts which were used as a support for a grapevine at Great Bridge, Va., and had produced numerous sprouts, doubtless from dormant buds. Whether roots were developed from these stems was not ascertained, and would hardly be expected. The species produces fruit quite abundantly in this region.

known as papaw gum, is plentiful, but is not nearly so large a tree as *N. biflora*. It is a very characteristic plant, however, with its large leaves and fruits, and is one of the first trees of the swamp to lose its leaves in autumn. Seedlings of both species of Nyssa are abundant about Lake Drummond. *Pinus taeda* is occasional, especially on higher lands near the eastern border of the swamp. One tree observed in the heart of the morass, however, was growing where it was surrounded by water 3 decimeters (1 foot) deep, which almost touched its base, yet it was perfectly healthy and of good size, about 25 meters (80 feet) high and nearly 5 decimeters (1½ feet) in diameter.[1] The water ash (*Fraxinus caroliniana*) is rather abundant as a slender tree, the largest specimen seen being about 25 meters (80 feet) high and 6 decimeters (2 feet) in diameter near the base.

Among the less important of the larger trees should be mentioned the willow oak (*Quercus phellos*), which is occasional in the wettest parts. One fine specimen observed was about 23 meters (75 feet) high.

Among small trees *Magnolia virginiana* and *Persea pubescens*, both locally known as "bay," are abundant, especially about Lake Drummond, at the edges of clearings. The two species are much alike in habit, having usually slender crooked stems 6 to 9 meters (20 to 30 feet) high. The largest magnolia observed was about 18 meters (60 feet) high and 4½ decimeters (1½ feet) in diameter, with the stocky habit often assumed by *Ilex opaca*. Blue beech (*Carpinus caroliniana*), black willow (*Salix nigra*), and black alder (*Alnus rugosa*) are rather common near Lake Drummond, but hardly attain the size of trees. The same may be said of *Populus heterophylla*, which is frequent in the smaller swamps along streams, and rarely grows to be more than 5 meters (16 feet) high.

Near the eastern border of the Dismal Swamp, where *Pinus taeda* is most abundant, the tulip tree (*Liriodendron tulipifera*) and the sweet gum (*Liquidambar styraciflua*), occur in the deciduous-forested swamp, and are often of considerable size.

In typical areas of this deciduous or "black gum" forest the trees stand closely together and the shade is dense. This, and the usual presence of standing water, accounts for the absence or scarcity in many places of the smaller forms of terrestrial vegetation, which often find a substratum suitable to their growth only in the limited accumulations of humus about tree stumps and old logs. The trunks of most of the trees are very straight, usually small in diameter, and of almost uniform girth and destitute of branches for two-thirds or more of their

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[1] The adaptability of this species is somewhat remarkable. It seems equally at home in almost every soil of the region, making a good growth even among the open dunes. According to Shaler, it is most abundant in the Dismal Swamp on land that is slightly (1 meter or less) higher than the lowest adjacent area. Shortly after the civil war a considerable quantity of pine timber was removed from the eastern part of the swamp, and was used for masts and spars of naval vessels. Logs 6 meters (20 feet) long, 9 decimeters through at the butt, and 6 decimeters at the tip were thus obtained.

height. *Nyssa biflora*, *Taxodium distichum*, and *Fraxinus caroliniana* have the base of the trunk much enlarged, a phenomenon which is most characteristically developed in the few still living old cypress trees which stand in Lake Drummond near the shore (Pl. LXVIII). Some of these have huge, block-like bases, often 8 or 10 times as great in diameter as are the stems above the swelling.[1] Other species, e. g., *Nyssa uniflora*, also have this character, but to a less striking degree. The development of "knees" on the roots of cypress and of arched roots rising above the surface, in cypress and black gum, contributes

FIG. 78.—Rattan (*Berchemia scandens*) climbing on trees in the Black Gum swamp.

much to the somewhat weird aspect of this portion of the swamp (Pl. LXIX).

No less conspicuous are the numerous, large, often intertwined stems of woody lianas, that embrace the trunks and climb often to the tree tops (fig. 78). Most abundant and characteristic are the supple-jack or "rattan" (*Berchemia scandens*), yellow jessamine (*Gelsemium sempervirens*), cross vine (*Bignonia crucigera*), and muscadine grape

[1] The most remarkable individual owes to this peculiarity its local designation of "Samson's Maul."

CYPRESS TREES IN LAKE DRUMMOND, BEARING SPANISH MOSS (TILLANDSIA USNEOIDES).

PLATE LXIX.

BLACK GUM SWAMP, SHOWING KNEES OF THE CYPRESS (TAXODIUM) AND ARCHED ROOTS OF THE BLACK GUM (NYSSA BIFLORA).

(*Vitis rotundifolia*), which climb by twining (the young stems and branches of the two latter with the aid of tendrils); and *Decumaria barbara* and the poison ivy (*Rhus radicans*), which hold fast to the bark by means of innumerable aerial roots (Pl. LXX). In spring the fragrant bright yellow campanulate blossoms of Gelsemium and the large trumpets, dusky red outside, orange-colored within, of Bignonia are produced in great profusion among the crowns of the trees. In early summer Decumaria puts forth numerous cymose clusters of small white flowers. Less common are *Vitis labrusca*, *Smilax rotundifolia*, and *S. walteri*, the latter quite conspicuous when its scarlet fruits are mature. *Smilax laurifolia*, abundant in the open swamp, occurs only on the edges of the black gum forest, being decidedly a sun-loving plant. *Clematis crispa*, with handsome, lilac-purple flowers, and the ground nut, *Apios apios*,[1] are frequent, but are not to be classed among the larger woody lianas. The former has weak, thin stems with a comparatively slight development of wood, while the latter is a perennial twining herb. Farther south, near Newbern, *Ampelopsis arborea* is a common liana of the wooded swamps.

In every direction the ground is encumbered with old logs and stumps in all stages of decomposition. Upon these is the favorite haunt of saprophytic fungi, as well as of small phanerogams such as *Tipularia unifolia*, *Habenaria clavellata*, *Gaultheria procumbens*, and *Mitchella repens*. Liverworts and mosses are likewise abundant on dead stumps and upon the bases of living trees. The smooth, light-gray bark of the red maple affords a home to numerous Bryophyta. A woody parasite, the mistletoe (*Phoradendron flavescens*), is abundant upon the branches of *Nyssa biflora* and *Acer rubrum*, especially around Lake Drummond, where in the spring its dark leaves contrast strikingly with the tender green of the young foliage of the host trees (fig. 79). Occasionally it grows upon the main trunk of small red maples, sometimes at a height of only 1 meter (3 feet) from the ground.

Two vascular epiphytes, besides numerous lichens, make their home upon the branches of Taxodium, especially on the margin of the lake and other open places, where light is plentiful. These are a fern, *Polypodium polypodioides* (*incanum*), and a phanerogam, Spanish moss (*Tillandsia usneoides*). The latter was noticed only upon the small cypress trees in Lake Drummond (Plate LXVIII), where it is rather scarce, and none was seen with stems over a half meter (1½ feet) long.[2]

[1] The one species of the Leguminosae which can be said to be thoroughly at home in the Dismal Swamp.

[2] On Long Creek, near Cape Henry, *Tillandsia usneoides* grows to a length of 4 feet. This plant must formerly have been common in the region, to judge from a remark of Colonel Byrd in the "Westover Manuscript," where, speaking of the trees near the Dismal Swamp, he writes that they "looked very reverend, with the long moss that hung dangling from the branches. Both cattle and horses eat this moss greedily in winter when other provender is scarce, though it is apt to scour them at first."

The Polypodium is abundant upon the larger branches of Taxodium, sometimes 30 meters (100 feet) above the ground.

In more open and drier places in the deciduous forest, shrubby growth, composed largely of Ericaceae, plays an important part. This association is more characteristic, however, of the open parts of the evergreen or juniper forest, and will be described under that heading. One low shrub, however, *Leucothoë axillaris*, with curving branches, thick evergreen leaves, and dense clusters of heavy-scented white

FIG. 79.—Mistletoe (*Phoradendron flavescens*) on a red maple.

flowers, is most at home in the deep shade of the black gum swamp. Next to this characteristic plant stands *Clethra alnifolia* in adaptability to the feeble diffuse light of this type of forest, although Clethra does not find conditions here so congenial as in the more open woods and clearings. The big cane or "reed" (*Arundinaria macrosperma*) (Pl. LXXI), is plentiful in the Black Gum forest, especially along ditches, and here it attains its largest size in the Dismal Swamp region—a height of 5 or 6 meters (15 to 20 feet). In

POISON IVY (RHUS RADICANS) IN BLACK GUM SWAMP, ON THE RIGHT; CANE (ARUNDINARIA MACROSPERMA) AND OSMUNDA REGALIS, FOREGROUND.

CANE NEAR HOPE, N. C.

BIG CANE (ARUNDINARIA MACROSPERMA) ALONG A DITCH IN BLACK GUM FOREST.

abundance of individuals, however, this plant is most important in the lighter parts of the Juniper swamp.

In some parts of the deciduous or Black Gum forest ferns are abundant, especially *Woodwardia areolata*, *Osmunda regalis*, and *O. cinnamomea*. The lizard's tail (*Saururus cernuus*) is plentiful.

The most extensive herbaceous growth observed in any part of this formation covers a limited area upon the eastern shore of Lake Drummond, where the ground is rather high, firm under foot, and devoid of standing water, at least during the summer. Here the rich, black humus, containing only 6 per cent of inorganic matter, is at least 3 meters (10 feet) deep and bears an herbaceous growth such as is often seen in alluvial forests farther north. Besides a vast number of seedlings of *Acer rubrum*, the following perennial herbs are abundant: *Saururus cernuus*, *Boehmeria cylindrica*, *Polygonum arifolium*, *Scutellaria lateriflora*, *Aster diffusus*, *Lycopus rubellus*, *Eupatorium purpureum*, *Impatiens biflora*, and *Woodwardia areolata*.

OPEN OR LIGHT SWAMP.

Juniper forest association.—This formation, usually known locally as "Juniper swamp," is most characteristically developed in the peripheral portions of the Great Dismal and does not extend beyond the limits of the main swamp. On the eastern margin, near the source of the Northwest River, is a typical body of such forest. The prevailing tree is the white cedar (*Chamaecyparis thyoides*), known by the inhabitants of the region as "juniper" (fig. 80). On account of the commercial value of its wood, great numbers of the trees have been removed, and those which remain are mostly small. In places they still form tracts of dense forest, but more often the trees are scattered or mixed with other species. Indeed, extensive areas formerly covered with juniper forest are now almost entirely destitute of trees, and are occupied by woody undergrowth, or even largely by herbaceous plants. Such lands are particularly subject to fires, which effectually prevent the renewal of the forest.

The "Juniper swamp" is usually not so wet as the "Black Gum swamp," yet large areas of it, especially along the Dismal Swamp Canal, are under 3 to 6 decimeters (1 or 2 feet) of standing water even in midsummer. Without doubt this condition of things is partly due to artificial causes. According to Professor Shaler, Chamaecyparis is most at home in parts of the Great Dismal that are subject to partial desiccation at some period of the year.

The substratum in the Juniper swamp consists of a red-brown peat composed largely of the stems, leaves, and roots of the Chamaecyparis, and often containing, to a considerable depth, stumps and logs in a remarkably well-preserved condition. This peat often extends to a depth of 3 meters (10 feet) and usually contains small traces of sand.

It is normally saturated with water, which here has a reaction more decidedly acid than in the parts of the swamp that are covered with deciduous forest. To this quality is undoubtedly due its marked preservative properties. Juniper peat, when exposed to the air, assumes a tough, stringy consistency, and rapidly cakes and burns under the influence of the hot summer sun. Consequently, while land reclaimed from the deciduous or black gum forest is of great agricultural value, that which has supported a growth of juniper is almost worthless.

FIG. 80.—Forest of "juniper" (*Chamaecyparis thyoides*) on the margin of the Dismal Swamp.

The Chamaecyparis trees now standing in the parts of the Dismal Swamp visited are mostly 6 to 9 meters (20 to 30 feet) high and 3 decimeters (1 foot) or less in diameter. Here and there, however, occur fine trees which are 20 meters (70 feet) or so high and 1 meter (over 3 feet) in diameter (fig. 81). Juniper logs 6 meters (20 feet) long and "squaring" 9 decimeters (3 feet) are said to be still obtained within the confines of the Great Dismal. The contracted, spire-like shape of the juniper is in striking contrast to that of other trees of the

region, and suggests the great coniferous forests of northwestern America rather than the southern coastal swamps in which it is at home.

Juniper, unlike cypress, ordinarily reproduces quite rapidly, so that from some tracts of this forest in the Dismal Swamp three cuttings of the merchantable timber have been made with profit within twenty years. The wood is said to increase in thickness about 2½ centimeters (1 inch) per year. Despite its rapid growth and tendency to spread, frequent fires prevent a material increase of the area occupied by this tree.

FIG. 81. Trunk of "juniper" (*Chamaecyparis thyoides*).

As above stated, where the juniper has been left undisturbed it grows in nearly pure association. Where much of it has been removed by the woodman, however, other trees appear. Notable among these is the loblolly pine (*Pinus taeda*), which is almost always associated with the juniper, usually as a small tree of about the same size. The sweet bay (*Magnolia virginiana*), *Persea pubescens*, holly (*Ilex*

opaca), and even small red maples (*Acer rubrum*) and black gums (*Nyssa biflora*) are often present. The cotton gum (*Nyssa aquatica*) is abundant in some parts of the Open swamp, as a small tree 6 meters (20 feet) or so high. On somewhat higher and drier land, oaks (*Q. nigra, Q. michauxii*), beech (*Fagus americana*), and other trees invade what was originally juniper forest.

Ericaceae (shrub) association.—Very abundant and important in the light swamp, especially in the more open places where most of the trees have been removed, is an association of shrubs in which Ericaceae largely predominate (Pl. LXXII). The more important species, named approximately in the order of their abundance, are: *Clethra alnifolia, Itea virginica, Xolisma* (*Andromeda*) *foliosiflora, Leucothoë racemosa, Pieris* (*Andromeda*) *nitida, Ilex glabra, Azalea viscosa*, and *Vaccinium corymbosum*. Frequent, but not usually abundant, are *Viburnum nudum, Ilex lucida, I. decidua, Aronia* (*Pyrus*) *arbutifolia*, and *Amelanchier botryapium*. *Kalmia angustifolia* is somewhat rare and *Leucothoë axillaris* appears to be less at home here than in the black gum forest. *Rhus vernix* (*venenata*) and *Rosa carolina*, which are abundant in the lesser swamps of the region, are of small importance within the borders of the Great Dismal proper.

These shrubs often grow so densely as to exclude almost all other vegetation, usually to a height of 1 to 2½ meters (4 to 8 feet), but with larger individuals here and there which are 5 meters (15 feet) or so high. The stems are usually very crooked and the branches numerous. Most of the species are deciduous-leaved, but two of the most common, *Pieris nitida* and *Ilex glabra*, have thick, shining, evergreen leaves, a character likewise possessed by the less common *Ilex lucida* and *Leucothoë axillaris*. Almost all of these species have showy clusters of white flowers. Those of Itea, Leucothoë, Azalea, and Pieris appear in May, while Clethra is in full blossom in midsummer. The flowers of *Azalea viscosa, Leucothoë axillaris*, and *Clethra alnifolia* are very fragrant. This woody undergrowth is especially well developed along the ditches and in clearings. It is an association which is rapidly increasing in the interior of the Dismal Swamp, where it is said to have been once almost unknown.

Occurring primarily as a constituent of the shrub association is the exceedingly abundant *Smilax laurifolia*, one of the most conspicuous and characteristic plants of the region. This vigorous liana forms great masses among the undergrowth, bearing down the supporting plant by the weight of its heavy wood, thick leaves, and abundant fruit. It is a handsome plant, with evergreen leaves of the laurel type. A striking contrast is afforded by the colors of the leaves of different age—light, almost pea-green, when young, dark and shining when older. The young plants and young branches ascend by means

ASSOCIATION OF SHRUBS AND SMALL TREES ALONG DITCHES IN THE "LIGHT SWAMP."

of tendrils, while the older stems twine about supporting objects. In consonance with the strongly xerophilous structure and aspect of this plant is its marked preference for the open, sunny parts of the swamps. It also occurs at the edges of the Black Gum swamp, and often ascends small trees.

Less abundant, but quite conspicuous when its scarlet fruits are ripe, is a species of greenbrier with deciduous leaves, *Smilax walteri*, which, however, shows a greater liking for shade than does *S. laurifolia*.

Arundinaria macrosperma (*Canebrake*) *association.*—No less im-

FIG. 82.—Big cane (*Arundinaria macrosperma*).

portant in the open parts of the swamp than the association just described is the "canebrake," which covers extensive areas, often in nearly pure association, where the shrubby growth has not secured the upper hand. The cane (*Arundinaria macrosperma*), a woody, bamboo-like grass, locally known as "reeds," grows usually to a height of 2 meters (over 6 feet), although, especially along the ditches and at the edges of woods, it is not rarely 4½ meters (15 feet) high (fig. 82). Along the water courses the aspect of the plant is peculiarly

attractive, with its stems and leaves bending in graceful curves, especially after a heavy rain. In the wetter parts of the swamp the cane forms small hummocks, with its culms often standing so closely together that it is difficult to insert a finger between them. In such cases the dead leaves, as they fall, accumulate among the stems, often to a height of 3 decimeters (1 foot) or more; and, as the strong woody root stocks form a dense sod, one can readily believe that this plant, next to the trees and larger shrubs, is the most effective contributor to the sum total of dead organic matter which year by year accumulates upon the surface of the swamp. Arundinaria spreads rapidly by means of its creeping, much-branched underground stems, so that in land recently reclaimed from the swamps and not thoroughly drained it is sometimes a serious pest.

Woodwardia-Sphagnum (Fern and Peat Moss) association.—The more open parts of the wooded swamp are not always occupied by Arundinaria or other woody undergrowth. Occasionally a large fern, *Woodwardia virginica*, predominates, growing usually upon low hummocks surrounded by standing water. The fronds often measure more than 12 decimeters (4 feet) from the base of the stipe.[1] Other species often associated with the fern are *Eriophorum virginicum*, *Decodon verticillatus*, a suffrutescent lythraceous plant with curving, whip-like stems that strike root and develop aerenchyma where they touch the ground or water, and a handsome orchid, *Limodorum tuberosum*, which here grows to remarkably large size.

Among the stipes of the Woodwardia, and especially in the shallow water on the margins of the hummocks, a species of peat moss (*Sphagnum cymbifolium glaucescens* and its form *squarrulosa*) is abundant. This plant usually has its basal portion submerged, but with a considerable length of the stem rising above the surface of the water. The longest stems observed were about 4½ decimeters (1½ feet), although 15 centimeters (6 inches), or even less, is a more common length. Peat mosses can not be regarded as very important humus-builders in this region, although their value in this regard has been somewhat underestimated. Nowhere are to be seen areas of any considerable size covered with a continuous growth of Sphagnum. Except in some of the ditches of the swamp,[2] these mosses are always secondary members of associations. Of course nothing analogous to the "climbing bogs" and no supplanting of the tree growth by Sphagnum has been observed in the region of the Dismal Swamp. On the contrary, these mosses can make little headway until the forest has been removed or thinned by artificial means. They do not thrive in

[1] For an interesting observation that would indicate positive heliotropism in the fronds see W. Palmer in Proc. Biol. Soc. Washington, vol 13, p. 68 (1899).

[2] See under "Aquatic Vegetation," p. 445.

the shade of the Black Gum forest, nor are they common where Arundinaria is most abundant.[1]

In the swampy woods that border streams a few kilometers west of the main body of the Great Dismal Swamp a number of species enter into the Black Gum forest association that were not observed farther east. The tree growth remains the same; but, among shrubs, the fringe tree (*Chionanthus virginica*), cornel (*Cornus candidissima*), elder (*Sambucus canadensis*), and *Viburnum dentatum* are common. *Lilium superbum* on hummocks and old stumps grows to a height of nearly 2 meters (6 feet). Less frequent is *Habenaria cristata* with small flowers of a brilliant orange color.

Along brooks, especially when flowing through cleared land, occur small specimens of a number of trees that are comparatively rare or altogether wanting in the large wooded swamps. Noteworthy are the buttonwood (*Platanus occidentalis*), black cherry (*Prunus serotina*), and *Catalpa bignonioides*, associated with small examples of cypress (Taxodium), red maple (*Acer rubrum*), and other species common in the palustrine forest.

ADAPTATIONS TO ENVIRONMENT IN THE HYGROPHILE FOREST—LIFE FORMS.

An analysis of the physical environment that prevails in this type of forest leads to the segregation of certain factors which are known to be of primary importance in their influence upon plant life:

1. High temperatures during at least six months of the year, a comparatively mild winter, and, consequently, a long growing season.

2. Strong light during a great part of the growing season, the annual percentage and number of hours of sunshine being relatively high.

3. Abundant atmospheric humidity and a heavy rainfall, fairly equably distributed throughout the year.

4. Absence of exposure, for the most part, to strong winds.

5. Soil very wet, usually saturated, often covered with 3 decimeters (1 foot) or more of standing water; cold; poor in oxygen; more or less acid; exceedingly rich in partially decomposed organic matter.

To the soil conditions all the vegetation, save the epiphytic and para-

[1] Lesquereux, in a paper entitled "Torfbildung im grossen Dismal Swamp," published in Zeitschr. der deutschen geolog. Gesellsch., vol. 4, pp. 695 to 697 (1852), ascribes a much greater importance to Sphagnum in the Dismal Swamp than it really possesses. He writes of the vegetation as "consisting, as in Switzerland, chiefly of Sphagnum, of which, besides European species, there occur several which are peculiar to this continent." This author is surely in error when he interprets the swamp, with its central lake, as an example of "that lacustrine peat formation which occurs in the great bogs of Scandinavia and Denmark." There, he states, "whenever the covering which overlies the underground lake becomes too heavy it sinks easily and gradually, first in the middle and then toward the periphery." We have no evidence that Lake Drummond was produced in any such way.

sitic forms, is directly subject. Likewise the high temperatures which prevail for many months in the region must affect all plants, but, of course, those that grow in the shade much less than those exposed to the direct sunlight. On the other hand, exposure to strong light is experienced in the deep forest only by the large trees, but in the more open parts also by smaller plants.[1] This exposure to strong light and much heat is partially responsible for certain characteristics of the leaves of woody plants in the Dismal Swamp, which can be interpreted as affording protection against excessive transpiration (possibly also against the injurious effect upon the chlorophyll of too intense light). Peculiarities of swamp soil which are well known to cause a lowering of the absorbing action of roots, and hence to reduce the plant's water supply, are probably still more important causes of such modifications, which are thus serviceable in compensating the restricted absorption of water by diminishing the quantity that is transpired by the leaf surfaces. These qualities of the soil are coldness, poverty in oxygen, and acidity, and to them we must ascribe the seeming anomaly that plants growing in shade in wet forests may possess certain peculiarities of structure which are generally known as xerophytic, and are likewise developed, albeit to a much higher degree, in plants of the most arid and sun-baked deserts.[2] In other words, as has been well expressed by Schimper,[3] a physically very wet soil is not necessarily physiologically wet, for the amount of water which the roots can take up is by no means always proportionate to the amount present in the substratum.

ADAPTATIONS TO REDUCE TRANSPIRATION.

An examination of the leaves of the woody plants which occur in the Dismal Swamp shows that almost every species is in some way equipped to reduce the amount of transpiration. Adaptations of the following kinds may be mentioned:

1. *Position and general structure of the leaf.*—In only one species, the parasitic *Phoradendron flavescens*, were the leaves found to be isolateral in structure and orthotropic (approximately vertical, or, in other words, parallel to the direction of the light rays) in position. It goes without saying that we have here an excellent protection against excessive loss of water.[4] All other species examined (except-

[1] To the intensity in this region of the light and heat rays of the sun, anyone who has been on Lake Drummond in a boat at noon on a midsummer day can testify. Only on the sand dunes does one's skin burn more quickly and fiercely.

[2] The existence in the Hygrophile forest of conditions of environment which induce xerophytic characters in vegetation, may account for the presence there of *Pinus taeda*, which is most abundant in the drier parts of the nonhygrophile forest, and flourishes even amid the sand dunes. The converse fact that the bald cypress (Taxodium) can be grown successfully when transplanted to a well-drained upland soil is perhaps to be explained in the same way.

[3] Pflanzengeographie, p. 4.

[4] Moreover, the leaf of Phoradendron is very thick, indeed succulent, and the cuticle is quite massive.

ing *Smilax walteri*), have leaves that are strongly bifacial (dorsiventral) as to structure, and plagiotropic in position, i. e., approximately horizontal, and thus receiving the incident rays as nearly as may be at a right angle. As has already been mentioned, in discussing adaptations to environment in the Sand Strand, leaves thus constituted and placed, unless shaded by other plants or objects from the direct rays of the sun, may have their structure modified in various ways so as to reduce the amount of water transpired, while some of the modifications may serve likewise to shield the sensitive chloroplasts from the injury and even decomposition caused by excess of light. Consequently we find the following arrangements.

2. *Position of the stomata.*—In all the species examined (excepting Phoradendron and *Smilax walteri*, the latter to a certain extent shade-loving) the stomata occur exclusively on the lower (dorsal) leaf surface, and are thus protected by the whole thickness of its tissues from the direct light and heat rays. The stomata of *Smilax laurifolia* are further protected by being deeply sunken, the entire thickness of the massive cuticle lying above the guard cells, while exchange of gases with the outer air is permitted only by a narrow canal through the cuticle.

3. *Epidermal outgrowths.*—The lower surface of the leaf is protected in some species by outgrowths of the epidermis.

(*a*) Hairs, which soon lose their living contents and become filled with air. These are in some cases sufficiently numerous to form a close, downy covering on the under surface of the leaves, especially when young.[1] They occur in the following species: *Persea pubescens*, *Acer rubrum* var., *Magnolia virginiana*, *Nyssa uniflora*. This hairy covering, by forming spaces between the hairs and the leaf surface which are not readily accessible to atmospheric currents, undoubtedly assists in reducing the quantity of vapor of water transpired from the leaf. It may also help to keep the leaf surface free from rain water, which would otherwise cover the mouths of the stomata at times and hinder the entrance and exit of gases. A number of species with persistent, leathery leaves, i. e., *Ilex glabra*, *I. lucida*, *Leucothoë axillaris*, have scattered, prickle-like hairs, which are confined to the impressed larger veins on the ventral surface of the mature leaf.

(*b*) A coating of wax, giving the leaf surface a glaucous appearance. This occurs in *Acer rubrum*,[2] *Magnolia virginiana*, *Persea pubescens*, *Rosa carolina*, *Kalmia angustifolia*. In *Berchemia scandens* the cuticle of both surfaces of the strongly ombrophobic (water shedding) leaf is granular-roughened, probably with a slight deposit

[1] In very young leaves the upper surface also is protected.

[2] The red maple when growing in sunny situations, as on the margin of Lake Drummond, has a thickish leaf, with dark green, shining upper surface, and a very glaucous, usually more or less pubescent, dorsal surface. In deep shade the leaf is thin, and merely pale or only slightly glaucous, usually not pubescent beneath when mature.

of wax. Waxy incrustations prevent such transpiration from the general surface of the leaf as normally takes place in addition to that from the stomatal pores, and which, while relatively slight, amounts in the total to a considerable quantity. Moreover wax, even more effectually than a covering of hairs, prevents rain water from standing upon the leaf surface. A glaucous leaf, in other words, "sheds water."[1]

4. *Strong secondary thickening of the cuticle and outer walls of the epidermis cells.*—The leaves of almost all the woody plants of this formation which were examined exhibit such thickening, especially upon the more exposed upper (ventral) surface. This is particularly evident in the rather numerous species with thick, coriaceous, persistent leaves, e. g., *Pieris nitida*, *Leucothoë axillaris*, *Ilex opaca*, *I. lucida*, *I. glabra*, *Gelsemium sempervirens*, *Magnolia virginiana*, *Smilax laurifolia*. The possible advantages of the polished, shining upper surface of these leaves were discussed in relation to certain species of the Sand Strand. Wiesner has advanced the theory that they serve to reflect some of the incident light.

In a number of species the cuticle is roughened; wrinkled in *Smilax laurifolia*, *Leucothoë axillaris*, *Pieris nitida*, *Xolisma foliosiflora*, and *Chionanthus virginica*; granular in *Berchemia scandens*. In the first three of the species with wrinkled cuticle the ridges are stronger on the lower (dorsal) surface; in the last two, on the upper (ventral) surface. As the leaves of all these species are plagiotropic with ventral surface upward, this difference seems unaccountable. It has already been mentioned that such unevennesses on the surface of the cuticle are believed to refract part of the light, and hence to diminish the intensity of its action upon the tissues below.

5. *Mucilage in the cells of the epidermis.*—This occurs in *Berchemia scandens*, and may aid in preventing the too rapid escape of water from the leaf.[2]

6. *Hypoderm.*—A continuous hypoderm, of one layer of cells, lies beneath the ventral epidermis in the leaves of *Pieris nitida*. Its func-

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[1] Equally effective in preventing the accumulation of water on the surface of the leaf is a dense covering of papillae, such as occurs on the upper surface of the floating leaves of some aquatics and is not rarely present in ombrophobic, shade-loving plants, especially in the tropics. Ombrophobic leaves are injured by long-continued exposure to rains or immersion in water, while this is not the case with foliage that is ombrophilous. Ombrophobic leaves are almost always possessed by xerophilous plants, while of plants that are hygrophilous some have ombrophilous, others ombrophobic foliage. "Largely speaking one can regard the 'unwetableness' of the leaf as a sign that it is ombrophobic; 'wetableness' as an indication that it is ombrophilous." Wiesner, Sitzungsber. der K. Acad. zu Wien, Math.-Naturw. Classe, vol. 102, Abth. 1, pp. 503 to 521 (1893); and vol. 103, Abth. 1, pp. 169 to 191 (1894).

[2] Volkens, Flora der ägypt. arab. Wüste, pp. 43–45, discusses this question at some length, and suggests the above-mentioned as the probable advantage of mucilage in the epidermis cells.

tion is in all probability the protection of the chlorophyll tissue proper against the effect of too much heat and light by removing it thus much farther from the surface of the leaf.

7. *Palisade.*—The value of palisade tissue in reducing transpiration was discussed under "Adaptations to Environment in the Strand Vegetation."[1] It is rather strongly developed in the following plants of the Dismal Swamp: *Smilax laurifolia* (2 layers), *Magnolia virginiana* (2 layers), *Persea pubescens* (2 layers), *Liquidambar styraciflua* (2 layers), *Ilex glabra* (4 layers), *Ilex lucida* (3 layers), *Acer rubrum* var. (only one layer, but the cells are so high as to form more than one-half the thickness of the mesophyll), *Leucothoë axillaris* (2 layers), *Leucothoë racemosa* (2 layers), *Kalmia angustifolia* (2 layers), *Gelsemium sempervirens* (3 layers, but only the uppermost very compact).

AERATING ADAPTATIONS.

Passing now to other epharmonic characters of the vegetation in the Hygrophile forest formation, we encounter some very interesting modifications of structure in certain of the swamp trees which are believed to have as their function the furnishing of air to the roots, which lie in a substratum unusually poor in oxygen. The roots of certain trees which grow in the water or in saturated soil in various parts of the world[2] develop pneumatophores—projections which rise vertically above the surface. These processes, strikingly different from most roots in their negative geotropism, are believed to perform the function of supplying air to the roots, swamp soils being notoriously deficient in oxygen, and with their light, spongy cortex they seem well adapted to the purpose.

In North America the "knees" of the bald cypress (*Taxodium distichum*) are a well-known example of this habit (Pl. LXXIII). They are most conspicuously developed when the tree is growing in a water-covered soil. In the great morasses of the Lower Mississippi and its tributaries these conical outgrowths often rise to a height of 2 meters (about 6 feet) from the roots on which they originate. In Virginia, however, they are never so tall. Shaler[3] believes that the largest cypress knees in the Dismal Swamp do not exceed 9 decimeters (3 feet) in height, measured from their base on the root proper. My own observations indicated that the knees rise usually about 3 decimeters (1 foot), but sometimes 6 or 8 decimeters (2 to 2½ feet) above the

[1] See p. 390.

[2] Compare Goebel, Ueber einige Eigentümlichkeiten der südasiatischen Strandvegetation; Pflanzenbiolog. Schilderungen, Theil 1. The occurrence on the roots of pneumatophores is there noted in certain palms, in the sugar cane, in a species of Jussiaea, and especially in two trees of the mangrove formation, *Sonneratia acida*, and an Avicennia (pp. 139 to 144). In his paper on "Wasserpflanzen," Biolog. Schild. Theil 2, pp. 256 to 259, Goebel notes the presence of pneumatophores in the case of some semiaquatic plants.

[3] Ann. Rep. U. S. Geol. Surv., vol. 10, p. 323.

surface of soil or water. An interesting peculiarity of the knees in this region is that they appear as if still living long after the destruction of the tree which produced them, another evidence of the preservative effect of the swamp water.

Arching of the larger roots which lie on or near the surface of the soil is a peculiarity of both Taxodium and *Nyssa biflora* (Pls. LXIX, LXXIII). In case of the former it is the initial step to knee forming, as these projections seem always to form the summits of root arches. One cypress root which was examined had 1 meter (nearly 4 feet) of its length raised above the surface of the ground, to a maximum height of 25 centimeters (8 inches). The arches are usually, however, shorter and rather higher. In *Nyssa biflora* such a striking development of arched roots as that figured by Shaler[1] was not observed. In both species the roots above ground are more or less compressed laterally. It is possible that the elevation of such arched portions of the root above the surface of the substratum is, like the development of pneumatophores, useful to the plant by aerating the underground parts of the root system, but exact knowledge on this point is wanting.

Distension or tumidity of the basal part of the trunk, already mentioned, is a peculiarity common to most of the larger swamp trees, although more conspicuous in Taxodium and the two species of Nyssa (*biflora* and *aquatica*) than in other species. Shaler, who discusses this question at some length in the paper just quoted, is inclined to regard the swollen base as physiologically homologous with the pneumatophores and arched roots, i. e., as an aerating structure. It seems more likely, however, that the principal object is to secure to the tree a firm foundation in the watery, often unstable soil. The fact that most large forest trees, although growing in soils not deficient in oxygen, are more or less enlarged at base, argues for the explanation of this phenomenon on mechanical principles.

"Juniper" (*Chamaecyparis thyoides*), is, from an ecological point of view, chiefly remarkable in that, while always a hygrophile species, often growing in standing water, it exhibits none of the just described structures for facilitating respiration in the subterranean parts. It possesses neither knees nor projecting, arched roots, and the trunk is either not swollen at base, or not as much so as in most ordinary forest trees.

OTHER ECOLOGICAL CHARACTERS.

The preponderance of woody over herbaceous vegetation, characteristic of most parts of the Non-Hygrophile forest, is even more strongly accentuated in the wooded swamps. In the most typical areas, e. g., the Black Gum swamp near Lake Drummond, almost all the embryophytic plants have their stems more or less lignified. Even the char-

[1] Loc. cit., p. 324, fig. 33.

CYPRESS KNEES AND BLACK GUMS (NYSSA BIFLORA) WITH SWOLLEN BASES.

acteristic grass of the swamp, *Arundinaria macrosperma*, is a woody plant. In the more open parts of the swamp herbaceous forms predominate: in the aquatic vegetation, in areas occupied by the Woodwardia-Sphagnum Association, in the extensive deforested tracts on the periphery of the Dismal, which are chiefly occupied by the Scirpus-Erianthus Association, and in the very limited areas of Low Marsh bordering Lake Drummond.

Among herbaceous phanerogams in the depths of this Hygrophile forest annuals are almost, if not entirely, wanting. Few, if any, of the species complete their development in one growing season. Of life forms, the caespitose form is absent, and likewise the rosette form, so common in the pine barrens. The following are common modes of growth in the wooded swamps:[1]

1. Stems creeping above ground and rooting at the nodes: In *Juncus repens*, *Hydrocotyle umbellata*, *Mitchella repens*, and the most abundant herbaceous grasses, *Panicum gilbum*, *Panicularia brachyphylla*, *P. pallida*.

2. Subterranean rootstocks: Saururus, Rhexia, Lycopus, many grasses, sedges, ferns, etc. In fact, this modification of the lower portion of the stem occurs in a large majority of the herbaceous species.

3. Stolons: *Lycopus rubellus*, *Rhexia mariana*, *R. virginica*, *Scutellaria lateriflora*, *Triadenum virginicum*, etc. Here are to be classed the leafy offsets or extravaginal innovations of many of the grasses and sedges.

Comparatively rare are—

4. Bulbs: present in *Lilium superbum;* and corms, in two orchids, *Tipularia unifolia* and *Limodorum tuberosum*.

5. Tubers: On the rootstocks of *Apios apios* (*tuberosa*) and of species of *Smilax*.

The epiphytic form, which is only sparingly represented here, has already been sufficiently discussed. The only purely parasitic herbaceous embryophyte observed was *Cuscuta gronovii*. No purely saprophytic flowering plant was detected in the woody swamps, although this life form is probably represented.

An impressive feature of the Great Dismal Swamp, especially of the typical Black Gum forest, is its ecological affinity to the tropical "rain forests" (Regenwälder), an affinity which appears in a much slighter degree in the systematic relationship of the species. A number of factors which contribute to this resemblance can at once be distinguished.

1. The general character of the trees, with their arched roots, swollen bases, and straight stems almost devoid of branches to a great height.

[1] Some of the species here enumerated belong properly to marsh associations, and will be mentioned in that connection.

2. The scarcity of terrestrial herbaceous vegetation.

3. The abundance of large, high-climbing lianas which open their blossoms in the tree tops.

4. The almost omnipresence of a woody, bamboo-like grass.

5. The occurrence of vascular epiphytes.

6. The presence of a woody, loranthaceous parasite on the trees.

7. The abundance of thick, evergreen, laurel-shaped leaves, with shining upper surface.

Of course the tropical influence is, after all, weak, and one can readily call to mind many characteristics of the Rain Woods that are not represented in this far extra-tropical region. Such are epiphylly (epiphytes on leaves); showy-flowered epiphytes and parasites; cauliflory (flowers produced from the old wood of trees); trees with compound leaves; trees with "plank roots;" certain ombropholous modifications, such as long-channeled points to the leaves, which carry off rain water, etc. Moreover there are many ecological forms that coincide with large systematic groups of the Tropics, and are wanting in the Dismal Swamp region, e. g., tree ferns, palms, climbing and epiphytic aroids, epiphytic orchids, epiphytic trees and shrubs (Ficus, Clusiaceae).

FRESH-WATER MARSH FORMATIONS.

REED MARSH FORMATION.

Along rivers—Typha-Sagittaria Association.—Above the normal influence of brackish water the larger streams of the region are fringed by a usually narrow belt of marsh vegetation, which, on the one hand, passes gradually into the salt marsh downstream; on the other, into the wooded swamps above. Typical examples are to be seen along the Nansemond, the Northwest, the Pasquotank, and other rivers, usually at or just above the upper limit of navigation. Like the marshes with a saline substratum, this formation is characterized by the preponderance of species with a grass-like habit and by the scarcity or entire absence of woody plants. When these occur, they are usually small cypress trees (*Taxodium distichum*), bushes of alder (*Alnus rugosa*), willow (*Salix nigra*, *S. uvardi*), red maple (*Acer rubrum*), *Itea virginica*, *Magnolia virginiana*, *Rosa carolina*, *Clethra alnifolia*, *Cephalanthus occidentalis*, etc., which sometimes support certain lianas—*Smilax laurifolia*, *Berchemia scandens*, *Clematis crispa*. Woody plants are usually absent from the wettest part of the marsh which borders the open channel of the stream, and first appear on higher ground farther back, becoming more and more numerous until the open marsh passes over into the swampy forest.

The outermost growth in water commonly 15 to 30 centimeters (6 to 12 inches) deep is most often dominated by the cat-tail (*Typha latifolia*), which sometimes forms a nearly pure association. A tall Sagittaria (*S. lancifolia*) and the showy pickerel weed (*Pontederia*

cordata) almost always grow with the Typha. Bulrush (*Scirpus lacustris*), wild rice (*Zizania aquatica*), usually small and 1 meter or so (3 or 4 feet), but sometimes 2½ meters (8 feet) high, *Sium cicutaefolium*, and *Polygonum hydropiperoides* are ordinarily abundant elements in this assemblage. At some points great quantities of *Acorus calamus*, in nearly pure association, occupy that zone of the marsh which immediately borders the open water. In limited areas *Juncus effusus* is predominant in the growth that fringes open water. In others *Dianthera americana* prevails, and is sometimes infested with masses of the golden-yellow stems of *Cuscuta gronovii*.

Farther from the channel, where the ground is a few centimeters higher and the depth of the surface water is less, a greater variety of species occur, many of which are characterized by showy flowers. Indeed, there is no plant association of the region that is more noteworthy in this respect, as the absence or scarcity of woody plants permits a better display of the bright colors than is elsewhere possible. Here, as in the outer belt, monocotyledons of grass-like habit are the dominant form. *Scirpus cyperinus eriophorum* is often abundant. The saw grass (*Cladium effusum*), so characteristic of the great marshes in southern Florida, is sometimes the principal element of the middle belt, especially along the Pasquotank River, near Elizabeth City. It does not grow as large as it does farther south, 1 to 1½ meters (4 or 5 feet) being the common height. *Juncus canadensis*, *J. effusus*, and other rushes are common. Species of Rynchospora (*inexpansa*, *glomerata*), of Eleocharis, and of Carex, notably C. *stricta* (forming strong tussocks), and, usually in rather shady places, *C. gynandra* contribute largely to the plant covering. The handsome lilac-colored blossoms of *Iris caroliniana* are conspicuous in spring, and the brilliant orange-red flowers of *Asclepias lanceolata* (*pauperula*) are even more so in midsummer. *Erianthus saccharoides* is usually not abundant in the river marshes, but always attracts the eye when present. The white, button-shaped heads of *Eriocaulon decangulare* and the beautiful, fragrant, rose-pink blossoms of *Sabbatia dodecandra* are often characteristic features of this association. In autumn the yellow rays of *Bidens trichosperma* give a bright color to the whole marsh. *Triselum palustre* and *Saururus cernuus* prefer the shadier edges of the open marsh. *Cicuta maculata* attains a great size in such situations, one plant having been observed which was 2½ meters (8 feet) high, and 3 centimeters (over an inch) in diameter at base. The suffruticous *Decodon verticillatus*, with numerous clusters of showy purple flowers, is often abundant on the inner edge of the marsh.

Numerous smaller and less showy plants enter into this association—*Centella asiatica*, *Hydrocotyle umbellata*, *Proserpinaca pectinata*, etc.

Edges of Hygrophile Forest—Scirpus-Erianthus Association.—Extensive tracts of wet land formerly covered with forest, but now almost destitute of living trees, border the Dismal Swamp, especially

on the north and east, while similar smaller areas occur at the edges of the lesser wooded swamps. In the plant covering of such places *Scirpus cyperinus eriophorum* is almost invariably the most important element. This handsome sedge usually grows to a height of 1 to 1½ meters (4 or 5 feet). With it, but in smaller numbers, usually occurs *Erianthus saccharoides*, very showy with its tufts of tall culms terminating in light colored, plume-like panicles (fig. 83). *Typha latifolia* and *Andropogon glomeratus* are likewise often abundant constitu-

FIG. 83.—*Erianthus saccharoides* on the eastern margin of the Dismal Swamp.

ents of this association. *Woodwardia virginica* and *Arundinaria tecta* are important in places, but these are species which are as characteristic of the forest formation as of the open marsh. Most of the woody plants that occur in the river marshes are likewise sparsely represented in this association.

Along ditches and in pools in the heart of the Dismal Swamp the Reed Marsh formation is well represented. *Dulichium arundinaceum* and *Triadenum virginicum* are very abundant in the shallow

"turnouts" of the canals, while Saururus is most at home in shady places, where it grows in shallow water or very wet soil, sometimes in pure associations of considerable size. Less important are *Scirpus cyperinus eriophorum*, *S. divaricatus*, *Erianthus saccharoides*, *Eleocharis mutata*, etc.

Topographical, rather than purely ecological considerations make it expedient to distinguish this from the preceding association, although it should be noted that the diversity of forms is much less than in the river marshes and the influence of the adjacent palustrine forest is greater.

LOW MARSH FORMATION.

The term "Low marsh" may be employed as an antithesis to that of "Reed marsh" in order to designate the limited areas of marshy ground or swales which occur here and there in the Forested Plain, especially at waysides, and which are covered chiefly with a low rather than a tall reedy growth. The wet places in the pine barrens, already described under the heading of "Pine Barrens,"[1] could properly be referred to this formation, with which they are ecologically homologous; but, as in other cases, it has seemed best to describe such extremely limited associations in connection with the extensive formations to which they belong topographically. For the same reason the "dune marshes" have been treated in connection with the sand strand, while from the strictly ecological point of view they belong to the "low marshes."

Rynchospora-Eleocharis Association.—The vegetation of the low marshes comprises a great variety of species, predominant among them being numerous sedges. Of these the most abundant are as follows:

Rynchospora cymosa.
Rynchospora inexpansa.
Rynchospora glomerata.
Rynchospora corniculata.
Eleocharis ovata.
Eleocharis tortilis.
Carex verrucosa (characteristic).
Fimbristylis autumnalis.
Fimbristylis laxa.
Lipocarpha maculata.
Fuirena squarrosa.
Cyperus flavescens.
Cyperus flavicomus.
Cyperus pseudovegetus.
Cyperus haspan.

Likewise abundant are various rushes, notably:

Juncus acuminatus.
Juncus acuminatus debilis.
Juncus marginatus.
Juncus canadensis.
Juncus setaceus.
Juncus repens.

Species of Xyris (*X. caroliniana*, *X. ambigua*, etc.) are conspicuous with their bright yellow flowers.

Grasses, mostly with weak, decumbent culms, are often an important element. Examples are:

Panicularia pallida.
Panicum gibbum.
Panicum verrucosum.
Panicum viscidum.

[1] Above, p. 405.

Among other species that commonly occur in the low marshes are—

Hydrocotyle umbellata.
Hydrocotyle ranunculoides.
Rhexia mariana.
Rhexia virginica.
Ludwigia linearis.
Ludwigia alternifolia.
Triadenum virginicum.
Ptilimnium capillaceum.
Limodorum tuberosum.
Gratiola sphaerocarpa.
Gratiola virginica.
Ilysanthes attenuata.
Ilysanthes gratioloides.
Gerardia purpurea.

Two white-flowered violets (*Viola primulaefolia*, *V. lanceolata*) are likewise characteristic. Most of these plants begin to flower about midsummer, the violets being the principal vernal-flowering species.

