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THE POND FLORA OF CAPE COD.

EDMUND W. SINNOTT.

THE flora of Cape Cod presents many features of interest to the botanist, for it includes scores of plants which are unknown or rare on the rest of the mainland of Massachusetts and which find their best development on the sandy soil of the coastal plain. Botanizing anywhere on the peninsula is consequently attended, at least to the new-comer, by the formation of many new acquaintances among the plants of the beaches, the salt-marshes, the barrens and the swamps, which have each their distinct vegetation and their particular interest.

Perhaps the most fascinating collecting-ground for the field botanist, however, is furnished by the hundreds of ponds scattered everywhere over the Cape. These range in size from the tiny sloughs in every hollow to such large lakes as Wakeby Pond in Mashpee, Nine-Mile Pond in Barnstable and Pleasant Lake and Long Pond in Harwich. It is in the waters and along the shores of these ponds that are found many of the characteristic coastal-plain plants which here reach their northern limit in the United States. During the past five summers the writer has been fortunate enough to visit nearly all the large ponds on Cape Cod and many of the smaller ones in almost every town of Barnstable County. The object of the present paper is to record certain observations as to the general character of the pond vegetation and as to the distribution of the various plants of which it is composed.

The ponds of Cape Cod fall naturally into two main groups: those which are well drained and have practically the same level throughout the year, and which include all mill-ponds, herring-ponds and others

from which streams are continuously flowing; and those which have poor drainage or none at all. To the latter group belong the great majority of the small ponds as well as most of the larger ones.

The vegetation along the shores of the well-drained ponds is not distinctive and is very much like that found in similar situations throughout southeastern New England, save that it is somewhat less luxuriant. Wide sandy shores are, of course, absent. Where the bottom shelves off deeply and the banks are at all precipitous, the pine and oak flora of the barrens comes down to the water's edge and the sandy or pebbly bottom near the shore will support only such plants as *Nymphoides lacunosum*, *Lobelia Dortmanna* and *Scirpus americanus*. In the majority of cases, however, the slope of the shore-line is much more gradual, and allows the accumulation of a considerable deposit of mud and silt, which forms a congenial habitat for a large group of plants, of which *Pontederia cordata* and *Decodon verticellatus* are perhaps the most characteristic. These are found along the shores of all ponds whose water-level is approximately stable, and with them are such familiar things as *Typha latifolia*, *T. angustifolia*, *Sparganium americanum* var. *androcladum*, *Sagittaria latifolia*, *Scirpus validus*, *Acorus Calamus*, *Impatiens biflora*, *Ludwigia palustris*, *Asclepias incarnata* var. *pulchra*, *Bidens connata* and very many others, which form the dense and (for the Cape) luxuriant vegetation of such pond-shores. In the water flourish *Castalia odorata*, *Nymphaea advena*, *Myriophyllum humile*, various species of *Potamogeton*, notably *P. Robbinsii*, and other equally familiar plants. This general group of mud-loving things, particularly *Sparganium americanum* var. *androcladum* and *Sagittaria latifolia* are also characteristic of cranberry-bog ditches and sloughs wherever alluvial mud has been deposited. This whole mud flora is practically identical with that of similar situations throughout southeastern New England but comprises a very different group of plants from those growing on the peaty mud of the undrained ponds in the sand-barrens.

The ponds where drainage is incomplete or absent constitute the great majority of all the bodies of water on Cape Cod, and have associated with them a large and distinctive flora. The water-level here is subject to great fluctuations, and the surrounding dry-ground vegetation is consequently forced to stop at the extreme high-water mark, with the result that in the summer months, when all the ponds are apt to be rather low, a sandy beach extends for some distance upwards

from the water's edge. In ponds with absolutely no outlet, the rise and fall of the water is greatest, and the beach here is of considerable width, but in many cases the pond overflows into a drainage-brook at a little above its normal summer height and is consequently surrounded at that season by only a narrow belt of sandy shore. This is the case with most of the large lakes.

The character and extent of the vegetation on these beaches and in the shallow water at the pond-edge vary considerably from one pond to another and seem to be under the control of several different factors.

Small ponds, in general, show a much more luxuriant plant-growth around their shores than do larger ones, which are apt to have long stretches of pure sand or gravel beach and bottom, practically devoid of vegetation. This may well be explained by the fact that the wave-action, which is much more vigorous on extensive sheets of water than on smaller ones, has in these larger ponds pretty thoroughly washed out all the mud and fine material in the sand, and left it in much the condition of a barren sea-beach. It is also conceivable that in the winter and spring, when the water is usually highest and storms are most frequent, the waves should wash out and destroy seeds and young plants which had found lodgment along the shore. It is noticeable that wherever the soil next the shore has been disturbed and broken up, as by a cutting or a road, the waves have spread the sand up and down the beach for a considerable distance, to the practical exclusion of all vegetation. These same sterile sandy beaches are also occasionally found on small ponds, but in such cases a good depth of water and an abruptly sloping bottom are always observable. Wherever conditions are favorable, therefore, for washing out fine material of all kinds from the shores and depositing on the bottom, a sterile beach of pure sand and gravel will result.