Along the Dismal Swamp Canal, in moist, sandy, more or less incoherent soil, which has been heaped up in the process of excavation, this formation is characteristically represented by—

Carex verrucosa.
Juncus canadensis.
Juncus acuminatus debilis.
Juncus repens.
Cyperus erythrorhizos.
Rynchospora glomerata.
Rynchospora axillaris.
Saururus cernuus.
Panicum scabriusculum.
Jussiaea decurrens.
Ludwigia alternifolia.
Gratiola sphaerocarpa.

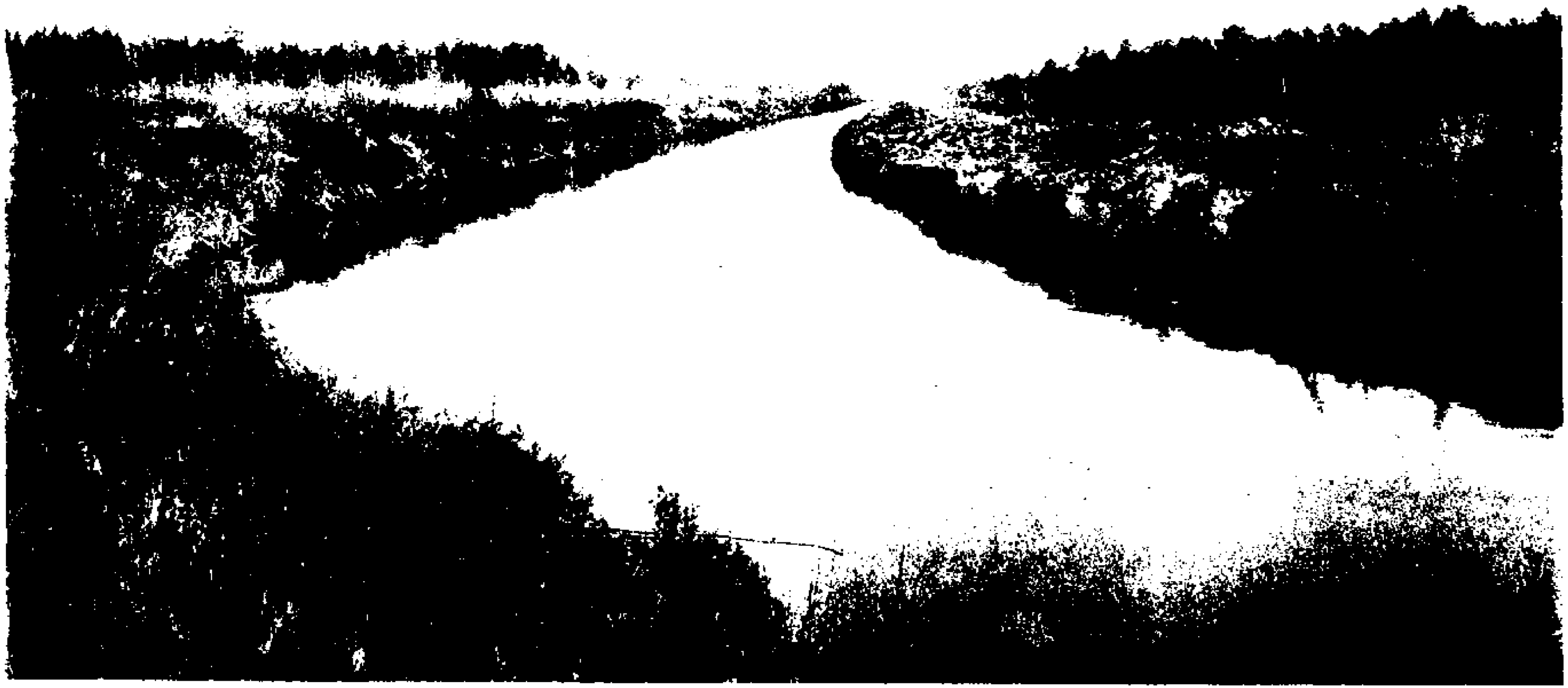
A rank growth of *Cyperus erythrorhizos* 6 decimeters (2 feet) or more high is shown in figure 84. *Funaria hygrometrica* is an abundant moss in the made ground along the canals in early May, but entirely disappears before midsummer. Ferns, notably *Osmunda regalis* and *Woodwardia areolata*, colonize the canal banks from the neighboring swampy forest.

On the margin of Lake Drummond, in the heart of the Dismal Swamp, there is a small area of perhaps a hectare (2½ acres) which is bare when the water level is low. Here occurs an association in which tall plants of the Reed Marsh formation, *Scirpus cyperinus eriophorum* and *Erianthus saccharoides*, mingle with Low Marsh forms. In almost pure white sand at the very edge of the lake *Juncus repens* is abundant, forming a short soft turf. Nearer the bordering woods the soil is a wet muck, composed almost entirely of organic matter, and is somewhat densely covered with a variety of species. *Panicum gilbum*, *Panicularia pallida*, and *Homalocenchrus oryzoides* are conspicuous and ecologically very similar grasses. In midsummer the showy flowers, pale pink to deep rose color, of *Rhexia virginica* and *R. mariana*, are the principal color element. Other species, notably Junci, *Hydrocotyle umbellata*, *Apios apios* (*tuberosa*), and *Decodon verticillatus* help to complete the assemblage.

ADAPTATIONS TO ENVIRONMENT IN THE FRESH-WATER MARSH—LIFE FORMS.

The vegetation of the treeless marshes is exposed to certain conditions which, in the palustrine forest, can greatly affect only the large woody plants and the epiphytes. These are—

1. The direct heat and light of the sun, as opposed to diffused light and radiated heat.
2. The unbroken mechanical and physiological action of air currents.



THE DISMAL SWAMP CANAL NEAR SOUTH MILLS, N. C.

THE HELIOTYPE PRINTING CO., BOSTON.

FEEDER CONNECTING THE DISMAL SWAMP CANAL WITH LAKE DRUMMOND.

THE HELIOTYPE PRINTING CO., BOSTON.

Other important life factors are—

3. Abundant precipitation and atmospheric humidity, as throughout the region.

4. A soil containing abundant moisture, and abundant nitrogenous matter, but relatively cold, poor in oxygen, and probably more or less acid.

This exposure to direct light and the accompanying and resulting heat, as well as to the drying effect of the wind, creates a tendency to

FIG. 84.—*Cyperus erythrorhizos* along the Dismal Swamp Canal.

excessive transpiration from the foliage. The coldness, and doubtless acidity, of the substratum, moreover, reduces the power of the roots to absorb water, although so abundant in the soil. Therefore it is not surprising that the vegetation of the fresh-water marshes, like that of the salt marshes, exhibits in a certain degree those peculiarities which are often termed "xerophytic." Indeed, there is but one important point of difference between the environment of the fresh-water marsh vegetation and that of the salt marsh, the absence in the former of any considerable amount of sodium chloride in the soil and

water. But as that is one of the most effective agents in the development of adaptations against excessive transpiration in salt-marsh plants, the xerophytic quality is naturally much less marked in the vegetation of fresh-water marshes.

In the Fresh-Water Marsh formation it is principally the reed-like monocotyledons which exhibit adaptations that can be regarded as protective against excessive transpiration and too intense light. The position of the exposed leaf surface is chiefly concerned. The leaves are often isolateral; they are usually orthotropic (vertical) or nearly so; the margins are sometimes involute (Cladium, Rynchospora, and numerous other sedges and many of the grasses), or the leaf is even terete (species of Juncus); and in several cases, e. g., Iris, Acorus, Xyris, Typha, the leaves are equitant, with edges opposed to the greatest number of incident rays. The cuticle is often considerably thickened. Hairy or waxy coverings, on the other hand, are either wanting or so little developed as to be of slight protective value. Neither the possession of leathery leaves with shining upper surface nor of water-storage tissue (succulency) are characteristic of this formation.

The remainder of the Fresh-Water Marsh vegetation exhibits little or no xerophytic structure. It is, indeed, for the most part markedly hygrophile. The tall, reed-like plants afford the smaller forms considerable shelter from sun and wind, so that the majority of them require no other protection against excessive transpiration. A result of that exposure to the direct mechanical action of the wind to which the vegetation of the larger marshes, unsheltered by tall woody plants, is subjected is the development of much strengthening tissue (stereome), noticeable especially in the stems and leaves of many of the sedges, grasses, and rushes.

The marsh vegetation is established upon a watery, incoherent soil which would afford but a precarious footing to the plants were not most of them especially fitted to hold themselves in place by their strong, creeping, in many cases branching, rootstocks. This is conspicuous, as in the salt marsh formation, in the case of tall, heavy plants like *Typha latifolia*, *Erianthus saccharoides*, *Scirpus cyperinus*, *S. lacustris*, *Cladium effusum*, etc. The richness of the substratum in organic matter permits a dense, luxuriant plant covering, and thus the danger to the individual plant of being uprooted is reduced to a minimum. Some of the lower growing plants, being less liable to this danger, have thick, comparatively short rootstocks, which are better adapted to the storage of reserve food than to soil binding. Such are *Acorus calamus*, *Peltandra virginica*, *Pontederia cordata*, *Iris caroliniana*. *Cicuta maculata* has a cluster of fleshy, dahlia-like roots.

Water contains of course a smaller percentage of free oxygen than does the atmosphere. Consequently a soil rich in water is relatively poor in free oxygen, and all the more so if the soil is acid.

Now, oxygen, as we know, is necessary to the roots, as to all other organs of the plant, furnishing energy for the carrying on of their vital processes. We have seen that the knees of the bald cypress possibly supply the roots of that tree with oxygen which they obtain from the air and transmit through their open, spongy cortex. A similar function is probably performed in various herbaceous marsh plants by the soft, open tissue which often forms a thickening near the base of the stem (or rather, just above the surface of the water or the watery soil) to which Schenck[1] has given the name *aërenchyma.* This spongy, aerating tissue, usually bright white in color, is developed in the cortex and soon ruptures the epidermis, usually first breaking through longitudinal fissures. Although analogous to cork in its point of origin true aerenchyma consists of delicate parenchyma with thin, nonsuberized walls, and contains, when fully developed, numerous large intercellular spaces. It is particularly noticeable in this region in species of the three related orders, Lythraceae (*Decodon verticillatus*),[2] Melastomaceae (*Rhexia virginica*), and Onagraceae (*Ludwigia linearis*). South of the Dismal Swamp region, in the latitude of Cape Hatteras, occur other species which develop aerenchyma, i. e., *Rhexia glabella*, *Ludwigia pilosa*, and *L. glandulosa.* In *Ludwigia linearis*, however, most of the thickening tissue, at least toward the end of the growing season, and in *L. pilosa* all of it above the very base of the stem, is suberized, and therefore not true aerenchyma.

AQUATIC VEGETATION.

The true water plants of the region were not studied with the same care as was bestowed upon other formations, because with this part of the plant covering the problem which was kept chiefly in view during the progress of the survey does not especially concern itself, and because an exhaustive ecological investigation of the aquatic flora of a region demands much more time than could be devoted to it in this case. Consequently only a superficial description of this interesting formation is possible here, and the lower forms, algae, etc., are not treated.

This, unlike most of the other formations, presents no clearly defined associations corresponding to topographical conditions. On the contrary, the distribution of aquatic plants seems to be largely determined by the accidents of dissemination, so that in this pond one species or life form, in that another, may happen to predominate. Therefore it has seemed most expedient to present a general view of the aquatic vegetation of the entire region without attempting to sub-

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[1] Über das Aërenchym, ein dem Kork homologes Gewebe bei Sumpfpflanzen; Jahrb. für wissenschaft. Botanik, vol. 20, pp. 526 to 574, *t. 23 to 28* (1889). Also Goebel, Wasserpflanzen; Biolog. Schild. Theil 2, pp. 259 to 266 (1891).

[2] See J. Schrenk, Bull. Torr. Bot. Club, vol. 16, pp. 315 to 323, pls. 95 to 97 (1889).

divide the formation, and to follow this with a classification of the ecological forms. These, like the systematic forms (as to genera and families), are, without exception, such as are widely distributed over the face of the globe.

COMPOSITION AND PHYSIOGNOMY.

The greater part of the aquatic vegetation occupies bayous, ponds, and ditches, where the current is very feeble or none is perceptible. *Philotria canadensis* was the only truly aquatic embryophyte which was observed to grow in the channel of the larger streams.

Myriophyllum heterophyllum and *Castalia odorata* are two of the most abundant and characteristic water plants of the region, and are often associated, especially in the numerous shallow pools which occur in the open marsh land that borders the Dismal Swamp on the north. The water lily is especially common, covering the surface of ponds with its shining leaves and handsome white flowers. Both species have strong rhizomes that creep in the mud at the bottom. But, while the stout brittle stems of the Myriophyllum, often over 1 meter (40 inches) long, rise above the surface of the water, Castalia usually sends up its petioles and pedicels only so far that the fully developed leaves and flowers float upon the surface. In *Myriophyllum heterophyllum* the upper part of the stem, often to a length of 2 decimeters (over 6 inches), is emersed and bears simple, entire, or merely serrate leaves, which are sharply differentiated from the finely divided submersed ones. Both Castalia and Myriophyllum prefer water that is exposed, at least for some hours of the day, to direct sunlight.

Nymphaea advena, which is sometimes terrestrial and then enters the Reed Marsh formation, is often aquatic, with the habit of Castalia. The handsome yellow lotus (*Nelumbo lutea*) was observed only near Edenton, N. C., where it covered densely a shallow bayou opening into Albemarle Sound. The great orbicular, peltate leaves either float upon the surface of the water or are lifted considerably above it upon elongated petioles. The pale yellow flowers are likewise lifted above the surface. Growing among the petioles and pedicels of Nelumbo were great quantities of free-swimming *Spirodela polyrhiza*, which in other quiet waters of the region sometimes grows in nearly pure association, spreading a sheet of green over the surface.

Almost as important as Castalia and Myriophyllum are species of Utricularia, notably *U. purpurea* and *U. inflata*, which are also plants that grow best where their floating or emersed portion is exposed to the sun's rays. *U. purpurea* is most abundant in ditches in the open part of the Dismal Swamp, where it associates with *Castalia odorata* or, in the recesses of the morass, with *Sphagnum cuspidatum plumosum* forma *serrata*, and *S. kearneyi*. It often grows in such great quantity as to obstruct navigation in the smaller canals by pole, paddle, or wheel. The masses of stems and leaves, with innumerable swim blad-

ders, float just beneath the surface of the water, unattached to the bottom, and send up into the air peduncles bearing numerous small purple flowers. *U. inflata*, on the other hand, inhabits open ponds outside the palustrine forest, where it is often accompanied by *Callitriche heterophylla*. The inflated petioles of its uppermost whorl of leaves form a small buoy, which floats upon the surface and enables the summit of the stem, with its raceme of bright yellow flowers, to develop outside the water. The submersed leaves are provided with numerous bladders.

The hepatic *Riccia fluitans* is a common plant of the region, often growing terrestrially, even in moist corn fields, but also occurring in an aquatic form, which floats just beneath the surface of ponds.

Isnardia (*Ludwigia*) *palustris* and *Juncus repens* are likewise often terrestrial marsh plants, but sometimes grow in shallow water, where only their uppermost leaves reach the surface. The difference between the terrestrial and aquatic forms of *Juncus repens* is striking.[1] The former has short creeping stems, with short internodes and leaves, often makes a veritable sod, as on the margin of Lake Drummond, and flowers profusely. The water form develops greatly elongated internodes and longer leaves, and apparently does not produce flowers. It sometimes grows in water 3 decimeters (1 foot) deep.

The species of Sphagnum, *S. cuspidatum plumosum* forma *serrata* and *S. kearneyi*, already mentioned as associating with *Utricularia purpurea* in the waters of the ditches in the Dismal Swamp, are there the most abundant of the aquatic plants. Their stems, usually 3 to 6 decimeters (1 to 2 feet) long, often become detached, and seem to grow equally well when floating freely. Either they are wholly submersed or the uppermost portion is emersed. The foliage is very pale, especially upon the submersed portion.

Inhabiting the cold water of ditches in the heart of the Dismal Swamp, where the amount of direct sunlight which reaches the surface of the water is small or none, are *Potamogeton lonchites*, with stems rooting in the mud at the bottom and with its firm, rather large, uppermost leaves floating, and *Sparganium androcladum*, likewise rooted in the substratum, while the upper part of the stem, bearing the uppermost leaves and the inflorescence, rises into the air.

ADAPTATIONS TO ENVIRONMENT.

The characteristic aquatic plants of the Dismal Swamp region may be ecologically classified as follows:[2]

1. Submersed:

(*a*) Freely floating (near the surface): *Utricularia* spp. (flowering peduncles emersed); *Riccia fluitans*.

(*b*) Attached to the bottom: *Philotria canadensis* (always submersed): *Sphag-*

[1] See Holm, Bull. Torr. Bot. Club, vol. 26, p. 359 (1899).

[2] Following roughly the classification used by Schenck, Biologie der Wassergewächse.

num kearneyi and *S. cuspidatum plumosum* forma *serrata* (often submersed): *Callitriche heterophylla*, *Juncus repens*, and *Isnardia palustris* (sometimes submersed).

2. Floating upon the surface.

(*a*) Freely: *Spirodela polyrhiza*.

(*b*) Attached to the bottom, uppermost leaves floating:

Flowers floating—*Castalia odorata*, *Nymphaea advena* (usually).

Flowers usually emersed—*Nelumbo lutea*, *Potamogeton lonchites*.

Flowers submersed—*Callitriche heterophylla* (usually).

3. Rising above the surface, attached to the bottom: *Sparganium androcladum* and *Myriophyllum heterophyllum* (the uppermost flower-bearing portion of the stem emersed).

The general characteristics of aquatic plants are much the same the world over, and have been so often described that a detailed account of them here would be superfluous.

The root system is usually comparatively little developed, since water plants absorb most of their fluid nutriment directly through the foliage. In the freely swimming forms the roots reach their minimum development, being entirely aborted in some cases, while in larger plants that are attached to the bottom there is a greater production of mostly simple roots, which are perhaps chiefly used as holdfasts.

The stems in the latter group usually creep at some distance over the bottom as rhizomes, sending down roots into the soil before rising toward the surface. That portion of the stem which ascends through the water is most frequently slender and branching. The rootstock is sometimes thickened and serves for the storage of reserve food, especially in the Nymphaeaceae.

The submersed leaves are usually either elongated, narrow, and flexuous (*Philotria canadensis*, *Juncus repens*, *Sparganium androcladum*), or finely divided with filiform segments (*Myriophyllum heterophyllum*, *Utricularia* spp.); and, in Utricularia, provided with insectivorous bladders. They are always thin and delicate, wilting rapidly when exposed to the air. The floating leaves are more often broad (*Potamogeton lonchites*, *Nymphaea advena*), often orbicular, or nearly so, and peltate (Nelumbo, Castalia), and with an ombrophobous (water-shedding) upper surface. Peculiarly specialized are the floating leaves of *Utricularia inflata*, mentioned above.

In anatomical structure water plants are chiefly remarkable for the feeble development of certain elements which are strongly developed in most land plants. In the stem the mestome bundles are small, and are grouped together in a central cylinder with the vessels few and but slightly or not at all lignified. Large lacunes, which probably serve as an aerating apparatus, are present. Mechanical strengthening tissue is in most cases wanting.

Submersed leaves usually have few or no stomata, chlorophyll tissue of the spongy type (no palisade), epidermis without hairs, its cell walls not thickened, the radial walls usually undulate and the cells often containing chlorophyll. In short, there is a total lack of provision against excessive transpiration, and this explains the rapidity

with which submerged aquatics wilt when removed from the water. The floating leaves are better protected, possessing stomata (on the upper surface only); a thicker-walled epidermis; often true palisade; and sometimes a dense covering of papillae (e. g., Nelumbo), which causes water to roll off the surface without wetting it. In aquatics of this class a transpiration current is maintained from the roots to the leaf surfaces. Large floating leaves are, moreover, provided with more or less mechanical strengthening tissue and with large intercellular spaces near the lower surface which serve as swim-bladders, cooperating with the water-shedding papillae in keeping the leaf afloat upon the surface and the layer of palisade always horizontal and opposed to the light rays.

The flowers of embryophytic water plants in most cases either are emersed or float upon the surface.

PHYTOGEOGRAPHICAL AFFINITIES OF THE FLORA.

The factor in the physical environment of plants and animals which exerts the largest control over their geographical distribution is temperature. It is the sum total of effective temperatures (above 6° C.) received during the period of greatest vital activity, the "growing season," that seems to determine the polar or the upward limit beyond which a given organism can not successfully maintain itself against the stress of its physical or biological environment. Hence it is the sum of effective temperatures which fixes the limits, polar in point of latitude, upward in point of altitude, of the great life zones. These zones in North America, as now often recognized,[1] are as follows:

1. **Boreal Region.**
   - (*a*) **Arctic-Alpine zone.**
   - (*b*) **Hudsonian zone.**
   - (*c*) **Canadian zone.**
2. **Austral Region.**
   - (*d*) **Transition zone.**
   - (*e*) **Upper Austral zone** { **Carolinian area.** / **Upper Sonoran area.**
   - (*f*) **Lower Austral zone** { **Austroriparian area.** / **Lower Sonoran area.**
3. **Tropical Region.**

Another factor which in great measure controls the distribution of life on the surface of the globe is water. The quantity of atmospheric humidity and of rainfall is next in importance to that of heat in determining the distribution of plants, and, less directly, of animals. We have, therefore, a division of the Lower Austral life zone into two areas—an eastern or humid, the Austroriparian area; and a western or dry, the Lower Sonoran area. The actual difference in quantity of rainfall which fixes the dividing line between these two areas has not yet been ascertained. They are even more strikingly different

[1] Merriam, C. H., Yearbook U. S. Dept. Agr. for 1894, pp. 203 to 214 (1895); and Bull. Div. Biolog. Surv., U. S. Dept. Agr., No. 10, pp. 18 to 53 (1898).

ecologically than in their systematic forms, the humid area being heavily forested, while the dry Lower Sonoran area is destitute of forest in the strict sense of the term.

POSITION IN THE LIFE ZONES OF NORTH AMERICA.

The southeastern corner of Virginia, including the Great Dismal Swamp, constitutes the northeastern termination of the Austro-riparian Area. Here this area covers but a limited tract which does not greatly exceed the bounds of the Dismal Swamp region. It is the low elevation of this strip of sandy coastal plain and its neighborhood to the ocean that permits the presence of Austroriparian flora, while not far westward, with a comparatively only slight increase of altitude, the Austroriparian element becomes subordinated to the Carolinian (Upper Austral), which prevails throughout the hilly middle country or Piedmont region of Virginia, the Carolinas, and Georgia, as well as in the greater part of Maryland, Delaware, and New Jersey. This transition from the Lower to the Upper Austral zone is probably induced as much by increasing distance from the sea, with its tempering influence upon the climate, as by the relatively insignificant increase in the elevation of the land.

Farther southward the width of the Austorriparian belt constantly increases. In North Carolina it covers nearly one-third the total area of the State, while fully half of South Carolina and Georgia and the whole of Florida, excepting the extreme southern (tropical) portion, belong to this zone.[1]

AUSTRORIPARIAN PLANTS REACHING THEIR NORTHERN LIMIT IN THE DISMAL SWAMP REGION.

Not a few species of plants which belong properly to the Lower Austral zone range, in gradually decreasing number of forms and individuals, north of the mouth of Chesapeake Bay. Nevertheless, as a whole, or, better speaking, as the predominant floral element, the Austroriparian flora finds there its northeastern limit. Conversely, many of the species that inhabit the Dismal Swamp are most abundant in and characteristic of the Upper Austral zone (Carolinian area), and some even belong to the Transition zone. But the most conspicuous and abundant species, such as contribute largely to the physiognomy

[1] The limits of this area are defined by Dr. Merriam (Bull. Div. Biol. Surv., U. S. Dept. Agr. No. 10, p. 45) as follows: "The *Austroriparian* area occupies the greater part of the South Atlantic and Gulf States. Beginning near the mouth of Chesapeake Bay, it crosses more than half of Virginia, North and South Carolina, Georgia, Florida, Alabama, the whole of Mississippi and Louisiana, eastern Texas, nearly all of Indian Territory, more than half of Arkansas, southern Missouri, southern Illinois, the extreme southwestern corner of Indiana, and the bottom lands of western Kentucky and Tennessee." It does not seem proper that so much of Virginia and North Carolina should be included in the Lower Austral zone. Certainly the flora of all but the most eastern portion of Virginia is predominantly Carolinian rather than Austroriparian.

of the vegetation, are properly Austroriparian plants. Among these "character plants" are a considerable number which do not extend north of the Dismal Swamp region, namely:

Pinus palustris.
**Erianthus saccharoides.*
**Panicum gibbum.*[1]
**Uniola paniculata.*
Arundinaria macrosperma.
**Cyperus haspan.*
**Fimbristylis spadicea.*
Cladium effusum.
Carex verrucosa.
**Tillandsia usneoides.*
Atamosco (Zephyranthes) atamasco.
Quercus laurifolia.
**Quercus virginiana.*
Clematis crispa.
Persea borbonia.
Persea pubescens.
**Decumaria barbara.*[1]
Zanthoxylum clava-herculis.
Jatropha stimulosa.
Berchemia scandens.
Cornus stricta.
Nyssa aquatica.
Nyssa biflora.
Leucothoë axillaris.
**Pieris nitida.*
Styrax grandifolia.
**Fraxinus caroliniana.*
Gelsemium sempervirens.
Callicarpa americana.[1]
**Physalis viscosa.*
Bignonia crucigera.[1]
**Eupatorium capillifolium.*
**Borrichia frutescens.*

Those species whose names are preceded by an asterisk (*) are not confined to the Lower Austral zone, but extend southward into the tropical region. A complete list of the species which are known to reach their northern limit in the Dismal Swamp region is given in the table of northern limits of Austroriparian species, which will be found at the end of this chapter.

PLANTS REACHING THEIR SOUTHERN LIMIT IN THE DISMAL SWAMP REGION.

Besides the Lower Austral element which dominates the flora of this region and the large number of Upper Austral species, there are a number of plants which apparently here reach their southern limit, at least in the Coastal plain. These belong to three categories: (1) Strand plants hardly to be reckoned to any of the life zones; (2) mostly palustrine species, chiefly of boreal origin, to which the cold, wet soil of the swamps offers a congenial environment; and (3) non-palustrine species, which are either of the Transition zone or of both that and the Upper Austral. A prefixed (*) indicates that the species reaches its actual austral limit in point of latitude, irrespective of altitude, in the Dismal Swamp region.

1. STRAND PLANTS.

**Ammophila arenaria.*[2]
* *Festuca rubra.*[3]
* *Lechea maritima.*[4]
**Ammodenia peploides.*
* *Hudsonia tomentosa.*

[1] Occurs sparingly in mountain valleys in eastern Tennessee.
[2] Ranges several miles south of Virginia Beach and perhaps into North Carolina.
[3] The var. *glaucescens* Hack. occurs in central Tennessee.
[4] Accredited by Watson to Georgia, but this requires confirmation.

2. PALUSTRINE SPECIES.

Dryopteris (Aspidium) spinulosa dilatata.
Panicularia (Glyceria) brachyphylla.
**Panicularia obtusa.*
Panicularia pallida.
**Carex canescens.*
Gaultheria procumbens.
**Utricularia clandestina.*

3. NONPALUSTRINE SPECIES.

Carex costellata.
Juncoides (Luzula) pilosum.
Cypripedium acaule.
Salix fluviatilis (longifolia).
Potentilla pumila.
Agrimonia striata.
Valerianella chenopodifolia.

NORTHERN LIMITS OF AUSTRORIPARIAN PLANTS REACHING THE DISMAL SWAMP REGION.

The following tables give the northern limit of most of the characteristic species belonging to the Coastal plain or Austroriparian area, which extend northward along or near the coast as far as the southern border of North Carolina or farther. In some cases there is room for doubt as to whether the species is really of Austroriparian rather than of Carolinian origin. But the great majority of the species tabulated unquestionably reach their greatest development and widest distribution in the former zone.

A number of signs are used in order to denote the further distribution of the given species. Thus an asterisk (*) indicates that the species so designated also extends into the Tropical Zone, or at least into subtropical parts of Mexico or the West Indies. A dagger (†) is appended to the names of species which range northward in the Mississippi Valley to latitude 36° or farther. A double dagger (‡) denotes a strand plant. Species of that formation usually have a wider range than is embraced within the limits of a single life zone. Species indicated in the columns of the table by a cross (×) are definitely known to extend northward to the latitude given. In almost every case such record of northward range is based upon the examination of reasonably authentic specimens. A query (?) in one of the columns, opposite the name, indicates that the species is reported to range thus far northward, but is not certainly known to do so. A number of these Austroriparian plants also occur in more or less limited areas in the midst of the Carolinian, or even of the Alleghanian (Transition) zones, chiefly in the Appalachian area, or farther west. Such stations are to be regarded as outposts of the main Austroriparian flora, for which local conditions of climate or soil exposure (or of both) are responsible.[1]

[1] See Kearney, The Lower Austral element in the flora of the southern Appalachian region, Science, n. ser., vol. 12, p. 830 (1900).

Northern limit of species.

Name of species.	Latitude 34°, N.C.	Latitude 34° 30', N C.	Latitude 35°, N.C.	Latitude 36°, N.C.	Latitude 37°, Va.	Latitude 38°, Va.	Latitude 39°, Md. and Del.	Latitude 40°, N.J.	Latitude 41°, N.Y.	Latitude 41° 30', Conn. and R.I.	Latitude 42°, Mass.
Lycopodium alopecuroides L								×			
Lycopodium carolinianum L								×			
Pinus palustris Mill					×						
Pinus serotina Mx			×								
Pinus taeda L							×				
Taxodium distichum L							×				
Chamaecyparis thyoides (L.) B. S. P											×
Triglochin striata (L.) Ruiz & Pav.*							×				
Sagittaria lancifolia L.*							×				
Sagittaria subulata (L.) Buchenau									×		
Sagittaria teres S. Wats											×
Erianthus compactus Nash								×			
Erianthus contortus Ell											
Erianthus saccharoides Mx					×						
Manisuris rugosa (Nutt.) Kuntze							×				
Andropogon argyraeus Schult.†							×				
Andropogon glomeratus (Walt.) B. S. P									×		
Andropogon tetrastachyus Ell					×						
Paspalum compressum (Sw.) Nees*											
Paspalum floridanum Mx							×				
Paspalum membranaceum Walt							×				
Paspalum paspaloides (Mx.) Scribner							×				
Paspalum praecox Walt			×								
Paspalum purpurascens Ell					×						
Amphicarpon amphicarpon (Pursh) Nash								×			
Anthaenantia villosa Beauv	×										
Sptitherisma serotinum Walt											
Panicum amarum Ell					×						
Panicum amarum minus Vasey & Scribn									×		
Panicum angustifolium Ell											
Panicum ciliatum Ell					×						
Panicum columbianum Scribner											×
Panicum digitarioides Carpenter							×				
Panicum gibbum Ell					×						
Panicum hians Ell.†											
Panicum lanuginosum Ell								×			
Panicum longifolium Torr									×		
Panicum nashianum Scribner					×						
Panicum neuranthum (Griseb					×						
Panicum pauciflorum Ell					×						
Panicum scabriusculum Ell					×						
Panicum sphagnicola Nash								×			
Panicum verrucosum Muhl											×
Panicum viscidum Ell.†								×			
Oplismenus setarius (Lam.) Nash			×								
Chaetochloa perennis (Curtis) Bicknell											
Chaetochloa imberbis perennis (Hall) Scribn. & Merrill											
Cenchrus incertus M. A. Curtis											
Cenchrus tribuloides macrocephalus Doell								×			
Homalocenchrus hexandrus (Roem. & Schult.) Britton	×										
Hydrochloa fluitans (Mx.) Nash											
Zizaniopsis miliacea (Mx.) Doell & Aschers											
Phalaris caroliniana Walt											
Aristida lanata Poir							×				
Aristida stricta Mx			×								
Aristida virgata Trin	×										
Muhlenbergia filipes M. A. Curtis			×								
Sporobolus junceus (Mx.) Kunth	×										
Sporobolus virginicus (L.) Kunth*											
Agrostis altissima (Walt.) Tuckerm								×			
Agrostis elliottiana Schult.†											
Danthonia sericea Nutt											×
Campulosus aromaticus (Walt.) Scribner			×								
Chloris petraea Sw.*			×								
Gymnopogon ambiguus (Mx.) B. S. P								×			
Gymnopogon brevifolius Trin								×			
Triplasis americana Beauv	×										
Eragrostis hirsuta (Mx.) Nash				×							
Eragrostis nitida (Ell.) Chapm			×								
Eragrostis refracta (Muhl.) Scribner							×				
Uniola laxa (L.) B. S. P									×		
Uniola longifolia Scribner				×							

Northern limit of species—Continued.

Name of species.	Latitude 34°, N. C.	Latitude 34° 30', N. C.	Latitude 35°, N. C.	Latitude 36°, N. C.	Latitude 37°, Va.	Latitude 38°, Va.	Latitude 39°, Md. and Del.	Latitude 40°, N. J.	Latitude 41°, N. Y.	Latitude 41° 30', Conn. and R. I.	Latitude 42°, Mass.
Uniola paniculata L.*†					×						
Arundinaria macrosperma Mx					×						
Arundinaria tecta (Walt.) Muhl							×				
Cyperus compressus L.*†							×				
Cyperus cylindricus (Ell.) Britton									×		
Cyperus echinatus (Ell.) Wood	×										
Cyperus flavicomus Mx					×						
Cyperus grayi Torr											×
Cyperus haspan L.*					×						
Cyperus microdontus Torr					×						
Cyperus pseudovegetus Steud.†							×				
Cyperus stenolepis Torr	×										
Cyperus tetragonus Ell	×										
Eleocharis albida Torr							×				
Eleocharis capitata (L.) R. Br.*†							×				
Eleocharis melanocarpa Torr											×
Eleocharis microcarpa Torr.*								×			
Eleocharis ochreata (Nees) Steud.*					×						
Eleocharis prolifera Torr					?						
Eleocharis tortilis (Link) Schult							×				
Eleocharis triostata Torr									×		
Eleocharis tuberculosa (Mx.) Roem & Schult											×
Dichromena colorata (L.) Hitchc.*								×			
Dichromena latifolia Baldw			×								
Psilocarya nitens (Vahl) Wood									×		
Stenophyllus stenophyllus (Ell.) Britton	×										
Stenophyllus ciliatifolius (Ell.) Mohr	×										
Fimbristylis castanea (Mx.) Vahl*†									×		
Fimbristylis spadicea (L.) Vahl*				×							
Fimbristylis vahlii (Lam.) Link†	×										
Scirpus cylindricus (Torr.) Wood						×					
Scirpus divaricatus Ell.†				×							
Fuirena squarrosa Mx											×
Fuirena squarrosa hispida (Ell.) Chapm									×		
Hemicarpha micrantha (Vahl) Britton										×	
Lipocarpha maculata (Mx.) Torr				×							
Rynchospora axillaris (Lam.) Britton									×		
Rynchospora microcephala Britton								×			
Rynchospora ciliata Vahl	×										
Rynchospora corniculata (Lam.) A. Gray†						×					×
Rynchospora corniculata macrostachya (Torr.) Britton											
Rynchospora cymosa Ell.*†								×			
Rynchospora fascicularis (Mx.) Vahl			×								
Rynchospora filifolia A. Gray	×										
Rynchospora gracilenta A. Gray								×			
Rynchospora grayi Kunth	×										
Rynchospora inexpansa (Mx.) Vahl				×							
Rynchospora knieskernii Carey								×			
Rynchospora megalocarpa A. Gray	×										
Rynchospora miliacea A. Gray	×										
Rynchospora oligantha A. Gray							×				
Rynchospora pallida M. A. Curtis								×			
Rynchospora plumosa Ell	×										
Rynchospora raviflora Ell				×							
Rynchospora schoenoides (Ell.) Britton				×							
Rynchospora torreyana A. Gray								×			
Cladium effusum Torr					×						
Scleria torreyana Walp*								×			
Carex elliottii Schw. & Torr	×										
Carex grandis Bailey†							×				
Carex littoralis Schwein									×		
Carex venusta Dewey	×										
Carex verrucosa Muhl					×						
Carex walteriana Bailey								×			
Peltandra sagittaefolia (Mx.) Morong	×				(?)						
Orontium aquaticum L											×
Sabal minor (Jacq.) Mohr	×										
Sabal palmetto Roem. & Schult	×										
Mayaca aubleti Mx	×										
Xyris ambigua Beyrich			×								
Xyris baldwiniana Roem. & Schult	×										
Xyris caroliniana Walt											×
Xyris communis Kunth†						×					

Northern limit of species—Continued.

Name of species	Latitude 34°, N. C.	Latitude 34° 30', N. C.	Latitude 35°, N. C.	Latitude 36°, N. C.	Latitude 37°, Va.	Latitude 38°, Va.	Latitude 39°, Md. and Del.	Latitude 40°, N. J.	Latitude 41°, N. Y.	Latitude 41° 30', Conn. and R. I.	Latitude 42°, Mass.
Xyris fimbriata Ell								×			
Xyris torta J. E. Smith								×			
Eriocaulon compressum Lam.*								×			
Eriocaulon decangulare L.*								×			
Lachnocaulon anceps (Walt.) Morong			×								
Dupatya flavidula (Mx.) Kuntze		×									
Tillandsia usneoides L.*					×						
Commelina hirtella Vahl†								×			
Commelina nodiflora L.*†								×			
Tradescantia rosea Vent.†							×				
Juncus polycephalus Mx		×									
Juncus repens Mx.*							×				
Juncus roemerianus Scheele								×			
Juncus scirpoides Lam											
Juncus sclicens Rostk.†							×				
Pleea tenuifolia Mx	×										
Tofieldia glabra Nutt	×										
Tofieldia racemosa (Walt.) B.S.P.								×			
Zygadenus glaberrimus Mx				×							
Zygadenus leimanthoides (Gray) Wats								×			
Lilium catesbaei Walt	×										
Aletris aurea Walt			×								
Yucca aloifolia L			×								
Yucca filamentosa L							×				
Yucca gloriosa L			×								
Smilax auriculata Walt	×										
Smilax lanceolata L	×										
Smilax laurifolia L								×			
Smilax tamnifolia Mx								×			
Smilax walteri Pursh								×			
Gyrotheca capitata (Walt.) Morong.*											×
Atamosco atamasco (L.) Greene				×							
Lophiola americana (Pursh) Coville								×			
Iris caroliniana S. Wats				×							
Habenaria cristata (Mx.) R. Br								×			
Habenaria integra (Nutt.) Spreng								×			
Habenaria nivea (Nutt.) Spreng							×				
Pogonia divaricata (L.) R. Br								×			
Gyrostachys odorata (Nutt.) Kuntze†				×							
Gyrostachys praecox (Walt.) Kuntze									×		
Listera australis Lindl									×		
Limodorum pauciflorum (Lindl.) Nash			×								
Hicoria aquatica (Mx.) Britton†				×							
Hicoria carolinae-septentrionalis Ashe							×				
Myrica cerifera L.							×				
Quercus catesbaei Mx		×									
Quercus cinerea Mx				?							
Quercus digitata (Marsh.) Sudworth								×	?		
Quercus laurifolia Mx				×							
Quercus michauxii Nutt†							×				
Quercus nigra L.†							×				
Quercus phellos L.†									×		
Quercus virginiana Mill				×							
Ulmus alata Mx.†				×							
Parietaria debilis Forst			×								
Asarum arifolium Mx				×							
Aristolochia nashii Kearney				×							
Eriogonum tomentosum Mx											
Polygonum setaceum Baldw.†			×								
Sesuvium maritimum (Walt.) B.S.P.†									×		
Arenaria caroliniana Walt											
Stipulicida setacea Mx											
Cabomba caroliniana A. Gray†											
Nymphaea sagittaefolia Walt.†											
Magnolia virginiana L											×
Clematis crispa L											
Ranunculus oblongifolius Ell.†											
Ranunculus pusillus Poir.†									×		
Cebatha carolina (L.) Britton†											
Persea borbonia (L.) Spreng							?				
Persea pubescens (Pursh) Sarg											
Malapoenna geniculata (Walt.) Coulter											
Benzoin melissaefolium (Walt.) Nees.†											
Cardamine arenicola Britton										×	

Northern limit of species—Continued.

Name of species.	Latitude 34°, N. C.	Latitude 34° 30', N. C.	Latitude 35°, N. C.	Latitude 36°, N. C.	Latitude 37°, Va.	Latitude 38°, Va.	Latitude 39°, Md. and Del.	Latitude 40°, N. J.	Latitude 41°, N. Y.	Latitude 41° 30', Conn. and R. I.	Latitude 42°, Mass.
Sarracenia flava L			×								
Sarracenia rubra Walt	×										
Sarracenia variolaris Mx	×										
Drosera brevifolia Pursh	×										
Drosera filiformis Raf											×
Dionaea muscipula Ell			×								
Decumaria barbara L					×						
Itea virginica L								×			
Fothergilla carolina (L.) Britton		×									
Rubus cuneifolius Pursh †										×	
Rubus trivialis Mx. †					×						
Crataegus apiifolia (Marsh.) Mx. †					×						
Crataegus spathulata Mx. †					×						
Prunus angustifolia Marsh								×			
Prunus caroliniana (Mill.) Ait	×										
Chamaecrista aspera (Muhl.)			×								
Baptisia villosa (Walt.) Nutt			×								
Crotalaria purshii DC				×							
Crotalaria rotundifolia (Walt.) Poir					×						
Trifolium carolinianum Mx			×								
Psoralea pedunculata (Mill.) Vail					×						
Cracca ambigua (M. A. Curtis) Kuntze	×										
Cracca hispidula (Mx.) Kuntze		×									
Cracca spicata (Walt.) Kuntze						×					
Kraunhia frutescens (L.) Greene†		×									
Astragalus glaber Mx			×								
Indigofera caroliniana Walt			×								
Aeschynomene virginica (L.) B. S. P							×				
Zornia bracteata (Walt.) Gmel. *					×						
Stylosanthes riparia Kearney						×					
Meibomia arenicola Vail						×					
Meibomia stricta (Pursh) Kuntze							×				
Meibomia tenuifolia (Torr. & Gr.) Kuntze	×										
Lespedeza angustifolia (Pursh) Ell. †											×
Lespedeza hirta oblongifolia Britton							×				
Bradburya virginiana (L.) Kuntze *							×				
Galactia regularis (L.) B. S. P									×		
Galactia sessiliflora Torr. & Gr			×								
Erythrina herbacea L	×										
Rhynchosia erecta (Walt.) DC						×					
Rhynchosia simplicifolia (Walt.) Wood		×									
Rhynchosia tomentosa (L.) Hook. & Arn											
Zanthoxylum clava-herculis L											
Polygala brevifolia Nutt											
Polygala cymosa Walt							×				
Polygala lutea L									×		
Polygala ramosa Ell							×				
Croton maritimus Walt											
Crotonopsis linearis Mx. †								×			
Tragia urens L											
Jatropha stimulosa Mx											
Stillingia sylvatica L. †											
Euphorbia curtisii Engelm			×								
Euphorbia ipecacuanhae L. †											
Cyrilla racemiflora Walt. *											
Ilex ambigua (Mx.) Chapm											
Ilex decidua Walt. †											
Ilex glabra (L.) A. Gray											×
Ilex lucida (Ait.) Torr. & Gr											
Ilex vomitoria Ait											
Aesculus pavia L. †											
Berchemia scandens (Hill) Trelease †											
Vitis rotundifolia Mx. * †							×				
Ampelopsis arborea (L.) Rusby * †			×								
Kosteletzkya altheaefolia (Chapm.) Rusby *	×										
Kosteletzkya virginica (L.) A. Gray									×		
Stewartia malacodendron L											
Gordonia lasianthus L	×										
Ascyrum stans Mx									×		
Hypericum adpressum Bart											×
Hypericum aspalathoides Willd											
Hypericum densiflorum Pursh							×				
Hypericum fasciculatum Lam			×								
Hypericum galioides Lam							×				

Northern limit of species—Continued.

Name of species.	Latitude 34°, N. C.	Latitude 34° 30', N. C.	Latitude 35°, N. C.	Latitude 36°, N. C.	Latitude 37°, Va.	Latitude 38°, Va.	Latitude 39°, Md. and Del.	Latitude 40°, N. J.	Latitude 41°, N. Y.	Latitude 41° 30', Conn. and R. I.	Latitude 42°, Mass.
Hypericum pilosum Walt			×								
Hypericum virgatum Lam.†							×				
Triadenum petiolatum (Walt.) Britton								×			
Helianthemum corymbosum Mx	×										
Viola septemloba Le Conte											×
Passiflora incarnata L.†					×						
Opuntia opuntia (L.) Coult											×
Opuntia pes-corvi Le Conte			×								
Ammania koehnei Britton								×			
Lythrum lineare L								×			
Rhexia aristosa Britton								×			
Rhexia ciliosa Mx							×				
Rhexia glabella Mx			×								
Rhexia lutea Walt			×								
Rhexia mariana L.†								×			
Ludwigia alata Ell.†			×								
Ludwigia capitata Mx	×										
Ludwigia glandulosa Walt.†				×							
Ludwigia hirtella Raf								×			
Ludwigia linearis Walt									×		
Ludwigia microcarpa Mx			×								
Ludwigia pilosa Walt			×								
Ludwigia sphaerocarpa Ell											×
Ludwigia virgata Mx			×								
Jussiaea decurrens (Walt.) DC.†						×					
Jussiaea grandiflora Mx	×										
Oenothera humifusa Nutt‡								×			
Proserpinaca pectinata Lam											×
Myriophyllum pinnatum (Walt.) B. S. P.*†										×	
Aralia spinosa L.†									×		
Lilaeopsis lineata (Mx.) Greene											×
Eryngium virginianum Lam								×			
Ptilimnium capillaceum (Mx.) Hollick											×
Hydrocotyle canbyi Coult. & Rose								×			
Hydrocotyle verticillata Thunb											×
Centella asiatica (L.) Urban*							×				
Cornus stricta Lam					×						
Nyssa aquatica L.†					×						
Nyssa biflora Walt					×						
Dendrium buxifolium (Berg.) Desv								×			
Kalmia hirsuta Walt											
Leucothoë axillaris (Lam.) D. Don					×						
Leucothoë racemosa (L.) A. Gray											×
Pieris mariana (L.) Benth. & Hook										×	
Pieris nitida (Bartr.) Benth. & Hook.*					×						
Zenobia cassinefolia (Willd.) Pollard			×								
Xolisma foliosiflora (Mx.) Small					×						
Gaylussacia dumosa hirtella (Ait.) A. Gray					×						
Rhododendron arboreum (Marsh.) Nutt.†					×						
Vaccinium crassifolium Andr	×										
Vaccinium virgatum Ait					×						
Vaccinium virgatum tenellum (Ait.) A. Gray					×						
Pyxidanthera barbulata Mx								×			
Hottonia inflata Ell											×
Bumelia lycioides (L.) Pers.†			×								
Symplocos tinctoria (L.) L' Hér							×				
Styrax americana Lam					×						
Styrax grandifolia Ait					×						
Styrax pulverulenta Mx		×									
Fraxinus caroliniana Mill.*					×						
Osmanthus americanus (L.) Benth. & Hook											
Gelsemium sempervirens (L.) Ait. f					×						
Cynoctonum mitreola (L.) Britton.*			×								
Cynoctonum sessilifolium (Walt.) Gmel											
Polypremum procumbens L.*†								×			
Sabbatia angustifolia (Mx.) Britton†	×										
Sabbatia brachiata Ell											
Sabbatia calycina (Lam.) Heller*				×							
Sabbatia campanulata (L.) Torr*											×
Sabbatia dodecandra (L.) B. S. P											×
Sabbatia elliottii Steud	×										
Sabbatia lanceolata (Walt.) Torr. & Gr								×			
Sabbatia paniculata (Mx.) Pursh				×							

Northern limit of species—Continued.

Name of species.	Latitude 34°, N. C.	Latitude 34° 30′, N. C.	Latitude 35°, N. C.	Latitude 36°, N. C.	Latitude 37°, Va.	Latitude 38°, Va.	Latitude 39°, Md. and Del.	Latitude 40°, N. J.	Latitude 41°, N. Y.	Latitude 41° 30′, Conn. and R. I.	Latitude 42°, Mass.
Gentiana elliottii Chapm					×						
Gentiana porphyrio J. F. Gmelin								×			
Bartonia verna (Mx.) Muhl	×										
Limnanthemum aquaticum (Walt.) Britton								×			
Amsonia angustifolia Mx		×									
Trachelospermum difforme (Walt.) A. Gray							×				
Asclepias amplexicaulis Mx	×										
Asclepias lanceolata Walt								×			
Asclepias rubra L								×			
Asclepias tomentosa Ell		×									
Cynanchum palustre (Pursh) Heller			×								
Vincetoxicum carolinensis (Jacq.) Britton					×						
Vincetoxicum gonocarpos Walt.†					×						
Vincetoxicum hirsutum (Mx.) Britton							×				
Vincetoxicum suberosum (L.) Britton					×						
Dichondra evolvulacea (L. f.) Britton*					×						
Breweria aquatica (Walt.) A. Gray†	×										
Breweria humistrata (Walt.) A. Gray					×						
Breweria pickeringii (M. A. Curtis) A. Gray								×			
Ipomoea sagittata Cav.*			×								
Nama quadrivalvis (Walt.) Kuntze					×						
Verbena caroliniana Mx	×										
Lippia nodiflora (L.) Mx.*†			×								
Callicarpa americana L					×						
Teucrium nashii Kearney			×								
Trichostema lineare Nutt										×	
Physostegia denticulata (Ait.) Britton					×						
Macbridea pulchra Ell	×										
Clinopodium carolinianum (Sweet) Heller											
Mesosphaerum rugosum (L.) Pollard			×								
Koellia aristata (Michx.) Kuntze								×			
Koellia hyssopifolia (Benth.) Britton					×						
Physalis angulata L.*†					×						
Physalis viscosa L.*					×						
Monniera acuminata (Walt.) Kuntze						×					
Monniera caroliniana (Walt.) Kuntze								×			
Monniera monniera (L.) Britton*						×					
Gratiola pilosa Mx								×			
Gratiola sphaerocarpa Ell.*								×			
Micranthemum micranthemoides (Nutt.) Wettst.*								×			
Micranthemum orbiculatum Mx	×										
Buchnera elongata Sw			×								
Gerardia linifolia Nutt						×					
Schwalbea americana L											×
Utricularia biflora Lam†											×
Utricularia fibrosa Walt									×		
Utricularia juncea Vahl*					×						
Utricularia subulata L.*											×
Pinguicula elatior Mx	×										
Pinguicula lutea Walt	×										
Bignonia crucigera L.†					×						
Diandhera ovata Walt					×						
Oldenlandia uniflora L.*									×		
Diodia teres Walt†										×	
Diodia virginiana L								×			
Galium hispidulum Mx								×			
Galium tinctorium filifolium Wiegand					×						
Viburnum molle Mx											×
Viburnum nudum L									×		
Viburnum obovatum Walt											
Melothria pendula L.*					×						
Lobelia amoena Mx											
Lobelia amoena glandulifera A. Gray							×				
Lobelia canbyi A. Gray								×			
Lobelia glandulosa Walt					×						
Lobelia paludosa Nutt							×				
Sitilias caroliniana (Walt.) Raf							×				
Nabalus virgatus (Mx.) DC								×			
Iva frutescens L. ‡											×
Iva imbricata Walt. ‡					×						
Vernonia oligophylla Mx			×								
Elephantopus nudatus A. Gray							×				
Sclerolepis uniflora (Walt.) Porter								×			
Eupatorium aromaticum L											×

Northern limit of species—Continued.

Name of species.	Latitude 34°, N.C.	Latitude 34° 30′ N. C.	Latitude 35°, N.C.	Latitude 36°, N.C.	Latitude 37°, Va.	Latitude 38°, Va.	Latitude 39°, Md. and Del.	Latitude 40°, N. J.	Latitude 41°, N. Y.	Latitude 41° 30′ Conn. and R. I.	Latitude 42°, Mass.
Eupatorium capillifolium (Lam.) Small *					×						
Eupatorium coronopifolium Willd	×										
Eupatorium linearifolium Walt											×
Eupatorium leucolepis Torr. & Gr								×			
Eupatorium pinnatifidum Ell			×								
Eupatorium rotundifolium L									×		
Eupatorium semiserratum DC					×						
Eupatorium serotinum Mx. †							×				
Eupatorium torreyanum Short †								×			
Eupatorium verbenaefolium Mx											×
Lacinaria elegans (Walt.) Kuntze											
Lacinaria graminifolia (Walt.) Kuntze					×						
Lacinaria graminifolia pilosa (Ait.) Britton								×			
Lacinaria tenuifolia (Nutt.) Kuntze	×										
Trilisa odoratissima (Walt.) Cass	×										
Trilisa paniculata (Walt.) Cass			×								
Carphephorus bellidifolius (Mx.) Torr. & Gr	×										
Carphephorus tomentosus (Mx.) Torr. & Gr			×								
Heterotheca subaxillaris (Lam.) Britton *†							×				
Chrysopsis graminifolia (Mx.) Nutt							×				
Chrysopsis mariana (L.) Nutt									×		
Chrysopsis pilosa (Walt.) Britton			×								
Chondrophora nudata (Mx.) Britton								×			
Solidago elliottii Torr. & Gr											×
Solidago fistulosa Mill								×			
Solidago petiolaris Ait.†			×								
Solidago puberula pulverulenta (Nutt.) Chapm			×								
Solidago stricta Ait. *								×			
Solidago tortifolia Ell					×						
Euthamia caroliniana (L.) Greene†											×
Sericocarpus bifoliatus (Walt.) Porter			×								
Aster concolor L											×
Aster coridifolius Mx											×
Aster gracilis Nutt								×			
Aster paludosus Ait.*			×								
Aster purpuratus Nees	×										
Aster squarrosus Walt	×										
Aster tenuifolius L.‡											×
Erigeron quercifolius Lam		×									
Erigeron vernus (L.) Torr. & Gr					×						
Doellingeria humilis (Willd.) Britton								×			
Baccharis angustifolia Mx	×										
Baccharis glomeruliflora Pers	×										
Baccharis halimifolia L.‡											×
Pluchea camphorata (L.) DC.*											×
Pluchea foetida (L.) B.S.P.*								×			
Pterocaulon pycnostachyum Ell	×										
Silphium asteriscus L.†							×				
Silphium compositum Mx	×										
Borrichia frutescens (L.) DC.*‡					×						
Helianthus angustifolius L									×		
Coreopsis angustifolia Ait			×								
Coreopsis delphinifolia Lam											
Coreopsis gladiata Walt			×								
Coreopsis rosea Nutt											×
Bidens coronata (L.) Fisch											
Actinospermum uniflorum (Nutt.) Baruh	×										
Marshallia graminifolia (Walt.) Small		×									
Helenium vernale Walt		×									
Arnica acaulis (Walt.) B.S.P							×				
Senecio tomentosus Mx								×			
Carduus repandus (Mx.) Pers				×							
Carduus virginianus L.†											
Chaptalia tomentosa Vent		×									

RELATIONSHIP TO OTHER FLORAS.

Let us now turn to the broader relationships of the flora. The total number of indigenous genera of Pteridophta and Embryophyta of which representatives were collected or observed in the Dismal Swamp region is 330. Of these there are—

Endemic in eastern North America (east of the Rocky Mountains)	26
Endemic in North America (including Mexico and the Antilles)	17
Endemic in America (North and South)	27
Endemic in eastern North America and eastern (chiefly extratropical) Asia	26
Endemic in the Northern Hemisphere	44
	136
Of wider distribution	194
	330

The distribution of the less widely dispersed genera is shown in the following table, the names of monotypic genera being preceded by an * and those of genera almost but not quite confined to the particular category being followed by a ±:

Distribution of genera of limited range.

Eastern North America.	North America, Mexico, and the Antilles.	America, North and South.	Eastern North America and eastern Asia.	Northern Hemisphere.
Triplasis.	Taxodium.	Philotria (Elodea).	*Zizania.	Osmunda. +
Eatonia.	Yucca.	Uniola.	Tipularia.	Woodwardia. ±
*Dulichium.	Proserpinaca.	Distichlis. ±	Saururus.	Juniperus.
Peltandra.	Xolisma (Lyonia).	Tillandsia.	Nelumbo.	Ammophila.
Uvularia.	Monarda.	Pontederia.	Magnolia.	Acorus.
Limodorum (Calopogon).	Koellia (Pycnanthemum).	Atamosco (Zephyranthes).	Liriodendron.	Lilium.
Hicoria.	Pentstemon. ±	Sisyrinchium.	Decumaria.	Polygonatum.
Asimina.	Conopholis.	Phoradendron.	Itea.	Iris.
*Sassafras.	Houstonia.	Bradburya (Centrosema).	Hamamelis.	Juglans.
*Sanguinaria.	Sitilias (Pyrrhopappus).	Kosteletzkya.	Liquidambar.	Populus.
Aronia.	Chrysopsis.	Asyrum.	Falcata (Amphicarpaea).	Ostrya.
Baptisia.	Euthamia.	Opuntia.	Apios.	Carpinus.
Cyrilla.	Sericocarpus.	Oenothera.	Parthenocissus.	Alnus. ±
*Sarothra.	Ionactis.	Gaylussacia.	Triadenum (Elodes).	Fagus.
Hudsonia.	Iva.	*Polypremum.	Ptilimnium (Discopleura).	Castanea.
Lechea. +	Rudbeckia.	Gonolobus.	Nyssa.	Quercus.
*Decodon.		Verbena. +	Azalea. ±	Ulmus.
Rhexia.		Mimulus. ±	Pieris.	Morus.
Kalmia. +		Gerardia.	Epigaea.	Comandra.
*Oxydendrum.		Bignonia.	Chionanthus.	Asarum.
Sabbatia.		Willughbeya (Mikania).	Gelsemium.	Sagina.
Bartonia.		Bacharis.	Trachelospermum.	Ammodenia (Honkenya).
Dasystoma.		Parthenium.	*Phryma.	Nymphaea (Nuphar).
Adopogon (Krigia).		Borrichia.	Mitchella.	Cakile.
Lacinaria (Liatris).		Helianthus.	Nabalus.	Spiraea.
Boltonia.				Fragaria. +
Silphium.				Potentilla. +
				Geum. +
				Agrimonia. +
				Rosa.
				Malus.
				Amelanchier.
				Crataegus. ±
				Cercis.
				Euonymus.
				Circaea.
				Cicuta.
				Cornus. +
				Chimaphila.
				Oxycoccus.
				Fraxinus.

An analysis of these columns shows that more than two-thirds of the genera occurring in the Dismal Swamp region which are endemic in eastern North America are small ones, numbering 1 to 6 species, and of these a half dozen are monotypic. Of the 26 genera common to eastern North America and eastern Asia 2 are monotypic, 9 have 2 species each, and 4 consist of 3 species each. The others, with one exception (Azalea), number 4 to 10 species each. On the other hand, the genera which are widely distributed in America, or throughout the Northern Hemisphere, are mostly of considerable size. The majority, which have still more extensive ranges, include several of the largest of the genera of vascular plants. It is generally admitted that in small genera of comparatively restricted distribution we have to do in many cases with very old and failing types. On the other hand, the large, widely dispersed genera are dominant and in many cases comparatively modern types.

The total number of species of pteridophytes and embryophytes collected or observed is, roughly, 720, of which about 100 have been introduced by the direct or indirect agency of man from other regions, while the remainder are indigenous. Of the indigenous species over 500 are endemic in extratropical North America, the great majority in the country east of the Rocky Mountains and a large percentage in the Austroriparian area. The nonendemic but indigenous species occur likewise in the following regions:

1. *Tropical Zone.*

(*a*) Of both hemispheres	9	
(*b*) Of the New World alone	50	
		— 59

2. *North Temperate Zone.*

(*a*) Europe alone	2	
(*b*) Europe and Asia	23	
(*c*) Asia alone	6	
		— 31
Total		90

1. *Tropical Zone.*

(*a*) BOTH HEMISPHERES.

Cyperus haspan.
Cyperus esculentus.
Spirodela polyrhiza.
Hydrocotyle umbellata.
Hydrocotyle ranunculoides.
Centella asiatica.
Dichondra evolvulacea.
Physalis angulata.
Monniera monniera.

(*b*) THE NEW WORLD ALONE.

Polypodium polypodioides.
Triglochin striata.
Sagittaria lancifolia.
Erianthus saccharoides (Cuba).
Paspalum distichum.
Paspalum compressum.
Panicum gibbum (Cuba).
Cenchrus tribuloides macrocephalus.
Uniola paniculata.
Eleocharis mutata.
Eleocharis ochreata.
Stenophyllus capillaris.
Fimbristylis autumnalis.
Fimbristylis castanea.
Fimbristylis laxa.
Fimbristylis spadicea.
Rynchospora cymosa (Cuba).
Scleria pauciflora (Cuba).
Juncus repens (Cuba).
Quercus virginiana (Cuba).
Lepidium virginicum.
Chamaecrista fascicularis.
Bradburya virginiana.
Phyllanthus caroliensis.
Parthenocissus quinquefolia (Cuba).
Sida spinosa.
Rotala ramosior.
Oenothera laciniata.
Proserpinaca palustris (Cuba).
Pieris nitida (Cuba).
Samolus floribundus.
Fraxinus caroliniana (Cuba).
Gelsemium sempervirens.
Polypremum procumbens.
Sabbatia calycina.
Trachelospermum difforme.
Cuscuta arvensis.
Physalis viscosa.
Linaria canadensis.
Oldenlandia uniflora (Cuba).
Cephalanthus occidentalis (Cuba).
Ambrosia artemisiaefolia.
Eupatorium capillifolium.
Willughbaea scandens.
Leptilon canadense.
Pluchea camphorata.
Gnaphalium purpureum.
Borrichia frutescens.
Bidens bipinnata.
Erechtites hieracifolia.

2. *North Temperate Zone.*

(*a*) EUROPE ALONE.

Ammophila arenaria.
Drosera intermedia.

(*b*) EUROPE AND ASIA.

Osmunda regalis.
Dryopteris spinulosa.
Pteris aquilina.
Asplenium filix-foemina.
Lycopodium inundatum.
Typha angustifolia.
Homalocenchrus oryzoides.
Alopecurus geniculatus.
Festuca rubra.
Carex canescens.
Scirpus lacustris.
Acorus calamus.
Juncoides campestre.
Atriplex hastata.
Salicornia herbacea.
Salsola kali.
Ammodenia peploides.
Tissa marina.
Isnardia palustris.
Circaea lutetiana.
Chimaphila umbellata.
Bidens cernua.
Potentilla monspeliensis.

(*c*) ASIA ALONE.

Zizania aquatica.
Pogonia ophioglossoides.
Ostrya virginiana.
Triadenum virginicum.
Monotropa uniflora.
Phryma leptostachya.

The equatorial origin of the dominant element in the flora of the Dismal Swamp region is strikingly illustrated by the fact that of its nonendemic indigenous species twice as many occur in tropical America as in the temperate regions of the Old World.

Of introduced plants that have become naturalized in the Dismal Swamp region, 96 species were collected or observed, although the total number occurring there is undoubtedly considerably greater. The origin of these species is as follows:

Europe	76
Tropical America	9
Tropical Asia	6
Eastern extratropical Asia	3
Extratropical North America	2
Total	96

In the following table is given a list of the families of Pteridophyta and Embryophyta which are represented in the flora of the Dismal Swamp region, with the number of genera and species of each which there occur. Owing to the fragmentary nature of the collections of Thallophyta which were made, it has seemed best to omit these, and likewise the Bryophyta, from the table. It is not to be supposed that nearly the total number of species, or even of genera, which actually occur in the region are here included. But it is believed that the enumeration embraces a large majority of both the species and the genera in the groups included. Only such species as are certainly or very probably indigenous are here enumerated.

The object of the table is to present the distribution of the flora by families, so that those which are dominant in the region will at once appear. The twelve largest families are as follows:

Family.	Number of genera.	Number of species.	Family.	Number of genera.	Number of species.
Poaceae (Gramineae)	32	83	Ericaceae	8	13
Cyperaceae	14	69	Scrophulariaceae	8	12
Compositae	28	68	Juncaceae	2	12
Viciaceae (Papilionaceae)	15	26	Orchidaceae	6	11
Fagaceae	3	15	Nepetaceae	8	11
Rosaceae	7	15	Rubiaceae	6	11

The prominence of such families as Fagaceae, Rosaceae, Ericaceae, Juncaceae, Nepetaceae, and, in Cyperaceae, the genus Carex, in the Dismal Swamp region is sufficient evidence that there is a strong boreal element in its flora. On the other hand, there is a great development of other Cyperaceae (notably Cyperus and Rynchospora), which belong essentially to the warmer parts of the world; of Viciaceae (chiefly belonging to tribes and even genera which are widely distributed in the tropics); and of Scrophulariaceae (principally in the largely tropical tribes Gratioleae and Gerardieae). In Compositae, the Eupatorieae, a mainly tropical tribe, are abundantly represented, while the Anthemideae and Senecionideae, which are largely boreal tribes, are almost wanting, the former being represented only by introduced species. Furthermore in the largest family, that of the true grasses, Poaceae (Gramineae), one-half of the indigenous species belong to the two largely tropical tribes Andropogoneae and Paniceae.

The respectively chiefly tropical and chiefly extratropical families of the flora are indicated in the table, the former by an affixed (T), the latter (E). Families of which the majority of species are American are designated (TA) or (EA) as the case may be. Extratropical families that are more strongly developed in the northern than in the southern hemisphere are marked (EB). It may be mentioned that the number of families and of genera recognized in the following list is somewhat larger than would be the case if the limits of families and genera, as defined in most standard systematic works, had been followed.

Summary of families, genera, and species, with data of distribution.

No.	Family.	Genera.	Species.	No.	Family.	Genera.	Species.
1	Osmundaceae	1	2	62	Rutaceae (T)	1	1
2	Polypodiaceae	5	8	63	Polygalaceae	1	3
3	Lycopodiaceae	2	3	64	Euphorbiaceae (T)	6	9
4	Pinaceae (EB)	4	5	65	Callitrichaceae	1	1
5	Typhaceae	2	3	66	Anacardiaceae (T)	1	5
6	Naiadaceae	1	1	67	Ilicaceae (T)	1	5
7	Alismaceae	2	2	68	Celastraceae (T)	1	1
8	Vallisneriaceae (T)	1	1	69	Aceraceae (EB)	1	1
9	Poaceae	32	83	70	Impatientaceae (T)	1	1
10	Cyperaceae	14	69	71	Rhamnaceae (T)	2	2
11	Araceae (T)	3	3	72	Vitaceae (T)	2	5
12	Lemnaceae	1	1	73	Malvaceae (T)	2	2
13	Xyridaceae (TA)	1	2	74	Hypericaceae	3	7
14	Eriocaulaceae (T)	1	1	75	Cistaceae (EB)	3	6
15	Bromeliaceae (TA)	1	1	76	Violaceae (E)	1	7
16	Commelinaceae (T)	1	1	77	Passifloraceae (TA)	1	2
17	Pontederiaceae (T)	1	1	78	Cactaceae (EA)	1	1
18	Juncaceae	2	12	79	Lythraceae (TA)	3	3
19	Liliaceae	6	6	80	Melastomaceae (TA)	1	2
20	Smilaceae (T)	1	5	81	Onagraceae (E)	7	10
21	Amaryllidaceae (T)	2	2	82	Haloragidaceae	2	3
22	Dioscoreaceae (TA)	1	1	83	Araliaceae (T)	1	1
23	Iridaceae	2	4	84	Apiaceae (EB)	7	9
24	Orchidaceae (T)	6	11	85	Cornaceae (EB)	2	6
25	Saururaceae	1	1	86	Clethraceae (TA)	1	1
26	Juglandaceae (EB)	2	5	87	Pyrolaceae (EB)	1	2
27	Salicaceae (EB)	2	4	88	Monotropaceae (EB)	1	1
28	Myricaceae	1	2	89	Ericaceae (E)	8	13
29	Betulaceae (EB)	3	3	90	Vaccinaceae (EB)	5	8
30	Fagaceae (EB)	3	15	91	Primulaceae (EB)	2	3
31	Ulmaceae	2	4	92	Ebenaceae (T)	1	1
32	Moraceae (T)	1	1	93	Symplocaceae (T)	1	1
33	Urticaceae (T)	2	2	94	Styracaceae (T)	1	1
34	Loranthaceae (T)	1	1	95	Oleaceae	2	2
35	Santalaceae (T)	1	1	96	Loganiaceae (T)	2	2
36	Aristolochiaceae (TA)	2	3	97	Gentianaceae (E)	3	6
37	Polygonaceae (EB)	2	7	98	Apocynaceae (T)	2	3
38	Chenopodiaceae (E)	2	2	99	Asclepiadaceae (T)	2	4
39	Phytolaccaceae (T)	1	1	100	Convolvulaceae (T)	2	3
40	Aizoaceae (T)	1	1	101	Cuscutaceae	1	2
41	Alsinaceae (E)	3	3	102	Boraginaceae	1	1
42	Nymphaeaceae (TA)	3	3	103	Verbenaceae (T)	3	3
43	Ranunculaceae (EB)	3	4	104	Nepetaceae (E)	8	11
44	Berberidaceae (EB)	1	1	105	Solanaceae (T)	2	4
45	Magnoliaceae (EB)	2	2	106	Scrophulariaceae (E)	8	12
46	Anonaceae (T)	1	1	107	Bignoniaceae (T)	3	3
47	Lauraceae (T)	3	3	108	Orobanchaceae (EB)	1	1
48	Papaveraceae (EB)	1	1	109	Pinguiculaceae	1	4
49	Brassicaceae (EB)	3	3	110	Acanthaceae (T)	2	2
50	Droseraceae (E)	1	1	111	Phrymaceae (EB)	1	1
51	Saxifragaceae (EB)	2	2	112	Plantaginaceae (E)	2	2
52	Hamamelidaceae	2	2	113	Rubiaceae (T)	6	11
53	Platanaceae (EB)	1	1	114	Viburnaceae (EB)	3	5
54	Rosaceae (EB)	7	15	115	Valerianaceae (E)	1	2
55	Pyraceae (EB)	4	7	116	Cucurbitaceae (T)	1	1
56	Amygdalaceae	1	3	117	Campanulaceae (E)	1	1
57	Cassiaceae (T)	3	4	118	Lobeliaceae (T)	1	5
58	Viciaceae	15	26	119	Cichoriaceae (EB)	5	6
59	Geraniaceae (E)	1	1	120	Ambrosiaceae (EA)	2	3
60	Oxalidaceae (T)	1	5	121	Carduaceae	28	68
61	Linaceae	1	4				

AGRICULTURAL PRODUCTS.

In order that we may discuss intelligibly the connection between the character of the native vegetation and that of the soil, especially as affording an indication of the probable agricultural value of the latter, it is necessary to describe briefly the principal crops of the region, and to indicate the methods employed in cultivating them, as well as the leading types of soil which are best adapted to each (Pls. LXXVI, LXXVII). The chief cultivated plants of the country have already been enumerated in the description of the plant formations, but there only in order to complete the picture of the plant covering of the region.

The most important of the crop plants of the Dismal Swamp region can be classified as follows: (1) garden vegetables or truck crops, (2) cereals, (3) cotton, (4) forage plants, (5) peanuts, (6) fruits.

TRUCK CROPS.

There is now an almost continuous strip of land along the coast of the United States, from Massachusetts to southern Florida, which is devoted to the production of market-garden vegetables, or "truck." The country about Norfolk was one of the first in this belt to adopt the trucking industry upon a large scale, and it is still equal in importance to any other area, excepting, perhaps, that about New York City. The different table vegetables can be brought to maturity several weeks earlier in this mild climate than in the vicinity of the large Northern cities which afford the principal market for them. By the extension of the trucking industry much farther south than southeastern Virginia, it has become possible to supply Northern tables with most of the favorite vegetables in fresh condition throughout the year. But this has not destroyed the market for truck raised about Norfolk, because, while any particular vegetable grown, for example, in South Carolina or in Florida reaches the Northern cities much earlier than the Norfolk crop, there is a period following the gathering of the more Southern and preceding the maturity of the more Northern crop, during which the region around Norfolk has a monopoly of the market for that particular vegetable. Consequently there is a constant succession from South to North, during each season, in the maturing and marketing of each of the principal garden vegetables.

As has been mentioned in the chapter on soils, the land which is best fitted for the cultivation of these crops lies immediately upon or very near the coast. There are several reasons for this: First, the tempering effect upon the climate of the neighborhood of the sea, which greatly diminishes the danger of loss from late spring and early fall frosts; second, the light, sandy, warm, and well-drained character of the soil, which facilitates the process of forcing; finally, the convenience for

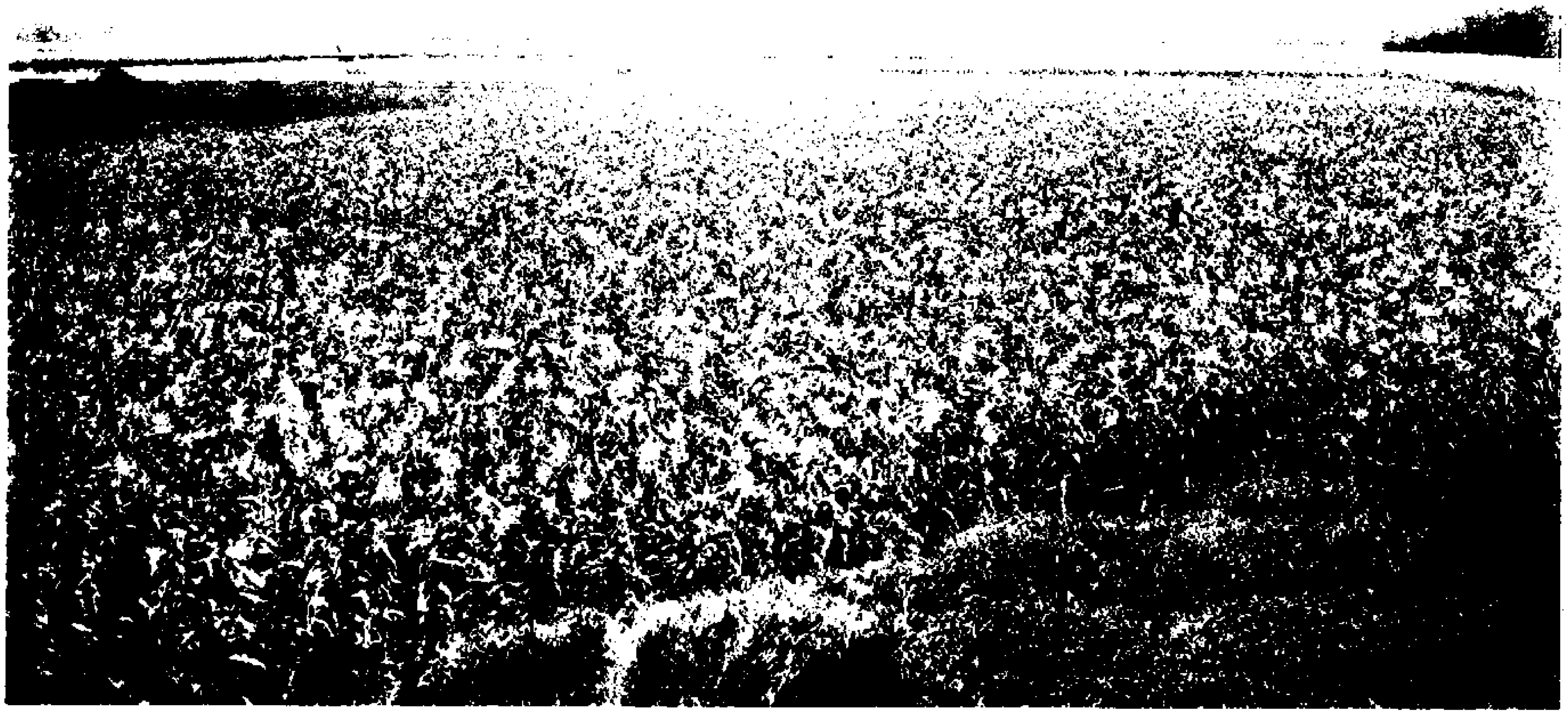
cheap transportation by water. In the Dismal Swamp region, as elsewhere, it is the land bordering salt water or within a very few miles of it that is most largely used for growing truck. No statistics later than those given in the reports of the Eleventh Census could be obtained as to the extent of country occupied by these crops, and it would be difficult to form a close estimate, owing to the fact that the truck farms are scattered over a long and much indented shore line, and also because the area planted varies, although not, perhaps, to any great extent, from year to year.

The largest areas of truck land in the region border upon the Elizabeth River and its branches, especially the southern and western branches; but there are also numerous large truck farms immediately north and east of Norfolk and south of Portsmouth and Berkley. Certain truck crops, notably potatoes and strawberries, are largely and successfully grown in the heavier soils farther inland along all the railways which enter Norfolk, but for most vegetables the light soils along the coast are decidedly best suited. The sands of the outer coast, bordering Chesapeake Bay and the Atlantic Ocean, are of course not adapted to cultivation, as they are too much exposed to winds laden with sand or with spray.

On the southern border of the region, along Albemarle Sound, truck crops are grown to some extent, but are of secondary importance; e. g., near Edenton, N. C., where cotton and peanuts are the staple agricultural products. South of the Dismal Swamp region, near Newbern, N. C., is another of the most important and best known trucking areas along the coast. Here most of the crops mature about ten days earlier than around Norfolk. The well-drained, warm, loamy lands lying between the Neuse and Trent rivers, immediately west of this town, are almost entirely devoted to crops of garden vegetables.

The sandy or light loamy soils of the plain about Norfolk are not naturally very fertile, but they are warm and easily worked, which makes them eminently fitted for bringing crops to early maturity. Their original poverty in various elements of plant food is compensated by the use of enormous quantities of fertilizers, and this is a source of great expense to the trucker, whose initial outlay is much more considerable than that of other farmers. The method of cultivation of most truck crops is highly intensive. In addition to heavy fertilizing, much time and labor must be spent upon most of the crops. Moreover, the gathering of them requires the employment of many laborers, as the work is slow and the crop can not be allowed to stand upon the ground after it has matured. This is particularly true of strawberries, but applies to all the truck crops.

The principal garden vegetables grown in the country about Norfolk are, in about the order in which they mature, kale, spinach, lettuce (these three marketed in winter), radishes, asparagus, strawber-



HORSE TOOTH CORN ON LAND CLEARED FROM THE DISMAL SWAMP AT WALLACETON, VA.

THE HELIOTYPE PRINTING CO., BOSTON.

TIMOTHY MEADOW ON LAND CLEARED FROM THE DISMAL SWAMP AT WALLACETON, VA.

THE HELIOTYPE PRINTING CO., BOSTON.

ries (these three are spring crops), peas, beans, squash, cabbage (these four are marketed in early summer), cucumbers, potatoes, tomatoes, watermelons, cantaloupes, and sweet potatoes. The largest acreage is in potatoes, the next in cabbage, the third in strawberries. Crops of comparatively small importance are beets, turnips, and onions. Sweet corn is raised in a small way for local consumption, but the difficulty of transportation precludes its being an important truck crop.

The cultivation of celery has been successfully undertaken upon the rich black-gum lands which have been reclaimed from the wooded swamps. Only one crop can be made in a season on account of the warmth of the climate, but the product is said to equal in quality the best Michigan celery.

The Norfolk region is well known for its potato crop. Potatoes are grown not only on the light soils near the coast, where they mature early, but also on a large scale in the heavier, rich soils along the eastern border of the Dismal Swamp, where the average yield is said to be about 80 barrels per acre. Two crops are often raised on the same land in one season. The first is marketed, while the second-crop potatoes are smaller and are partly used for "seed," being usually gathered before they have fully matured, which insures great vitality. The "seed" potatoes are largely shipped to Northern and Eastern growers, many of whom prefer them to native-grown "seed." They are generally too small to cut in pieces, but are "bled" by slicing off a small piece before planting.

Strawberries are cultivated extensively, the Thompson and the Hoffman being the favorite varieties. The plants are often set out the first year in rows with cabbages, which protect them while young. The greater part of the crop is marketed by the middle of May, the berries being picked in the field into the boxes in which they are sold. The boxes are then packed in crates, 60 boxes to the crate, small sheds being often erected in the fields for the purpose of packing. The pickers are negroes and receive usually 2 cents, but, toward the end of the season, sometimes only 1½ cents a box for their work. A strawberry field at picking time, alive with men, women, and children gathering the berries, is an animated sight.

Peas and beans are usually gathered in large baskets, and the taking off of these crops also requires many laborers. Most of the other truck crops can be gathered more rapidly, and fewer hands are needed for them.

On the southern border of the Dismal Swamp region other crops are usually more important than truck. Around Edenton, however, the light, warm, loamy soils, which are best suited to cotton, are also well adapted to sweet potatoes, tomatoes, etc., and they are raised in considerable quantity.

At Newbern, N. C., the season is usually nearly two weeks earlier than about Norfolk, and the former usually holds the market for each

important truck crop for about that length of time. But a spring with unusually rapidly rising temperature will largely obliterate the difference and bring Newbern into competition with Norfolk.

The principal garden vegetables grown at Newbern are potatoes, cabbages, strawberries, tomatoes, peas, beans, squash, rutabagas, cantaloupes, sweet potatoes, eggplant, cucumbers, asparagus, and lettuce. Of these, as at Norfolk, potatoes rank first in acreage, cabbages second, and strawberries, of which the cultivation is rapidly increasing, third. Pumpkins are also raised in the vicinity of Newbern, the usual practice of planting them with corn being followed. Of several of the early summer vegetables a second crop is often made in the fall—e. g., potatoes, string beans, and peas. The second crop of potatoes is partly used for seed and the remainder is marketed for table use. Potatoes are largely grown near Newbern on land that has been reclaimed from swamps, but the product of such soil is said to be often dark in color, while the Early Rose potatoes, which are grown in the typical truck soils of the region—light, sandy loams—have a fine white color. Potatoes are extensively grown in the bottom land of the Neuse River, but there the soil is sandy rather than silty.

Cabbages are grown in the vicinity of Newbern in the light loams as well as in heavier soils, but the latter are best suited to this crop. When cabbages are to be put into the light lands, compost is usually applied to serve as a mulch. The ordinary yield of this crop at Newbern is about 200 barrels to the acre.

Strawberries are successfully grown both on the light loams and on the somewhat heavier and richer "gallberry" lands. This crop is usually more highly cultivated than at Norfolk, care being taken to keep the rows constantly free from weeds. Quality rather than quantity is aimed at in the endeavor to hold a high-grade market for this section. The Thompson is a popular variety, and lately the Brandywine has come into favor with some growers. The "vines" live through the winter about Newbern without protection, but are usually covered in early spring with a mulch of pine straw, which tends to prevent the plants being buried in the sand during heavy rains as well as to protect them against late frosts. At Norfolk some growers believe that the presence of weeds among the strawberry plants serves as a partial protection during the winter.

Lettuce is sown at Newbern in frames, and the plants are then set out in large beds, 16 feet wide and over 200 feet long. Two crops are usually made, one being marketed between Thanksgiving Day and Christmas and the second some weeks later.

The amount of fertilizer necessary in order to make a good truck crop of course varies somewhat with the character of the soil and the crop, but is always considerable. About one ton to the acre is the usual quantity for the typical light soils. The black gallberry lands near Newbern require

something like 1,800 pounds of potash for potatoes and 1,000 for berries. These crops also demand much labor and care for planting, cultivating, gathering, and marketing. An experienced grower at Newbern estimated that one team of mules or horses to every 10 acres is the minimum requirement for a truck farm. In addition to the expense of producing a crop, the uncertainty of the yield, and especially of the market, must be taken into consideration. It can be safely said that no branch of agriculture in the United States makes heavier demands upon the courage, the industry, and the intelligence of the farmer than does truck growing.

CEREALS.

The only important cereal and, next to the truck crops, the most important agricultural product of the Dismal Swamp region is corn. Corn is largely raised on the truck soils, after one or two earlier crops of garden vegetables have been removed. But land of this character is too light and has too little bottom to yield a first-class crop, even if the corn were planted early enough to make its full growth. The stalks are usually short and thin and the total leaf surface is small and has not the fine green color which corn at its best should have. Consequently the ears are neither large nor full, and the crop hardly meets the local demand.

The heavier lands of the interior, in Norfolk and Princess Anne counties, are naturally better for cereals than are the coast soils, having a greater content of silt or of clay and therefore holding water better. But in many places they have been exhausted by long cultivation in corn or cotton, without the practice of intelligent rotation.

The finest corn land of the region is unquestionably that which has been cleared from the wooded swamps. Extensive bodies of such land occur along the Dismal Swamp Canal, and are largely in corn. When first cleared, the best type of black-gum land brings, without application of lime or fertilizers, 80 bushels of corn to the acre. The stalks are often 10, 12, and sometimes 16 feet high. Even after several years of cultivation such land, with little or no treatment, continues to yield 40 bushels. One field, said to have been in corn almost continuously for at least forty years, still produces 20 to 25 bushels of corn to the acre. It has been allowed to lie idle sometimes for a year or two, but rotation has not been practiced. Most of the corn raised on the largest farm in the section (about 800 acres in extent) is exported to Germany, where it is used for seed. It is a White Dent with a very long grain, and is known as "Horse-tooth Corn" (Pl. LXXVI).

Swamp lands at Newbern are usually planted in corn immediately after clearing, without the application of fertilizers. The first year two or three crops are made. Then the stumps are burnt off and cultivation is begun. Land of this character at Newbern will produce

75 barrels per acre of early potatoes and in the same season about 5 barrels of corn.

Wheat is said to have been successfully grown near Suffolk and elsewhere in the region, and is still raised in small quantities here and there on the inland soils with clayey bottom and considerable water content, but it is hardly worth mentioning as a crop of the region. The summers are doubtless too hot for the profitable cultivation of this cereal.

Oats are grown to a considerable extent and to fair advantage, chiefly in the stiffer upland soils at some distance from the coast. Barley and rye are also occasionally raised in land of similar character. The last three cereals are used in this region as forage plants. Oats and barley are frequently sown with field peas.

Numerous small fields of upland rice are to be seen near the north shore of Albemarle Sound, where it is grown on the same light, loamy soil that is preferred for cotton. Of course this variety is not cultivated with periodical sluicing of the fields, as is common rice, which is a staple crop farther south, near Wilmington.

COTTON.

This great staple is grown in a small way in the lower part of Norfolk and Princess Ann counties, Va., but on land which is for the most part pretty well worn out. In the most southern part of the Dismal Swamp region, however, e. g., about Edenton, N. C., cotton is the principal crop, and thrives on the light, brown, loamy soils. Near Newbern it is also an important product, being grown to advantage on the truck soils. It is often sown after a crop of peas, potatoes, or other early truck has been removed from the land. Cotton does well also on the richer gallberry land in the neighborhood of Newbern.

FORAGE PLANTS.

The ordinary meadow grasses are not cultivated to any noteworthy extent about Norfolk. The comparatively small number of live stock raised in the region can be supplied with green pasturage during a great part of the year, thanks to the long moist summers and the mild winters.

In winter and early spring cattle are allowed to graze chiefly on the young leaf shoots of the "reeds" or cane (*Arundinaria macrosperma* and *A. tecta*) which abound in every moist woodland. The broomsedges (species of Andropogon, especially *A. virginicus*) afford considerable natural pasturage during the spring months. In early summer the various Leguminosae (especially species of Meibomia and Lespedeza), which abound in open woodlands, afford some grazing to cattle. The native partridge pea (*Chamaecrista fascicularis*) and the introduced Japan clover (*Lespedeza striata*), both of which

are occasionally abundant on sandy roadsides, are much relished by stock.

What hay is needed is largely afforded by crab grass (*Syntherisma* (*Panicum*) *sanguinale*), which springs up abundantly and spontaneously in every truck field after the crop has been removed. If the land is then allowed to lie idle, two crops of "crab hay" can be secured before the fall-sown truck is put in. The first crop makes excellent forage, while the second is inferior, and is chiefly useful for bedding. It takes about ten days to cure crab grass thoroughly. After it has been mown the stubble is usually plowed under, but sometimes is left standing until the next crop of truck is to be sown, when the crab-grass stubble is burnt over.

Cowpeas are the principal cultivated forage crop in this section, and are usually planted with corn, but sometimes alone. Here, as elsewhere through the southeastern States, this legume is more highly valued for restoring exhausted soils than any other, as its roots penetrate deeper than those of clover, and it is better adapted to the long, hot summer. It is said in one year to render "kind" and "mellow" soils which were stiff and almost unworkable. When used for this purpose the peas are plowed under. If the next crop is to be potatoes, however, the tops of the vines should first be cut, as otherwise the potatoes are liable to "scab." Cowpea hay is often cured in ricks. The vines, either alone or mixed with crab grass, are stacked upon wooden frames which consist of horizontal arms fastened to a vertical pole, and are thus left to dry. In the Dismal Swamp region, and near Newbern, the "Black-Eye" pea is the variety most frequently grown. At Newbern the "Lady" pea also is sometimes used.

German millet is frequently cultivated near Norfolk as a forage plant and grows well in the light truck soils. The use of oats, rye, and barley has already been mentioned.

Timothy is successfully cultivated on the heavier soils, especially those reclaimed from the Dismal Swamp (Pl. LXXVII). One field of about 22 acres, at Wallaceton, which had been cultivated for about five years, part of the time in potatoes, and had therefore been treated with lime and fertilizers, yielded as much as 2 tons of timothy hay to the acre.

Clovers, red and alsike, are frequently grown on the heavier inland soils, where oats, barley, and rye thrive best. Crimson clover is often sown upon somewhat lighter soils.

It is probable that at some distance from the seashore, by selecting soils which have a stiff clay bottom and therefore hold considerable water, the cultivation of meadow grasses and clovers could be made profitable if the land is given a preliminary liming. The luxuriant growth of Kentucky blue grass (*Poa pratensis*), orchard grass (*Dactylis glomerata*), timothy (*Phleum pratense*), redtop (*Agrostis alba vulgaris*), and meadow fescue (*Festuca elatior*), as well as clovers and

vetches, at the edges of ditches along the shell roads would indicate that a little lime is the principal requirement for a good meadow in this region.

PEANUTS.

Norfolk is the principal point at which peanuts are prepared for the market and are shipped to various parts of this country and abroad. There are several peanut factories in the city where the nuts are received, sorted, and graded, the better kinds polished and those for confectioners' trade shelled.

Peanuts are not grown to any noteworthy extent east or north of the Dismal Swamp, but on the higher lands west of Suffolk the acreage in this crop is considerable. On the north side of Albemarle Sound, near Edenton, peanuts rank next to cotton as a staple crop, and nowhere do they grow better than on the warm, brown loams which are best suited to the cultivation of cotton.

FRUITS.[1]

The principal cultivated fruits of the Dismal Swamp region, strawberries, watermelons, and canteloupes, have already been discussed under the head of truck; no others are of first importance.

Orchard fruits, with a few exceptions, do not appear to be well adapted to conditions in this section. Apples are frequently planted, but the trees are small and the fruit is usually inferior. However, certain summer apples, especially the Red Astrakhan, do quite well on the heavier soils, and orchards of limited size are not rare. Pears (Keifer) are less planted than apples. Peaches do not seem to thrive as a rule, and receive little attention, although one fruit grower at West Norfolk reports 50 acres of peach orchard. Figs are often planted near dwellings, especially in the southern part of the region, and mature their fruit freely. Grapes, especially the scuppernong, a derivative of the ubiquitous native muscadine, are much grown in arbors. There are a few small vineyards in the region, the varieties cultivated being chiefly derivatives of *Vitis labrusca*.

The growing of bramble fruits is very limited. Blackberries are raised here and there, one grower having as much as 15 acres. The most popular variety in this region is the "Wilson." An obstacle to success with this fruit is the prevalence of the disease known as "double blossom." It is possible that the native sand blackberry, whose sweet, well-flavored fruit might be susceptible of improvement, would be found immune from this disease when cultivated. The cultivation of dewberries should also prove a profitable industry. Plantations of raspberries occur, but these are very few and very small. It would seem highly desirable to increase the production of fruits of this class in the Dismal Swamp region, as the demand for them is con-

[1] For much of my information in regard to the fruits of this section I am indebted to Mr. W. A. Taylor, assistant pomologist of the Department of Agriculture.

stantly increasing. As is the case with the truck crops, berries shipped from Norfolk would have the market largely to themselves for a period of about two weeks each year.

Some of the wild fruits of the region are quite palatable. Worthy of mention are: The muscadine grape (*Vitis rotundifolia*), wild currants or service berry (*Amelanchier botryapium*), Chicasaw plum (*Prunus angustifolia*), the wild strawberry (*Fragaria virginiana*), blackberries (*Rubus cuneifolius*, the sand blackberry, *R. nigrobaccus*, the common high blackberry, and *R. villosus*, the dewberry), and huckleberries (*Vaccinium corymbosum*, *V. vacillans*, *Gaylussacia frondosa*, and especially *G. resinosa*). Edible, but less pleasant to the average taste, are the papaw (*Asimina triloba*), the persimmon (*Diospyros virginiana*), the hackberry (*Celtis occidentalis*), and the maypop (*Passiflora incarnata*). The cranberry (*Oxycoccus macrocarpus*) also grows wild in the region. Its cultivation here is probably not feasible, owing to the length and heat of summer and the difficulty of properly controlling the water supply. The cold soil of the Dismal Swamp, where peat moss grows abundantly, would meet the requirements of this fruit were it possible to retain these conditions after the timber has been cleared away. However, it is not likely that the cultivation of this fruit, except, possibly, in limited quantities for the local market, would prove remunerative, because of the difficulty of preserving it for the winter market. The berries would naturally mature much earlier here than in New Jersey. It is also a question whether cranberries would not be even more liable to "scald" and other diseases than is the case farther north.