Most of the smaller ponds, which are protected by their size from violent wave action, have bottoms sloping gently to no great depth and consequently both the beaches and the shallow shores are well able to support a considerable vegetation.

It is also noticeable that on the same pond such portions of the shoreline as are most exposed to the waves or which have especially steep slopes are much less thickly covered with plants than are the protected stretches, and that the coves or sheltered places always show a more luxuriant vegetation than do the open straight beaches.

This condition has had an important influence on the process of filling which has been going on since the ponds were left at the retreat of the ice-sheet. Their original shape seems in most cases to have been decidedly irregular, for every pond of any size has along its shore a number of indentations in all stages of filling, from shallow pools with thickly covered shores to peat-filled swamp-holes. These are cut off from the rest of the pond, at least in their later stages, by a barrier of sandy beach, and simply represent small arms of the original pond which from their sheltered position have filled rapidly and been constricted off from the main body of water. The tendency is always for a pond to smooth off its shores, thus approaching more and more to a roughly circular shape, and for the large, and especially the long and narrow ponds to become divided up into a number of smaller ones, each of which centers about some particularly broad and deep portion of the original.

The flora of the pond-shores is varied and, as has been said, contains many characteristic Cape Cod plants which from their distribution are worthy of note.

The upper edge of the beach is dry sand or gravel in summer and is apt to be invaded by herbaceous members of the surrounding sand-barren flora. Here *Aletris farinosa*, *Polygala polygama*, *Cassia nictitans*, *Linum virginianum*, *Chrysopsis falcata* and many other common things find a congenial habitat.

The plants of the lower parts of the beach, however, whose roots are in damp sand, form a distinct group, the members of which occur in practically no other situation. A list of the commonest and most characteristic beach plants, which would be found along almost every undrained pond of any size on Cape Cod, includes the following:—

Lycopodium inundatum var. *Bigelovii*, on damp sand and also on peaty mud.

Cyperus diandrus, universal and usually the first plant to gain a foothold on the sterile portions of the beach.

Rhynchospora glomerata.

Xyris caroliniana.

Polygonum Carey.

Hypericum virginicum and *Gratiola aurea*, extremely common everywhere and flourishing equally well on sand or mud.

Hypericum canadense.

Rhexia virginica.

Lysimachia terrestris.

Sabatia dodecandra, a beautiful flower and one of the glories of the Cape. It is apparently absent below Eastham.

Drosera filiformis, flourishing everywhere and sometimes attaining a height of 18 inches.

Drosera longifolia.

Polygala cruciata.

Stachys hyssopifolia, abundant on the upper Cape but rare beyond Brewster.

Lycopus sessilifolius.

Gerardia purpurea.

Coreopsis rosea, extremely abundant.

Solidago tenuifolia, characteristic of dry sandy soil all over the Cape, yet thriving on the damp sand of every pond-shore.

These are all very common and universally distributed, but there are many others the occurrence of which is less general or which are rare and local. Such plants are, —

Panicum Wrightianum Scribn., common on the middle Cape. This species, based upon Cuban collections of Charles Wright's, was unknown in the northern states at the date of issue of the 7th edition of Gray's Manual; but it was collected on Cape May, New Jersey, in 1909 by Mr. Witmer Stone and its discovery as a common grass on Cape Cod makes a striking addition to our "pine barren" flora. The material was determined by Mrs. Agnes Chase.

Scleria reticularis and *Fuirena squarrosa*, rare, collected by the writer only from the "Mary Dunn's" Ponds in Barnstable.

Rynchospora macrostachya, rather common.

Hemicarpha micrantha, easily overlooked but probably pretty common. It prefers pure sand.

Fimbristylis Frankii, occasional.

Eleocharis melanocarpa. On a few ponds.

Carex of several species, notably *C. lurida*, but *C. albolutescens*, *C. hormathodes* and others are often present.

Xyris flexuosa, rather common.

Lachnanthes tinctoria, abundant on many ponds but often lacking especially on the lower Cape.

Drosera rotundifolia, common on *Sphagnum*, patches of which are often present on well-covered shores.

Crotalaria sagittalis, local, found only on two ponds in Sandwich.

Sabatia gracilis, found by the writer only on a few ponds in the eastern part of Barnstable.

Lycopus rubellus, locally common.

Utricularia cornuta, rather frequent on sandy shores. It also appears on *Sphagnum* and occasionally on the edge of brackish marshes.