OTHER CROPS.

Tobacco is not cultivated to any important extent in the Dismal Swamp region, although it is occasionally raised by the negroes in small patches for their own use. It grows very well upon the light truck soils, but would not be as profitable as the garden vegetables. Near Newbern its cultivation is increasing, wrapper leaf being the variety preferred. There are now two tobacco warehouses in that town. However, tobacco is in Virginia and North Carolina a crop of the Piedmont rather than of the Coastal Plain region.

Small fields of sorghum are seen here and there in the region, but it is probably grown only for home consumption. The cane, cut into small pieces, is ground in a very primitive little mill, the power being furnished by a mule, which is hitched to the beam that serves as a crank.

AGRICULTURAL WEEDS.

The most injurious weeds of the Dismal Swamp region are mainly such as are common elsewhere in Atlantic North America, by far the greater number being introduced from Europe.

In spring the truck lands, especially fields of strawberries, are often badly infested with chickweed or winter grass (*Alsine media*). This weed appears to be stimulated by the use of fertilizers, so that land which has been in cultivation for some time is usually much more badly infested than newly cleared land. Sheep sorrel (*Rumex acetosella*), wart cress (*Coronopus didymus*), and little barley (*Hordeum pusillum*) are very common and noxious weeds of truck fields in the spring. Owing to the greater difficulty of eradicating them, these small spring weeds are more abundant among strawberries than among other truck crops. In summer nut grass (*Cyperus rotundus*) is sometimes a bad weed, but it is not as common here as it is farther south. Near Newbern it is considered the worst weed of the country, as it spreads by means of its peculiar underground tubers, and is consequently difficult to eradicate. Bermuda grass (*Capriola* (*Cynodon*) *dactylon*) is also frequently a troublesome pest, as its creeping stems strike root anywhere, and it is almost impossible to destroy it with a hoe. Owing to the high cultivation practiced and the frequency with which one crop is removed and another is put into the ground, truck lands are not subject to being overrun by weeds as are fields of other crops, especially corn.

Corn fields, if the soil is thin and the crop is not well cultivated, are apt to be invaded by woody plants, especially sassafras (*Sassafras sassafras*), persimmon (*Diospyros virginiana*), and sumach (*Rhus copallina*). In richer soils cockleburs (*Xanthium strumarium*) and morning glories (*Ipomoea purpurea* and *I. hederacea*) are often bad weeds among the corn. Corn fields that have been recently cleared from the Dismal Swamp are much infested by the reed or cane (*Arundinaria macrosperma*), which spreads underground by means of its strong, creeping rootstocks. Drainage and cultivation for a few years, however, will remove this pest.

In old fields which are more or less neglected or are allowed to lie fallow for a time, certain chiefly native plants often become troublesome. If the land is rather low and badly drained, the showy yellow-flowered butter weed (*Senecio tomentosus*) is very common in the spring. In late summer and fall, large plants, chiefly of the sunflower and the grass families, are abundant. Dog fennel or hogweed (*Eupatorium capillifolium*), the white daisy (*Aster ericoides*), ragweed (*Ambrosia artemisiaefolia*), horse weed (*Leptilon* (*Erigeron*) *canadense*), crab grass (*Syntherisma* (*Panicum*) *sanguinale*), sprouting crab grass (*Panicum proliferum*), barnyard grass (*Panicum crus-galli*), and yellow foxtail (*Chaetochloa glauca*) are the most important. Land which is left to itself still longer is usually taken possession of by the common broomsedge (*Andropogon virginicus*), and among the tufts of this grass seedling pines often spring up in great numbers.

Fields of red clover are often badly infested in late spring and early

summer by the broom rape (*Orobanche minor*), which grows as a parasite on the roots of the clover plants and greatly reduces their vitality. Grass meadows, especially of timothy, sometimes contain great quantities of the prickly horse nettle (*Solanum carolinense*), which considerably reduces the value of the hay.

Weeds which are largely confined to roadsides and waste ground need not be discussed here, as the more important species have already been enumerated in the description of the plant formations.

RELATION OF THE NATIVE PLANT GROWTH TO THE CHARACTER OF THE SOIL.

It is known to farmers the world over that in the nature of the virgin growth upon a body of land they have the best possible indication of its agricultural value. An experienced person can take his stand on a hilltop and, looking off across the country, indicate the quality of the soil here or there by the forest that grows out of it. Where he sees a slope covered with a heavy growth of black walnut and yellow poplar (tulip) he knows that the soil will be rich and deep, well suited to wheat. Where tall sycamores and elms flourish on the bank of a stream, there will surely be found fat alluvial soil, the best of all land for growing corn. The Southern planter recognizes promising cotton land by the growth of oaks, dogwood, myrtle, etc., which it bears.[1] On the other hand, he is well aware that a soil which supports only pine, with very little undergrowth, is too sandy and thin to be valuable in its natural state, but, when heavily fertilized, is excellent for forcing early vegetables.

In a general way such facts as these are known and practically applied wherever the soil is tilled. Little, however, has been done to put this knowledge upon a scientific basis. It would undoubtedly be most helpful to the farmer if he could find out how far the value of this test of uncleared land can be relied upon. He would like to know just how sharp a line can be drawn between soils of different chemical composition, texture, and drainage by carefully noting the wild growth which they bring forth.

It was largely in the hope of being able to throw light upon this problem that the present survey was undertaken. The Dismal Swamp region was selected for the preliminary investigation because it was known that here conditions are less complicated than in many other sections. The evenness of the surface of the Coastal Plain and the absence of abrupt changes of level would naturally tend to simplify

[1] In his Catalogue of the Natural Orders of Plants Inhabiting the Vicinity of the Santee Canal, South Carolina (Proc. Am. Assoc. Adv. Sci., vol. 3, p. 5, 1850), H. W. Ravenel writes, "On the highlands bordering these swamps, where the best cotton lands are found, hickories, dogwood (*Cornus florida*), oaks, etc., constitute the principal vegetation."

the premises from which deductions were to be drawn. As will presently be seen, this very lack of diversity, while removing some difficulties from the survey, was an obstacle to obtaining very striking results.

COMPARATIVE INFLUENCE OF DRAINAGE AND CHEMICAL FACTORS.

In the Dismal Swamp region, if we consider only lands that give some promise of agricultural value, variations in drainage constitute the most important soil differences. In other parts of the country chemical composition of the soil plays a leading part. For example, limestone and freestone soils are often very sharply differentiated within a limited area. Such differences are of little importance in the country we are considering. Only the salt-marsh and sand-dune soils, and those of the fresh-water wooded swamps previous to being drained, present important peculiarities in their chemical composition. Needless to say, these three formations are worthless from an agricultural point of view, so long as they remain in their natural condition. Omitting them from the discussion, the problem becomes chiefly one of water content, depending in great part upon the fineness of subdivision exhibited by the soil. When this is coarse, the soil is sandy and well drained. When finely divided, it becomes silty or clayey, holding water longer and in greater quantity.

Now the respective characteristics of vegetation upon a sandy well-drained soil and upon clayey wet land are much less striking, and the transition from one to another is more gradual and less easy to define than is the case where important chemical differences exist. The line between vegetation that grows in a soil rich in lime and that upon a lime-poor soil is often so abrupt and sharply defined as to be easily recognizable at a distance. Not only size, habit, hairiness, etc., differ markedly in the same species when growing upon one or the other kind of soil, but there are a number of species which prefer limestone soils, while others show a strong aversion to soil that contains much lime. Thus the systematic makeup of the vegetation changes to a large extent as we pass from one soil to the other.[1]

[1] In the United States the distribution of plants upon soils rich or poor in lime (which means chiefly calcium carbonate, $CaCO_3$) has not received the attention which it deserves. Undoubtedly interesting results await the student of this important problem in soil chemistry and plant geography. In Europe much work has been done in the line indicated. Especially in France the matter has been approached from the standpoints of chemistry, physics, and geology, as well as of botany. The agricultural journals, and writers upon forestry, have devoted much space to its consideration. Several attempts have been made to segregate the indigenous plants of various regions as confined to limestone soils, preferring lime, preferring freestone, confined to freestone, or indifferent. Bonnier and others have indicated, however, that a hard and fast classification is not easily attainable, as species which are "lime-loving" in one chain of mountains are

In the exceptional cases noted above, easily recognizable changes in the vegetation coincide with important differences in the chemical quality of the soil. Near the sea, in what we call the maritime formations, the soil contains a much larger percentage of common salt (NaCl) than is present in ordinary soils. This substance acts upon the great majority of plants as a poison if it occurs in the soil in considerable quantity—1 per cent or, for many species, even less. Consequently the vegetation of the dunes and beach is sparse and is composed of but few species, most of which are peculiarly adapted to salt-impregnated soil and air, and are not found in normal inland soils. Even more strikingly is this the case with the salt marshes, where the soil is overflowed with brackish water at every high tide. Their vegetation is extremely different from that which occupies ordinary, moderately well drained soils which contain but a small trace of salt.

Peculiar chemical conditions are also found in the soil of the swampy forests so long as they remain in their natural condition. Chief among these peculiarities are exceeding richness in vegetable matter and poverty in oxygen, to which is due the presence of much humic acid. The soil is sour. In addition, we have the physical peculiarity of a very high water content, the soil being normally saturated. Given such conditions and it is not strange that the vegetation, notably the forest growth, of these swamps is sharply differentiated from that on adjacent, not swampy soils, even where the latter are moderately moist.

Both the maritime and the swamp soils are agriculturally worthless in their natural condition. It is not likely that any treatment could be devised which would render arable the salt marshes or the beach

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sometimes "lime-avoiding" in another. Some of the principal works dealing with the subject are:

Unger. Über den Einfluss des Bodens auf die Verteilung der Gewächse. 1836.

Thurman, J. Essai de phytostatique appliqué à la chaîne du Jura et aux contrées voisines. 1849.

De Candolle, A. Geographie botanique raisonné. Vol. 1, pp. 264, 422–447. 1855.

Bonnier, G. Quelques observations sur les relations entre la distribution des phanérogames et la nature chimique du sol. Bull. Soc. Bot. de France, vol. 26, pp. 338–341. 1879.

Contejean, C. Géographie botanique. Influence du terrain sur la végétation. 1881.

Vallot, J. Recherches physico-chimiques sur la terre végétale et ses rapports avec la distribution géographique des plantes. 1883.

Fliche et Grandeau. Recherches chimiques et physiologiques sur la brûyere commune. Ann. de la Science Agronomique (1884), vol. 1, 394–411. (Two other papers by the same authors are there cited—De l'influence de la composition chimique du sol sur la végétation du pin maritime. Ann. de Chimie et de Physique. ser. 4, vol. 29. 1873. De l'influence de la composition chimique du sol sur la végétation du châtaignier, op. cit., ser. 5, vol 2.

Ramann, E. Forstliche Boden-Kunde und Standortslehre, pp. 365, 366. 1893.

Warming, E. Lehrbuch der ökologische Planzengeographie. pp. 63, 75. 1896.

Schimper, A. F. W. Pfanzengeographie. 105-118 (1898.)

and dune areas, at least without great expense; but by careful drainage a great part of the wooded swamps can be converted into highly valuable land. In this process, however, the soil loses the chemical and physical peculiarities just enumerated, and if afterwards permitted to lie fallow it becomes rapidly overgrown with the ordinary not swampy forest vegetation of the region. Unless it reverts to its original condition as to drainage, such land has ceased forever to belong to the swampy forest formation.

TYPES OF ARABLE SOILS.

Two leading types of soil are easily distinguishable in that part of the Dismal Swamp region which is occupied by neither salt marshes, sand strand, nor wooded swamps.

1. Soils of a light, sandy texture, warm, and capable, when cleared, of thorough drainage. These are the "truck soils," which are largely devoted to the growing of garden vegetables, the chief industry of the region. They usually occur on or very near tide water.

2. Soils with a relatively high content of silt or clay, and consequently colder and more retentive of water. These are mostly inland soils, and as has already been pointed out, are ill adapted to many truck crops, but give good returns, under proper management, with grasses and some cereals.

The truck lands are at present by far the most valuable of the region, and with them we shall therefore chiefly concern ourselves. What is the character of the original forest and undergrowth on soils of this class? Is it sufficiently well marked to enable us to say with confidence, after an examination of the native vegetation alone, "Here we have or have not a good truck soil?"

NATIVE VEGETATION OF TRUCK LANDS.

Before answering this question it may be well to describe briefly the more important growth upon a number of representative tracts of forest where the question could be satisfactorily answered in the affirmative after an inspection of the soil itself and of the appearance of crops in adjacent fields.

1. On one of the largest and best truck farms along the Western branch of Elizabeth River, near Norfolk, the following growth was noted: Short-leaf pine (*Pinus taeda*), 40 to 50 feet high, intermixed with much hardwood—water oak (*Quercus nigra*), willow oak (*Quercus phellos*), white oak (*Quercus alba*), sweet gum (*Liquidambar styraciflua*), and sour gum (*Nyssa sylvatica*). Undergrowth dense, composed of red maple (*Acer rubrum*), sourwood (*Oxydendrum arboreum*), huckleberry (*Gaylussacia frondosa*), pepper bush (*Clethra alnifolia*), sassafras, sumac (*Rhus copallina*), spikenard tree (*Aralia spinosa*), small cane (*Arundinaria tecta*), etc. The presence of several of these plants, especially of the water oak, red maple, and

small cane, indicates a soil that is naturally not well drained, as is very generally the case in the region.

2. Along the Southern branch of Elizabeth River, near Berkley: Forest of small short-leaf pines (20 to 30 feet high), mixed with sweet gum, water oak, Spanish oak (*Quercus digilata*), sourwood, etc. Undergrowth moderately dense, of sumac (*Rhus copallina*), sweet gum, and gallberry (*Ilex glabra*). Nearer the water where the soil is still lighter and sandier, myrtle (*Myrica carolinensis*), becomes important in the undergrowth, while sumac disappears.

3. Lamberts Point, near Norfolk: Timber chiefly large short-leaf pine (sometimes 80 feet high and 4 feet through), mixed with some sweet gum (also of large dimensions), and small trees or bushes of various oaks (willow, white, water, and quercitron (*Quercus velutina*), holly (*Ilex opaca*), sour gum (*Nyssa sylratica*), pepper bush (Clethra), bay (*Persea pubescens*), etc. Greenbrier (*Smilax rotundifolia*), and muscadine grape (*Vitis rotundifolia*) are abundant.

4. Suffolk: Forest of small short-leaf pines, averaging 40 feet in height. Undergrowth especially heavy near the border of the forest, composed of sourwood (very abundant), sweet gum, myrtle (*Myrica carolinensis*), holly, gallberry, tulip tree (*Liriodendron tulipifera*), Spanish oak, white oak, water oak, huckleberry (*Gaylussacia frondosa*), and blueberry (*Vaccinium virgatum tenellum*).

5. Edenton: Rather heavy growth of large short-leaf pine (*P. taeda*), some of the trees being 80 feet high and 4 feet in diameter. Other trees are tulip (*Liriodendron tulipifera*), sweet gum, sourwood (*Oxydendrum*), white oak, black cherry (*Prunus serotina*), and red cedar (*Juniperus virginiana*), all small. The undergrowth is made up of dwarfed plants of the trees mentioned, together with myrtle, spikenard tree (*Aralia spinosa*), holly, sassafras, *Callicarpa americana*, and various climbing plants, trumpet creeper (*Tecoma radicans*), yellow jessamine (*Gelsemium sempervirens*), muscadine grape (*Vitis rotundifolia*), and greenbrier (*Smilax rotundifolia*). This soil, as the growth indicates, has rather more body than is necessary or even advantageous for growing most truck crops. The neighboring fields were planted in cotton which was in excellent condition and indicated a soil well adapted to that staple.

6. Edenton, near the preceding tract: Pines small and giving place to hardwoods, chiefly tulip tree and Spanish oak, with a scattered undergrowth of persimmon (*Diospyros virginiana*), sumac, sourwood, sweet gum, spikenard tree, yellow jessamine, etc. Here the soil was lighter and sandier than in No. 5, and therefore better adapted to truck.

The problem of ascertaining just what plants are useful as indicators of a good truck soil is not a simple one. As we have already remarked, it is the water content of the soil, depending very largely upon its fineness of texture, that chiefly determines the distribution

of plant life in the Dismal Swamp region. The dunes and salt marshes are of course exceptions, but these can be left out of the discussion, which concerns only soils that are likely to be of agricultural value.

Now, there exists an element of uncertainty, which made itself evident at the outset of the investigation, in the very considerable versatility as to habitat which many plants exhibit in this region. Woody plants are elsewhere usually quite sensitive to differences of water content in the soil. Thus, in regions where the surface of the country is more broken and exhibits a greater variety of elevation the red maple is rarely found outside of swamps, while such trees as sweet gum, willow oak, buttonwood, sand-bar willow, and blue beech are confined to the banks of streams. In the Dismal Swamp region, however, all these plants are met with in the driest soils of that section, even occurring upon the sand dunes of the coast. Sweet gum and red maple are present almost everywhere, usually in the greatest abundance.

Sassafras, sumac (*Rhus copallina*), persimmon, sourwood (*Oxydendrum*), and spikenard tree (*Aralia spinosa*) are all common plants in the Piedmont and the mountain regions of the Southern States, as well as in the Coastal Plain. But while in the more elevated parts they are most characteristic of dry uplands, near the coast they occupy very wet as well as comparatively very dry soils, even thriving in all but submersed ground in the Dismal Swamp. As partially explaining this peculiarity of distribution, however, it must be borne in mind that arid soils, or even soils that remain constantly dry for any considerable period, are unknown in the region we are describing. The difference between the wettest and the driest land is here much less sharp than in districts having a more perfect drainage.

Still, with every allowance for the absence of sharp limits between the vegetation of soil that is moderately heavy and wet, but not swampy, and that which is relatively light and dry, we are, nevertheless, able to recognize a type of native growth which serves fairly well as an indication of a soil of the latter character and one therefore that is well adapted to truck.

Short-leaf pine (*Pinus taeda*) is always present in such land if it has retained its original vegetation. This tree does not, however, reach its largest size on the truck soils, but in land having considerably more bottom, such as usually occurs farther from salt water. Where the original growth of pine has been disturbed hardwoods tend to replace it, and these are also usually present as undergrowth in the more open pine forest. Various oaks, especially Spanish oak (*Quercus digitata*), white oak (*Q. alba*), red oak (*Q. rubra*), quercitron (*Q. velutina*), and the so-called water oak (*Q. nigra*) are usually present. Sweet gum (*Liquidambar styraciflua*) is almost always found upon land that is adapted to truck crops, often forming the principal undergrowth. The presence of dogwood (*Cornus florida*)

in any considerable quantity is a safe indication of a good soil of this type. Holly (*Ilex opaca*), black walnut (*Juglans nigra*), and hickory are trees whose presence indicates a type of soil that is richer than the lightest pine lands, yet highly esteemed by truck farmers.

A variety of shrubs are found in good truck land. Myrtle (*Myrica carolinensis*) is often a very important feature of the undergrowth. Although common on the dunes, where the soil is agriculturally worthless, its presence in the pine forests denotes a promising truck soil. Gallberry (*Ilex glabra*), while frequent in land that is too heavy to meet the requirements of truck farming, is occasionally common on high-grade soils which are well adapted to some truck crops, especially potatoes and strawberries. Near Newbern a type of soil which is sandy but richer in organic matter than most truck soils and to which we have already referred is known as "gallberry land" because of the predominance of this shrub upon it.

Sweet bay (*Persea pubescens*) resembles gallberry in its distribution upon both light and heavy soils. The presence of a number of other shrubs in considerable quantity among the undergrowth may be taken as fairly conclusive evidence of a good truck soil. These are: *Callicarpa americana*, sourwood (*Oxydendrum arboreum*), persimmon (*Diospyros virginiana*), spikenard tree (*Aralia spinosa*), huckleberry or blue tangle (*Gaylussacia frondosa*), blueberry (*Vaccinium virgatum tenellum*), and deerberry (*Vaccinium stamineum*). Less characteristic of this type of soil are sassafras and sumac (*Rhus copallina*). Muscadine grape (*Vitis rotundifolia*) and summer grape (*V. aestivalis*) are much more abundant on this than on heavier soils. Roundleaved greenbrier (*Smilax rotundifolia*) and yellow jessamine (*Gelsemium sempervirens*) are very often present, but are also common in heavier land.

VEGETATION OF LANDS UNSUITED TO TRUCK FARMING.

The fact has already been noted that certain plants, such as red maple (*Acer rubrum*), willow oak (*Quercus phellos*), and small cane (*Arundinaria tecta*), while normally swamp-loving species, are found in the Dismal Swamp region upon a great variety of soils. The presence of any or all of them among the undergrowth does not necessarily indicate a soil too heavy for truck, but is good evidence that the natural drainage is for some reason deficient. But wherever red maple and black gum in numbers grow to be good-sized trees it can be concluded with safety that here the soil is too heavy and too rich in organic matter for purposes of truck farming. Similarly the occurrence of beech or of cow oak (*Quercus michauxii*) of any considerable size betrays a clay content in the soil that precludes the successful prosecution of this branch of farming. There are a number of plants, e. g., cypress (*Taxodium distichum*), juniper (*Chamaecyparis thyoides*), black gum (*Nyssa biflora*), cotton gum (*N. uniflora*), rattan (*Berchemia volubilis*), big cane (*Arundinaria macrosperma*),

poison dogwood or boarwood (*Rhus vernix*), cottonwood (*Populus heterophylla*), laurel-leaved greenbrier (*Smilax laurifolia*), sweet bay (*Magnolia virginiana*), etc., whose presence betrays at once that the soil is too rich in organic matter to be at all suited to "trucking" as the industry is at present practiced.

While the trees and shrubs enumerated in the preceding paragraph show that the soil on which they grow is not adapted to forcing garden vegetables to early maturity, with the exception of juniper they by no means indicate a worthless soil. The heavier clayey, but not swampy, lands, which are mostly found at some distance from tide water, can be made to yield excellent crops of oats, clover, timothy, cowpeas, and other forage plants. It is to be strongly recommended that more attention be paid in the Dismal Swamp region to growing forage crops and raising cattle. Truck farming, although yielding large returns to a few successful growers, is already overcrowded, and is becoming more so every year. It is no uncommon thing in the extensive trucking areas along the coast for a large part of the berry crop to be left on the vines; and much of the potato crop remains in the ground because overproduction has brought the market price down to a figure where it no longer pays to gather the crop. Meanwhile a large part of the beef and even the dairy products consumed in the region are imported from the North and West.

While some lands are fairly well adapted to wheat, cotton, and tobacco, it is much to be doubted whether this region can successfully compete with others in the production of any of these crops. Much of the heavy interior soils are now in corn, and in the lower part of Norfolk and Princess Anne counties, Va., a noteworthy amount of cotton is raised. As a rule neither crop gives good results, chiefly because the land has been worn out by long cultivation in one or the other crop, without the practice of intelligent rotation. Greater attention to clover and meadow grasses, as well as more diligent cultivation, would go far to restore them. There are some farms in that part of the region which afford admirable object lessons of what can be accomplished by this treatment. But as a rule the interior lands are in sorry contrast to the highly cultivated truck farms that border tide water.

A final word should be said concerning the swamp lands, which are more fully discussed in the chapter on "Soils." These are of two types—the peaty juniper soil and the rich black-gum land. The first type, which does not occur in any noteworthy area outside the main borders of the Dismal Swamp, is characterized by a native growth of "juniper" or white cedar (Chamaecyparis). According to all testimony, it is agriculturally valueless. "Black-gum land" is so called from the principal tree which it bears when in its virgin state, the black gum (*Nyssa biflora*). Most of it is covered with a heavy forest composed of this tree, red maple (*Acer rubrum*), some (formerly

much) cypress (*Taxodium distichum*), blue ash (*Fraxinus caroliniana*), etc. When cleared and well drained such land yields much better crops of corn than can be had on any other soil of the region. The corn crop of the Dismal Swamp lands is likely to prove peculiarly valuable, as the product is mostly shipped abroad. Being within 10 to 20 miles of a seaport that is hardly surpassed on our coast, this region has a great advantage over the better known corn-producing country of the Mississippi Valley. The variety chiefly grown on the swamp soils is known as horsetooth corn. It is a white dent which possesses an unusually long kernel, and is largely exported to Germany for use as a seed corn.

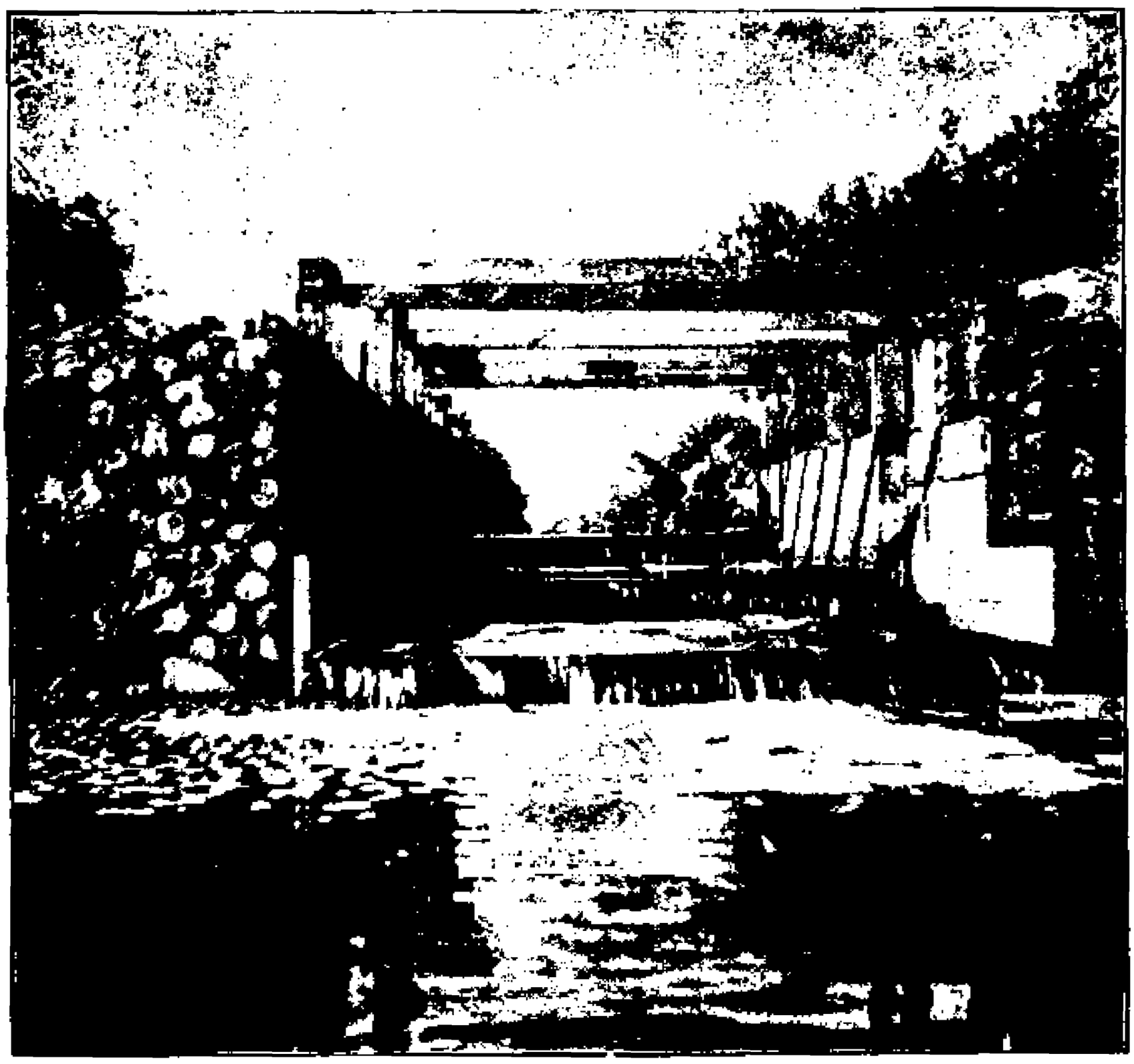

FIG. 85.—Mouth of main drainage ditch emptying into the Dismal Swamp Canal, Wallaceton, Va.

Irish potatoes and cabbage also give excellent results on such land. It has lately been demonstrated that celery can be successfully and profitably grown in black-gum land. And last, but not least, it is probably better suited to the establishment of permanent meadows than any other type of soil in the Dismal Swamp country.

ILLUSTRATIVE QUOTATIONS.

It may not be out of place to quote in conclusion a few published descriptions of the natural growth on different types of soil in other parts of the United States east of the Mississippi. They will serve to illustrate how generally this means of distinguishing good from bad soils is employed.

The younger Michaux gives an interesting note on this subject in

his "Voyage à l'ouest des monts Alleghanies," published in 1804. I quote [redacted]203 to 206 of the English translation, "Travels to the westy[redacted]the Alleghany Mountains," which was printed in the follow[redacted]:

In th[redacted]6 States [Kentucky and Tennessee] they appreciate the degree of fertilit[redacted]e land by the different species of trees which grow upon them; thus when [redacted]e of a lot of land is advertised, they are careful to specify that such or such k[redacted] of trees grow on such or such parts, which is sufficient information to the pu[redacted]aser. This rule, however, admits of an exception with respect to the *Barre*[redacted]he soil of which, as I have mentioned, is very fertile and on which, nevertheless, there are found the *Scroby oak*, Quercus nigra, and the *Juglans hickery*, which in the [redacted]rest are evidences of the worst soil. Supported by this mode of estimating the [redacted]cundity of the soil by the nature of the trees which it produces, I shall mention [redacted]very remarkable observation which I made as soon as I arrived in this State. In [redacted]entucky and Cumberland[1] independently of a few trees which are peculiar to th[redacted]e countries, the mass of the forests in lands of the first class, is composed of those [redacted]pecies which are very rarely met with to the east of the mountains in the most fertile soils. These species are principally the following: *Cerasus virginiana*, cherry tree; *Juglans oblonga*, white walnut; *Pavia lutea*, buck eye; *Fraxinus alba, nigra, cerulea*, white, black, and blue ash; *Celtis folliis villosis*, hackberry; *Ulmus viscosa*, slippery elm; *Quercus imbricaria*, black-jack oak; *Guilandina dioica*, coffee tree; *Gleditsia triacanthos*, honey locust, and *Annona triloba*, papaw, which rises to the height of 30 feet. These three last species, in particular, denote the richest lands. In cool mountainous places and by the sides of the rivers which have not steep banks, there are also found the *Quercus macrocarpa*, over-cup white oak, the acorns of which are as large as a hen's egg; the *Acer saccharinum*, sugar maple; the *Fagus sylvatica*, beech; and also the *Platanus occidentalis*, plane; the *Liriodendrum tulipifera*, white and yellow tulip tree, and the *Magnolia acuminata*, cucumber tree, the three last of which attain to a circumference of 18 or 20 feet. The plane, as has been mentioned before, grows to a larger size.

In the lands of the second class are found *Fagus castanea*, chestnut; *Quercus rubra*, red oak; *Quercus tinctoria*, quercitron; *Laurus sassafras*, sassafras; *Dios-piros virginiana*, persimmon; *Liquidambar styraciflua*, sweet gum; *Nyssa villosa*, gum tree, a tree which neither yields gum nor resin, as its name seems to imply.

Those of the third class which are generally arid and mountainous, scarcely produce any but the black and red oak; the *Quercus primus montana*, rocky oak, some pines, and sometimes Virginian cedars.

Mr. W. W. Ashe (Bull. N. C. Geol. Survey, vol. 5, pp. 14 to 16) describes as follows the natural vegetation on different soils in eastern North Carolina:

The timber over the entire section is, on the highlands, largely of two species of pine; one, the loblolly pine (*Pinus taeda* L.), more confined to the counties north of the Neuse River and to the moister soil; the other, the long-leaf pine (*Pinus palustris* Mill.), to those south of this river and to the drier, more sandy soil. Beneath these trees, where the soil is not too dry and sandy, is a lower growth of small white and post oaks, dogwood, haws, and the narrow-leaved crab apple, while where the soil is very sandy and dry there grows, either with the long-leaf Pine or where it has been removed, a small worthless oak, the sand black-jack or

[1] "In the United States the name of Cumberland is given to that part of Tennessee which lies west of the mountains of that name."

barren oak (*Quercus catesbaei* Michx.), and, less frequently, the high-ground willow oak (*Quercus cinerea* Michx.). This oak is also a small tree and indicates the most barren soil. Besides the pines just referred to, there are two others found with them, the short-leaf [yellow] pine (*P. echinata* Mill.), an uncommon tree except on dark loam or gravelly soil along the western and northern limits of this section, and the savanna pine (*P. serotina* Michx.), a knotty, unsymmetrical tree occurring from Virginia southward along the margins of "pine barren" ponds or scattered in small clumps over the open savannas and marsh lands. These few species form the chief growth of the higher lands.

The swamp lands, with a total area of about 3,500 square miles, have a very characteristic and varied growth. Bordering these swamps are water and willow oaks, with the evergreen loblolly bay and sweet bay. Farther in them are huge swamp chestnut oaks (*Quercus michauxii* Nutt.), elms, maples, beech, holly, and tall rosemary pines (*P. taeda* L.). These lands constitute the *oak flats*, areas which are under water only during the wettest seasons of the year. They have usually a good soil and can be easily drained.

Where the water is deeper in the swamps and remains longer grow the cypress, sweet gum, black gum, tupelo, and yellow poplar.

In the mud swamps along the larger streams there are, besides cypress and gums, ash, overcup oak, cottonwood, sycamore, and hackberry. Mixed with the other swamps, but covering less area and occurring only on sandy or peaty soil, are white cedar swamps, or "juniper bays," as they are usually called. The tree growth in these is largely and often entirely juniper or white cedar (*Chamaecyparis spheroidea* Spach) and white bay (*Magnolia glauca* L.). In the extreme eastern part of this section, in the immediate vicinity of the seacoast, there is a characteristic arborescent flora of red cedars and live oaks, while along its southern limits the palmetto and American olive (*Olea americana* L.) give it a semitropical aspect. On the other hand, as the clay and loam of the hill country is neared, the oaks and hickories rapidly increase among the pines, making the transition to the hard-wood uplands.

Several well-marked soil types of peninsular Florida, with their native growth, are thus described by Professor Whitney (A preliminary report on the soils of Florida, Bull. Div. Agric. Soils, U. S. Dept. Agr., vol. 13, pp. 8, 9, 1898):

There is a marked difference in the character of the native vegetation on the different types of soil in the State. The hammock land, considered the most valuable for most purposes, has a more or less heavy growth of white oak, live oak, water oak, bay, hickory, magnolia, and dogwood, so dense at times as to form a veritable jungle. The white oak is found only on the very best hammock lands, while the red oak and the long-leaf pine grow together on what is called the mixed lands. The high pine land and the pine flats, as the names imply, contain a monotonous growth of long-leaf or spruce pine, the character of the land having a great influence upon the forest growth.

There is, as a rule, a more or less marked difference in the appearance of the soils of these different types of land, but notwithstanding the very great difference in the character of the vegetation on the hammock and pine land soil no appreciable difference has yet been found, either from a chemical analysis or from an examination of the physical texture of the soils. * * *

The second quality of high pine land covers vast areas in the peninsula. It is a very light, rather coarse, sandy soil, less coherent than the hammock or first quality of pine land. Still the roads through it are good. The characteristic growth is the long-leaf pine. The trees are sparsely set and often of quite large size. There is very little undergrowth, and a wagon or carriage can be driven

through the forest in almost any direction. There is generally a good growth of grass, and these lands are very extensively used for grazing.

* * * These second quality high pine lands form the principal truck areas at Gainesville, Orlando, Winterhaven, Grand Island, and Bartow. The country is generally rolling, with differences of elevation of from 25 to 50 feet. The whole elevation of the lake region, which is used for truck growing, is from 100 to 200 feet above sea level. The soil is a coarse white or yellow sand, underlaid by a coarse, sandy subsoil. It looks like a barren sea sand or a coarse, sharp, building sand; but that it is very productive is shown by the large and vigorous growth of pines, the luxuriant growth of grass, the great quantity of truck crops which can be produced during the season, and the enormous growth of beggar weed which takes possession of the land after the crops are removed. * * *

As already explained, the hammock lands are characterized by a native growth of hardwood trees, principally of oak, hickory, magnolia, dogwood, and the cabbage palmetto. There are quite a number of grades of hammock land, distinguished by the kind and density of the growth as well as by the character of the soil. There are light and heavy hammocks, so named from the density of the growth rather than from any appreciable difference in the character of the soil. The low, flat hammock, the high hammock, the heavy clay hammock, and the marl hammock, the various grades differing somewhat in the kind and relative proportion of the native trees. * * *

The great Etonia scrub formation was examined at Altoona. It is an impressive sight to stand at the border line between the scrub and the high pine land and notice the difference in the character of the vegetation. The high-land pine is open, the trees are large and vigorous, and the ground is covered with a crop of grass, which gives very good grazing for cattle. The vegetation is quick and generous, and the most tender plants will grow luxuriantly if properly attended to. These conditions stop abruptly at the edge of the scrub. The boundary between the high pine land and the scrub can be located without trouble within a few feet. * * * In the scrub there is a dense growth of scrub oaks and low bushes and plants, all having thick leaves protected to the utmost from loss of water by evaporation by the property that desert plants have of turning the leaves up edgeways to the sun to expose as little surface as possible to the direct rays. No grass is found, and only the most hardy desert plants grow. When pines grow, it is the dwarf spruce pine and not the long-leaf pine, while on the other hand the spruce pine is not found across the border in the high pine lands proper. The full-grown scrub vegetation reaches about the height of a man's head. * * * This scrub growth stretches out at this place in an unbroken line for 10 or 15 miles to the northward, and the whole country presents a most desolate appearance.

ANATOMICAL NOTES.

In the following pages are presented brief descriptions of the anatomy of some of the plants of the Dismal Swamp region which are most interesting from an ecological point of view. The leaf alone is described in most cases, that being the organ from whose structure conclusions can usually most readily be drawn as to the interaction of the organism and its environment, especially in matters of soil and climate. As a rule only the epharmonic characters—in other words, those by which the plant adapts itself to the physical conditions of its environment—so far as they have been determined, are here discussed. Most of these having already been mentioned collectively in describing adaptations to environment in the several plant formations,

the species are here arranged in their systematic order, for convenience of comparison. The following is a synopsis of the species of each formation which are described below:

I. Maritime formations.[1]

A. Salt Marsh formation: Oxycoccus macrocarpus.

B. Sand Strand formation: Smilax bona-nox, Helianthemum canadense, Hudsonia tomentosa, Lechea maritima, *Gelsemium sempervirens*,[2] Galium hispidulum. *Lonicera sempervirens.*

II. Inland formations.

A. Dry Land formations.

1. Forest formations.

(*a*) Mixed Forest: Asarum virginicum, *Persea pubescens*, *Liquidambar styraciflua*, *Malus angustifolia*, *Ilex glabra*, Batodendron (Vacciniun) arboreum, Symplocos tinctoria, Styrax grandifolia, *Gelsemium sempervirens*, *Lonicera sempervirens.*

2. Cleared Land formations (noncultural).

(*b*) Shrubby: *Rosa carolina.*

(*c*) Herbaceous: Ascyrum stans, Hypericum pilosum, H. virgatum, Senecio tomentosus.

B. Fresh-water formations.

1. Palustrine.

(*a*) Forest: Smilax laurifolia, S. walteri, Phoradendron flavescens, Magnolia glauca, *Persea pubescens*, *Liquidambar styraciflua*, Itea virginica, Decumaria barbara, *Rosa carolina*, *Malus angustifolia*, *Ilex glabra*, I. lucida, Acer rubrum, Berchemia scandens, Nyssa aquatica, Leucothoë axillaris, L. racemosa, Pieris nitida, Xolisma foliosiflora, Kalmia angustifolia, Chionanthus virginica, *Gelsemium sempervirens*, *Lonicera sempervirens.*

(*b*) Open Marsh.

Low Marsh formation: Pluchea foetida.

SMILAX BONA-NOX L.

Sand Strand formation (innermost dunes).

Leaf thickish, evergreen, bifacial.

Epidermis: Ventral, cell walls thickish, the radial strongly undulate; cuticle nearly smooth. *Dorsal*, cuticle delicately wrinkled. Stomata numerous, level with the surface, each bordered by a pair of irregularly crescent-shaped subsidiary cells, the inner walls of the guard cells strongly thickened. Hairs none.

Palisade in one layer of short, wide cells. Pneumatic tissue rather compact.

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[1] The following maritime species which occur in the Dismal Swamp region were described by the author, as to their leaf anatomy, in Contr. U. S. Nat. Herb., vol. 5, pp. 285 to 312 (1900):

Sand Strand.—Panicum amarum Ell., Spartina patens (Ait.) Muhl., Uniola paniculata L., Myrica carolinensis Mill., M. cerifera L., Quercus virginiana Mill., Q. laurifolia Michx., Zanthoxylum clava-herculis L., Oenothera humifusa Nutt., Physalis viscosa L., Iva imbricata Walt.

Salt Marsh.—Spartina stricta (Ait.) Roth. Juncus roemerianus Scheele, Kosteletzkya virginica L., Monniera monniera (L.) Britton, Solidago sempervirens L., Aster tenuifolius L., Iva frutescens L., Borrichia frutescens (L.) DC.

[2] The names of species which normally occur in more than one formation are printed in *italics.*

Hypodermal collenchymatic tissue beneath the larger veins.

Stereome surrounding the mestome bundles, especially strong above and below them.

SMILAX LAURIFOLIA L.

Hygrophile Forest formation.

Leaf thick, evergreen, strongly bifacial, markedly xerophytic in structure (fig. 86).

Epidermis: Ventral, cell walls thickish, the radial strongly undulate; cuticle thick, finely wrinkled, yellow, sharply differentiated from the

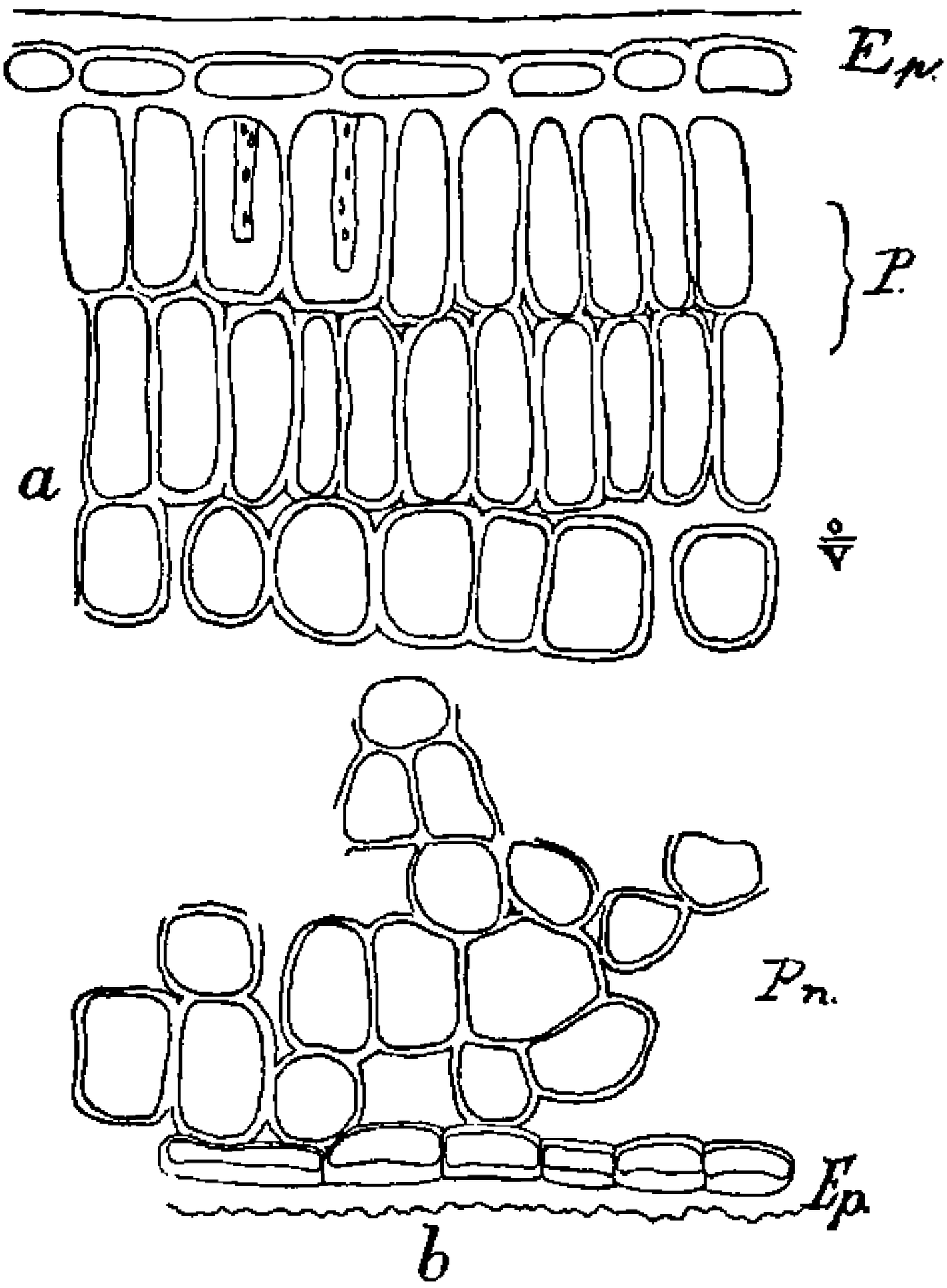

FIG. 86.—*Smilax laurifolia*, leaf in cross section. *a*, Ventral face; *b*, dorsal face. Magnified 360 times.

whitish, highly refractive outer walls of the epidermis cells. *Dorsal*, radial walls not undulate; cuticle thicker than on the ventral surface, nearly equaling the height of the lumina of the epidermis cells, strongly wrinkled, with a few broad, blunt ridges to each cell, otherwise as on the ventral surface. Stomata only on the dorsal surface, lying at right angles to the leaf's axis, deeply sunken (below the cuticle). Hairs none.

Palisade in two dense layers, the cells wide, with thick, pitted walls; then several layers of short-celled pneumatic tissue, with rather large intercellular spaces; and finally, beneath the dorsal epidermis, two rather compact layers of short cells.

Hypodermal collenchymatic tissue beneath the midvein, palisade not interrupted above it.

Stereome massively developed around the mestome bundles, completely surrounding them, but especially strong above and below them, very thick-walled.

SMILAX WALTERI Pursh.

Hygrophile Forest formation.

Leaf not thick, deciduous, approximately isolateral.

Epidermis: Cells containing much chlorophyll (especially those of the ventral surface), walls—especially the outer—thickish, the radial walls somewhat undulate on the ventral face, not undulate on the dorsal. Stomata few on the ventral face, numerous on the dorsal, about level with the surface, lying in all directions, each bordered by three to four undifferentiated epidermis cells. Hairs, none.

Mesophyll homogeneous through the leaf; palisade none, but intercellular spaces rather larger on the dorsal side.

Smaller *mestome bundles* entirely surrounded by rather thin-walled stereome.

PHORADENDRON FLAVESCENS (Pursh) Nutt.

Hygrophile Forest formation.

Leaf isolateral, thick, leathery, glabrous; veins, even the midvein, embedded in the mesophyll.

Epidermis: Cell walls straight, thick; cuticle thick, smooth. Stomata on both faces, lying in all directions, each bordered by a pair of subsidiary cells which are larger than the guard cells. Hairs none.

Mesophyll perfectly homogeneous, compact, in about ten layers of nearly isodiametric cells without intercellular spaces.

Groups of *stereome* adjoin the mestome bundles on both the hadrome and the leptome sides.

ASARUM VIRGINICUM L.

Forest (nonhygrophile) formation.

Leaf thickish, bifacial, smooth, punctate with semitransparent points.

Epidermis: Ventral, cells rather large in all dimensions, radial walls undulate;[1] the cuticle delicately wrinkled, thick, smooth, except on the leaf margins. *Dorsal*, cells smaller, lower, radial walls thicker and less undulate, the walls collenchymatically thickened beneath the midvein. Stomata confined to the dorsal surface, rather large, level with the surface, lying in all directions, each bordered by four to six ordinary epidermis cells. Rounded secretion cells numerous (one to

[1] Solereder states that the cells of the epidermis on both faces have pitted walls (Engler's Bot. Jahrb., vol. 10, p. 427).

every four stomata).[1] Hairs confined to the impressed veins of the upper surface and to the margins of the petiole, scattered, short, conical, blunt-pointed, four or five celled.

Palisade in two layers of short, broad cells, the inner less compact.[2] Pneumatic tissue from five to six layers, very open, with large air spaces.

Hypodermal collenchyma in several layers beneath the midvein and in the margins.

Stereome none.

Small groups of colorless parenchyma with small, thickish-walled cells occur above and below the mestome of the larger veins.

MAGNOLIA VIRGINIANA L.

Abundant in the Hygrophile Forest formation.

Leaf coriaceous, semipersistent (deciduous farther north, more persistent farther south), bifacial, dark green above, very glaucous beneath, densely pubescent when young, veins numerous, reticulated, prominent on the lower surface.

Epidermis: Ventral, cells low, considerably greater in the dimension parallel to than at right angles to the leaf surface, their walls straight or but slightly undulate; cuticle somewhat thickened. *Dorsal*, cuticle coated with granular wax. Stomata none on the ventral surface, lying in all directions on the dorsal surface, slightly sunken, each accompanied by two subsidiary cells.[3] Hairs numerous on the young leaves, more or less persistent along the veins, especially beneath, long, slender, sharp-pointed, with smooth cuticle, bicellular, the terminal cell much the longer.[4]

Hypoderm present on the ventral face above the large veins, its cells tabular, considerably larger than those of the epidermis, their walls rather thick.[5]

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[1] The presence of secretion cells in the epidermis is characteristic of most Aristolochiaceae (Solereder, loc. cit., p. 414; see also below, p. 506, foot note 4). In some species the walls of the secretion cells are suberized (Solereder, loc. cit., p. 417). In all Aristolochiaceae examined by Solereder the secretion was found to contain ethereal oil, although otherwise differing somewhat in different species (loc. cit., p. 419). In *A. virginicum* the secretion cells, found only in the lower epidermis, are of two kinds—large spherical or ellipsoidal cells 0.015 to 0.06 mm. in diameter, and smaller cells hardly distinguishable in size and shape from the ordinary epidermis cells (Solereder, loc. cit., pp. 423-424).

[2] Solereder describes *Asarum virginicum* as having three layers of palisade. The number probably varies. Even with the aid of the polarizer he failed to detect in the mesophyll crystals such as are abundant in *A. arifolium* and other species (loc. cit., pp. 423–424).

[3] A character of the Magnoliaceae. See Vesque in Nouv. Archiv. Mus., sér. 2, vol. 4, pp. 34, 35.

[4] Although the disproportion is less than in the hair of the *M. conspicua* figured by Vesque. (Loc. cit., *t.* 2, *f.* 4.)

[5] Lalanne (Feuilles persistantes, p. 79) describes a similar hypoderm occurring in the leaves of *M. grandiflora*, but apparently not confined to the neighborhood of the larger veins.

Palisade in two layers, the cells rather low. Pneumatic tissue only moderately open. Oil reservoirs numerous in the mesophyll.

Collenchymatic tissue strongly developed above the large veins, especially the midvein; less strongly developed beneath them.

Mestome bundle of the large veins arranged in a more or less perfect cylinder.

Stereome completely surrounding the midvein, especially strong beneath it, where it is separated from the collenchymatic tissue by a few layers of thin-walled colorless parenchyma. Narrow plates of stereome support the smaller veins, extending through the entire thickness of the leaf.[1] Stereome is also rather strongly developed in the leaf margins.

PERSEA PUBESCENS (Pursh) Sargent.

Mixed and Hygrophile Forest formations.

Leaves thick, more or less persistent, bifacial, dark green and somewhat shining above, somewhat glaucous and, especially when young, short-pubescent beneath. Structure in many respects similar to that of *Magnolia glauca*.

Epidermis: Ventral, cells tabular, the cuticle considerably thickened, the radial walls undulate. *Dorsal*, cell walls thinner, cuticle covered with a granular coating of wax, radial walls not undulate. Stomata confined to the dorsal surface, exceedingly numerous,[2] small, lying in all directions, level with the surface, each bordered by usually five unmodified epidermis cells. Hairs confined to the dorsal surface in older leaves, chiefly along the veins, long, sharp-pointed, with thick cuticle, unicellular.

Palisade in two layers, the outer more compact, interrupted over the veins by stereome. Pneumatic tissue lacunous.

Oil reservoirs in the chlorenchyma, large, spheroidal.

Larger *veins* strengthened above and below the mestome by massive groups of thick-walled stereome. Smaller veins supported by thin plates of thin-walled stereome.

Several layers of rather thick-walled colorless parenchyma separate the stereome supporters beneath the veins from the epidermis.

As would be expected, this species, which grows where air and soil contain abundant moisture at almost all seasons, exhibits a much less pronounced xerophytic structure than is found in others of the Lauraceae whose leaves are longer-lived and are adapted to a drier climate and soil. *Laurus nobilis*, for example, has an extremely compact palisade tissue of very long and narrow cells, and its stomata are placed at the bottom of cavities of which the external orifice is very small.[3]

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[1] In *M. tripetala* (*M. umbrella*) chlorenchyma occurs above and below the stereome supporters of the small veins, although that species has a leaf considerably thinner than that of *M. virginiana*. (Vesque, Nouv. Archiv. Mus., sér. 2, vol. 4, p. 37.)

[2] Lalanne (Feuilles persistantes, p. 82) finds the presence of a very large number of stomata on the under surface to be characteristic of leaves which are coriaceous, even when not "evergreen."

[3] Lalanne, op. cit., pp. 66 to 68.

LIQUIDAMBAR STYRACIFLUA L.

Occurs abundantly in the Mixed and the Hygrophile Forest formations.

Leaf bifacial.

Epidermis: Cells, especially those of the dorsal face, rather small, much broader than high, radial walls undulate; cuticle thin. Stomata none on the ventral face, numerous on the dorsal face, lying in all directions, level with the surface, each bordered by a pair of irregularly crescent-shaped subsidiary cells which are smaller than the other epidermis cells. Hairs in densely matted tufts in the axils of the principal veins at the base of the under surface of the blade, usually disappearing later on, long, flexuous, pointed, unicellular, with thick, smooth cuticle.[1]

Palisade in two layers, cells of the inner layer short. Pneumatic tissue moderately open. Large resin cavities in the mesophyll.[2]

Hypodermal collenchyma strongly developed above and especially beneath the principal veins, six to eight layers in old leaves.

Stereome forming an almost continuous thin sheath about the concentrically arranged mestome bundles of the large veins; in younger leaves often limited to a few thin-walled cells above the mestome group or altogether wanting.

A large resin canal occupies the center of the mestome group of the large veins.[3]

ITEA VIRGINICA L.

Hygrophile Forest formation.

Leaf rather thin, bifacial, midvein very prominent beneath.

Epidermis: Ventral, cells large, their walls straight or nearly so, thickish; cuticle smooth, thick, strongly thickened in the leaf margins, where it constitutes the only strengthening tissue. *Dorsal*, cell walls thinner, the radial strongly undulate. Stomata confined to the lower surface, small, nearly orbicular, lying in all directions, level with the surface,[4] each bordered by four or five ordinary epidermis cells. Hairs on the upper surface along the larger veins and on the leaf margins, few, short, pointed, thick-walled, prickle-like, unicellular, with smooth cuticle.[5]

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[1] According to Reinsch (Engler's Bot. Jarhb., vol. 11, p. 354) there are *no* hairs on the leaf of Liquidambar.

[2] Liquidambar and Altingia are among the genera of Hamamelidaceae which are distinguished from Hamamelis and other genera by the absence of sclerotic idioblasts (Spicularzellen) in the mesophyll of their leaves. (Reinsch, loc. cit., 363; Thouvenin, Ann. Sc. Nat. Bot., sér. 7, vol. 12, p. 135.)

[3] The presence of this duct is characteristic of Liquidambar and Altingia. (Reinsch, loc. cit., p. 363; Thouvenin, loc. cit., pp. 140, 141.)

[4] My observation on this point does not agree with Thouvenin's, who states (loc. cit., p. 123) that in Itea the guard cells are always lower than the other epidermis cells.

[5] Smooth according to Thouvenin, loc cit., pp. 118, 125.

Palisade in two layers, the cells short, especially those of the second layer, which is not sharply differentiated from the upper layers of the quite compact pneumatic tissue. Clusters of crystals of calcium oxalate in the palisade.[1]

Collenchymatic hypoderm in one layer beneath the midvein.

Stereome in a large group of very thick-walled cells below and adjoining the leptome of the midvein, separated from the hypodermal collenchyma by rather thick-walled, colorless parenchyma; also a smaller group of thinner-walled stereome on the hadrome side of the bundle, separated from the ventral epidermis by parenchyma like that below. All but the largest veins embedded in the mesophyll.[2]

DECUMARIA BARBARA L.

Hygrophile Forest formation, climbing high.

Leaf thin, bifacial.

Epidermis: Ventral, cells large, thin-walled, the radial walls not or but slightly undulate; cuticle but slightly thickened. *Dorsal*, cells smaller, their radial walls strongly undulate. Stomata confined to the dorsal surface, lying in all directions, level with the surface, each bordered by four or five ordinary epidermis cells. Hairs only on the lower surface, especially along the veins, long, pointed, with rather thick, granular[3] cuticle, unicellular, each surrounded by several small radially arranged foot cells.[4]

Palisade in one layer. Pneumatic tissue open. Large cells, extended at right angles to the surface and containing raphides, in the palisade.

Hypodermal collenchyma above and especially below the larger veins (seven or eight layers below the midvein).[5]

ROSA CAROLINA L.

Cleared land (noncultural), Shrubby, and Hygrophile Forest formations.

Leaves thin, bifacial, more or less glaucous beneath, the veins impressed above, prominent beneath.

Epidermis: Cells high on the ventral surface, lower and smaller

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[1] Crystals of calcium oxalate aggregated into "macles" in the pneumatic tissue and in the parenchyma of the nerves; also in the palisade, where they occupy cells that are "a little higher than the neighboring ones and almost spherical." (Thouvenin, loc. cit., 125.)

[2] Smaller veins embedded in the mesophyll, their strengthening tissue not "durchgehend" (going through to the epidermis). (Holle in Bot. Centralbl., vol. 53, p. 211, 1893.)

[3] Incrusted with $CaCO_3$. (Holle, Bot. Centralbl., vol. 53, p. 166, 1893.)

[4] Exactly like the hairs on the leaf of *Philadelphus billardieri* as figured by Solereder, Syst. Anat., p. 358, *f.* 8 *A*.

[5] Most of the cells of the outermost layer of the hypoderm and some in the succeeding layers contain tannin, as do the palisade cells and many of those of the pneumatic tissue, according to Thouvenin, Ann. Sc. Nat. Bot., sér. 7, vol. 12, p. 98

on the dorsal, the walls thin (even the outer only slightly thickened), radial not undulate. Stomata confined to the dorsal surface, lying in all directions, slightly prominent, each bordered by five to eight (mostly six) undifferentiated epidermis cells. Hairs along the veins, slender, flexuous, pointed, with very thick, smooth cuticle, unicellular, each bordered by several small radially arranged foot cells.

Hypodermal collenchyma strongly developed above and below the larger veins.

MALUS ANGUSTIFOLIA (Ait.) Michx.

(*Pyrus angustifolia* Ait.)

Hygrophile and Mixed Forest formations.

Leaf thin, bifacial.

Epidermis: Cells alike on both surfaces, radial cell walls not undulate; cuticle considerably thickened, strongly wrinkled. Stomata confined to the dorsal surface, lying in all directions, level with the surface, each bordered by four or five ordinary epidermis cells. Hairs none.

Palisade in two layers of rather low cells. Pneumatic tissue open, with large intercellular spaces.

Hypodermal collenchyma strongly developed above the large veins and much more so below them, thick-walled.

ILEX GLABRA (L.) A. Gray.

Mixed and Hygrophile Forest formations.

Leaf thick, persistent, bifacial.

Epidermis: Ventral, cells small, almost isodiametric, radial walls slightly undulate; cuticle much thickened. *Dorsal*, radial cell walls not undulate; cuticle and cellulose layer of the outer walls beneath the midvein nearly twice as thick as elsewhere and about equaling the lumen of the cells in height. Stomata confined to the dorsal surface, bordered by four or five ordinary epidermis cells. Hairs on the upper surface only, scattered along the midvein (as in *I. opaca* and *I. vomitoria*, but less pointed and with thinner cuticle), erect, prickle-like, thick-walled, unicellular.[1]

Palisade compact, four-layered, the cells only slightly higher than wide, all but about one layer replaced by collenchymatic tissue above the midvein. Pneumatic tissue open, with large intercellular spaces.

Hypodermal collenchymatic tissue in about four layers beneath the midvein, with an equal number of layers beneath the thin stratum of chlorenchyma above the vein.

Stereome very thick-walled, in a large slightly curved group adjoin-

[1] According to Solereder (Syst. Anat., p. 237) "hairs are rare in Ilicaceae." Trichomes of the type here described are known to him only on the petiole of *Ilex aquifolium* and the blade of *I. pseudothea*. For a description of similar hairs in *Ilex vomitoria* see Kearney, Contr. U. S. Nat. Herb., vol. 5, p. 296.

ing the leptome of the larger mestome bundles, in two or three small groups adjoining the hadrome.

ILEX LUCIDA (Ait.) Torr. & Gr.

Hygrophile Forest formation.

Leaf thick, persistent, bifacial. The material examined was in an advanced stage of development.

Epidermis: Ventral, cells small, radial walls thick and porous, straight; cuticle massive, especially above and below the midvein, there about equaling, with the cellulose layer of the wall, the height of the lumina of the epidermis cells. *Dorsal*, cells as on ventral surface; cuticle thinner, except beneath the midvein, where it considerably exceeds the lumina of the epidermis cells in height. Stomata confined to the dorsal face, apparently less numerous than in *I. glabra*, lying in all directions, the whole stoma considerably larger than each of the five to seven bordering epidermis cells. Hairs, as in *I. glabra*, only on the ventral surface along the impressed larger veins (especially the midvein) having a massive, roughened cuticle and an almost obliterated lumen.

Palisade much as in *I. glabra*, three-layered, occupying about one-half the leaf's thickness, very compact, the cells about twice as high as they are wide. Pneumatic tissue less open, with smaller lacunes than in *I. glabra*.

Hypoderm (as in *I. opaca*) in a single layer above the midvein.[1]

Beneath the hypoderm occur about two layers of chlorenchyma with nearly isodiametric cells. On the dorsal surface beneath the midvein there are five or six layers of thick-walled collenchyma.

Stereome very thick-walled, in interrupted bands above and below the midvein, which is composed of several radially arranged mestome bundles; but only on the leptome side of the small veins, each of which consist of a single bundle.

Leaf margins containing neither stereome nor collenchyma, but strengthened by the great thickening of the cuticle.

ACER RUBRUM L., var.

Hygrophile Forest formation.

Leaf bifacial, dark green and somewhat shining above, white-glaucous beneath.

Epidermis: Ventral, cells with nonundulate radial walls. *Dorsal*, cells much smaller; cuticle covered with wax. Stomata confined to the dorsal surface, lying in all directions, very numerous, level with

[1]Not, as in *I. aquifolium*, occuring under the epidermis of the entire ventral surface. In that species the hypoderm is described by Lalanne (Feuilles persistantes. p. 55) as a second layer of epidermis. But Pfitzer (Pringsheim's Jahrb., vol. 8, p. 51), who studied its development, found it to be true hypoderm, originating from tissue beneath the epidermis. Its cell walls are moderately thickened collenchymatically.

the surface, each bordered by five to seven undifferentiated epidermis cells. Hairs densely covering the dorsal surface of the young leaf, especially along the veins; long, weak, flexuous, blunt-pointed, thin-walled, unicellular.[1]

Palisade in one layer, the cells high, forming more than one-half the thickness of the mesophyll. Pneumatic tissue with small lacunes.

Sacs containing a milky fluid occur in the pneumatic tissue[2] and in the leptome of the veins.

Veins prominent beneath, the larger reenforced above and below by strongly developed, hypodermal collenchymatic tissue. Mestome bundles surrounded by a sheath of stereome. Thin-walled, colorless parenchyma in a few layers beneath the larger veins, lying between the sterome and the collenchymatic tissue.

BERCHEMIA SCANDENS (Hill) Trelease.

Hygrophile Forest formation, climbing high.

Leaves ombrophobic, thin, bifacial, veins very prominent beneath, leaves not punctate.

Epidermis: Ventral, cells large, high (i. e., extended at right angles to the surface), the outer wall and the granular cuticle thickened, the other walls thin, not undulate. *Dorsal*, cells similar, but with thinner outer walls (except under the large veins). Stomata on the lower face only, lying in all directions, level with the surface, each bordered by usually four or five undifferentiated epidermis cells. Hairs none.

Palisade in a single layer, very compact. Pneumatic tissue rather open.

Subepidermal collenchyma in several very narrow layers above, and several wide layers beneath the larger veins.

Stereome rather thin-walled, weakly developed adjacent to the hadrome and leptome of the larger veins, that beneath the leptome separated from the subepidermal collenchyma by several layers of thin-walled, colorless parenchyma.

Mucilage in the cells of the epidermis[3] and in one or two layers of the colorless parenchyma beneath the mestome bundles of the midvein.

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[1] "Several-celled glandular hairs in all species [of Acer] except *A. distylum*."—Solereder, Syst. Anat., p. 271. I did not detect them in *A. rubrum*, even on quite young leaves.

[2] Heretofore known to occur in the mesophyll of Acer only in *A. campestre*.—Solereder, Syst. Anat., p. 271.

[3] Volkens (Flora der Ägyptisch-Arabischen Wüste, p. 115) says of *Zizyphus spinacristi*: "A great part of its extraordinarily high epidermis cells is filled with cellulose slime."

Berchemia is one of the genera of Rhamnaceae in which there are no special mucilage reservoirs, such as occur in Rhamnus, Ceanothus, and other genera of this family, where they are found in the mesophyll, and in the primary cortex and pith of the stem. Guignard et Colin, Bull. Soc. Bot. de France, vol. 35, pp. 325–327.

Blenk (Flora, vol. 67, p. 356) states that he does not find mucilage in the epidermis cells of any Rhamnaceae which have crystals of calcium oxalate in the palisade.

ASCYRUM STANS Michx.

Cleared land (noncultural), Herbaceous formation, preferring rather moist soil.

Leaf nearly erect (when growing where it is exposed to strong light), bifacial.

Epidermis: Ventral, cells large, with rather thick walls, the radial ones not undulate. *Dorsal*, radial walls slightly undulate; cuticle bearing a coating of wax. Stomata on the dorsal surface only, lying in all directions, sunken, each bordered by three to five ordinary epidermis cells,[1] the guard cells with thick cuticle. Hairs none.

Palisade in one layer; then two layers of tissue, similar but not compact; then open pneumatic tissue with low cells. Secretion cavities in the mesophyll near the ventral surface.

Hypodermal collenchymatic tissue well developed above, and especially below the midvein.

HYPERICUM VIRGATUM LAM.

Cleared land (noncultural), Herbaceous formation, often with the preceding.

Leaf small, erect, and often somewhat appressed to the stem, isolateral.

Epidermis much alike on both surfaces, the cells comparatively very large, their radial walls slightly undulate on the ventral surface, more so on the dorsal; cuticle granular. Stomata on both faces, more numerous on the dorsal, mostly parallel to the veins, sunken, each bordered by three (rarely four) undifferentiated epidermis cells. Hairs none.

Palisade in one layer on each side of the leaf,[2] inclosing the thin, central stratum of nearly colorless pneumatic tissue. Large secretion cavities present in the mesophyll.

Hypodermal collenchymatic tissue above and below the midvein.

Stereome none.

HYPERICUM PILOSUM Walt.

Cleared land (noncultural), Herbaceous formation, growing in dry, sandy fields.

Leaf much like that of *H. virgatum* as to position, but densely pubescent, isolateral (fig. 87).

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[1] Compare Vesque (Comptes Rendus, vol. 100, p. 1089), who says, "The Hypericums are characterized by stomata bordered by three epidermis cells."

[2] *H. virgatum* and *H. pilosum* (see below) are exceptional among Hypericaceae in the isolateral structure of their leaves. Solereder (Syst. Anat., p. 134) describes the mesophyll in this family as, "so far as is known, bifacially arranged." He further says (p. 135) that "stomata in the Hypericaceae are present only on the underside of the leaf."

Epidermis alike on both faces, the cells large, with strongly undulated radial walls; cuticle rather thick, granular. Stomata about equally numerous on both surfaces, lying in all directions, sunken, each bordered by three ordinary epidermis cells. Hairs rather thin-walled, tapering to a rounded apex, pluricellular, cells in a single row (sometimes as many as sixteen), each hair surrounded by several radially arranged foot cells.[1]

Palisade on each face, inclosing the thin central stratum of pneumatic tissue.

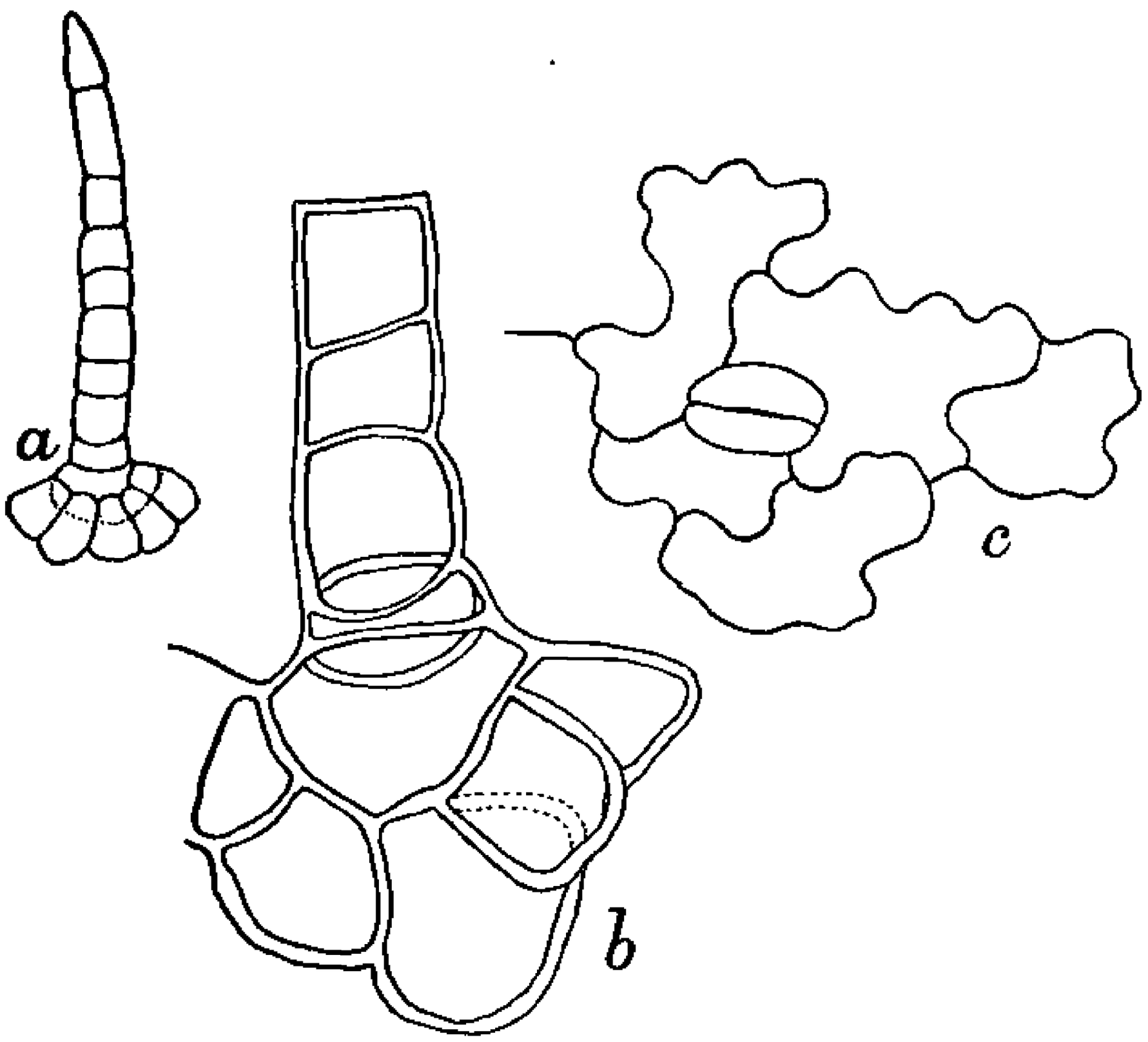

FIG. 87.—*Hypericum pilosum*, leaf. *a*, Hair from ventral face magnified 112 times; *b*, same magnified 480 times; *c*, portion of epidermis showing stoma, magnified 480 times.

Hypodermal collenchyma above and below the midvein, more strongly developed below.

Stereome none.

LECHEA MARITIMA Leggett.

Belongs to the Sand Strand formation, growing abundantly among the open dunes with *Hudsonia tomentosa*.

Leaf isolateral, pilose, with long hairs.

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[1] Such multicellular, unbranched hairs have not been hitherto detected in Hypericaceae, so far as I can learn. Vesque (Comptes Rendus, vol. 100, p. 1089, 1885) found stellate hairs with a stalk consisting of a single row of cells in three genera of Vismieae—Vismia, Psorospermum, and Haronga. Solereder (Syst. Anat., p. 135) mentions only hairs of that type as occurring in Hypericaceae, nor does he mention the occurrence of any kind of hairs in the tribe Hypericeae.

Epidermis: Cells large, with thin, not undulate walls. Stomata few on the ventral surface, much more numerous on the dorsal, lying mostly parallel to the leaf's axis, each bordered by four or five undifferentiated epidermis cells. Hairs (fig. 88) on both surfaces, but much more numerous and with more warty cuticle on the dorsal face, long, rather stout, sharp-pointed, with very thick cuticle, contracted shortly above the base, seemingly bicellular, the basal portion separated from the rest of the lumen by a membrane which is convex toward the apex of the hair, the lower portion about one-half as long as the upper, base of hair bordered by several radially arranged footcells. Many of the epidermis cells on both faces are greatly enlarged, and probably serve for storage of water.[1]

Palisade in one layer on each face of the leaf. Pneumatic tissue central.

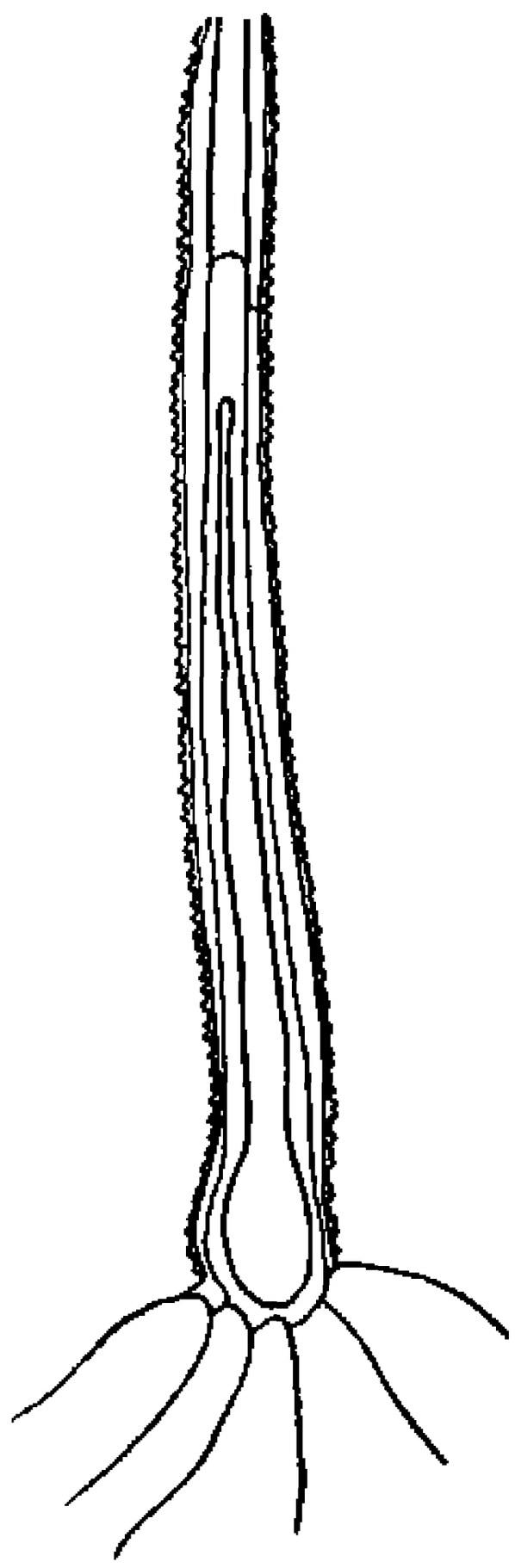

FIG. 88.—*Lechea maritima.* Falsely bicellular hair from leaf. Magnified 360 times.

Hairs similar to those just described form the dense covering of the leaves of *Hudsonia tomentosa*, but in that species they are more slender and have a smooth cuticle. They also occur in *Helianthum canadense* (which see). Solereder[2] describes hairs of this character in *Lechea major* and *Hudsonia ericoides*, and figures one from the leaf of *Cistus creticus*, in which, however, the basal portion of the lumen cut off by the dividing membrane is proportionately much shorter than in *Lechea maritima*. He found that Eau de Javelle stains the dividing membrane yellow, while the walls of the original cell remain white. He states that this type of hair is peculiar to Cistaceae and Combretaceae.

A very interesting description of these falsely bicellular hairs in Combretaceae is given by Heiden,[3] who found them so characteristic in that family that he terms them "Combretaceae hairs." Thiloa is apparently the only genus of Combretaceae in which they are even rare. Heiden's description is as follows:

"But what is characteristic of these hairs is the circumstance that the mostly somewhat bulbous-swollen base is separated from the principal part of the hair, which is filiform, by a layer of cellulose which projects more or less convexly or conically toward the latter. So in many cases it seems as if the Combretaceae hairs in question are not one-celled, but rather two-celled.

"That these apparently two-celled hairs are not to be regarded as two-celled is very clearly shown by their development.

"The first stage of development here considered (see plate fig. 1a) consists of an already pretty thick-walled, long-pointed, one-celled hair, whose lumen widens out in the lower part, while in the upper part it is almost filiform. The entire lumen

[1] Solereder (Syst. Anat., p. 91) mentions similarly specialized epidermis cells in *L. minor* L. (*Lechea norae-caesareae* Aust.).

[2] Syst. Anat., p. 91, *f.* 21 *A*.

[3] Bot. Centralbl., vol. 55, pp. 358, 359, and vol. 56, p. 64, *f.* 1, 1893.

of the one-celled hair is filled with protoplasm, which contains a pretty large cell nucleus in the base of the hair. In a hair which has developed somewhat farther one finds that the wall of the hair has become somewhat thicker, and that the protoplasm which originally filled both the base of the cell and the channel of the hair has altogether withdrawn to the base of the cell and has completely left the channel; the protoplasm now fills only the base of the cell and deposits on the side which faces the channel of the hair a membrane which in the particular plant in which its development was studied increases considerably in thickness. In other species, as will be shown, this membrane, which is thrown off by the protoplasm (on the side) facing the apex of the hair, remains relatively thin.

"No nuclear division, therefore, occurs in this hair cell; in these Combretaceous hairs, as has already been said, we have to do with true one-celled trichomes."

HELIANTHEMUM CANADENSE (L.) Michx.

In open pine woods near the strand.

Leaf bifacial, pubescent, especially beneath.

Epidermis: Cells with thin walls, the radial somewhat undulate. Hairs on both surfaces of three types: (1) Pluricellular, scale-like, stellate hairs with 3 to 8 slender, sharp-pointed arms that are parallel to the leaf surface, each hair bordered by several radially arranged foot cells; (2) long, stout, very thick-walled falsely bicellular hairs of the peculiar cistaceous type described under *Lechea maritima*, and (3) rather few multicellular, glandular hairs. Stomata only on the dorsal surface, numerous, mostly parallel to the longer axis of the leaf, level with the surface.

Palisade compact; pneumatic tissue rather open.

Hypodermal collenchyma strongly developed above and below the larger veins.

NYSSA AQUATICA L.

(*Nyssa uniflora* Wang.)

Hygrophile Forest formation.

Leaf large, thin, bifacial, pubescent beneath, especially when young.

Epidermis: Ventral cells containing mucilage, radial walls not undulate; cuticle striate. *Dorsal* cells much smaller,[1] radial walls slightly undulate. Stomata on the dorsal surface only, lying in all directions, level with the surface, each bordered by 4 or 5 undifferentiated epidermis cells. Hairs, confined to the dorsal surface in mature leaves, of two kinds: (1) Abundant along the veins, long, pointed, with thick, warty cuticle, unicellular, and (2) much fewer, small, thin-walled, clavate, unicellular, probably glandular.

Palisade in one layer. Pneumatic tissue rather open. Sclerotic idioblasts extending from the ventral almost to the dorsal epidermis.

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[1] The outer walls of the cells of the dorsal epidermis are described as "papillosely convex" by Sertorius (Bull. de l'Herb. Boiss., vol. 1, p. 633).

Hypodermal collenchymatic tissue in a few layers above and below the larger veins.

Stereome in a thin ring almost or quite surrounding the larger veins, that on the leptome side separated from the collenchymatic tissue by several layers of colorless parenchyma.

LEUCOTHOË AXILLARIS (Lam.) D. Don.[1]

Hygrophile Forest formation.

Leaf thick, evergreen, bifacial, dark and shining above, pale beneath.

Epidermis: Cells alike on both faces, large; their radial walls slightly undulate; outer wall and cuticle strongly thickened; cuticle slightly wrinkled. Stomata (fig. 89) large, mostly parallel to the veins but, with many exceptions, slightly prominent; guard cells with thick, strongly wrinkled cuticle; each stoma bordered by usually four epidermal cells, two of which are parallel to and in all respects resemble the guard cells. Hairs scattered along the impressed midvein on the upper surface of the leaf, nearly erect, very thick-walled, sharp-pointed, unicellular (much as in species of Ilex).

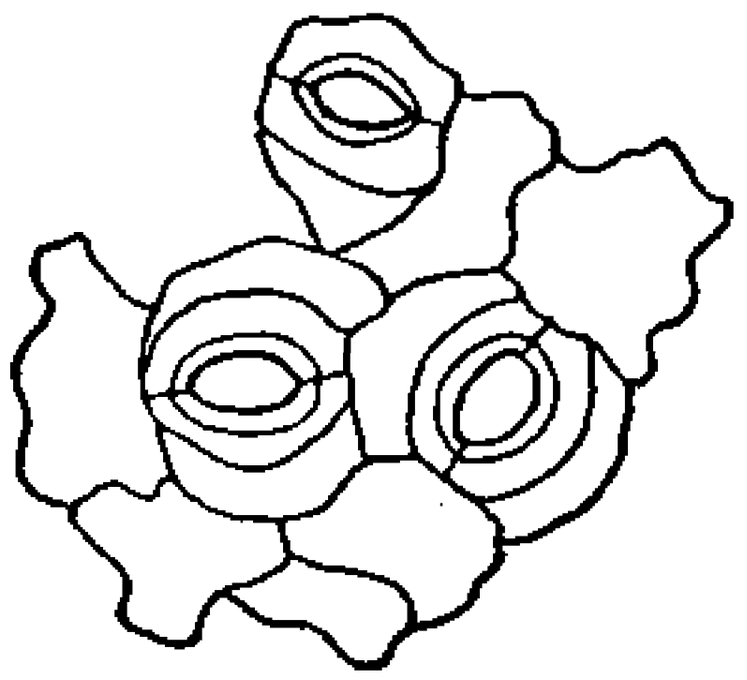

FIG. 89.—*Leucothoë axillaris.* Lower surface of leaf showing stomata. Magnified 480 times.

Palisade two-layered, compact. Pneumatic tissue very open, with numerous, rather large, intercellular spaces. Scattered cells of the mesophyll contain sharp-pointed masses of calcium oxalate crystals.

Hypodermal collenchymatic tissue in two or three layers above and beneath the larger veins—that above adjoining stereome, that beneath separated from the mestomatic stereome by very open pneumatic tissue, which contains crystals.

Stereome in two strong groups adjoining, respectively, the hadrome and the leptome of the larger veins; also in strong groups in the leaf

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[1] Vesque (Ann. Sc. Nat. Bot., sér. 7, vol. 1, p. 233) observes that "apart from some rare species the Ericaceae are eminently xerophile." The truth of this statement is borne out by the structure of those species which occur in the Dismal Swamp, where, if anywhere, hygrophile species would be sought.

Compare Niedenzu in Engler's Bot. Jahrb., vol. 11, p. 185 (1890). *L. axillaris* and *L. catesbaei* are there characterized and the glandular hairs of both species are figured (*t. 3. f. 10*). Although Niedenzu says "the glandular hairs persist on the old leaf," I could find none on my material of either species. Nor did my specimens of *L. axillaris* show more than two layers of palisade, while Niedenzu gives 3 or 4 as their number. He found 4 to 6 subsidiary cells about the stomata in this group of species.

margins, very thick-walled (lumen almost obliterated), interrupted by numerous thin-walled tannin cells.[1]

LEUCOTHOË RACEMOSA (L.) A. Gray.

Hygrophile Forest formation, usually in sunny places.
Leaf thin, not persistent, bifacial.

Epidermis: Cells smaller than in *L. axillaris* and *L. catesbaei*, with thinner, smooth cuticle and more undulate radial walls. Stomata only on the dorsal surface, much smaller than in the other species of Leucothoë, mostly lying at right angles to the veins but with some exceptions, slightly prominent, their cuticle thin and smooth, each bordered by usually four epidermis cells, of which two are parallel to the guard cells (subsidiary),[2] but not otherwise differentiated. Pluricellular, glandular hairs along the veins on the dorsal surface.

Palisade in two layers, the outer compact, the inner more open, with shorter (lower) cells. Pneumatic tissue less open than in the persistent-leaved species.

Hypodermal collenchymatic tissue in about two layers above and one beneath the midvein, that above adjoining the stereome supporters of the mestome bundles, that below separated from it by several layers of colorless parenchyma (which, like the corresponding tissue in *L. axillaris*, contains crystals).

Stereome about the mestome bundles, as in the other two species, but less strongly developed; none in the leaf margins.

Differs from the evergreen species, especially in its thinner leaf, with less development of cuticle, palisade, mechanical tissue, and wood.

PIERIS NITIDA (Bartr.) Benth. & Hook.[3]

Hygrophile Forest formation, chiefly in sunny places.
Leaf thick, evergreen, bifacial, shining above.

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[1] LEUCOTHOË CATESBAEI (Walt.) A. Gray.

A remarkably similar plant, occurring along streams in the Alleghany Mountains. (Material examined in cultivation at Brookland, D. C.)

Leaf much as in *L. axillaris*.

Stomata somewhat more irregular in position. Palisade more compact, in three layers (the innermost more open). Collenchymatic tissue with thinner, less lignified walls. Hadrome of midvein only about one-half as great in quantity. Midvein much more deeply impressed.

These differences, with the exception of the position of the stomata, are possibly due in part to the fact that the leaves of *catesbaei* examined were younger than those of *axillaris*, although the differences in age must have been but small.

[2] Niedenzu (Engler's Bot. Jahrb., vol. 11, p. 185 (1890) mentions the occurrence of usually four subsidiary cells adjoining the guard cells of the stomata in *Leucothoë racemosa* and *L. recurva*.

[3] Compare Niedenzu in Engler's Bot. Jahrb., vol. 11, pp. 180–182 (1890). The glandular hairs of *P. floribunda* (Pursh) Hook. f. are figured, *t. 3. f. 8;* and the stomata of *P. japonica* (Thunb.) Don, *t. 3. ff. 11, 12.*

Epidermis: Cells alike on both surfaces, rather small, the radial walls somewhat undulate, the tangential (especially the outer) greatly thickened; cuticle thick, delicately wrinkled. Stomata confined to the lower surface, large, lying in all directions, the ridges of entrance slightly prominent, the guard cells with greatly thickened cuticle, each bordered by usually five ordinary epidermis cells which they greatly exceed in size. Hairs scattered over the surface of the midvein on the dorsal side of the leaf, short, erect, conical, pointed, very thick-walled, unicellular; also scattered pluricellular glands on short pluricellular stalks.

Hypoderm continuous on the ventral side of the leaf, one-layered, its cells nearly iso-diametric, containing chlorophyll.

Palisade one-layered, very compact, the cells little higher than broad. Pneumatic tissue occupying most of the thickness of the leaf, very open, with large intercellular spaces, containing scattered crystal cells (calcium oxalate).

Mestome bundle of the midvein strongly compressed in the plane of the leaf.

Hypodermal collenchymatic tissue in one layer above and two or three below the midvein.

Stereome in a thin interrupted supporting band above and below the midvein, also (rather thin-walled) in the leaf margin.

XOLISMA FOLIOSIFLORA (Michx.) Small.[1]

Hygrophile Forest formation, usually in sunny places.

Leaf comparatively thin, probably deciduous, bifacial, somewhat shining above.

Epidermis: Ventral, radial cell-walls somewhat undulate, the outer and cuticle moderately thickened; cuticle strongly wrinkled. *Dorsal*, radial walls strongly undulate; the cuticle thinner and less wrinkled. Stomata only on the lower surface, lying in all directions, about level with the surface, each bordered by four to six undifferentiated epidermis cells. Hairs confined to the lower surface, scattered, somewhat elongated, pluricellular, glandular; also, along the midvein, there are blunt-pointed, unicellular hairs with thick granular wall.

Palisade in one compact layer of rather low cells. Pneumatic tissue open.

Hypodermal collenchymatic tissue in one or two layers above and two or three beneath the midvein.

Stereome rather thin-walled, forming an almost uninterrupted thin sheath around the larger mestome bundles.

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[1] Compare Niedenzu's characters for the nearly related *Xolisma* (*Lyonia*) *ligustrina* in Engler's Bot. Jahrb., vol. 11, pp. 180, 181 (1890). That species is described as having two layers of palisade, the cells high and narrow. Its glandular hairs are figured in *t. 3, f. 9*. Vesque (Ann. de Sc. Nat. Bot., ser. 7, vol. 1, p. 235) describes *Lyonia paniculata* as having the palisade in two layers, and "the cells of both layers alike are six to eight times longer than wide."

KALMIA ANGUSTIFOLIA L.

Hygrophile Forest formation.

Leaf persistent, coriaceous, bifacial, dark green above, glaucous beneath.

Epidermis: Ventral, cells small, their radial walls somewhat undulate; cuticle greatly thickened. *Dorsal*, cells much smaller, their lumen in old leaves hardly wider than the thickness of the cuticle; cuticle bearing a deposit of wax. Stomata none on the ventral surface, numerous on the dorsal surface, small, lying in all directions, bordered by several undifferentiated cells of the epidermis, the guard cells not projecting.[1] Hairs of two types, the first short, straight, or curved, conical, pointed, unicellular, with very thick, smooth cuticle and lumen almost obliterated. These form a dense covering on the under surface of the young leaf, where many persist, while on the upper surface they soon become broken off, for the most part.[2] Second, much fewer and larger, long-stalked, capitate, multicellular, glandular hairs.

Palisade in two or three layers of high, narrow cells, only the outermost compact. Pneumatic tissue with numerous lacunes, its cells much like those of the palisade. Cells which contain rather large and unusually perfect masses of crystals ("Drusen" or "macles") of calcium oxalate are numerous in the mesophyll.

Hypodermal collenchymatic tissue in three layers above and below the midvein.

Stereome in a thin band of thick-walled cells adjoining the under side of the mestome bundle-group of the midvein. Also, in well-developed leaves, a small group of thinner-walled stereome adjoining the upper side of the vein. Finally, a small group of thin-walled stereome in the slightly incurved leaf margins.

BATODENDRON ARBOREUM (Marsh.) Nutt.[3]

(*Vaccinium arboreum* Marsh.)

Mixed Forest formation, growing in dry, open woods.

Leaf flat, horizontal, bifacial, veins rather prominent beneath.

Epidermis: Cells low and small, with thin, undulate radial walls, outer wall and cuticle considerably thickened; cuticle wrinkled, especially opposite the larger veins; somewhat thinner on the dorsal sur-

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[1] In many Rhododendroideae which have the under side of the leaf provided with a hairy covering, the guard cells are very prominent. Breitfeld in Engler, Bot. Jahrb., vol. 9, pp. 327–329.

[2] They are the "poils tecteurs unicellulés" of Vesque (Ann. Sc. Nat. Bot., sér. 7, vol. 1, p. 226), who distinguishes three types of hairs in Ericaceae. He remarks that those of Kalmia are noteworthy as being narrower than the epidermis cells from which they originate—a "particularité très caractéristique."

[3] Compare Niedenzu in Engler's Bot. Jahrb., vol. 11, pp. 193, 195 (1890). The two subsidiary cells about the guard cells of the stomata are characteristic of the Vacciniaceae (loc. cit., p. 193).

face except beneath the larger veins. Stomata large, confined to the dorsal surface, lying in all directions, level with the surface, each bordered by four epidermal cells, of which two are subsidiary (parallel to the guard cells but not otherwise differentiated). Hairs only on the dorsal surface, scattered along the veins, long, pluricellular, glandular, with large heads.

Palisade in one compact layer, the cells high. Pneumatic tissue with rather small intercellular spaces.