Certain members of this group of beach-plants, such as both species of *Sabatia*, *Drosera filiformis*, *Hemicarpha* and *Crotalaria* prefer a situation rather well up the beach, where the sand is not too wet, while others, such as *Rynchospora macrostachya*, *Gratiola*, *Hypericum virginicum*, *Lysimachia terrestris* and *Lycopodium* choose lower and damper locations, and usually appear only after a perceptible amount of fine material has accumulated. Most of the plants, however, are satisfied with almost any situation where the soil is essentially sandy and not too dry. They must of necessity be able to adapt themselves to the migrating shoreline.

The nature of the vegetation in the shallow water along the shore depends on the character of the pond and the amount of filling and of deposition of mud that has taken place. On a bottom of pure sand the first thing to make its appearance is *Nymphoides lacunosum* which usually grows in a rather narrow zone at some distance from the shore. Nearer the water's edge flourishes *Juncus militaris*, the most common and characteristic rush of the sandy ponds, and growing with it and nearly as universal is *Lobelia Dortmanna*. *Scirpus americanus* is always present, either scatteringly or in wide patches. These four plants prefer a sandy bottom and until sediment begins to accumulate comprise practically all the marginal vegetation. The deposition of decaying plant remains and the formation of peat accompany the filling of these ponds and the fine material is in this instance different from the more or less alluvial mud of the drained ponds and supports quite another group of plants. The most characteristic things associated with these later stages in the pond's history and which flourish only in the calm and shallow waters of the protected coves, or on their peaty shores and islands, are the following: —

Sparganium lucidum, local, and found by the writer only in Barnstable.

Sagittaria Engelmanniana, very common everywhere and showing great variety in the shape of its leaves.

S. teres, probably rather common but found by the writer only in Sandwich, Barnstable, Yarmouth and Wellfleet. In shallow water and where the bottom is sandy it has short and stout phyllodes, but more commonly they are long and tapering.

Eleocharis acicularis, on peaty shores everywhere.

E. Robbinsii, the dominant plant in very shallow, peaty ponds, gradually encroaching from the shore and finally converting the whole pond into a grassy swamp.

Cladium mariscoides, common on many ponds but often absent.

Dulichium arundinaceum, abundant and delighting in the thick vegetation along the peaty shores.

Rhynchospora alba, locally common on peat.

Eriocaulon septangulare, on muddy bottoms in shallow water everywhere.

Xyris Smalliana, a striking species, usually confined to floating masses of peat, and fairly common where they are present. The writer has observed it in Barnstable, Harwich and Wellfleet.

Juncus pelocarpus, common everywhere, but exceedingly abundant on certain ponds where there is a rather pebbly bottom and not much mud. It also thrives well above the water-mark.

J. canadensis, often abundant at the water's edge.

J. marginatus, rather common.

Proserpinaca pectinata, locally common on mud.

P. palustris, rare, found only an Snake pond in Sandwich.

Myriophyllum tenellum, fairly common.

Utricularia vulgaris var. *americana*, occasional.

U. purpurea, common on muddy bottoms.

U. biflora, rare, on sandier shores.

Castalia and *Pontederia* are often present, and in the last stages of filling, when the pond has become a bog, other plants appear, which are more characteristic of the half-drained and muddy swamps. These are *Sparganium americanum* var. *androclodum*, *Sagittaria latifolia*, *Cyperus dentatus*, *Eriophorum virginicum*, *Nymphaea advena*, *Brasenia Schreberi*, *Sium cicutaefolium* and many others.

It will therefore be apparent that, as might be expected, a large percentage of the flora of the undrained sandy and peaty ponds, where conditions are very similar to those on Long Island and New Jersey, is composed of plants whose distribution is confined to the Atlantic coastal plain and its extensions.

The distribution of the pond-plants, in common with that of the rest of the flora, is influenced to a considerable extent by the topography of Cape Cod. The "backbone of the Cape" is formed by two fan-shaped terminal moraines, one of them of rather low hills running north and south along the eastern shore of Buzzard's Bay and stringing out into the Elizabeth Islands; and the other, with slightly higher elevations, which sometimes reach nearly 300 feet, extending east and west down the north shore of the main body of the Cape. East and south of these moraines, respectively, the country is mostly barren sand-plain from the soil of which practically all the fine material was washed by the waters flowing from the glacial ice-front; while on the narrow strips of land on the other side of the hills, in each case, and between them and the water, the country is much more fertile. This is particularly noticeable on the north shore of the Cape, in the northern parts of the towns of Sandwich, Barnstable, Yarmouth and Dennis, where there is considerable clay in the soil, deposited on the bottom of a dammed-up glacial lake or scooped up by the ice-sheet from the bottom of the bay. In these richer strips muddy drained ponds and alluvial swamps are conspicuous, while the typical sandy ponds, with their coastal-plain vegetation, are practically confined to the above-mentioned barrens and to the very sandy "forearm," from Chatham to Provincetown.