Stereome rather strongly developed next both the hadrome and the leptome of the larger veins, interrupted by thin-walled tannin (?) cells.

Subepidermal, thick-walled colorless parenchyma between stereome and epidermis, very little above the veins, in considerable quantity below.

Hypodermal collenchymatic tissue in about two layers in the margins.

OXYCOCCUS MACROCARPUS (Ait.) Pers.

In brackish meadows.

Leaf small, thickish, persistent, bifacial, dark green above, glaucous beneath.

Epidermis: Ventral, cells small, radial walls strongly undulate, rather thin; cuticle moderately thickened. *Dorsal*, cells with less undulate walls;[1] cuticle covered with a finely roughened coating of wax. Stomata confined to the lower surface, very numerous, small, lying mostly parallel to the leaf axis but with many exceptions, level with the surface, each bordered by four epidermis cells, two of them subsidiary. Hairs none on the surface of the leaf; small multicellular, clavate glandular hairs sparsely scattered along the margins.

Palisade in one layer of short cells, which are little longer than wide. Pneumatic tissue open, with large lacunes. Tabular crystals, probably of calcium oxalate, in the mesophyll.

Hypodermal collenchymatic tissue in small quantity above and below the midvein.

Stereome in massive groups of very thick-walled cells above and below (adjoining) the mestome of the midvein, but only below the smaller veins, which are embedded in the mesophyll.

SYMPLOCOS TINCTORIA (L.) L'Hér.

Mixed Forest formation, usually in low woods.

Leaf rather large, nearly horizontal, bifacial, rather thin, lateral veins prominent beneath.[2]

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[1] This stronger undulation of the radial walls on the *upper* leaf surface appears somewhat anomalous.

[2] Solereder, Syst. Anat. der Dicot., p. 587, describes the lateral veins of *S. adenophylla* as embedded in the mesophyll.

Epidermis: Alike on both faces, cells containing chlorophyll, rather large, with thin, undulate radial walls and thickish wrinkled cuticle. Stomata confined to the dorsal surface, small, lying in all directions, level with the surface, each bordered by usually four epidermis cells, of which two are subsidiary (parallel to the guard cells but not otherwise differentiated). Hairs few on the ventral, numerous on the dorsal surface, soon deciduous, pointed, with rather thick, rough cuticle, pluricellular (the cells in a single row).

Palisade in a single layer, the cells high. Pneumatic tissue rather open.

Hypodermal collenchyma strongly developed above and below the midvein.

Stereome both above and below the veins (especially adjoining the leptome).

STYRAX GRANDIFOLIA Ait.

Mixed Forest formation, growing in low woods.

Leaf large, thin, bifacial, pubescent beneath.

Epidermis: Cells alike on both faces, the radial walls strongly undulate; cuticle delicately wrinkled. Stomata only on the dorsal face, small, comparatively few, lying in all directions, level with the surface, each bordered by four to seven undifferentiated epidermis cells. Hairs confined to the dorsal surface, more or less abundant, especially along the veins, long, sharp-pointed, thick-walled, unicellular.[1]

Mesophyll not well differentiated, two layers of compact but not elongated cells beneath the ventral epidermis, the rest open pneumatic tissue with large unicellular spaces.

Hypodermal collenchymatic tissue in small quantity above the large veins. True collenchyma in corresponding position below the veins.

Stereome none.

CHIONANTHUS VIRGINICA L.

Hygrophile Forest formation, inhabiting swampy woods along streams.

Leaf large, bifacial, green on both surfaces, becoming somewhat coriaceous, glabrous when mature, pubescent on both surfaces, but especially beneath, when young.

Epidermis: Ventral, cells small with thickish walls, the radial walls not undulate; cuticle strongly wrinkled. *Dorsal*, cells with straight or slightly undulate radial walls; cuticle with more numerous finer wrinkles. Stomata confined to the lower surface, very numerous,

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[1] It does not appear that unicellular hairs have been previously noted in this family (cf. Solereder Syst. Anat., 587).

small, lying in all directions, level with the surface, each bordered with 5 or 6 ordinary epidermis cells. Hairs of two types, about equally numerous. First, long, sharp-pointed, with cuticle somewhat roughened, composed of 2 to 4 cells in one series. Second, multicellular, probably glandular, shield hairs, with a very short stalk which occupies slight depressions in the epidermis so that the flattened, disk-shaped head appears to rest on the surface; head composed of 6 to 18 wedge-shaped cells.[1]

Palisade in one layer. Pneumatic tissue quite compact.

Larger veins prominent beneath, the mestome bundle or group of bundles (several bundles, inclosing pith, form the midvein), almost entirely surrounded by a narrow ring of rather thin-walled sterome, which is separated above and below from the finally massively developed hypodermal collenchyma by thin-walled, colorless parenchyma, which becomes collenchymatic in old leaves.

GELSEMIUM SEMPERVIRENS L.

In most different situations, from the Hygrophile Forest to the Sand Strand.

Leaves evergreen, thickish, shining above, horizontal, bifacial. (Leaves examined probably in their second season.)

Epidermis: Ventral, cells large and high, the cuticle and outer wall much thickened, the other walls thin, the radial not undulate. *Dorsal*, cells smaller, their walls thinner, and not or but slightly undulate. Stomata only on the dorsal surface, lying in all directions, somewhat prominent, the guard cells each accompanied by a parallel subsidiary cell, with occasionally a third parallel cell of similar form.[2] Hairs, none.

Palisade, cells low and comparatively wide, only the uppermost layer perfectly compact; the next two similar but with small intercellular spaces; then about two layers of open pneumatic tissue with nearly isodiametric cells; and finally a continuous layer of chlorenchyma adhering to the dorsal epidermis, easily separating from the pneumatic tissue, with its cells elongated in a direction parallel to the surface.

Hypodermal collenchyma in two layers beneath the midvein, thick-walled.

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[1] Prillieux (Ann. Sc. Nat. Bot., sér. 4, vol. 5, p. 9, *t. 2, f. 14*) states that the number of cells is 12 and the diameter of the head is 55 micromillimeters. These figures can be taken as representing the average number and size, although the variation is considerable.

[2] The relation is comparable to that figured for stomata of Rubiaceae with three subsidiary cells (Solereder, Syst. Anat., p. 503, *f. 101, G*), except that in Gelsemium all the cells are of approximately equal size.

Stereome in a thin, wide group beneath the leptome and a small group above the hadrome of the midvein.

GALIUM HISPIDULUM Michx.

Sand Strand formation, inhabiting the innermost wooded dunes and the pine woods immediately behind them.

Leaf thickish, bifacial (fig. 90).

Epidermis nearly alike on both faces. Cells considerably elongated parallel to the length of the leaf; those of the ventral surface high, radial walls thickish (especially on the ventral surface), strongly undulate; cuticle strongly thickened, especially in the leaf margins, where it greatly exceeds the lumen, wrinkled, raised to a papilla in the center of the outer wall of each cell which is not extended into a hair.[1] Stomata few on the ventral surface, very numerous on the dorsal, lying in all directions, level with the surface, each bordered by two (occasionally four) parallel crescent-shaped subsidiary cells, one of which is usually larger,[2] these bordered by three to five (usually five) ordinary cells. Hairs on both surfaces stout, blunt-pointed, curved, unicellular, prickle-like, with a thick, granular cuticle.[3] Large cells containing resin scattered in the dorsal epidermis[4] (fig. 90, *c*).

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[1] "In *Bouvardia cordifolia* virtually every epidermis cell of the upper surface is raised into a small conical point furnished with radiating cuticular striae." Vesque, Ann. Sc. Nat. Bot., ser. 7, vol. 1, p. 192.

[2] "The stoma [in Rubiaceae] is always accompanied by two lateral cells, which often entirely surround it. I have not encountered a single exception in this respect, and I believe that one can boldly exclude from the family of Rubiaceae every plant of which the stomatal apparatus does not present this configuration." Vesque, loc. cit., 193.

[3] The hairs in Rubiaceae are "very rarely [both] elongated and unicellular." Vesque, loc. cit., p. 192.

"The midnerve of the large-lobed leaves of *Pentagonia laciniata* is armed with short hooked hairs, whose form is probably the result of adaptation to a sort of clambering, which allows the leaves to support themselves on neighboring plants, a method of clambering which one finds greatly developed in several Galieae (Galium, Asperula, Rubia); with these last plants the hair is reduced to a great curved cell borne at the summit of a more or less considerable emergence." Loc. cit., pp. 192–193.

As *Galium hispidulum* does not support itself upon other plants, its possession of hairs of this type is to be attributed not to adaptation to an existing condition, but to the retention of an inherited character which was formerly useful.

Hairs almost identical with those of *G. hispidulum* occur in *Triosteum perfoliatum*, as figured by Vesque, loc. cit., *t.* 9, *f.* 2.

[4] Radlkofer (Über Pflanzen mit durchsichtigen punktierten Blättern, p. 319; quoted by Solereder, in Engler's Bot. Jahrb., vol. 10, p. 415) found secretion cells in the leaf epidermis of some species of Rubia. Epidermal cells of this type are not common, although occurring in most Aristolochiaceae (see under *Asarum virginicum*), in Monimiaceae, Myrtaceae, and a few other families.

Palisade in one or two layers of rather short cells, passing without sharp demarkation into the open pneumatic tissue.[1]

Mestome bundles completely embedded in the chlorenchyma,[2] each surrounded by a one-layer sheath of delicate, small-celled, colorless parenchyma. Collenchymatic hypodermal parenchyma in small quantity beneath the midvein.

Stem four-angled, the angles winged, the wings composed of strong peripheral groups of thick-walled stereome, and of compact chlorenchyma toward the circumference of the stem proper. Mestome cylinder entirely surrounded by a thin-walled endodermis. Medullary rays

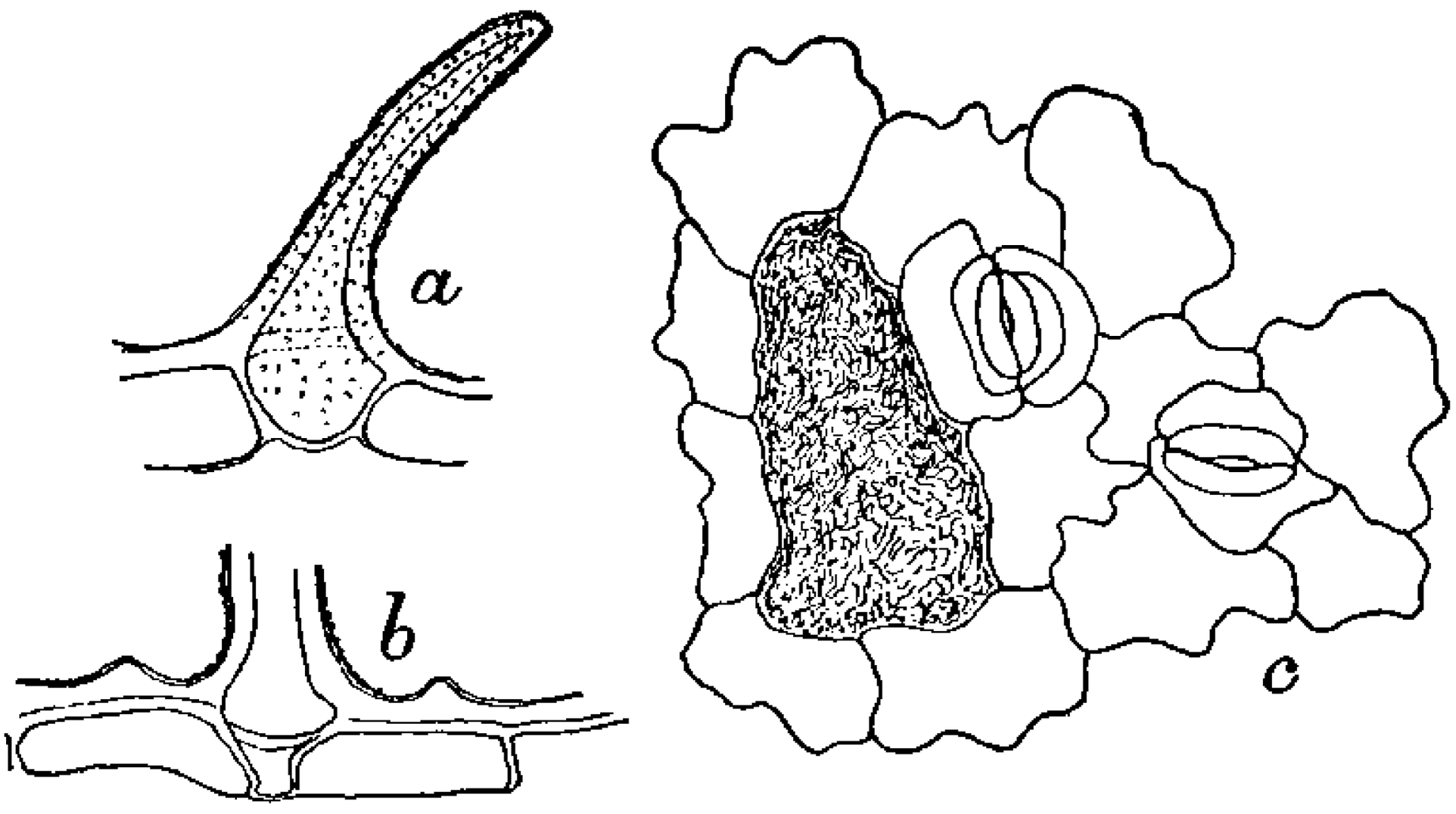

FIG. 98. *Lonicera sempervirens*, leaf. *a* and *b*, Hairs from upper surface; *c*, portion of lower epidermis showing stomata as secretion cells. Magnified 300 times.

very narrow. Pith occupying the center of the stem, finally breaking down and producing a lacuna.

LONICERA SEMPERVIRENS L.

In various situations, but most abundant on the inner sand dunes.

Leaf bifacial, dark green above, glaucous beneath, more or less persistent, midvein prominent beneath, under surface sparsely pubescent when young.

Epidermis: Ventral, radial cell walls straight, thin; cuticle very thick, roughened. *Dorsal*, cell walls thin, the radial undulate; cuticle bearing a coating of wax. Stomata confined to the dorsal surface, small, numerous, lying in all directions, level with the surface, each bordered by four or five ordinary epidermal cells. Hairs numerous

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[1] "Raphides-holding cells occur in the mesophyll beneath the palisade, and sometimes in the parenchyma of the nerves of all Galieae studied." Vesque, loc. cit., p. 193. I did not detect raphides in the leaves or stems of *G. hispidulum*.

[2] "In general the bundles [in Rubiaceae] are completely immersed in the mesophyll; that is to say, the tissues pass above and below the bundles without undergoing the least change." Vesque, loc. cit., p. 202.

beneath, especially along the veins, straight or curved, pointed, with rather thick cuticle, unicellular.[1]

Palisade (typical) in one layer. Pneumatic tissue in older leaves quite open, with large lacunes.

Hypodermal collenchyma in one to three layers above and two or three beneath the larger veins, separated from the mestome bundles by several layers of colorless parenchyma above and beneath, that adjoining the collenchyma thickish-walled. Inner walls of the epidermis cells also collenchymatically thickened above and beneath the larger veins.

Mestome bundles bicollateral, leptome in much smaller quantity above than beneath the hadrome.

PLUCHEA FOETIDA (L.) B. S. P.

Low Marsh formation, growing in shallow pools and ditches.

Leaf bifacial, nearly horizontal, veins prominent, almost rugose beneath.

Epidermis: Cells large, the walls thickish, the radial very slightly undulate on the ventral surface, strongly so on the dorsal surface.

Stomata confined to the under surface, lying in all directions, somewhat prominent, each bordered by three or four ordinary epidermis cells. Hairs abundant on both faces; glandular, short, stout, pluricellular, uniseriate.

Chlorenchyma nearly homogeneous, rather open, typical palisade none.

Hypodermal collenchyma in two or three layers above and below the principal veins. Mestome bundles collateral, reenforced by stereome above and below, this separated from the collenchyma by thin-walled parenchyma.

BACCHARIS HALIMIFOLIA L.

Although the leaf anatomy of this species was treated in the above-quoted paper on "The plant covering of Ocracoke Island,"[2] certain emendations are to be made to the description there given.

The epidermis cell walls, even the outer, are only moderately thickened, except over the larger veins. The cuticle is conspicuously wrinkled. Few-celled, capitate, glandular hairs occur in groups occupying small depressions on both ventral and dorsal surfaces, each group of hairs being surrounded by a circle of wedge-shaped foot cells.

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[1] Vesque (Ann. de. Sc. Nat. Bot., ser. 7, vol. 1, p. 185) describes glandular capitate hairs as characteristic of Caprifoliaceae; and Solereder (Bull. de l'Herb. Boissier, vol. 1, p. 171; Syst. Anat., p. 497) believes them to be present throughout the family, saving in the anomalous genus Alseuosmia. I failed to detect such hairs in *Lonicera sempervirens*, even in young leaves which were well provided with the long, pointed hairs.

[2] Contr. U. S. Nat. Herb. 5, p. 307. 1900.

Palisade occurs in about two layers of cells on each leaf face, those on the ventral face being somewhat more elongated, and is much interrupted on both faces by the hypostomatal air chambers. The chlorenchyma of the interior of the leaf is shorter-celled, with numerous intercellular spaces, but is not typical pneumatic tissue.

The stems of this species, as described by Heering,[1] from cultivated material, have very prominent stomata, chlorenchyma composed of roundish cells rich in chlorophyll, and strands of collenchyma in the salient angles.

Senecio tomentosus Michx.

Cleared land (noncultural), Herbaceous formation, inhabiting moist open ground.

Leaves (especially the radical), nearly vertical, approximately isolateral, arachnoid-tomentous, especially when young.

Epidermis: Ventral, cells large, the walls not undulate; cuticle roughened. *Dorsal*, cell walls thinner, undulate. Stomata somewhat more numerous on the dorsal surface, large, lying in all directions, level with the surface, each bordered by three to five (mostly four) undifferentiated epidermis cells. Hairs weak, flexuous, blunt-pointed, thin-walled, with slightly roughened cuticle, unicellular, more abundant on the lower than the upper surface (especially in older leaves).

Chlorenchyma homogeneous, with no well-differentiated palisade.

Midvein prominent beneath, composed of several (usually four) mestome bundles, of which one, in the material examined, had its greatest transverse diameter at right angles to the leaf surface. Bundles bicollateral, perileptomatic (the leptome almost entirely surrounding the hadrome, but much more strongly developed on one side), separated from each other and from the epidermis by much colorless, thin-walled parenchyma. Stereome groups adjoining the leptome usually on both sides of the bundle, but much stronger on the side where the leptome is most developed. Hypodermal collenchymatic tissue in several layers beneath the midvein. Hypodermal collenchyma in the leaf margins.

LIST OF THE PLANTS COLLECTED OR OBSERVED.

The species enumerated in the following list were collected within the limits of the Dismal Swamp region as above defined, with the exception of a considerable number which were obtained near Newbern, N. C., and which are included for the sake of recording their occurrence at that station. Where the specimen was collected in North Carolina, the name of the State is given with the station. Where this is omitted, the station is understood to be in Virginia. Species of which specimens were collected are so denoted by the collection number; others here recorded are such as were carefully noted

[1] Engler's Bot. Jahrb., vol. 27, p. 457. 1899.

on the spot, and concerning the identity of which there could be no reasonable doubt. Numbers 1 to 115, denoted by the initials "C. & K," were collected by Mr. Frederick V. Coville and the author.

THALLOPHYTA.

FUNGI.[1]

Exobasidium discoideum Ellis. In the Dismal Swamp, May 1, on *Azalea viscosa* L.

Coleosporium sonchi-arvensis (Pers.) Liv. Virginia Beach, Oct. 2, on leaves of *Solidago sempervirens* L.

LICHENES.[2]

Usnea angulata Ach. Near Pungo, Princess Anne County (No. 1159), on the bark of *Pinus taeda* L.

Usnea barbata rubiginea Michx. With the preceding (No. 1159a).

Usnea barbata serotina Schaer (?). With the preceding (No. 1159b).

Usnea trichodea Ach. With the preceding and on the branches of *Taxodium distichum* L.

BRYOPHYTA.

HEPATICAE.[3]

Odontoschisma sphagni Dumort. Margin of Lake Drummond, July 14 (No. 1672), on bases of tree trunks, with *Plagiothecium micans* Sw.

Riccia fluitans L. Floating near the surface of ponds, common (Nos. 1344, 1631).

Trichocolea tomentella Dumort. Stumps, old logs, etc., in the Dismal Swamp (Nos. 1640, 1641a).

MUSCI.

SPHAGNACEAE.[4]

Sphagnum brevicaule Warnstorf sp. nov. Near Newbern, N. C., Aug. 1 (No. 1977), in a small open bog.

Sphagnum cuspidatum plumosum f. serrata Warnstorf. In the Jericho Ditch, Dismal Swamp, July 15 (No. 1676), entirely submersed.

Sphagnum cymbifolium glaucescens Russ. In the Dismal Swamp and in swales in the Desert, Cape Henry, July 14, 27 (Nos. 1673, 1861a).

Sphagnum cymbifolium glaucescens Russ. f. squarrulosa Warnstorf. With the preceding (Nos. 1675, 1860).

Sphagnum henryense Warnstorf, sp. nov. In a swale in the Desert, Cape Henry, July 27 (No. 1861).

Sphagnum imbricatum cristatum Warnstorf f. glaucescens Warnstorf. Near Newbern, N. C., Aug. 1 (No. 1975).

Sphagnum kearneyi Warnstorf, sp. nov. In the Jericho Ditch, Dismal Swamp, July 15 (No. 1677), all but the summits of the stems submersed, stems sometimes 4.5 dm. long.

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[1] Determined by Mrs. Flora W. Patterson.

[2] Determined by Mr. T. A. Williams.

[3] Determined by Mr. O. F. Cook.

[4] Determined by Dr. C. Warnstorf. See Hedwigia, vol. 39, pp. 101 to 109 (1900), for descriptions of the new species.

Sphagnum medium glaucescens Warnstorf. Virginia Beach, Oct. 2 (No. 2091), in a marshy place in the pine woods.

Sphagnum recurvum ambliphyllum f. pulchricoma C. Muell. In swales in the Desert, Cape Henry, July 27 (No. 1861b).

Sphagnum virginianum Warnstorf, n. sp. Margin Lake Drummond, Dismal Swamp, July 14 (1668).

BRYACEAE.[1]

Aulacomnium palustre (L.) Schwaegr. Margin of Lake Drummond (No. 1655).

Aulacomnium palustre polycephalum Bruch & Schimp. On an old tree stump, Dismal Swamp (No. 2352).

Aulacomnium sp. With the preceding (No. 2351).

Dicranum flagellare Hedw. On decaying logs, Dismal Swamp (Nos. 1612, 1654, 1674).

Dicranum scoparium (L.) Hedw. On the ground in moist woods; along Cohoon Creek, near Suffolk (No. 1710); the Desert, Cape Henry (No. 1835).

Funaria hygrometrica (L.) Sibth. Moist soil, Virginia Beach (No. 1419); abundant along the Dismal Swamp Canal.

Funaria hygrometrica calvescens Bruch & Schimp. Moist soil, Virginia Beach (No. 1423).

Hypnum boscii Schwaegr. On old stumps and logs, border of Lake Drummond (No. 2363).

Hypnum cupressiforme L. On a moist bank at roadside, Northwest (No. 2373).

Hypnum spp. Undetermined, material insufficient. (Nos. 1642, 1787, 1849.)

Leptodon trichomitrion (Hedw.) Mohr. On old logs and stumps, Dismal Swamp (No. 1642).

Leucobryum albidum Brid. (*L. minus* Sull., not Michx.) Moist ground, near margin of Lake Drummond (Nos. 1670, 1671).

Leucobryum glaucum (L.) Schimp. On a moist bank at roadside, Northwest (Nos. 2373a, 2374).

Leucodon brachypus Brid. (No. 215a.)

Leucodon julaceus (Hedw.) Sull. On the bark of Liquidambar and other trees, Wallaceton (No. 1789); Virginia Beach (No. 2150).

Mnium affine Bland. On old logs and stumps, Dismal Swamp (No. 1641).

Plagiothecium latebricola Bruch & Schimp. (No. 2351.)

Plagiothecium micans Sw. Near the margin of Lake Drummond (No. 1672a).

Polytrichum commune L. Moist ground: Northwest (Nos. 1509, 2369); Wallaceton (1791); common.

Polytrichum ohiense R. & C. Kempsville, Princess Anne County (No. 1048).

Raphidostegium microcarpum (Muell) Jaeg. & Sauerb. Near the margin of Lake Drummond (No. 1662).

Thelia hirtella (Hedw.) Sull. On the bark of *Acer rubrum*, Dismal Swamp (No. 1790).

Thuidium recognitum (Hedw.) Lindb. On old logs and stumps in the Dismal Swamp (Nos. 1641 b, 1656, 2364).

Thuidium scitum (Beauv.) Aust. On old logs in the Dismal Swamp (No. 1786).

PTERIDOPHYTA.

OSMUNDACEAE.

Osmunda cinnamomea L. Common in shaded swamps (Nos. 1214, 1628, 2159).

Osmunda regalis L. With the preceding, but less common (No. 100 C. & K).

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[1] Determined by Mrs. Elizabeth G. Britton.

POLYPODIACEAE.[1]

Polystichum acrostichoides (Michx.) Schott. Near Suffolk (No. 1237) and at Virginia Beach, in rich woods.

Dryopteris spinulosa dilatata (Hoffm.) Underw. Margin Lake Drummond, Dismal Swamp (No. 108, C. & K.).

Woodwardia areolata (L.) Moore. Common in bogs and swamps (Nos. 1625, 2130, 2360).

Woodwardia virginica (L.) J. E. Smith. Common in open swamps (Nos. 1151, 1351, 1591, 1678.)

Asplenium filix-foemina (L.) Bernh. Near Virginia Beach, May 29 (No. 1410), in rich woods.

Pteris aquilina L. Common, especially in low ground.

Pellaea atropurpurea (L.) Link. On brick walls, in Norfolk.

Polypodium polyodioides (L.) Hitchcock. Abundant on the limbs of *Taxodium distichum* L., in the Dismal Swamp (No. 113 C. & K.).

LYCOPODIACEAE.

Lycopodium alopecuroides L. In marshy places, Newbern, N. C., Aug. 1 (Nos. 1930, 1973).

Lycopodium inundatum L. In open, marshy places: Northwest (No. 1539) and Cape Henry (No. 1825).

SELAGINELLACEAE.

Selaginella apus (L.) Spring. In a shady swamp, Edenton, N. C., July 30 (No. 1918).

EMBRYOPHYTA.

GYMNOSPERMAE.

PINACEAE.

Pinus[2] **echinata** Mill. Near Suffolk (No. 1232); Lynnhaven Bay (No. 1843). Locally known as "rosemary pine," which is said to be the popular name of *P. taeda* in North Carolina.[3]

Pinus taeda L. Everywhere (Nos. 4 and 99, C. & K., 1003, 1060, 1160, 1745, 1806). Locally known as "short-leaf pine."

Taxodium distichum L. Common in swamps and along streams (Nos. 1157, 1916, 2077, 2361).

Chamaecyparis thyoides (L.) B. S. P. Abundant in parts of the Dismal Swamp (Nos. 87 C. & K., 1600, 1663). Locally known as "juniper."

Juniperus virginiana L. Common in woodlands and on roadsides in dry soil (Nos. 1176, 1724).

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[1] For an account of the ferns of the Dismal Swamp see W. Palmer, in Proc. Biol. Soc. Washington, vol. 13, pp. 61 to 70, 1899. The following species, not included here, are enumerated in that paper: *Onoclea sensibilis* L., *Dryopteris noveboracensis* (L.) A. Gray, *Dryopteris thelypteris* (L.) A. Gray, *Dryopteris goldiana celsa* Palmer, *Dryopteris marginalis* (L.) A. Gray, *Dryopteris spinulosa* (Retz) Kuntze, *Asplenium platyneuron* (L.) Oakes, and *Botrychium obliquum* Muhl. Interesting observations are given concerning the distribution and ecology of the species.

[2] Pinus determined by Mr. G. B. Sudworth.

[3] Ashe, Bull. N. C. Geolog. Surv., vol. 5, p. 15 (1894). "Short-leaf pine" is there given as the popular name for *P. echinata*.

ANGIOSPERMAE.

MONOCOTYLEDONES.

TYPHACEAE.

Typha angustifolia L. Common in fresh-water river marshes (Nos. 1349, 1518, 1522).

Typha latifolia L. More abundant than the preceding, in fresh and brackish marshes.

Sparganium androcladum (Engelm.) Morong. In the cool, shaded water of Washington Ditch, Dismal Swamp, July 14 (No. 1627).

NAIADACEAE.

Potamogeton lonchites Tuckerm. With *Sparganium androcladum* (No. 1626).

ALISMACEAE.

Echinodorus radicans (Nutt.) Engelm. In shaded swamp, Edenton, N. C., July 30 (No. 1915).

Sagittaria graminea Michx. In an open, grassy bog, Newbern, N. C., August 1, (No. 1952).

Sagittaria lancifolia L. Common in fresh-water river marshes (No. 1359, 1713, 1717, 2011).

VALLISNERIACEAE.

Philotria canadensis (Michx.) Britton. Bottom of Nansemond River, near Suffolk (No. 1697). An unusually small, slender, short-leaved form.

POACEAE.

Erianthus contortus Ell. Common along ditches, in fields, and at the edge of woodlands, near Norfolk and Portsmouth (Nos. 1741, 2398).

Erianthus saccharoides Michx. In open marshes, especially on the border of the Dismal Swamp (Nos. 2146, 2354). Occasional in drier soil.

Andropogon argyraeus Schult. Dry soil at roadsides (No. 2149).

Andropogon elliottii Chapm. Dry soil at roadsides and at the edges of woodlands, near Northwest (No. 2383); a slender form approaching var. *gracilior* Hack.

Andropogon glomeratus (Walt.) B. S. P. In open, boggy places; at Ocean View.

Andropogon scoparius Michx. Common in dry, sandy soil, at roadsides and in fields.

Andropogon sorghum halepensis (L.) Hack. Persisting as a weed in cultivated land at Wallaceton, Norfolk County. Introduced.

Andropogon tetrastachyus Ell. In a swale at Cape Henry, October 5 (No. 2129).

Andropogon virginicus L. Abundant in old fields.

Paspalum angustifolium Le Conte. In moist, sandy soil along the Dismal Swamp Canal, Wallaceton, Norfolk County, July 21 (No. 1785).

Paspalum dasyphyllum Ell. In pine woods on Lynnhaven Bay, July 27 (No. 1856).

Paspalum distichum L. Brackish marshes near Virginia Beach, August 4 (No. 2028).

Paspalum floridanum Michx. Dry soil in an old field, Kempsville, Princess Anne County, October 7 (No. 2168).

Paspalum floridanum glabratum Engelm. In dry fields near Lynnhaven Bay, October 3 (No. 2142.)

Paspalum laeve Michx. Roadside near Ocean View, July 8 (No. 1473).

Paspalum longipedunculatum Le Conte. With the preceding (No. 1474).

Paspalum paspaloides (Michx.) Scribn. Moist, sandy soil near Virginia Beach, August 3 (No. 2012).

Paspalum purpurascens Ell. Cornfields, near Wallaceton, Norfolk County, November 4 (No. 2341); and near Newbern, N. C., July 21 (No. 1951).

Syntherisma filiforme (L.) Nash. Dry, sandy roadsides near Virginia Beach, October 5 (2104).

Syntherisma sanguinale (L.) Nash. Abundant in cultivated and fallow land, waste ground, etc. Introduced.

Panicum[1] **agrostoides** Muhl. Grassy marshes near Newbern, N. C., October 10 (No. 2249). Form approaching *P. longifolium* Torr., with preceding (No. 2242), and in slightly brackish marshes near Virginia Beach, August 4 (No. 2025).

Panicum amarum Ell. Abundant on the strand (No. 1405, 1775, 2021, 2063).

Panicum amarum minus Vasey & Scribn. With, but more abundant than, the type (Nos. 1401, 2064). Differs from the type form in its more widely creeping rootstocks, more numerous innovations, more slender, contracted panicle, and fewer spikelets. Anatomically identical, at least as to the leaves.[2]

Panicum angustifolium Ell. (?) Dry, sandy soil, Portsmouth (No. 1369) and Virginia Beach (No. 1416).

Panicum barbulatum Michx. Rather common in partly shaded bogs (No. 1307).

Panicum ciliatum Ell. Moist sandy soil in pine woods near Ocean View, July 20 (No. 1761).

Panicum colonum L. Low ground, Virginia Beach, August 5 (No. 2049). Introduced.

Panicum commonsianum Ashe. Among sand dunes, Ocean View to Virginia Beach (No. 1447). Doubtful forms of this species are Nos. 1393, 1454, and 1776, the first being a very hairy form, the other two apparently representing the branched condition.

Panicum commutatum Schult. Common in low woods, May (Nos. 1029, 1317, 1414, 1463).

Panicum crus-galli L. Abundant in fields and waste ground. Introduced. (No. 2187.)

Panicum dichotomum L. Common in woodlands. May (No. 1374).

Panicum gibbum Ell. Margin Lake Drummond (No. 1618); border of a pond near Virginia Beach (No. 2122).

Panicum latifolium L. Common in woodlands, May (Nos. 1411, 1469).

Panicum laxiflorum Lam. Low, moist, shaded ground, common. May (Nos. 1033, 1104, 1179, 1308, 1467).

Panicum microcarpon Muhl. Low ground in open pine woods, Ocean View, July 8 (No. 1476).

Panicum neuranthum Griseb. Dry sandy soil; Northwest, July 9 (No. 1566; near Virginia Beach, August 4 (No. 2038); near Edenton, N. C., July 29 (No. 1871).

Panicum pauciflorum Ell. Among the inner dunes; Virginia Beach, May 28 (No. 1386); Cape Henry, May 28 (No. 1400).

Panicum pubescens Lam. Frequent in dry sandy soil (Nos. 1461, 1559, 2043).

Panicum rostratum Muhl. Low ground, common (No. 1748).

Panicum scabriusculum Ell. Along Dismal Swamp Canal, Wallaceton, July 22 (No. 1798).

Panicum sphaerocarpon Ell. In rather dry soil, Northwest, July 9 (No. 1560).

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[1] Species of Panicum of the *dichotomum* section determined by Mr. Geo. V. Nash.

[2] See Contr. Nat. Herb., vol. 5, p. 285.

Panicum sphagnicola Nash. In a moist meadow near the river, Northwest, July 9 (No. 1514); in an open marsh near the beach, below Virginia Beach, August 4 (No. 2026).

Panicum verrucosum Muhl. Frequent in moist, low, shaded ground (No. 2053).

Panicum virgatum L. Edge of a brackish marsh, Virginia Beach, August 3 (No. 2018). In grassy swales, Edenton, N. C., July 28 (No. 1899), a variety with culms only one to three from each rootstock, and a small, open, few-flowered panicle.

Panicum viscidum Ell. Common in ditches and low ground (No. 1477).

Panicum sp. (No. 1375.)

Panicum sp. (No. 2114.) Near *P. pubescens* Lam.

Chaetochloa glauca (L.) Scribner. Abundant in fields and roadsides (No. 2158). Introduced.

Chaetochloa imberbis (Poir.) Scribner. Low ground near Nansemond River, Suffolk, July 18 (No. 1735); in ditches near Berkley.

Chaetochloa imberbis perennis (Hall) Scribn. & Merrill. Marshes bordering lagoon below Virginia Beach, August 4 (No. 20, 35).

Chaetochloa ventenatii (Kunth) Nash[1] (?). Dry sandy roadside near Newbern, N. C., October 10 (No. 2221).

Cenchrus tribuloides macrocephalus Doell. Common on the sand strand, Ocean View to Virginia Beach (Nos. 1813, 1814, 1948).

Zizania aquatica L. Fresh-water marshes. Along Nansemond River, Suffolk, July 18; near Edenton, N. C., July 30.

Homalocenchrus oryzoides (L.) Poll. Marshes.

Homalocenchrus virginicus (Willd.) Britton. Wet shaded ground.

Anthoxanthum odoratum L. Grassy fields and roadsides, common (No. 1274). Introduced.

Stipa avenacea L. Dry pine woods, frequent (No. 1102).

Aristida dichotoma Michx. Dry sandy fields, Kempsville, Princess Anne County, October 7 (No. 2171).

Aristida purpurascens Poir. Dry woodlands near Virginia Beach, October 4 (No. 2117).

Aristida stricta Michx. Pine barrens, Newbern, N. C.

Muhlenbergia capillaris (Lam.) Trin. Dry sandy roadside, Newbern, N. C., October 10 (No. 2206).

Phleum pratense L. Fields and roadsides, common. Introduced.

Alopecurus geniculatus L. Rather moist, sandy soil along railways, Princess Anne County, May 13 (No. 1147).

Sporobolus asper (Michx.) Kunth. Dry pine woods, Lynnhaven Bay, October 4 (No. 2113).

Sporobolus indicus (L.) R. Br. Common at roadsides, Newbern, N. C. Introduced.

Agrostis alba L. Moist ground at roadsides, Northwest, July 9 (No. 1546). Introduced.

Agrostis alba vulgaris (With.) Thurb. Common in fields and roadsides. Introduced.

Agrostis hiemalis (Walt.) B. S. P. Sandy fields and roadsides, common (Nos. 1205, 1409).

Agrostis intermedia Scribner. Shaded banks, Virginia Beach, October 2 (No. 2073); Northwest, November 8 (No. 2382), a large form, very near *A. altissima* (Walt.) Tuckerm.

Ammophila arenaria (L.) Link. Abundant on the sand strand, Lamberts Point to Virginia Beach (Nos. 1017, 1406, 1770, 1811).

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[1] *Setaria ventenatii* Kunth, Rév. Gram. 1: 251, *t.* 37.

Holcus lanatus L. Roadsides, occasional. Introduced.

Aira caryophyllea L. Common in sandy fields (No. 1279). Introduced.

Aira praecox L. Dry sandy soil in pine woods, Virginia Beach, May 28 (No. 1379). Introduced.

Trisetum pennsylvanicum (L.) Beauv. Shaded marshy ground at edge of forest, frequent, May (No. 1044).

Danthonia sericea Nutt. Dry sandy soil in pine woods, frequent (Nos. 1129, 1219).

Danthonia spicata (L.) Beauv. Dry soil on roadsides and in open woods, common (No. 1203).

Capriola dactylon (L.) Pers. Abundant on roadsides and in lawns, waste ground, etc., (No. 1517). Introduced.

Spartina patens (Ait.) Muhl. Common along the coast; a tall, stout form on the sand strand (Nos. 1694, 1815); a low, slender form in the salt marshes.

Spartina stricta maritima (Walt.) Scribn. Abundant in salt marshes (No. 2112).

Campulosus aromaticus (Walt.) Scribn. Open grassy pine barrens, Newbern, N. C.

Gymnopogon ambiguus (Michx.) B. S. P. Dry sandy uplands, near Suffolk.

Eleusine indica (L.) Gaertn. Fields and waste ground, common. Introduced.

Dactyloctenium aegyptiacum (L.) Willd. Cornfields, Newbern, N. C., October 10. Introduced.

Phragmites communis Trin. Occasional in brackish marshes.

Sieglingia seslerioides (Michx.) Scribner. Dry fields and open woods near Virginia Beach.

Triplasis purpurea (Nutt.) Chapm. Frequent among the dunes, Cape Henry to Virginia Beach (Nos. 1817, 2092).

Eragrostis hirsuta (Michx.) Nash. Sandy roadsides, Norfolk, August 5, 1895; Newbern, N. C., August 1 (No. 1968).

Eragrostis major Host. Roadsides, fields, etc. Introduced.

Eragrostis pectinacea (Michx.) Steud. Among the inner dunes near Virginia Beach, October 2 (No. 2087).

Eragrostis pilosa (L.) Beauv. Sandy roadside, Wallaceton, July 22 (No. 1801).

Eragrostis refracta (Muhl.) Scribner. Sandy roadside, Edenton, N. C., July 29 (No. 1922); low pine woods, Virginia Beach, October 2 (No. 2050).

Eatonia nitida (Spreng.) Nash. Open woodlands and borders of woods, near Suffolk, May 19 (No. 1240); Virginia Beach, May 29 (No. 1420). A form with the empty glumes, especially the second, scabrous toward the apex, the flowering glume distinctly scabrous.

Eatonia obtusata (Michx.) A. Gray. Open woods and edges of woods, in fertile soil (Nos. 1114, 1149, 1371).

Melica mutica Walt. Rich soil in woods, Virginia Beach, May 29 (No. 1413).

Uniola latifolia Michx. Bluff on Cohoon Creek above Suffolk, overhanging the water in shaded places.

Uniola longifolia Scribn. In fertile soil in a copse at roadside near Virginia Beach, October 4 (No. 2107).

Uniola laxa (L.) B. S. P. Frequent in low pine woods (No. 1475).

Uniola paniculata L. Frequent on the outer dunes near Cape Henry (Nos. 1753, 2134).

Distichlis spicata (L.) Greene. Brackish meadow near Virginia Beach, August 4 (No. 2030).

Dactylis glomerata L. Common along ditches at roadsides, etc. (No. 1291). Introduced.

Poa annua L. Roadsides and waste ground (No. 1383). Introduced.

Poa autumnalis Muhl. Frequent in moist low woodlands (Nos. 1049, 1141).

Poa compressa L. Fields and roadsides, common (No. 1426). Introduced.

Poa pratensis L. Common, especially at roadsides (No. 1142). Introduced.

Panicularia brachyphylla Nash. Rich swampy woods, margin of Lake Drummond, May 2 (No. 115 C. & K.).

Panicularia obtusa (Muhl.) Kuntze. Shaded swamp near Elizabeth City, N. C., August 2 (No. 2003).

Panicularia pallida (Torr.) Kuntze. Marshy ground near Portsmouth, May 13 (No. 1152); margin of Lake Drummond, July 13 (No. 1617).

Festuca elatior L. Frequent along ditches (No. 1287). Introduced.

Festuca myuros L. Sandy fields and roadsides, May (Nos. 1324, 1427).

Festuca octoflora Walt. Sandy fields and roadsides, common, May (Nos. 1267, 1272, 1370, 1403).

Festuca rubra L. Shore of Lynnhaven Bay, July 27 (No. 1855).

Festuca sciurea Nutt. Sandy field near Deep Creek, Norfolk County, May 17 (No. 1204).

Bromus secalinus L. Along railways, waste ground, etc., May (Nos. 1321, 1322). Introduced.

Hordeum pusillum Nutt. Fields and waysides, abundant, May (Nos. 1028, 1229). Introduced.

Elymus virginicus L. Along ditches, common (No. 1690).

Arundinaria macrosperma Michx. Wooded swamps, abundant, May (Nos. 86 C. & K., 1590, 1623). Known locally as "reeds."

Arundinaria tecta (Walt.) Muhl. Moist open woods, abundant, May (Nos. 1038, 1845).

CYPERACEAE.[1]

Cyperus cylindricus (Ell.) Britton. Common on the inner sand dunes (Nos. 1510, 1538, 1744, 2017).

Cyperus diandrus Torr. Open marsh. Cape Henry, October 5 (No. 2127a).

Cyperus erythrorhizos Muhl. Bank of the Dismal Swamp Canal, Wallaceton, Norfolk County, November 3 (No. 2343).

Cyperus esculentus L. Sandy soil along Lynnhaven Bay, July 27 (No. 1854).

Cyperus filiculmis Vahl. Sandy soil along Lynnhaven Bay, July 27 (No. 1852).

Cyperus flavescens L. Moist ground at roadside, Deep Creek, July 22 (No. 1780); moist sand near the shore, Virginia Beach, August 3 (No. 2037).

Cyperus flavicomus Michx. Moist open ground at roadsides; near Lamberts Point, July 16 (No. 1691); Newbern, N. C., August 1, October 10 (Nos. 1969, 2212).

Cyperus grayi Torr. Common among the sand dunes, Ocean View to Virginia Beach (No. 1778).

Cyperus haspan L. River marshes, Elizabeth City, N. C., August 3 (No. 1995); Northwest, November 8 (No. 2390).

Cyperus microdontus Torr. Moist ground at roadside, Deep Creek, Norfolk County (No. 1783).

Cyperus nuttallii Eddy. Moist ground near the beach, Virginia Beach, August 4, October 2 (Nos. 2066, 2127).

Cyperus ovularis (Michx.) Torr. Dry soil among undergrowth, Ocean View, July 8 (No. 1480).

Cyperus pseudovegetus Steud. Marshy ground and ditches at roadsides, frequent (Nos. 1479, 1889, 2161).

Cyperus retrofractus (L.) Torr. In sandy soil at roadside, Suffolk, July 11 (No. 1582).

Cyperus rotundus L. In a garden, Suffolk, July 11 (No. 1567). Introduced.

[1] Determined by Dr. N. L. Britton.

Cyperus strigosus L. Frequent in moist low ground (Nos. 2000, 2153, 2169, 2239).

Kyllinga pumila Michx. In a moist cornfield, Wallaceton, Norfolk County, November 3 (No. 2333).

Dulichium arundinaceum (L.) Britton. Along ditches in the Dismal Swamp; common; July 12 (No. 1593).

Eleocharis engelmanni Steud. Marshy ground in woods, Kempsville, Princess Anne County, October 7 (No. 2182).

Eleocharis mutata (L.) Roem. & Schult. In a pond in the Dismal Swamp, July 13 (No. 1632); in a marshy meadow near Virginia Beach, August 4 (No. 2027)

Eleocharis ochreata (Nees) Steud. In a marshy spot among the dunes, Cape Henry, July 26 (No. 1821).

Eleocharis ovata (Roth) R. Br. In open roadside marshes, Northwest, Norfolk County, July 9 (Nos. 1543, 1554).

Eleocharis glaucescens (Willd.) Schultes. Marshy banks of the Northwest River, May 11 (No. 1084); marshy meadow near Virginia Beach, August 4 (No. 2029), the latter number doubtfully referred here.

Eleocharis prolifera Torr. (?) In a pool in "The Desert," Cape Henry, July 27 (No. 1832). The specimen is without fruiting spikes.

Eleocharis tenuis (Willd.) Schultes. Marshy places, Kempsville, Princess Anne County, May 9 (No. 1041).

Eleocharis tortilis (Link) Schultes. Sedgy marshes at roadsides, Edenton, N. C., July 29 (Nos. 1870, 1876).

Eleocharis tuberculosa (Michx.) Roem. & Schult. Along the Dismal Swamp Canal, Wallaceton, Norfolk County, November 4 (No. 2348).

Dichromena colorata (L.) A. S. Hitchcock. In a grassy open bog, Newbern, N. C., July 31 (No. 1959).

Stenophyllus capillaris (L.) Britton. Sandy margin of a pond, Ocean View, July 8 (No. 1456).

Fimbristylis autumnalis (L.) Roem. & Schult. Frequent in moist sandy soil (Nos. 1822, 2334).

Fimbristylis laxa Vahl. In muddy places at a roadside, Virginia Beach, October 4 (No. 2152).

Fimbristylis spadicea (L.) Vahl. Common along the coast in the marshes and in moist places among the dunes (Nos. 1695, 1772).

Scirpus americanus Pers. Usually with the preceding, common; also in the nearly fresh-water river marshes at Suffolk (Nos. 1218, 1506, 1810).

Scirpus cyperinus eriophorum (Michx.) Britton. Abundant in the open lands in and bordering upon the Dismal Swamp, also in fresh-water river marshes (Nos. 1629, 2081).

Scirpus divaricatus Ell. In a shallow pond in the Dismal Swamp, July 13 (No. 1633).

Scirpus lacustris L. River marshes, at and above the upper limit of brackish water (No. 1358).

Eriophorum virginicum L. On hummocks, among Sphagnum and *Woodwardia virginica*, in the Dismal Swamp, July 15 (No. 1681).

Fuirena squarrosa Michx. In moist sand on the beach, Virginia Beach, August 4, October 2 (Nos. 2039, 2067); in a grassy bog, Newbern, N. C., August 1 (No. 1963).

Lipocarpha maculata (Michx.) Torr. In moist shaded ground: Edenton, N. C., July 29 (No. 1919); Virginia Beach, August 3.

Rynchospora axillaris (Lam.) Britton. Along the Dismal Swamp Canal, Wallaceton, November 3 (No. 2342), near var. *microcephala*.

Rynchospora axillaris microcephala Britton. In a low grassy meadow, Newbern, N. C., October 10 (No. 2236).

Rynchospora corniculata (Lam.) A. Gray. In a shallow pool in the Dismal Swamp, July 14 (No. 1638): in a ditch, Edenton, N. C., July 29 (No. 1892).

Rynchospora cymosa Ell. In open marshy meadows: Northwest, July 9 (No. 1536); Cape Henry, July 26 (No. 1826): Newbern, N. C., August 1 (No. 1974).

Rynchospora fascicularis (Michx.) Vahl. In a small open marsh, Newbern, N. C., October 10 (No. 2235).

Rynchospora glomerata (L.) Vahl. Common in open bogs (Nos. 1491, 1781, 1782).

Rynchospora glomerata paniculata (A. Gray) Chapm. Along a roadside ditch, Virginia Beach, October 10 (No. 2139).

Rynchospora inexpansa (Michx.) Vahl. In open sedgy bogs: Berkley, July 19 (No. 1743); Edenton, N. C., July 29 (No. 1886).

Rynchospora schoenoides (Ell.) Britton. Marshes on Pasquotank River, Elizabeth City, N. C., August 2 (No. 1993).

Cladium effusum Torr. Fresh-water river marshes: Northwest, July 9 (No. 1557); Elizabeth City, N. C., August 2 (No. 2006).

Scleria pauciflora Muhl. In an open grassy pine grove, Edenton, N. C., July 29 (No. 1887); dry open ground, Elizabeth City, N. C., August 3 (No. 2001).

Scleria triglomerata Michx. Dry sandy soil on Lynnhaven Bay, July 27 (No. 1848).

Carex albolutescens Schwein. Common in moist sandy soil, May–July (Nos. 1148, 1399, 1459, 1793).

Carex alata Torr. In marshy ground, Ocean View, May 30 (No. 1435).

Carex bullata Schk. Margin Lake Drummond, Dismal Swamp, July 14 (No. 1609).

Carex canescens L. Marshy banks of the Northwest River, May 11 (Nos. 1077, 1082).

Carex comosa Boott. Marshy banks of the Northwest River, July 9 (No. 1541).

Carex costellata Britton. In open woods, Ocean View, July 8 (No. 1471).

Carex glaucodea Tuckerm. Moist ground near Kempsville, Princess Anne County, May 9 (No. 1053).

Carex gynandra Schwein. In a shaded swamp, Deep Creek, Norfolk County, May 17 (No. 1207).

Carex laxiflora Lam. Frequent in low woodlands. May (Nos. 1006, 1191, 1424).

Carex lupulina Muhl. (?) Along Jericho Ditch, Dismal Swamp, May 1 (No. 98 C. & K.). Immature.

Carex lurida Wahl. Common in marshes. May–July (Nos. 1086, 1162, 1346, 1505).

Carex pedicellata (Dewey) Britton. Upland sandy woods near Suffolk, April 30 (No. 66 C. & K.).

Carex pennsylvanica Lam. Sandy pine woods near Virginia Beach, April 29 (No. 40 C. & K.).

Carex rosea Schk. Low woodlands, Kempsville, Princess Anne County, May 9 (No. 1046).

Carex scoparia Schk. Along a railway near Suffolk, May 19 (No. 1273).

Carex sterilis Willd. Marshy banks of the Northwest River, May 11 (Nos. 1080. 1099).

Carex stipata Muhl. In a swamp at Northwest, May 11 (No. 1107).

Carex stricta Lam. Marshy banks of the Northwest River, May 11 (No. 1083). Forming strong tussocks.

Carex tenuis Rudge. Deep, moist woods near Pungo, Princess Anne County, May 14 (No. 1169).

Carex triceps Michx. In sandy soil, fields, and dry woodlands, common, May (Nos. 1185, 1199, 1306, 1367, 1432).

Carex verrucosa Muhl. Sandy banks of the Dismal Swamp Canal, Wallaceton, November 4; in a grassy swale, "The Desert," Cape Henry, July 27 (No. 1844); in marshes and along ditches, especially in pine woods, Newbern (No. 1970) and Elizabeth City (No. 2002), N. C.

Carex virescens Muhl. Swampy woods, Northwest, Norfolk County, May 11 (No. 1106).

Carex vulpinoidea Michx. In a ditch along the railway, Suffolk, May 19 (No. 1255).

ARACEAE.

Acorus calamus L. Abundant in fresh-water marshes along the Northwest River, May 11 (No. 1085).

Arisaema triphyllum (L.) Torr. In low woods, Ocean View, May 6 (No. 1007).

Peltandra virginica (L.) Kunth. In marshes; near Virginia Beach, May 28 (No. 1381); Elizabeth City, N. C., August 2 (No. 2009).

LEMNACEAE.

Spirodela polyrhiza (L.) Schleid. Covering surface of a bayou, Edenton, N. C., July 29 (No. 1894).

XYRIDACEAE.

Xyris ambigua Beyrich. In an open, sedgy bog, Newbern, N. C., August 1 (No. 1976).

Xyris caroliniana Walt. Frequent in bogs and along ditches, July (Nos. 1685, 1820, 1920).

Xyris torta J. E. Smith. In open, sedgy bogs near Newbern, N. C., August 1 (No. 1984).

Xyris sp. Apparently intermediate between *X. caroliniana* and *X. platylepis* Chapm. In marshy ground in the pine woods, Virginia Beach, October 2 (No. 2088).

ERIOCAULACEAE.

Eriocaulon decangulare L. Marshy banks of the Northwest River, July 9 (No. 1558).

Lachnocaulon anceps (Walt.) Morong. In an open, sedgy bog, Newbern, N. C., August 1 (No. 1940).

BROMELIACEAE.

Tillandsia usneoides L. Not abundant in Virginia; common in North Carolina. On old cypress trees, margin of Lake Drummond, Dismal Swamp, May 2 (No. 73, C. & K.); on the branches of Fagus, *Quercus minor*, *Pinus taeda*, *P. echinata*, etc., about ponds and along Long Creek, in "The Desert," Cape Henry, July 27 (No. 1838).

COMMELINACEAE.

Commelina erecta L. Sandy shores of Lynnhaven Bay, July 27 (No. 1846).

PONTEDERIACEAE.

Pontederia cordata L. Very common in fresh-water river marshes (No. 1551).

JUNCACEAE.[1]

Juncus acuminatus Michx. Common in marshes and shallow water, especially in sandy soil (Nos. 1078, 1431, 1478, 1610, 1639).

[1] Determined by Mr. Frederick V. Coville.

Juncus acuminatus debilis A. Gray. On made ground, sandy banks of the Dismal Swamp Canal, July 22 (No. 1794).

Juncus canadensis J. Gay. Very common in marshes (Nos. 1624, 1779, 1896, 2248, 2344, 2388).

Juncus dichotomus Ell. Common in low marshy places among the sand dunes, Ocean View to Cape Henry (Nos. 1391, 1460, 1764, 1774).

Juncus effusus L. Abundant in marshes, especially on the edges of palustrine forest (No. 1465).

Juncus marginatus Rostk. Frequent in marshy places (Nos. 1762, 1828, 2379).

Juncus marginatus aristulatus (Michx.) Coville. In open marshes along the Northwest River, July 9 (No. 1540), near Virginia Beach, August 4 (No. 2031).

Juncus repens Michx. Frequent in moist sand or in shallow water, especially in the Dismal Swamp (Nos. 72 C. & K., 1462, 1616, 2349).

Juncus roemerianus Scheele. The most abundant plant in brackish marshes (Nos. 1360, 1696).

Juncus scirpoides Lam. Abundant in moist sandy places, especially among the sand dunes (Nos. 1537, 1771).

Juncus setaceus Rostk. Edge of pond, Ocean View, July 8 (No. 1466).

Juncus tenuis Willd. Common in dry sandy soil (Nos. 1373, 1436, 1444, 1445, 1795).

Juncoides campestre (L.) Kuntze. Dry upland pine woods near Suffolk, May 17 (No. 1238).

Juncoides pilosum (L.) Kuntze. Rich shaded soil along a brook near Suffolk, May 17. With *Kalmia latifolia* L.

LILIACEAE.

Uvularia sessilifolia nitida (Britton) Morong. In rather low open woods near Suffolk, April 30 (No. 62 C. & K.). With *Asarum virginicum*, L.

Hemerocallis fulva L. Roadside near Centerville, Princess Anne County, escaped from gardens.

Allium vineale L. A common weed in fields and roadsides (No. 1486). Introduced.

Nothoscordum bivalve (L.) Britton. Moist low ground, frequent near Virginia Beach, April 29 (No. 13 C. & K.); Munden's Point, Princess Anne County, May 16 (No. 1194).

Lilium superbum L. Swampy banks of Cohoon's Creek, above Suffolk, July 18 (No. 1711).

Yucca filamentosa L. In dry, open pine woods near the beach: Virginia Beach (No. 1380); Lynnhaven Bay.

Asparagus officinalis L. A weed in fields near Berkley, May 21 (No. 1303). Introduced.

Vagnera racemosa (L.) Morong. Rich, low woods near Virginia Beach, May 29 (No. 1418.)

Polygonatum biflorum (Walt.) Ell. Low woods near Berkley, May 21 (No. 1310).

SMILACEAE.

Smilax bona-nox L. Very common, especially in dry, sandy pine woods and among the dunes (Nos. 5 C. & K., 1251, 1385, 2216).

Smilax glauca Walt. Common, usually in dry soil (Nos. 1221, 1394, 1797).

Smilax laurifolia L. Abundant in the more open parts of the wooded swamps (Nos. 36 C. & K., 1525, 1602).

Smilax rotundifolia L. Very common in woods and thickets, preferring rather moist soil (Nos. 9 C. & K., 1010, 1018, 1342, 1636, 1737).

Smilax walteri Pursh. Frequent in the larger wooded swamps (Nos. 89 and 97 C. & K., 1598.)

AMARYLLIDACEAE.

Atamosco atamasco (L.) Greene. Frequent in moist, low ground, especially in open woods (Nos. 1004, 1408).

Hypoxis hirsuta (L.) Coville. Frequent in open woodlands (Nos. 1035, 1265, 1378).

DIOSCOREACEAE.

Dioscorea villosa L. Open woods near Centerville, Princess Anne County.

IRIDACEAE.

Iris caroliniana S. Wats. Frequent on the marshy banks of streams: along Northwest River, May 11 (Nos. 1079, 1550); along North Landing River, May 22 (No. 1350).

Iris verna L. Sandy soil, in the open; near Suffolk, April 30 (No. 61 C. & K.); near Portsmouth, May 13.

Sisyrinchium atlanticum Bicknell. In sandy soil; near Portsmouth, May 13 (No. 1154); Munden Point, Princess Anne County, May 16 (No. 1181).

Sisyrinchium graminoides Bicknell. In open, moist ground; Northwest, Norfolk County, May 11 (No. 1087); near Suffolk, May 19 (No. 1239).

ORCHIDACEAE.

Cypripedium acaule Ait. Rich, shaded soil in "The Desert," Cape Henry, July 27 (No. 1837).

Habenaria blephariglottis (Willd.) Torr. In open bogs, Newbern, N. C., August 1 (Nos. 1938, 1979).

Habenaria clavellata (Michx.) Spreng. On an old stump in the Dismal Swamp, July 13 (No. 1648).

Habenaria cristata (Michx.) R. Br. Frequent in moist, usually shaded soil; near Suffolk, July 11 (No. 1575), July 18 (No. 1708); near Edenton, N. C., July 29 (No. 1890); near Newbern, N. C., August 1 (Nos. 1944, 1964).

Pogonia ophioglossoides (L.) Ker. Along Jericho Ditch, Dismal Swamp, July 12 (No. 1604), on hummocks among Sphagnum.

Gyrostachys cernua (L.) Kuntze. In marshy ground, Northwest, Norfolk County, November 8 (No. 2388).

Gyrostachys gracilis (Bigel.) Kuntze. Roadside, Suffolk, July 11 (No. 1573).

Gyrostachys odorata (Nutt.) Kuntze. In marshy ground along the Northwest River, July 9 (No. 1507).

Gyrostachys praecox (Walt.) Kuntze. Marshy ground, Northwest, July 9 (No. 1555).

Tipularia uniflora (Muhl.) B. S. P. In rich, moist woods: margin Lake Drummond, Dismal Swamp (No. 107 C. & K.); "The Desert," Cape Henry, July 27 (No. 1840).

Limodorum tuberosum L. In an open marsh, Northwest, July 9 (No. 1542)—small; in hummocks among Sphagnum and *Woodwardia virginica*, Dismal Swamp, July 12 (No. 1596)—very large, attaining a height of .9 meter (3 feet).

DICOTYLEDONES.

SAURURACEAE.

Saururus cernuus L. Common at the edges of swampy woods, especially in the Dismal Swamp (Nos. 1508, 1653).

JUGLANDACEAE.[1]

Juglans nigra L. Frequent at roadsides; in deciduous woods at the margin of a small lake near Suffolk (No. 1731).

Hicoria alba (L.) Britton. A rather common forest tree on the heavier but not swampy soils (Nos. 1247, 1421, 1526, 1736).

Hicoria glabra (Mill.) Britton. Frequent in woods, especially near streams (Nos. 1534, 1716, 1851).

Hicoria microcarpa (Nutt.) Britton. In deciduous woods near Suffolk (No. 1243.)

Hicoria villosa (Sarg.) Ashe. Summit of a bluff on Cohoon Creek, near Suffolk (No. 1728).

MYRICACEAE.[2]

Myrica carolinensis Mill. Abundant in pine woods and among the dunes (Nos. 57 C. & K., 1095, 1402, 1755, 1853).

Myrica cerifera L. Less common than the preceding, chiefly about ponds; near Virginia Beach, April 29 (No. 38 C. & K.). Both species are locally known as "myrtle."

SALICACEAE.[1]

Populus alba L. Naturalized in woodlands near dwellings, etc.; Ocean View (No. 1012).

Populus heterophylla L. Frequent at the edge of swampy woods along streams (Nos. 1098, 1341).

Salix fluviatilis Nutt. In marshy spots among the dunes, and also occasionally upon them, Cape Henry (No. 1388).

Salix humilis Marsh. Near Berkley, May 21 (No. 1313).

Salix nigra Marsh. Abundant in swampy woods along streams.

BETULACEAE.

Carpinus caroliniana Walt. Frequent in swampy woods, especially along streams.

Ostrya virginiana (Mill.) Willd. Bank of Long Creek, Lynnhaven Bay (No. 1859).

Alnus rugosa (Du Roi) Koch. Abundant, usually with *Salix nigra*.

FAGACEAE.[1]

Fagus americana Sweet. An abundant forest tree on moist, heavy soils.

Castanea pumila (L.) Mill. Frequent in dry woodlands, most abundant near Cape Henry and near Suffolk. (No. 34 C. & K.).

Quercus alba L. An abundant forest tree, especially on rather moist, clayey soils (Nos. 1055, 1068, 1073, 1132, 1171, 1529, 1594, 1722, 2217).

Quercus digitata (Marsh.) Sudworth. Abundant, especially in dry, sandy soil; frequent near the strand (Nos. 1009, 1134, 1144, 1186, 1210, 1220, 1533, 1570, 1723, 1841). Varies greatly in the form of its leaves.

Quercus heterophylla Michx. f. In dry pine woods: Northwest (No. 1115); Ocean View (No. 1437).

Quercus imbricaria Michx. In swampy woods: Northwest (No. 1094); Dismal Swamp (No. 1647).

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[1] Determined by Mr. G. B. Sudworth. [2] Determined by Dr. John K. Small.

Quercus laurifolia Michx. In dry sandy soil: At top of a bluff on Cohoon Creek near Suffolk (Nos. 1720, 1721); innermost sand dunes near Cape Henry (Nos. 1829, 1830).

Quercus marylandica Muench. In sandy soil near Virginia Beach, April 20 (No. 58 C. & K.).

Quercus michauxii Nutt. A common forest tree in moist, heavy soil (Nos. 1051, 1063, 1090, 1139).

Quercus minor (Marsh.) Sarg. Common in rather dry, sandy soil, especially near streams (Nos. 1008, 1133, 1261, 1719, 1734, 1842, 1902).

Quercus nigra L. Very abundant in various soils, usually as low undergrowth in well-drained, sandy places but becoming a large tree in clayey, moist soils (Nos. 31 C. & K., 1065, 1067, 1092, 1127, 1156, 1197).

Quercus phellos L. Abundant, especially in low, moist ground, often planted as a shade tree (Nos. 1066, 1187, 1635). Locally known as "water oak."

Quercus rubra L. At water's edge on Cohoon Creek, near Suffolk (No. 1714).

Quercus velutina Lam. Usually in dry, sandy soil, frequent on the inner sand dunes (Nos. 1039, 1052, 1120, 1121, 1131, 1136, 1138, 1245, 1246, 1451, 1862, 2016).

Quercus virginiana Mill. On and among the inner dunes, Ocean View to Cape Henry (Nos. 1215, 1224, 1450, 1754), the last young plants with much-thickened roots.

Quercus alba x minor. In low woods near Cape Henry (No. 1858).

ULMACEAE.

Ulmus alata Michx. Roadside near Suffolk (No. 96 C. & K.).

Ulmus americana L. Frequent in low woods, especially along streams.

Celtis occidentalis L. Low, moist ground, Munden Point (No. 1192). Locally known as "skin and bones," from the nature of its fruit.

Celtis pumila Pursh. In dry, sandy woods, Ocean View (No. 1011); near Suffolk (No. 1252).

MORACEAE.

Morus rubra L. Frequent in mixed woods, usually as undergrowth (Nos. 1119, 1495).

Broussonetia papyrifera (L.) Vent. Naturalized on roadsides, Edenton, N. C. Frequently planted as a shade tree.

URTICACEAE.

Urticastrum divaricatum (L.) Kuntze. Rich low woods, Munden Point.

Boehmeria cylindrica (L.) Willd. Frequent along streams; abundant in the higher parts of the Dismal Swamp (No. 1760).

LORANTHACEAE.

Phoradendron flavescens (Pursh) Nutt. Abundant in the wooded swamps, upon *Acer rubrum* L. and *Nyssa biflora* Walt. (No. 2356).

SANTALACEAE.

Comandra umbellata (L.) Nutt. Dry woodland near Suffolk, April 30 (No. 50 C. & K.).

ARISTOLOCHIACEAE.

Asarum virginicum L. In rather low, open woods near Suffolk, April 30 (No. 56 C. & K.); low pine woods near Newbern, N. C., October 10.

Aristolochia serpentaria L. In dry upland woods near Suffolk (No. 1242); in open pine woods, Northwest (No. 1075); a form approaching *A. nashii* Kearney.

POLYGONACEAE.

Rumex acetosella L. An abundant weed in fields and roadsides, introduced (No. 1290).

Rumex conglomeratus Murr. Abundantly naturalized, in ditches (Nos. 1208, 1429, 1528).

Rumex crispus L. A common weed at roadsides and in neglected fields, introduced (No. 1280).

Rumex obtusifolius L. A common introduced weed (No. 1196).

Rumex verticillatus L. In marshy ground along a streamlet, Ocean View, May (Nos. 1216, 1434).

Fagopyrum fagopyrum (L.) Karst. In an old field near Norfolk, in which it was perhaps formerly cultivated (No. 1278).

Polygonum aritolium L. Very abundant in rich woods on the eastern margin of Lake Drummond, Dismal Swamp.

Polygonum aviculare L. Roadsides, etc., introduced (No. 1688).

Polygonum convolvulus L. In fields and at waysides, introduced (Nos. 1284, 1747).

Polygonum hydropiperoides Michx. Common in fresh-water river marshes and in pools in the Dismal Swamp (Nos. 1549, 1634, 1729, 2032, 2141).

Polygonum pennsylvanicum L. Abundant in old fields and on roadsides (No. 2166).

Polygonum persicaria L. A common naturalized weed (No. 1746).

Polygonum punctatum Ell. In rich, swampy woods, eastern margin of Lake Drummond (No. 2362).

Polygonum punctatum robustius Small. In marshy ground at roadside near Newbern, N. C., Oct. 10 (No. 2210).

Polygonum sagittatum L. Frequent in marshes.

Polygonum setaceum Baldw. In a low, grassy meadow near Newbern, N. C. Oct. 10 (No. 2246).

Polygonum virginianum L. In moist, low woodlands, frequent in Princess Anne County (No. 2183).

CHENOPODIACEAE.

Chenopodium album L. A common naturalized weed in waste and cultivated land (No. 1285).

Chenopodium ambrosioides L. Fields and roadsides, common, introduced (No. 2370).

Chenopodium anthelminticum L. A naturalized weed, frequent in waste ground; occasional on the sand strand.

Atriplex hastata L. At the border of salt marshes (No. 1022); in waste ground near Berkley (No. 1295).

Salsola kali L. Abundant on the beach and outer dunes, Ocean View to Virginia Beach (Nos. 1816, 2133).

PHYTOLACCACEAE.

Phytolacca decandra L. Frequent, especially in clearings in dry woodlands (No. 1802).

AIZOACEAE.

Mollugo verticillata L. Frequent in sandy fields and on the sand strand (Nos. 1929, 2125).

ALSINACEAE.

Agrostemma githago L. Along railways, Suffolk, introduced, May 19 (No. 1230).

Silene antirrhina L. Along railways near Suffolk, May 19 (No. 1268).

Saponaria officinalis L. Along railway tracks, Berkley, July 18.

Alsine media L. A common weed in fields and waste ground, introduced (Nos. 10 C. & K., 1293).

Cerastium viscosum L. Grassy places near Virginia Beach, introduced, April 29 (No. 11 C. & K.).

Cerastium vulgatum L. Sandy fields, introduced, May (No. 1145).

Sagina decumbens (Ell.) Torr. & Gr. Roadsides (No. 1137); common in crevices in the sidewalks of Norfolk, in the shade (No. 1195).

Sagina decumbens smithii (A. Gray) S. Wats. In a sandy field, Portsmouth, May 27 (No. 1376).

Ammodenia peploides (L.) Rupr. Beach at Cape Henry, scarce (No. 2132). An unusually slender and small-leaved form.

NYMPHAEACEAE.

Nymphaea advena Soland. Frequent in pools and fresh-water marshes (Nos. 1464, 1611).

Castalia odorata (Dryand.) Woodv. & Wood. Common in ponds and in ditches near the margin of the Dismal Swamp (No. 1081).

Nelumbo lutea (Willd.) Pers. Abundant in a shallow fresh-water bayou of Albemarle Sound, Edenton, N. C., July 29 (No. 1923).

RANUNCULACEAE.

Clematis crispa L. Common in the more open parts of the wooded swamps and in the partially timbered belt of the river marshes, May to July (Nos. 1348, 1503, 1643, 2005).

Ranunculus bulbosus L. An abundant, introduced weed in fields and on roadsides, May (No. 47 C. & K.).

Ranunculus parviflorus L. Grassy places near Virginia Beach, introduced, April 29 (No. 15 C. & K.).

Ranunculus recurvatus Poir. Rich, moist woods, Munden Point, May 16 (No. 1193).

Ranunculus sceleratus L. In a ditch at Deep Creek, May 17.

Thalictrum purpurascens L. Woods near Virginia Beach, May 29 (No. 1412).

BERBERIDACEAE.

Podophyllum peltatum L. Moist, rich woods, Virginia Beach.

MAGNOLIACEAE.

Magnolia virginiana L. An abundant small tree of the wooded swamps, May (Nos. 79 C. & K., 1605). This and Persea are known in the region as "bay."

Liriodendron tulipifera L. A common but rarely abundant forest tree on moist, heavy soils (No. 1804).

ANONACEAE.

Asimina triloba (L.) Dunal. Near Lake Drummond, Dismal Swamp, not frequent (No. 1649). Known locally by the odd name of "possum-pocket apples."

LAURACEAE

Persea pubescens (Pursh) Sarg. Common in woods, especially swampy woods (Nos. 104 C. & K., 1124, 1130, 1603, 2350). Popularly confused with *Magnolia virginiana*, under the name of "bay."

Sassafras sassafras (L.) Karst. Common in Virginia in dry soil, roadsides, fields, and edges of woods; Newbern, N. C. (No. 2188).

Benzoin benzoin (L.) Coulter. Banks of a small lake near Suffolk.

PAPAVERACEAE.

Sanguinaria canadensis L. Rich, shaded ground near Suffolk (No. 1241).

BRASSICACEAE.

Lepidium virginicum L. A common weed in fields and roadsides (Nos. 1270, 1404).

Coronopus didymus (L.) J. E. Smith. Abundantly naturalized in waste and cultivated land.

Sisymbrium officinale (L.) Scop. A common roadside weed, introduced (No. 1288).

Cakile edentula (Bigel.) Hook. Abundant on the beach and outer sand dunes, Ocean View to Virginia Beach (Nos. 1225, 1448).

Brassica campestris L. In old fields, introduced (No. 1302).

Raphanus raphanistrum L. In an old field near Norfolk, introduced, May 20 (No. 1275).

Cardamine arenicola Britton. In moist sand, near Kempsville, May 9 (No. 1040); near Pungo, May 14 (No. 1164).

SARRACENIACEAE.

Sarracenia flava L. In a bog in the pine woods near Newbern, N. C. (No. 2196).

DROSERACEAE.

Drosera intermedia Hayne. In a small marsh among the sand dunes, Cape Henry, July 26 (No. 1824).

SAXIFRAGACEAE.

Decumaria barbara L. Common in the Black Gum Swamp, near Lake Drummond, Dismal Swamp (No. 69 C. & K.); Edenton, N. C.

Itea virginica L. Abundant in the wooded swamps and along streams, May 25 (Nos. 94 C. & K., 1327, 1530).

HAMAMELIDACEAE.

Hamamelis virginiana L. Frequent in low woods (No. 28 C. & K.).

Liquidambar styraciflua L. A very abundant forest tree, especially on moist, heavy soils (Nos. 1800, 2371).

PLATANACEAE.

Platanus occidentalis L. Frequent along streams; often planted as a shade tree.

ROSACEAE.

Spiraea tomentosa L. In a low, marshy field, Edenton, N. C., July 28 (No. 1879); open, fresh-water marshes of the Pasquotank River, Elizabeth City, N. C. (No. 2007).

Rubus[1] **argutus** Link (*R. frondosus* Bigel). Along a ditch at roadside near Pungo, May 14 (No. 1161)—approaches var. *floridus*; on hummocks in the deep black-gum forest, Dismal Swamp (No. 1645)—a variety.

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[1] Rubus determined by Prof. L. H. Bailey.

Rubus cuneifolius Pursh. Common in dry sandy soil, fields and roadsides, May (Nos. 1165, 1212, 1366, 1395, 1586).

Rubus hispidus L. In moist, low ground, usually in woods (Nos. 1061, 1309, 1430, 1659).

Rubus trivialis Michx. In sandy fields and roadsides, Newbern, N. C. (No. 1965).

Rubus villosus Ait. (*R. canadensis* of authors, not of L.). In dry fields, common (Nos. 1057, 1177); on the open dunes, Virginia Beach (No. 22 C. & K.) (probably an outlying form).

Rubus nigrobaccus Bailey.[1] In a low field near Portsmouth, May 27 (No. 1365).

Fragaria virginiana Duchesne. Grassy roadside in pine woods, Ocean View, (No. 1443).

Fragaria virginiana australis Rydberg, var. nov. In low pine woods near Virginia Beach, April 29 (No. 16 C. & K.); along a railway near Suffolk (No. 1236).

Duchesnea indica (Andr.) Focke. At roadsides, near Norfolk; introduced (No. 1023).

Potentilla canadensis L. Roadsides near Suffolk, April 29 (No. 48 C. & K.).

Potentilla monspeliensis L. On comparatively high ground in a clearing, margin of Lake Drummond, Dismal Swamp, July 14 (No. 1665).

Potentilla pumila Poir.[2] Among grasses in dry sandy soil in woods of *Pinus echinata* near Suffolk, May 17 (No. 1235).

Geum canadense Jacq. In rich low woods, Northwest, July 9 (No. 1500).

Agrimonia parviflora Soland. Along a ditch in a field, Newbern, N. C., October 10 (No. 2233).

Agrimonia striata Michx. In rich low woods, near Suffolk, July 18 (No. 1738); near Virginia Beach, October 2 (No. 2071).

Rosa carolina L. Common in swamps and along ditches (Nos. 18 C. & K., 1118, 1458).

Rosa humilis Marsh. In a field near Portsmouth (No. 1362).

Rosa rubiginosa L. With the preceding; introduced (No. 1361).

PYRACEAE.

Malus angustifolia (Ait.) Michx. In swampy ground, especially along streams, frequent, April 29 (Nos. 8 C. & K., 1428).

Aronia arbutifolia (L.) Ell. Common in moist woods and the edges of wooded swamps (Nos. 92 C. & K., 1128, 1601, 2345).

Aronia nigra (Willd.) Britton. In low ground, Virginia Beach (No. 3 C. & K.); Suffolk (No. 59 C. & K.).

Amelanchier botryapium (L. f.) DC. Common in low woods and swamps (Nos. 51, 52, 81, 112 C. & K., 1100, 1125, 1173, 1259). Local name "wild currants."

Crataegus coccinea L. In swampy woods near Kempsville (No. 1047); a small form with small leaves.

Crataegus crus-galli L. Dry soil in the open, Ocean View (No. 1484).

Crataegus uniflora Muench. In dry, open woods near Edenton, N. C., (No. 1903).

AMYGDALACEAE.

Prunus americana Marsh. At water's edge on Cohoon Creek, near Suffolk (No. 1698).

Prunus angustifolia Marsh. Dry soil in fields and on roadsides, common, often forming small thickets (Nos. 80 C. & K., 1072).

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[1] *R. nigrobaccus* is the *R. villosus* of authors, not of Aiton.

[2] Determined by Mr. P. A. Rydberg.

Prunus cerasus L. A single tree in woods near Lynnhaven Station (No. 1122); adventive.

Prunus serotina Ehrh. Frequent, especially along streams (Nos. 1071, 1126); on the inner sand dunes, Ocean View to Cape Henry (Nos. 1209, 1396); a form with thickish leaves, as in var. *smallii* Britton.

MIMOSACEAE.

Albizzia julibrissin Duraz. Naturalized at roadsides and in open fields near the town. Edenton, N. C., July 28 (No. 1895).

CASSIACEAE.

Cercis canadensis L. On the wooded bank of a small lake near Suffolk (No. 1249).

Senna marilandica (L.) Roadsides near Virginia Beach.

Chamaecrista[1] aspera (Muhl.) Greene. Sandy roadsides, Newbern, N. C. (No. 2226).

Chamaecrista fascicularis Michx. Roadside near Virginia Beach, October 6 (No. 3136); in shallow water, marshy bank of the Trent River, Newbern, N. C., October 10 (No. 2218), growing with *Coreopsis gladiata* and *Centella asiatica.*

Chamaecrista nictitans (L.) Greene. In rather moist sandy soil, bordering a brackish meadow, Virginia Beach, August 4 (No. 2034).

VICIACEAE.

Baptisia tinctoria (L.) R. Br. In dry sandy soil, chiefly in pine woods, Lynnhaven Station; Edenton, N. C. (No. 1891).

Crotalaria purshii DC. In dry, open pine woods, Edenton, N. C., July 29 (No. 1905).

Medicago lupulina L. Introduced; common in fields and roadsides near Norfolk (No. 1294).

Trifolium arvense L. Dry sandy fields, introduced, Norfolk, May 20 (No. 1282).

Trifolium dubium Sibth. Roadsides, West Norfolk, introduced, May 10 (No. 1074).

Trifolium hybridum L. Roadsides near Norfolk, introduced, May (No. 1027).

Trifolium pratense L. Common, naturalized in fields and roadsides, May (No. 1301).

Trifolium procumbens L. Fields and roadsides, introduced, May; near Berkley (No. 1320); near Norfolk (No. 1277); a small form approaching *T. dubium.*

Trifolium repens L. Abundantly naturalized in fields and roadsides, May (No. 1298).

Psoralea pedunculata (Mill.) Vail. Sandy roadside near Edenton, N. C., July 29 (No. 1893).

Indigofera caroliniana Walt. In dry sandy soil, fields and edges of thickets, Newbern, N. C., August 1 (No. 1958).

Cracca spicata (Walt.) Kuntze. In dry sandy soil; Suffolk, July 11 (No. 1588); Edenton, N. C., July 29 (No. 1904).

Robinia pseudacacia L. In a thicket behind the dunes, Ocean View, May 18 (No. 1213); shore of Lynnhaven Bay.

Stylosanthes biflora (L.) B. S. P. Sandy soil along railways; Northwest, July 9 (No. 1489); Edenton, N. C., July 29 (No. 1869); a form approaching *S. riparia.*

Stylosanthes riparia Kearney. Sandy soil along railway near Suffolk, July 15 (No. 1684); prophyllum not lobed.

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[1] Chamaecrista determined by Mr. C. L. Pollard.

Zornia bracteata (Walt.) Gmel. Dry sandy roadsides, common. Newbern, N. C., August 1 (Nos. 1927, 1990).

Meibomia arenicola Vail. On the innermost sand dunes and in the flat pine woods behind them, Virginia Beach, October 3 (Nos. 2020, 2068).

Meibomia dillenii (Darl.) Kuntze. In dry pine woods, Edenton, N. C.

Meibomia marylandica (L.) Kuntze. With the preceding.

Meibomia nudiflora (L.) Kuntze. Low pine woods near Berkley, July 19 (No. 1742).

Meibomia obtusa (Muhl.) Vail. Roadsides, Newbern, N. C., October 10 (No. 2230).

Meibomia paniculata chapmani Britton. Low pine woods, Virginia Beach, August 3 (No. 2014).

Meibomia rigida (Ell.) Kuntze. Roadsides through pine woods, Virginia Beach, October 6 (No. 2144).

Meibomia stricta (Pursh) Kuntze. In an open pine wood, among grasses, Edenton, N. C., July 29 (No. 1884).

Meibomia viridiflora (L.) Kuntze. On the innermost pine-wooded sand dunes, Ocean View.

Meibomia sp. An apparently undescribed form with much the habit and foliage of *M. paniculata pubens*, but with the loment joints more rounded.

Lespedeza capitata Michx. Dry sandy roadsides, Newbern, N. C., October 10 (Nos. 2224, 2228).

Lespedeza procumbens Michx. In dry sandy soil, roadsides, and open pine woods, Northwest, July 9 (No. 1490); Virginia Beach, October 2 (No. 2096).

Lespedeza striata (Thunb.) Hook. & Arn. Frequent in dry sandy soil at roadsides, introduced (No. 2138).

Lespedeza stuvei neglecta Britton. Dry sandy roadsides, Newbern, N. C., October 10 (No. 2215).

Lespedeza virginica (L.) Britton. Dry sandy fields and borders of woods, Virginia Beach (No. 2100).

Vicia angustifolia Roth. Abundantly naturalized in fields and on roadsides, May (Nos. 75 C. & K., 1015).

Vicia hirsuta (L.) Koch. Abundant in dry sandy soil, fields, and roadsides, naturalized, May (No. 1014).

Vicia sativa L. Abundantly naturalized, fields and roadsides, May (Nos. 6 C. & K., 1030, 1323).

Bradburya virginiana (L.) Kuntze. Dry sandy soil, fields and roadsides, frequent, July (Nos. 1587, 1989, 2189).

Clitoria mariana L. Sandy soil at roadsides, Northwest, July 9 (No. 1523).

Falcata comosa (L.) Kuntze. In low, moist pine woods, Ocean View (No. 2395).

Apios apios (L.) MacM. Frequent in shaded, swampy ground (Nos. 1595, 2347). Known locally as "wild potato."

Galactia[1] **regularis** (L.) B. S. P. In dry sandy woods of *Pinus taeda*, Cape Henry, July 27 (No. 1831).

Galactia volubilis (L.) Britton. Abundant in dry sandy soil, roadsides, grassy fields, and pine woods (Nos. 1520, 1901, 1934, 2197). Exceedingly variable, especially in leaf form. No. 1934 has narrow, linear leaflets. No. 2197, collected at Newbern, N. C., has subcoriaceous leaflets with a shining upper surface, resembling those of *Galactia regularis*.

Rhynchosia tomentosa (L.) Hook. & Arn. In dry, sandy fields: Suffolk, July 11 (No. 1589); Newbern, N. C., October 10 (No. 1957).

Strophostyles helvola (L.) Ell. Among the outer sand dunes, Cape Henry, October 5 (No. 2135).

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[1] Galactia determined by Miss A. M. Vail.

Strophostyles umbellata (Muhl.) Britton. In dry sandy soil, fields, and roadsides (Nos. 1935, 2036).

GERANIACEAE.

Geranium carolinianum L. Roadside, Lambert Point, May 27 (No. 1021).

OXALIDACEAE.

Oxalis cymosa Small. Roadsides, etc., common (Nos. 1167, 1319, 1417).
Oxalis filipes Small. In open woodland, Suffolk, May 19 (No. 1266).
Oxalis recurva Ell. Sandy roadside, Ocean View, May 6 (No. 1016).
Oxalis stricta L. Roadsides, Suffolk, April 30 (No. 45 C. & K.).
Oxalis violacea L. Sandy field, Lynnhaven Station, May 13 (No. 1143).

LINACEAE.

Linum floridanum (Planch.) Trelease. Grassy roadside, Suffolk, July 11 (No. 1569); sandy field, Newbern, N. C., August 1 (No. 1978).
Linum medium (Planch.) Britton. In sandy fields, roadsides, etc., frequent, Cape Henry and Suffolk to Edenton, N. C. (Nos. 1492, 1569a, 1823, 1898, 2015).
Linum striatum Walt. In shade along a roadside ditch, Northwest, July 9 (No. 1527).
Linum virginianum L. (?) Shaded roadside, Virginia Beach, October 6 (No. 2140). Habit and spreading leaves of *L. virginianum*, but the capsule ovoid, pointed.

RUTACEAE.

Zanthoxylum clava-herculis L. Common on the innermost wooded sand dunes and in the pine woods behind them (No. 1767).

SIMARUBACEAE.

Ailanthus glandulosa Desf. Naturalized on bluffs along Nansemond River near Suffolk.

MELIACEAE.

Melia azedarach L. Roadside at Wallaceton, perhaps planted (No. 1805).

POLYGALACEAE.

Polygala incarnata L. Sandy fields, Northwest, July 9 (No. 1493); Suffolk, July 11 (No. — —).
Polygala lutea L. Boggy places, Newbern, N. C., July 31 (No. 1941).
Polygala mariana Mill. Open, sandy ground at waysides, Suffolk, July 11 (No. 1577); Edenton, N. C. (No. 1865).
Polygala verticillata L. Roadside, Suffolk, July 11 (No. 1568).

EUPHORBIACEAE.

Phyllanthus carolinensis Walt. In a low, sandy field, Edenton, N. C., July 29 (No. 1881).
Croton glandulosus L. Dry sandy waysides, Berkley; Newbern, N. C., July 31 (No. 1924).
Acalypha gracilens A. Gray. In a low field, Newbern, N. C., July 31 (No. 1926), not glandular; dry, sandy roadside, Virginia Beach, October 3 (No. 2103), sparingly glandular.

Tragia urens L. Dry sandy soil in open pine woods, Lynnhaven Bay (No. 2115).
Jatropha stimulosa Michx. Sandy soil, fields, and open pine woods, Ocean View, May 18 (No. 1222); near Suffolk, July 18 (No. 1727); Lynnhaven Bay.
Euphorbia ipecacuanhae L. Sandy soil in open woods, near Suffolk, July 18.
Euphorbia maculata L. Along railway, Edenton, N. C., July 29 (No. 1864).
Euphorbia nutans Lag. Roadside near Virginia Beach, October 3 (No. 2108).
Euphorbia polygonifolia L. Among the outer sand dunes, common, Ocean View to Virginia Beach (Nos. 1812, 2062).

CALLITRICHACEAE.

Callitriche heterophylla Pursh. In shallow ponds, common (Nos. 1109, 1256, 1257).

ANACARDIACEAE.

Rhus copallina L. Common in dry soil, fields, fence rows, open woods, etc. (Nos. 1150, 1683, 2372).
Rhus glabra L. Near Suffolk.
Rhus radicans L. Common, especially in low woods (Nos. 1026, 1123, 1759). Local name, "cow itch."
Rhus toxicodendron L. In dry woodlands, near Cape Henry (No. 1863); near Kempsville, Princess Anne County (No. 2165).
Rhus vernix L. Frequent in the more open parts of the wooded swamps. Known locally as "boar wood."

CYRILLACEAE.

Cyrilla racemiflora Walt. In a small swamp along a brook, Newbern, N. C.

ILICACEAE.

Ilex caroliniana (Walt.) Trelease. In dry sandy soil in copses near the Trent River, Newbern, N. C. (No. 2214).
Ilex decidua Walt. Frequent in the Dismal Swamp (No. 1667); at water's edge along Cohoon Creek above Suffolk (No. 1700).
Ilex glabra (L.) A. Gray. Common, especially in low pine woods (Nos. 1207, 2385).
Ilex lucida (Ait.) Torr. & Gr. Frequent about Lake Drummond (Nos. 95 and 106 C. & K., 1657, 1661).
Ilex opaca Ait. Common, especially in rather moist woods, May (Nos. 1117, 1188).
Ilex verticillata (L.) A. Gray. In the *Nyssa biflora* forest near Lake Drummond, Dismal Swamp, not common (No. 1644).

CELASTRACEAE.

Euonymus americanus L. Frequent in low woods and wooded swamps (Nos. 105 C. & K., 1347, 2102).

ACERACEAE.

Acer rubrum L. In low woods and wooded swamps, one of the most abundant trees of the region (No. 1637); in clearings about Lake Drummond, Dismal Swamp, occurs a form (No. 1660) with leaves less sharply lobed and white and somewhat pubescent on the under surface, which may be *A. drummondii* Hook. & Arn.

IMPATIENTACEAE.

Impatiens biflora Walt. Shaded soil on Lake Drummond, Dismal Swamp.

RHAMNACEAE.

Berchemia scandens (Hill) Trelease. Common in the wooded swamps, May (Nos. 1362, 1504). Locally known as "rattan."

Ceanothus americanus L. In low pine woods near Portsmouth.

VITACEAE.

Vitis aestivalis Michx. Common in dry pine woods, especially near the strand (Nos. 1318, 1769, 1777).

Vitis cordifolia Michx. In low woods, Northwest (No. 1502), near Suffolk (1707).

Vitis labrusca L. In swampy woods, Dismal Swamp (No. 1650), near Elizabeth City, N. C. (No. 2004).

Vitis rotundifolia Michx. In woods and among the inner sand dunes, very abundant (Nos. 39 and 103 C. & K., 1364, 1784).

Ampelopsis arborea (L.) Rusby. In a swamp near Newbern, N. C., August 1 (No. 1946).

Parthenocissus quinquefolia (L.) Planch. Abundant in woods (No. 1669).

MALVACEAE.

Sida spinosa L. An abundant weed in cornfields, Wallaceton (No. 2332).

Malva rotundifolia L. About wharves, Suffolk, introduced July 18.

Kosteletzkya virginica (L.) A. Gray. Salt marshes near Virginia Beach (No. 2120); edge of a marsh near Newbern, N. C. (No. 1925).

Hibiscus moscheutos L. Common at the edge of salt marshes (Nos. 1354, 1765). Local name "wild cotton."

HYPERICACEAE.

Ascyrum hypericoides L. Dry, sandy soil, open pine woods, roadsides, etc. (Nos. 1056, 1799, 2179).

Ascyrum hypericoides angustifolium (Nutt.) (*A. crux-andreae angustifolium* Nutt.). Dry, sandy roadside, Newbern, N. C. (No. 2205).

Ascyrum stans Michx. Low ground along ditches, etc., Suffolk (No. 1227); Edenton, N. C.; July 29 (No. 1888).

Hypericum galioides Lam. In moist, open ground near Newbern, N. C.; August 1 (Nos. 1932, 1933).

Hypericum mutilum L. Marshy ground on Lake Drummond; July 14 (No. 1651).

Hypericum perforatum L. At a roadside near Norfolk, introduced July 16 (No. 1686).

Hypericum pilosum Walt. Dry sandy fields near Newbern, N. C., August 1 (No. 1967).

Hypericum virgatum Lam. Frequent in sandy fields (Nos. 1953, 1982, 2048).

Sarothra gentianoides L. In moist sand about pools among the sand dunes, Ocean View (No. 1773); Virginia Beach (No. 2056).

Triadenum petiolatum (Walt.) Britton. In shady places along Washington Ditch, Dismal Swamp, July 13 (No. 1646).

Triadenum virginicum (L.) Raf. In the Dismal Swamp along Jericho Ditch (No. 1597); in a marsh near Newbern, N. C. (No. 2241).

CISTACEAE.

Helianthemum canadense (L.) Michx. In dry sandy soil among pines inside the sand dunes, Ocean View to Cape Henry, May (Nos. 1223, 1758, 2116).

Hudsonia tomentosa Nutt. Abundant among the sand dunes, Ocean View to Virginia Beach (Nos. 42 C. & K., 1000, 1398).

Lechea leggettii Britton & Hollick. Dry sandy soil, Edenton, N. C. (No. 1885): Newbern, N. C. (No. 1943); Virginia Beach (No. 2041).

Lechea maritima Leggett. Abundant among the sand dunes, Ocean View to Virginia Beach (Nos. 1001, 1387, 2094).

Lechea minor L. Dry sandy soil, fields and roadsides, Newbern, N. C. (Nos. 1966, 2204).

Lechea racemulosa Michx. In dry soil, roadside, Suffolk, July 11 (No. 1584).