Although conditions are very similar throughout these sandier parts of the peninsula, the pond flora, in common with the rest of the vegetation, grows less varied as one goes eastward "down" the Cape. Of course the commonest and most characteristic plants (with one or two exceptions, such as *Stachys hyssopifolia*, which apparently does not occur below Brewster) are nearly universal in their distribution, but many of the less common things stop somewhere on the upper (western) part of the Cape. *Sabatia dodecandra*, for example, gets as far as Eastham, but the smaller species, *S. gracilis*, together with such plants as *Scleria reticularis* and *Fuirena squarrosa* reach their eastern limit on the group of small ponds near the Barnstable-Yarmouth line. *Crotolaria*, in the same way, does not come east of the town of Sandwich.

This central part of the Cape, including the towns of Sandwich, Barnstable and Yarmouth, has by far the richest pond-flora in the county. Snake, Peter's, Triangle and Spectacle Ponds, in Sandwich have wide sandy beaches and a large flora which, together with their

comparative inaccessibility, makes them a fascinating collecting-ground. Wakeby Lake (really in Mashpee) with the Cotuit Ponds and Great Nine-Mile Pond, in Barnstable, are all partially drained and have narrow gravelly beaches for the most part, which are often uninteresting, though in certain spots there is excellent collecting. Perhaps the richest flora of all, however, is found on the "Mary Dunn's" Ponds near the eastern border of Barnstable township. There are a score or more of these, of all sizes and in all stages of filling, and a number of plants grow here which the writer has found nowhere else on the Cape. In Yarmouth, also, there are many interesting collecting-places, notably Dennis, Miller, Greenough and other smaller ponds in the northern part of the town and Sandy, Basslot, Flax and others nearer the south shore. Of course the ponds of the lower Cape, such as those about Pleasant Lake in Brewster and near the villages of Eastham and Wellfleet, have a large and varied flora, as have the ponds in the Falmouth region, to the west, but many plants are rare or absent there which occur commonly in the Barnstable area.

The often sporadic and local distribution of many Cape plants would conform to what one might naturally expect of the behavior of a previously more extended coastal plain flora which is gradually dying out, and, from other evidence, it seems very possible that something like this is happening. On the other hand, the fact that vegetation both to the eastward and to the westward of the above-mentioned central region is progressively less and less rich in coastal-plain plants makes it reasonable to suppose that we have here a center of distribution for these things, which have come north not along the southern coast of Connecticut and Rhode Island, probably, for they are rare or absent there, but through Long Island, across to Martha's Vineyard and Nantucket and thence across Vineyard Sound to the mainland of Cape Cod. Their distribution here perhaps marks out roughly the position of an arm of the ancient coastal plain. The whole question is of great interest in connection with Professor Fernald's discovery of a large coastal plain flora in Nova Scotia and Newfoundland, but more data must be gathered before any very definite conclusions can be drawn in regard to the origin of the flora of Cape Cod.

The foregoing paper does not pretend to give a complete account of the pond vegetation of Cape Cod, but the writer has attempted to

enumerate merely the common and distinctive members of the pond flora, together with such of the more rare plants as have come within his experience, and to set forth certain observations as to their behavior and distribution. Much more active collecting must be done on the Cape before we can feel sure that its flora is well known, and there are few regions so near Boston which offer to the field botanist such opportunities for interesting and valuable work.

The writer wishes to express his thanks to those who have aided him in gathering data, especially to Mr. William G. Vinal, of the Providence Normal School.

CAMBRIDGE, MASSACHUSETTS.

QUERCUS IMBRICARIA MICHX. IN MASSACHUSETTS.

GEO. G. KENNEDY.

SARGENT in his manual of the trees of North America (1905) gives Lehigh county, Pennsylvania, as the northern limit of this species in the Eastern United States and says of it: "occasionally planted as an ornamental tree in the northern states and hardy as far north as Massachusetts"; and in the *Sylva*, vol. VIII, p. 177, calls it "one of the most beautiful of the American oaks, and a most distinct and desirable ornament of the parks and gardens of eastern America, where it is perfectly hardy as far north at least as the shores of Massachusetts Bay."

And yet it appears to be a rare tree in cultivation in this vicinity, two trees only being reported outside the Arnold Arboretum. One of these is near the entrance to the Chestnut Hill Reservoir, and the other close to Brush Hill Road in the town of Milton.

Prof. Sargent informs me that he has had two plantings of this species in the Arboretum: one in 1873, and one in 1887, and both from Meehan of Philadelphia. The Reservoir tree is of the 1873 planting and was sent with other oaks from the Arboretum to be set in the Boulevard adjacent to the Reservoir. There are several fine trees of the 1873 planting in the Arboretum; the best one is growing near the Motley house. This tree has a girth of 47 inches at three



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