Lechea villosa Ell. In dry sandy soil, edge of pine woods near Virginia Beach, August 4 (No. 2040).

VIOLACEAE.

Viola asarifolia Pursh. Edge of pine woods, Northwest (No. 1499).

Viola brittoniana Pollard. In low pine woods, Munden Point, Princess Anne County, May 16 (No. 1180).

Viola emarginata (Nutt.) Le Conte. Roadside through woods, Northwest, May 11 (No. 1112); sandy soil, edge of pine woods, Portsmouth, May 27 (Nos. 1363, 1377).

Viola lanceolata L. Moist sandy soil, Virginia Beach, April 29 (No. 2 C. & K.); Pungo, Princess Anne County, May 14 (No. 1187).

Viola pedata L. Sandy soil along railway, Suffolk, April 30 (No. 68 C. & K.).

Viola primulaefolia L. Frequent in moist sandy ground, May (Nos. 1045, 2339).

Viola sororia Willd. (?) Roadside, Berkley, May 21 (No. 1325).

Viola sp. In low grassy places near Virginia Beach, April 29 (No. 14 C. & K.); a probably undescribed species, according to Dr. E. L. Greene.

PASSIFLORACEAE.

Passiflora incarnata L. Roadsides and railway embankments, July (No. 1535).

Passiflora lutea L. Pine woods behind the dunes, Ocean View (No. 1217).

CACTACEAE.

Opuntia opuntia (L.) Coulter. Frequent along Lynnhaven Bay and in pine woods behind the dunes at Virginia Beach (No. 1384).

LYTHRACEAE.

Rotala ramosior (L.) Koehne. Frequent in marshy places (Nos. 1912, 2090). Specimens, 35 cm. (14 inches) high were collected at Edenton.

Decodon verticillatus (L.) Ell. Frequent in open places in, and at the edges of, wooded swamps (No. 1524).

Lythrum lineare L. Frequent in salt marshes, Virginia Beach, August 3 (Nos. 2013, 2045).

MELASTOMACEAE.

Rhexia ciliosa Michx. Common in boggy places, Newbern, N. C., August 1 (Nos. 1939, 1983, 2195).

Rhexia glabella Michx. In open bogs near Newbern, N. C., August 1 (No. 1986).

Rhexia mariana L. Common in open marshes (Nos. 1619, 1620, 1877, 1878, 1882, 1956, 2047, 2234). In all but the first two numbers, the petals are distinctly aristate.

Rhexia virginica L. Common in marshy places (Nos. 1563, 1621, 1910, 2335); in the last number the leaves are short-petioled.

ONAGRACEAE.

Isnardia palustris L. Common in moist, low ground and in shallow pools (Nos. 1553, 2163).

Ludwigia alata Ell. In a bog, Newbern, N. C., August 1 (No. 1961).

Ludwigia alternifolia L. In open places in the Dismal Swamp, July 14 (No. 1666).

Ludwigia glandulosa Walt. Along a ditch at roadside, Edenton, N. C., July 30 (No. 1921).

Ludwigia linearis Walt. Frequent in ditches and marshes, Newbern, N. C. (No. 2243); Wallaceton (No. 2336).

Ludwigia pilosa Walt. In a bog, Newbern, N. C. (No. 1954).

Ludwigia virgata Michx. Dry sandy fields, Newbern, N. C., August 1 (Nos. 1931, 1981).

Jussiaea decurrens (Walt.) DC. In marshy ground along the Dismal Swamp Canal, Wallaceton (No. 2353).

Onagra biennis (L.) Scop. Roadsides.

Oenothera humifusa Nutt. Abundant among the dunes, Ocean View to Virginia Beach (Nos. 43 C. & K., 1389, 1452, 1808).

Oenothera laciniata Hill. Frequent in sandy fields and roadsides near Norfolk, May (Nos. 1013, 1024).

Kneiffia longipedicellata Small. In fresh-water river marshes; along Northwest River, July 9 (No. 1515); along Pasquotank River (No. 1998).

Circaea lutetiana L. In rich, low woods, Ocean View, July 8 (No. 1468).

HALORAGIDACEAE.

Proserpinaca palustris L. Frequent in open, fresh-water marshes: Northwest, July 9 (No. 1548).

Proserpinaca pectinata Lam. With the preceding.

Myriophyllum heterophyllum Michx. Frequent in ponds: Ocean View, July 8 (No. 1455); Duck Pond, Dismal Swamp, July 13.

ARALIACEAE.

Aralia spinosa L. Common in dry pine woods, abundant inside the dunes (No. 2176.)

APIACEAE.[1]

Daucus carota L. Abundantly naturalized in fields and roadsides (No. 1433).

Eryngium virginianum Lam. In fresh-water river marshes: Along the Pasquotank River, August 3 (No. 2008); along the Northwest River (No. 2380).

Sanicula canadensis L. In fertile soil, open pine woods, Ocean View (No. 1470).

Foeniculum foeniculum (L.) Karst. Frequent at roadsides and about dwellings, naturalized (No. 1571).

Sium cicutaefolium Gmel. Common in fresh-water river marshes (No. 1730).

Cicuta maculata L. Frequent in marshes, especially at the edge of swampy woods (No. 2357).

Ptilimnium capillaceum (Michx.) Holl. In moist ground at roadsides: Northwest, July 9 (No. 1564); Edenton, N. C., July 30 (No. 1911).

Ptilimnium sp. nov.? Swampy banks of Cohoon Creek, near Suffolk, July 18 (No. 1705); immature.

Hydrocotyle ranunculoides L. f. In marshy places at roadside, Edenton, N. C. (No. 1908).

Hydrocotyle umbellata L. Common in moist, sandy soil (Nos. 1556, 1827, 1907).

Hydrocotyle verticillata L. In moist, sandy soil, Virginia Beach (No. 1383).

Centella asiatica (L.) Urban. Common in moist, sandy soil (Nos. 24 C. & K., 1382).

[1] Determined with the assistance of Dr. J. N. Rose.

CORNACEAE.

Cornus[1] **candidissima** Marsh. Swampy banks of Cohoon Creek, near Suffolk, July 18 (No. 1704).

Cornus florida L. Common in rather dry woodland (Nos. 7 C. & K., 1116).

Cornus stricta Lam. Swampy woods near northwest (No. 1110).

Nyssa[2] **aquatica L.** Abundant in the larger wooded swamps (Nos. 111 and 114 C. & K., 1111, 1340, 1353, 1615). Known locally as "papaw gum."

Nyssa biflora Walt. The most abundant tree of the wooded swamps (Nos. 109 C. & K., 1108, 1345, 1599, 1679, 1712, 1792.) Local designations "gum" and "black gum."

Nyssa sylvatica Marsh. Common in nonpalustrine woods (Nos. 1034, 1314, 1733).

CLETHRACEAE.

Clethra alnifolia L. Abundant in swamps (Nos. 30 C. & K., 1439, 1687).

PYROLACEAE.

Chimaphila maculata (L.) Pursh. In dry sandy pine woods inside the sand dunes, Virginia Beach (No. 2023).

Chimaphila umbellata (L.) Nutt. With the preceding (No. 2024).

MONOTROPACEAE.

Monotropa uniflora L. In low woods, Virginia Beach, Oct. 3 (No. 2076).

ERICACEAE.

Azalea canescens Michx. In open places in woodlands, frequent, May (Nos. 49 C. & K., 1062).

Azalea viscosa L. Common in wooded swamps, especially in the Dismal Swamp (Nos. 90 C. & K., 1042, 1440, 1532).

Kalmia angustifolia L. In the Dismal Swamp, along Jericho Ditch, not abundant (No. 91 C. & K.).

Kalmia latifolia L. In low woods: Deep Creek, May 17 (No. 1202); near Suffolk, May 19.

Leucothoë axillaris (Lam.) D. Don. Rather common in the Dismal Swamp, especially near Lake Drummond, May 2 (No. 76 C. & K.); Deep Creek, May 17.

Leucothoë racemosa (L.) A. Gray. Common in low woods and in the open parts of the wooded swamps, May (Nos. 78 and 102 C. & K., 1043, 1175, 1494).

Pieris mariana (L.) Benth. & Hook. Railway embankment near Suffolk, May 19 (No. 1226).

Pieris nitida (Bartr.) Benth. & Hook. Abundant in the more open parts of the Dismal Swamp (Nos. 85 C. & K., 1592). Known in the region as "hemlock," the popular name of *Leucothoë catesbaei* in the Alleghanies.

Xolisma[3] **foliosiflora** (Michx.) Small. Common in the more open parts of the wooded swamps, May (Nos. 83 C. & K., 1343, 1606, 1607, 1658).

Xolisma ligustrina (L.) Britton. Frequent in low woods (Nos. 1064, 1442); along Jericho Ditch, Dismal Swamp (No. 1607a), but there much less common than the preceding.

Oxydendrum arboreum (L.) DC. Common in open woodlands (Nos. 1069, 1578).

Epigaea repens L. Summit of a wooded bluff near Suffolk.

Gaultheria procumbens L. In a clearing on Lake Drummond, Dismal Swamp (No. 71 C. & K.).

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[1] Cornus determined by Dr. W. A. Evans.

[2] Nyssa determined by Mr. G. B. Sudworth.

[3] Xolisma determined by Dr. John K. Small.

VACCINIACEAE.

Gaylussacia frondosa (L.) Torr. & Gr. Common in woodlands, especially in open places (Nos. 1070. 1096, 1233, 1449, 1531).

Gaylussacia resinosa (Ait.) Torr. & Gr. In low, mixed woods behind the dunes, Virginia Beach, April 30 (No. 33 C. & K.); Cape Henry (No. 1834).

Vaccinium corymbosum L. Common in woodlands, especially in dry soil and rather open places (Nos. 37 and 77 C. & K., 1183, 1184, 1198, 1580).

Vaccinium vacillans Kalm. In dry woods, especially in open places, common (Nos. 32 C. & K., 1103, 1521, 1581).

Vaccinium virgatum tenellum (Ait.) A. Gray. Edge of upland pine woods near Suffolk, April 30 (Nos. 44, 54, and 60 C. & K., 1579).

Batodendron arboreum Nutt. Summit of a wooded bluff on Cohoon Creek near Suffolk (No. 1725). Apparently known in the region as "hackberry," the name usually applied to species of Celtis.

Polycodium stamineum (L.) Greene. Common in woods (Nos. 27 and 67 C. & K., 1093, 1833).

Oxycoccus macrocarpus (Ait.) Pers. Edge of a brackish meadow near Virginia Beach (No. 2042).

PRIMULACEAE.

Samolus floribundus H. B. K. Edge of a salt marsh, Great Bridge, May 26 (No. 1355).

Lysimachia angustifolia Michx. In a bog, Newbern, N. C. (No. 1955).

Lysimachia quadrifolia L. Sandy soil in open woods near Berkley, May 21 (No. 1305).

Lysimachia terrestris (L.) B. S. P. Moist sandy ground at edge of woods, northwest (No. 1562).

EBENACEAE.

Diospyros virginiana L. Abundant in dry soil in fields and thickets and on roadsides, and frequent on the inner dunes (No. 1407).

STYRACACEAE.

Styrax grandifolia Ait. A small shrub in low woods, scarce. Northwest (No. 1091); Pungo (No. 1170).

SYMPLOCACEAE.

Symplocos tinctoria (L.) L'Hér. Frequent, especially in low ground (Nos. 35 C. & K., 1166, 1172, 1201).

OLEACEAE.

Fraxinus caroliniana Mill.[1] Common in the wooded swamps (Nos. 1050, 1328, 1630, 1680).

Chionanthus virginica L. Swampy banks of Cohoon Creek near Suffolk (No. 1703).

LOGANIACEAE.

Gelsemium sempervirens L. Abundant in almost all formations except the salt and fresh water river marshes (Nos. 17 and 101 C. & K., 1168, 1997).

Cynoctonum sessilifolium (Walt.) Gmel. In a sedgy bog, Newbern, N. C., August 1 (No. 1962).

Polypremum procumbens L. Sandy roadside, Suffolk, July 11 (No. 1574).

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[1] Fraxinus determined by Mr. G. B. Sudworth.

GENTIANACEAE.[1]

Sabbatia angularis (L.) Pursh. Low ground, Northwest, July 9 (No. 1512).

Sabbatia calycina (Lam.) Heller. Shaded, swampy banks of streams, Suffolk (No. 1726); Edenton, N. C. (No. 1917).

Sabbatia dodecandra (L.) B. S. P. Fresh-water river marshes, Pasquotank River, near Elizabeth City, N. C., August 1 (No. 1996); Northwest River (No. 2377).

Sabbatia lanceolata (Walt.) Torr. & Gr. In open, boggy ground, Newbern, N. C., August 1 (No. 1945).

Sabbatia stellaris Pursh. In salt marshes on Lynnhaven Bay, July 27 (No. 1857).

Gentiana elliottii Chapm. Shaded woodsides through woodland, Virginia Beach, October 4 (No. 2137); Northwest, November 8 (No. 2384).

Bartonia virginica (L.) B. S. P. In marshy ground among pine woods, Edenton, N. C., July 29 (No. 1875).

APOCYNACEAE.

Vinca major L. About dwellings, Pungo, Princess Anne County, May 14 (No. 1155); escaped from gardens.

Apocynum cannabinum L. In open pine woods near Berkley.

Apocynum pubescens R. Br. In open pine woods, Ocean View, July 8 (No. 1472).

Trachelospermum difforme (Walt.) A. Gray. In a pine-barren bog, Edenton, N. C. (No. 1874).

ASCLEPIADACEAE.

Asclepias lanceolata Walt. In fresh-water river marshes, Northwest, July 9 (No. 1513); Elizabeth City, N. C., August 2 (No. 1992).

Asclepias pulchra Ehrh. In marshes, aloug Pasquotank River, Elizabeth City, August 2 (No. 2010); Wallaceton (No. 2340).

Asclepias variegata L. In dry pine woods, Suffolk, May 19 (No. 1262); Portsmouth, May 27 (No. 1368).

Vincetoxicum carolinense (Jacq.) Britton. In low pine woods, Virginia Beach, October 2 (No. 2072).

CONVOLVULACEAE.

Dichondra evolvulacea (L. f.) Britton. Railway embankment (probably introduced from farther south), Northwest (No. 2368).

Ipomoea hederacea Jacq. In cornfields, introduced, Wallaceton

Ipomoea pandurata (L.) Meyer. In sandy fields.

Ipomoea purpurea (L.) Roth. In fallow and cultivated lands, frequent, introduced (No. 2185).

Ipomoea quamoclit L. In a sandy field near Kempsville, Princess Anne County, introduced, October 7 (No. 2186).

Convolvulus americanus (Sims) Greene. Sloping bank of a pond inside the sand dunes, Virginia Beach (No. 2022).

Convolvulus repens L. Sandy field, Ocean View, May 30 (No. 1446).

CUSCUTACEAE.

Cuscuta arvensis Beyrich. In a sandy field, Suffolk, July 11 (No. 1583).

Cuscuta gronovii Willd. Frequent in the more open parts of the Dismal Swamp, on various plants (e. g., *Dianthera americana* L. and *Rubus nigrobaccus* Bailey).

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[1] Determined by Mr. C. L. Pollard.

BORAGINACEAE.

Cynoglossum virginicum L. In rich low woods near Suffolk, May 19 (No. 1228): Virginia Beach.

VERBENACEAE.

Verbena officinalis L. About wharves, Suffolk, introduced, July 18.

Verbena urticifolia L. Swampy woods along Cohoon Creek near Suffolk, July 18 (No. 1739).

Lippia sp. nov.? In brackish marshes near Virginia Beach, August 4 (No. 2033); nearly related to *L. lanceolata* Michx., but differs in the rather strict, negatively geotropic growth of the upper part of its stems, the erect, appressed, narrow leaves, usually purplish color of the whole plant, etc.

Callicarpa americana L. Common in low woods, especially near the strand (most abundant near Virginia Beach), (Nos. 1296, 1498, 2086).

NEPETACEAE.

Teucrium canadense L. In shady places near a spring, Lynnhaven Bay, July 27 (No. 1850).

Trichostema dichotomum L. In dry sandy soil, Virginia Beach, October 5.

Scutellaria integrifolia L. In the open, in moist, sandy soil, Portsmouth, May 27 (No. 1372).

Scutellaria lateriflora L. In swampy woods, margin of Lake Drummond, Dismal Swamp, abundant, July 14 (No. 1652).

Scutellaria pilosa Michx. In dry soil, open pine woods, Northwest (No. 1488).

Prunella vulgaris L. In low woods near Berkley, naturalized, May 21 (No. 1316).

Physostegia denticulata (Ait.) Britton. In marshy ground along railway, Elizabeth City, N. C., August 2 (No. 1999), small-flowered.

Lamium amplexicaule L. Naturalized in waste and cultivated land near Norfolk (No. 1286).

Salvia lyrata L. Dry, sandy soil, Northwest, May 11 (No. 1113).

Monarda punctata L. Frequent in dry, sandy soil, common at Cape Henry among the sand dunes (Nos. 1390, 1819, 1928, 2126).

Mesosphaerum rugosum (L.) Pollard. In moist ground, in the open, Newbern, N. C., July 31 (No. 1949).

Koellia hyssopifolia (Benth.) Britton. In dry, sandy soil, roadsides, and open pine woods: Edenton, N. C., July 29 (No. 1867); Newbern, N. C., August 1 (No. 1971); Ocean View (No. 2397).

Koellia mutica (Michx.) Britton. Dry, sandy soil, Newbern, N. C. (Nos. 1960, 2225).

Lycopus europaeus L. Adventive about wharves, Suffolk, July 18 (No. 1740).

Lycopus rubellus Moench. Frequent in wet, shaded ground, Virginia Beach, October 5 (No. 2123); margin Lake Drummond, Dismal Swamp, November 5 (No. 2358).

Lycopus virginicus L. Along a ditch at roadside, Virginia Beach, October 5 (No. 2148); in wet ground among Rhexia and *Andropogon virginicus*, eastern margin of the Dismal Swamp, November 3 (No. 2337).

Mentha rotundifolia (L.) Huds. Abundantly naturalized along a roadside near Norfolk, July 16 (No. 1692).

Mentha spicata L. Introduced on the edge of Lake Drummond, Dismal Swamp, July 14.

SOLANACEAE.

Physalis[1] **angulata L.** Cornfields, Wallaceton, July 22 (No. 1803).

Physalis virginiana Mill. In woodlands, Virginia Beach, May 20 (No. 1122), anthers violet.

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[1] Physalis determined by Dr. P. A. Rydberg.

Physalis viscosa L. In thickets of *Myrica carolinensis*, Cape Henry, scarce, May 28 (No. 1392).

Solanum carolinense L. Common in waste and cultivated land (No. 1357).

Solanum nigrum L. In a pine grove among the dunes, Cape Henry, July 26 (No. 1818).

Datura stramonium L. Along the Dismal Swamp Canal, Wallaceton, introduced.

Datura tatula L. A common, naturalized weed in waste ground.

SCROPHULARIACEAE.

Verbascum blattaria L. Naturalized in sandy fields near Norfolk, May 20 (No. 1281).

Verbascum thapsus L. Introduced at roadside near Centerville, Princess Anne County.

Linaria canadensis (L.) Dumort. Very common and abundant in sandy soil, May (Nos. 25 C. & K., 1019).

Pentstemon hirsutus (L.) Willd. In upland pine woods near Virginia Beach (No. 2098)—a glabrescent form.

Pentstemon pentstemon (L.) Britton. In a low field, with *Eupatorium rotundifolium*, Newbern, N. C. (No. 1947).

Mimulus ringens L. In marshy ground at roadside, Edenton, N. C., July 30 (No. 1909).

Monniera acuminata (Walt.) Kuntze. In moist sandy soil in the open, Edenton, N. C., July 29 (No. 1883).

Monniera monniera (L.) Britton. In brackish marshes near Virginia Beach, August 4 (No. 2046).

Gratiola pilosa Michx. Sandy soil, fields and roadsides, Northwest, July 9 (No. 1561); Edenton, N. C., July 29 (No. 1872).

Gratiola sphaerocarpa Ell. In marshy ground, usually in partial shade, Kempsville, October 7 (No. 2162); Wallaceton, November 3 (No. 2346).

Gratiola virginiana L. Moist low ground in woods near Berkley, May 21 (No. 1315).

Ilysanthes attenuata (Muhl.) Small. Edge of a cypress swamp, Edenton, N. C., July 30 (No. 1914); marshy ground beside a woodland road, Kempsville, October 7 (No. 2160).

Ilysanthes gratioloides (L.) Benth. In moist sandy soil in the open, Northwest, July 9 (No. 1544); Edenton, N. C., July 29 (Nos. 1873, 1880).

Veronica arvensis L. Grassy places near Virginia Beach, naturalized, April 29 (No. 12 C. & K.).

Buchnera elongata Sw. Dry, sandy, open ground, Newbern, N. C., July 31 (No. 1937).

Dasystoma flava (L.) Wood. Fertile soil in woods near Cape Henry (No. 1839).

Gerardia purpurea L. Common in low ground at roadsides, Virginia Beach, October 3 (No. 2074).

Gerardia sp. At a roadside through low pine woods, Newbern, N. C., October 10 (No. 2200)—nearest *G. purpurea*. The same form occurs at Starkville, Miss.

Gerardia sp. Dry, sandy roadside, Newbern, N. C., October 10 (No. 2203)—apparently intermediate between *G. tenuifolia* Vahl. and *G. divaricata* Chapm.

BIGNONIACEAE.

Bignonia crucigera L. Common near the margin of Lake Drummond, Dismal Swamp, climbing high, May 1 (No. 88 C. & K.); swampy woods near Edenton, N. C. Local name, "smoke vine."

Tecoma radicans (L.) DC. Common in dry soil, especially in the pine woods inside the sand dunes, July (Nos. 1037, 1483). Local name, "devil's shoe string."

Catalpa catalpa (L.) Karst. Edges of swampy woods along streams, frequent but not abundant (No. 1329).

OROBANCHACEAE.

Orobanche minor L. A common, naturalized weed about Norfolk and Portsmouth, growing usually on *Trifolium pratense*, also on *Vicia sativa*, *Daucus carota*, *Ranunculus bulbosus*, etc., May (Nos. 1276, 1300).

Conopholis americana (L. f.) Wallr. Low woods near Virginia Beach, April 29 (No. 29 C. & K.).

PINGUICULACEAE.

Utricularia clandestina Nutt. In the Jericho Ditch, Dismal Swamp; scarce; July 15 (No. 1682).

Utricularia fibrosa Walt. In a pond, Northwest, July 9 (No. 1552).

Utricularia inflata Walt. Frequent and sometimes abundant in ponds; near Suffolk, May 19 (No. 1258); near Virginia Beach, May 29.

Utricularia purpurea Walt. Abundant in Jericho Ditch, Dismal Swamp, July 15 (No. 1608).

ACANTHACEAE.

Ruellia ciliosa Pursh. Dry sandy soil in open woods, Northwest, July 9 (No. 1565); bluff on Cohoon Creek near Suffolk, July 18 (No. 1718).

Dianthera americana L. Abundant along streams on the northern margin of the Dismal Swamp.

PHRYMACEAE.

Phryma leptostachya L. Rich low woods, Northwest, July 9 (No 1501).

PLANTAGINACEAE.

Plantago lanceolata L. Grassy lawns and roadsides, naturalized, May (No. 1326).

Plantago rugelii Dec. Grassy roadsides and fields, July (No. 1750).

Plantago virginica L. Common in sandy fields, May (No. 1146).

RUBIACEAE.

Houstonia caerulea L. Frequent in fields and on roadsides, May (No. 1200).

Oldenlandia uniflora L. Moist sandy soil on the beach, Virginia Beach, October 2 (No. 2065).

Cephalanthus occidentalis L. Frequent about ponds and along streams (No. 1453).

Mitchella repens L. Frequent in rich low woods, near Ocean View, May 30 (No. 1441).

Diodia teres Walt. Common among the open sand dunes, Ocean View to Virginia Beach (Nos. 1809, 2093).

Diodia virginiana L. Moist sandy soil among the dunes, Ocean View to Virginia Beach (Nos. 23 C. & K., 1545, 1757).

Galium[1] **aparine** L. Abundantly naturalized along railway tracks near Berkley, May 21 (No. 1311).

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[1] Species of Galium of the *tinctorium* group determined by Dr. K. A. Wiegand.

Galium circaezans Michx. Summit of a wooded bluff on Cohoon Creek, near Suffolk.

Galium claytoni Michx. Moist, shaded ground, border of a marsh, Ocean View, July 20 (No. 1766); marshes of the Northwest River, July 9 (No. 1547); open, marshy ground, margin of Lake Drummond, Dismal Swamp, July 13 (No. 1613).

Galium hispidulum Michx. Common in the dry pine woods on and behind the innermost dunes, Ocean View to Virginia Beach (Nos. 41 C. & K., 1768, 2089.)

Galium pilosum Ait. In dry soil among undergrowth, Ocean View, July 8 (No. 1481).

Galium tinctorium filifolium Wiegand. In moist, sandy, open ground near Kempsville, May 9 (No. 1054).

VIBURNACEAE.

Sambucus canadensis L. Common along ditches at roadsides and in fields (No. 1299).

Viburnum dentatum L. Frequent in swampy woods along streams (Nos. 1105, 1263, 1702).

Viburnum nudum L. Common in wooded swamps (Nos. 70 C. & K., 1174, 1292, 1438, 1664, 1796). The distinction between forms of this species and *V. cassinoides* L. is not always clear. For example, Nos. 70 and 1664 have crenulate leaf margins, while No. 1796 has the peduncle shorter than the cyme.

Viburnum prunifolium L. In deciduous woods on the bank of a pond near Suffolk (No. 1250); at water's edge along Cohoon Creek above Suffolk (No. 1703).

Lonicera japonica Thunb. Abundantly naturalized at roadsides, May (No. 1260).

Lonicera sempervirens L. Common in most formations, but especially on the inner sand dunes, scarce in the wooded swamps, April–May (Nos. 19 and 82 C. & K., 1397, 1715).

VALERIANACEAE.

Valerianella chenopodifolia (Pursh) DC. Roadside near Suffolk, May 1 (No. 74 C. & K.).

Valerianella radiata leiocarpa A. Gray. Sandy roadside, Northwest, May 11 (No. 1076).

CUCURBITACEAE.

Melothria pendula L. Edge of swampy woods, eastern margin of the Dismal swamp, Wallaceton, July 21 (No. 1788).

CAMPANULACEAE.

Legouzia perfoliata (L.) Britton. Along railways near Suffolk, May 19 (No. 1264).

Lobelia cardinalis L. On hummocks, swampy banks of Cohoon Creek near Suffolk, July 18 (No. 1709).

Lobelia glandulosa Walt. Open, fresh-water marshes of the Northwest River (No. 2378).

Lobelia inflata L. Sandy fields, Northwest, July 9 (No. 1497).

Lobelia nuttallii Roem. & Schult. Sandy upland soil, in the open, Suffolk, July 11 (No. 1576).

Lobelia puberula Michx. Low pine woods near Virginia Beach, October 3 (No. 2075), flowers almost rose-colored; sandy roadside along an empty ditch, Newbern, N. C., October 10 (No. 2229).

CICHORIACEAE.

Adopogon virginicum (L.) Kuntze. Sandy roadside, Suffolk, April 29 (No. 63 C. & K.).

Sonchus asper Vill. Roadside near Norfolk, introduced, May 7 (No. 1025).

Lactuca sagittifolia Ell. Low woods, Northwest, July 9 (No. 1496), lower leaves sinuate-pinnatifid.

Sitilias caroliniana (Walt.) Raf. Frequent at waysides, along railways, etc., May–July (Nos. 1356, 1519).

Hieracium gronovii L. Sandy soil, in or near open pine woods, frequent, July (Nos. 1763, 1836, 1980).

Hieracium venosum L. Dry, sandy soil, Northwest, May 11 (No. 1101).

Nabalus albus (L.) Hook. Common in low woods, Princess Anne County, October 7 (Nos. 2143, 2173).

AMBROSIACEAE.

Iva frutescens L. Common in salt marshes, October (No. 2121).

Iva imbricata Walt. Frequent on the outermost dunes, near Ocean View to Virginia Beach, October (Nos. 1752, 2061).

Ambrosia artemisiaefolia L. Abundant in old fields.

Xanthium sp. Nearest *X. italicum* Murr. On the outermost dunes at Cape Henry, October 5 (No. 2124).

Xanthium sp. Cotton fields near Newbern, N. C., common, October 10 (No. 2202).

Xanthium strumarium L. Abundant in cornfields at Wallaceton, November 3 (No. 2331).

CARDUACEAE.

Vernonia noveboracensis (L.) Willd. In low ground, frequent in fresh-water river marshes. July–October (Nos. 1706, 2181, 2389).

Vernonia noveboracensis tomentosa (Walt.) Britton. (?) Low shaded ground at roadside near Virginia Beach, October 10 (No. 2110).

Elephantopus nudatus A. Gray. Common in open pine woods, July (Nos. 1868, 2019, 2170). No. 1868 is unusually villous, and resembles *E. tomentosus* L.

Eupatorium[1] **album** L. Summit of a wooded bluff near Suffolk, July 18 (No. 1732).

Eupatorium aromaticum L. Dry pine woods near Virginia Beach, October 3 (No. 2101).

Eupatorium capillifolium (Lam.) Small. Abundant in fields and roadsides, October (Nos. 1969, 1487, 2147, 2223, 2338). Sometimes known as "jimson weed," a popular name usually given to species of Datura.

Eupatorium coelestinum L. Low ground, especially at edges of woods, common near Virginia Beach, October (No 2095).

Eupatorium linearifolium Walt. Common in dry fields and open pine woods, October (Nos. 2055, 2111).

Eupatorium maculatum L. In low ground at the edge of woods, Kempsville, October 7 (No. 2180).

Eupatorium perfoliatum L. Marshes; a peculiar small form in rather dry, sandy soil, Newbern, N. C., October 10 (No. 2238).

Eupatorium pinnatifidum Ell. In sandy fields near Newbern, N. C., October 10 (No. 2240).

Eupatorium pubescens Muhl. In dry, upland pine woods, Virginia Beach, October 3 (No. 2097).

Eupatorium purpureum L. Swampy banks of Cohoon Creek, near Suffolk, July 18 (No. 1699).

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[1] Eupatorium determined with the assistance of Dr. E. L. Greene.

Eupatorium rotundifolium L. Common in rather moist, sandy fields, October (No. 1985).

Eupatorium semiserratum DC. Low pine woods, Virginia Beach, October 2 (No. 2070); Ocean View (No. 2396).

Eupatorium serotinum Michx. Low ground in pine woods, Virginia Beach, October 2 (No. 2084).

Eupatorium verbenaefolium Michx.? Border of woods, Princess Anne County, October (Nos. 2145, 2178).

Eupatorium verbenaefolium Michx. var.? In a sandy field, Newbern, N. C., October 10 (No. 2190).

Eupatorium sp. Undescribed, related to *E. hyssopifolium* L. With *E. pinnatifidum* at Newbern, N. C. (No. ——).

Willugbaeya scandens (L.) Kuntze. Frequent in marshy places (Nos. 1622, 1942, 2085).

Lacinaria graminifolia pilosa (Ait.) Britton. Dry sandy soil, pine woods and roadsides, Newbern, N. C., October 10 (Nos. 2207, 2231).

Trilisa paniculata (Walt.) Cass. In low pine woods, Newbern, N. C., October 10 (No. 2199).

Carphephorus tomentosus (Michx.) Torr. & Gr. With the preceding (No. 219[illegible]).

Chrysopsis graminifolia (Michx.) Nutt. Common in dry soil in open pine woods. (No. 2393.)

Chrysopsis mariana (L.) Nutt. Often with the preceding (No. 2109).

Solidago[1] bicolor L. Low woods and shaded banks near Virginia Beach, October 1 (No. 2079).

Solidago canadensis L. Common in roadsides and old fields, October (Nos. 2080, 2227).

Solidago erecta Pursh. At roadsides through woodland, Northwest, November 8 (No. 2386).

Solidago fistulosa Mill. In low places in pine woods near the strand, Virginia Beach, October 1 to 6 (Nos. 2058, 2191); Newbern, N. C., October 10 (No. 2245).

Solidago neglecta Torr. & Gr. (?) Low woods, Princess Anne County, October 5 (Nos. 2164, 2177); roadsides, Newbern, N. C., October 10 (No. 2222).

Solidago nemoralis Ait. Dry soil at the border of woods, Princess Anne County, October 2 to 5 (Nos. 2099, 2156).

Solidago odora Ait. Common in pine woods (No. 1689).

Solidago petiolaris Ait. Shaded bank at roadside, in sandy soil, near Newbern, N. C., October 10 (No. 2220).

Solidago pulverulenta Nutt. Low woods near Kempsville, Princess Anne County, October 7 (No. 2157), a much-branched form; low pine woods near Newbern, N. C., abundant, October 10 (No. 2193), a slender, virgate form.

Solidago rugosa Mill. In moist ground at edge of pine woods, Virginia Beach, October 2 (No. 2078). Plant merely puberulent, with rather thin leaves and long slender branches, indicating a transition to *S. ulmifolia* Muhl.

Solidago sempervirens L. Common at the edges of salt marshes and in moist sand among the dunes, October (Nos. 21 C. & K., 2057, 2151, 2219).

Solidago sp. In a swale at roadside, Edenton, N. C., July 30 (No. 1913). Apparently nearest *S. canadensis glabrata* Porter, but the leaves strongly scabrous above; the smooth glaucous stem and the inflorescence resemble those of *S. serotina* Ait., and suggest a hybrid of that species with *S. canadensis*.

Solidago sp. nov.? In open marshy ground at roadsides, Edenton, N. C., July 30 (Nos. 1897, 1900). Leaves distinctly triple-nerved; species apparently intermediate between *S. juncea* Ait. and *S. missouriensis* Nutt. The same form was collected in west central North Carolina by Small & Heller (No. 314).

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[1] Solidago determined with the assistance of Dr. E. L. Greene.

Euthamia caroliniana (L.) Greene. Abundant among the inner dunes and in low pine woods near the strand, October (No. 2060).

Boltonia asteroides (L.) L'Hér. In open marshes of the Northwest River (No. 2392).

Sericocarpus asteroides (L.) B. S. P. Frequent in dry soil; roadsides and open woods, July (No. 1585).

Sericocarpus bifoliatus (Walt.) Porter. Dry sandy roadside, Newbern, N. C., October 10 (No. 2232).

Aster[1] **dumosus L.** In low ground at the edge of woods, Kempsville, October 7 (No. 2174).

Aster dumosus gracilentus Torr. & Gr. In a grassy meadow, Newbern, N. C., October 10 (No. 2237).

Aster elodes Torr. & Gr. In slightly moist ground among the sand dunes, among bushes of *Baccharis halimifolia* and *Myrica carolinensis*. Cape Henry, October 5 (No. 2128).

Aster elodes Torr. & Gr., var. Open marshes of the Northwest River (No. 2376).

Aster ericoides L. Common in sandy soil: fields and roadsides, October (No. 2059).

Aster gracilis Nutt. Dry, sandy roadside, Edenton, N. C., July 29 (No. 1866).

Aster lateriflorus (L.) Britton. Common in low woodlands, October (No. 2175).

Aster novi-belgii atlanticus Burgess. At the edge of swampy woods, Northwest, November 8 (No. 2367).

Aster patens Ait. Dry sandy soil at roadside, Newbern, N. C., October 10 (No. 2208).

Aster puniceus L. In a swale at roadside, Newbern, N. C., October 10 (No. 2211); rays rose-colored.

Aster subulatus Michx. Common in salt marshes, October (Nos. 2083, 2119).

Aster tenuifolius L. With the preceding, somewhat less abundant, October (No. 2118).

Aster vimineus Lam. Rich. low woods on the eastern margin of Lake Drummond, November 5 (No. 2359).

Aster vimineus columbianus Britton. In low ground along the Dismal Swamp Canal, November 5 (No. 2355); edge of swampy woods, Northwest, November 8 (No. 2366).

Aster sp. In open low pine woods near Virginia Beach, October 6 (No. 2155). Near *A. hirsuticaulis* Lindl.

Heleastrum paludosum (Ait.) DC. Low, moist ground, in and near pine woods, Newbern, N. C., October 10 (No. 2201).

Erigeron annuus (L.) Pers. At roadsides and in fields, July (No. 1751).

Erigeron pulchellus Michx. In fertile soil in mixed woods near Suffolk, May 19 (No. 1248).

Erigeron ramosus (Walt.) B. S. P. In dry sandy soil, pine woods, frequent, May (Nos. 1234, 1425).

Erigeron ramosus beyrichii (F. & M.) Smith & Pound. In dry sandy soil; fields and open woods, Newbern, N. C., August 1 (Nos. 1936, 1988).

Erigeron vernus (L.) Torr. & Gr. Edge of swampy woods: Northwest, May 11 (No. 1097); Munden Point, Princess Anne County, May 16 (No. 1182).

Leptilon canadense (L.) Britton. Abundant in fields and roadsides (No. 1987); a glabrescent form with thickish leaves in moist sand among the dunes (Nos. 1756 (depauperate), 1807, 2054).

Ionactis linariifolius (L.) Greene. Frequent in dry, open, upland pine woods (No. 1847).

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[1] Aster determined by Dr. E. S. Burgess.

Baccharis halimifolia L. Abundant on and near the strand, among the dunes, at the edge of salt marshes, in low woods, etc.; less common farther inland, along ditches and in moist woods, October (Nos. 1058, 1163, 2051, 2131).

Pluchea camphorata (L.) DC. In a marshy place among the inner dunes, Virginia Beach, October 2 (No. 2082).

Pluchea foetida (L.) B. S. P. In a bog, Newbern, N. C., August 1 (No. 1972); in boggy places in pine woods behind the dunes, Ocean View, November 11 (No. 2394).

Antennaria[1] **arnoglossa** Greene. In woods near Suffolk, April (Nos. 58 C & K., 1244).

Antennaria decipiens Greene. In low pine woods, Portsmouth, April 27 (No. 27 (No. 1 C. & K.)).

Antennaria fallax Greene. With the preceding (No. 1a C. & K.).

Gnaphalium helleri Britton. Common among the sand dunes and in the pine woods behind, Cape Henry to Virginia Beach, October (No. 2052).

Gnaphalium purpureum L. In sandy fields, and frequent among the dunes at Virginia Beach, May (Nos. 1031, 1415, 1485).

Polymnia uvedalia L. In fertile soil at the edge of woods, near Suffolk; near Virginia Beach.

Silphium trifoliatum L. Dry soil at roadside near Virginia Beach (No. 2106).

Parthenium integrifolium L. Low ground near Suffolk, May 19 (No. 1254).

Eclipta alba (L.) Hassk. Cornfields near Newbern, N. C., July 31 (No. 1950).

Rudbeckia laciniata L. In a swale at roadside, Newbern, N. C., October 10 (No. 2209).

Borrichia frutescens L. Edge of a salt marsh, Tanners Creek, near Norfolk, July 16 (No. 1693).

Helianthus angustifolius L. In sandy soil, openings in pine woods, Newbern, N. C., October 10.

Helianthus atrorubens L. Dry sandy soil in pine woods, near Suffolk; near Lynnhaven Bay.

Verbesina occidentalis (L.) Walt. Roadsides near Virginia Beach, October 3.

Verbesina virginica L. With the preceding (No. 2105).

Coreopsis angustifolia Ait. Low pine woods, Newbern, N. C., October 10 (No. 2192).

Coreopsis gladiata Walt.(?) Marshy shores of the Trent River, with *Chamaecrista fascicularis* and *Centella asiatica*, Newbern, N. C., October 10 (No. 2213). Stems more branching and leafy and heads smaller than is ordinarily the case in *C. gladiata*.

Bidens bipinnata L. Naturalized at roadsides and in waste ground.

Bidens cernua L. Marshes of the Northwest River (No. 2391).

Bidens frondosa L. Shaded ground at roadsides, Virginia Beach, October 6 (No. 2154).

Bidens trichosperma (Michx.) Britton. Marshes of the Pasquotank River, August 2 (No. 1994).

Bidens trichosperma tenuiloba (A. Gray) Britton. Marshes of the Northwest River, November 8 (No. 2375).

Achillea millefolium L. Abundantly naturalized in fields and roadsides, May–July (No. 1304).

Achillea millefolium L. var. In open pine woods near the strand, growing with *Apocynum pubescens*, etc., Ocean View, July 8 (No. 1482). Stem more rigid, plant somewhat tomentose, inflorescence small, very compact, leaves more appressed to the stem.

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[1] Antennaria determined by Dr. E. L. Greene.

Chrysanthemum leucanthemum L. Abundantly naturalized in fields and waste ground, May (No. 1289).

Arnica acaulis (Walt.) B. S. P. Frequent in rather low woods near Suffolk, May (Nos. 65 C. & K., 1231)

Erechtites hieracifolia (L.) Raf. In open woods and clearings, common, October (Nos. 1614, 2167).

Senecio smallii Britton. A single large clump along a railway near Suffolk, appearing as if introduced (from western Virginia?), May 19 (No. 1271).

Senecio tomentosus Michx. Abundant in fields and roadsides, especially in rather moist ground, April–May (Nos. 26 and 46 C. & K.).

Arctium lappa L. In waste ground at Deep Creek, Norfolk County; introduced.

Carduus spinosissimus Walt. In moist sandy soil, in the open, especially common near the strand, May (Nos. 1211, 1253).

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[1] Only such literature as was used in the actual preparation of this report is here cited.

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A SKETCH MAP OF THE DISMAL SWAMP DISTRICT OF VIRGINIA AND NORTH CAROLINA

___INUNDATED LANDS.

THE WHITE AREAS WITHIN THE SWAMPS ARE DRAINED LANDS.

SCALE = 0 1 2 3 4 5 MILES.

76° 30 — 76°15′ — 76°00′ — 75°45′

36° 45′ — 36° 30′ — 36° 15′ — 36°

CHESAPEAKE BAY

HAMPTON ROADS

Newport News

Ocean View

LYNN HAVEN BAY

CAPE HENRY

Tanner

Churchland

NORFOLK

Portsmouth

Berkley

Kempsville

Virginia Beach

ATLANTIC OCEAN

Sand Bridge

Deep Creek

ALBEMARLE & CHESEPEAKE CANAL

Great Bridge

Centerville

JERICHO CANAL

HERRING CANAL

DISMAL SWAMP CANAL

WASHINGTON DITCH

LAKE DRUMMOND

Wallceton

Indian Head

BACK BAY

ESCARPMENT

STATE BOUNDARY LINE

VIRGINIA

NORTH CAROLINA

DISMAL SWAMP

Northwest

Moyock

Currituck C.H.

NANSEMOND

South Mills

Baily

Camden C.H.

ELIZABETH CITY

Pasquotank

Pasquotank River

Hertford

Perquimon River

Little River

Jarvisburg

Poplar Br.

WADE PT.

STEVENSON PT.

HARVEY PT.

DRUMMOND PT.

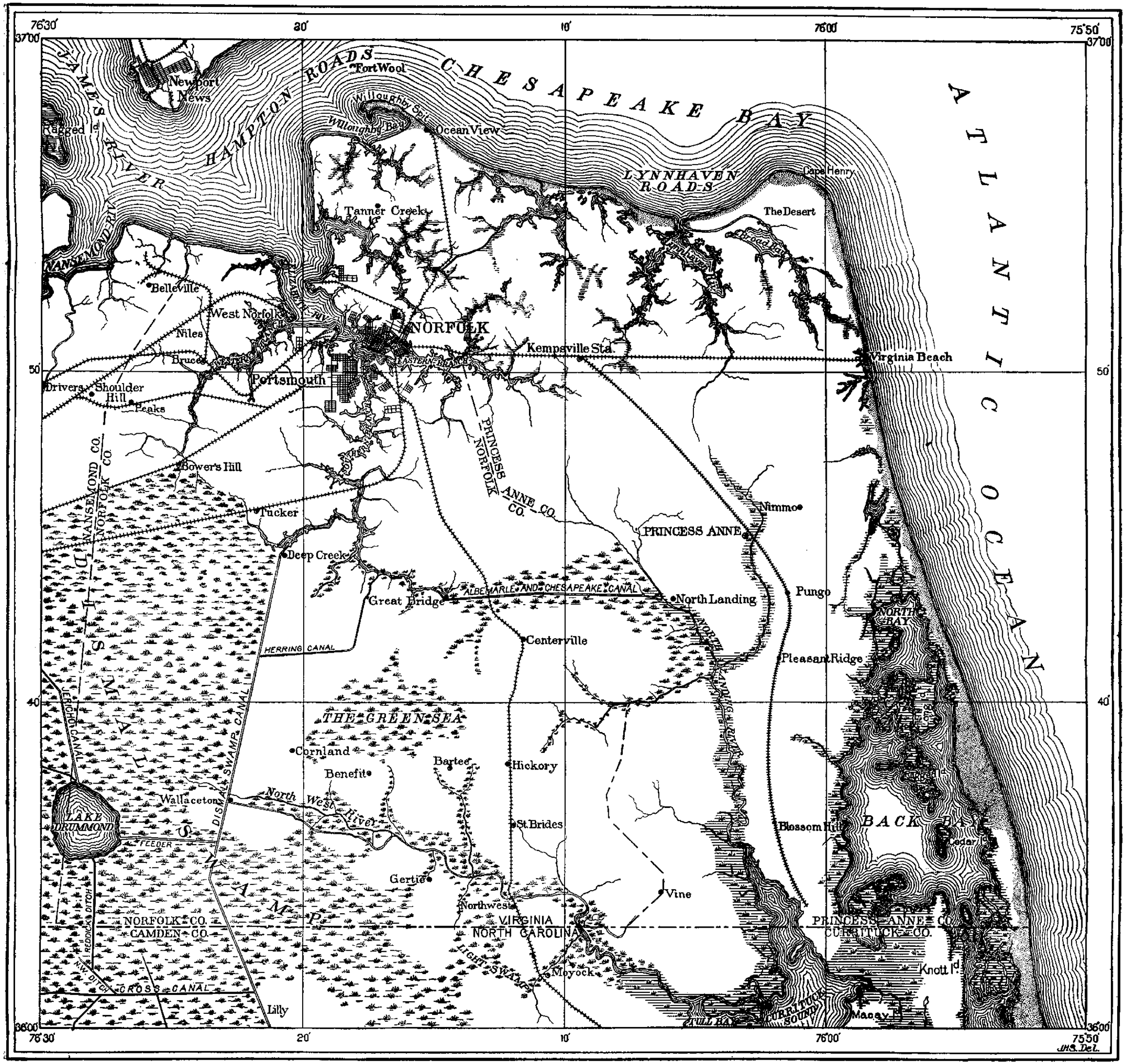
POWELL PT.

EDENTON

SANDY PT.

ALBEMARLE SOUND

W.R. SCHOLL DEL.



NORFOLK PENINSULA, SHOWING FRESH AND SALT WATER MARSHES, SAND DUNES, AND UPLANDS.