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PEAT DEPOSITS OF MAINE

BY

EDSON S. BASTIN

AND

CHARLES A. DAVIS

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CONTENTS.

	Page.
Preface	7
Fuel in New England	8
Nature of peat	9
General conditions of peat formation	9
Conditions favoring plant decay	9
Conditions of growth of peat-forming plants	10
General outline	10
Plants concerned in formation of peat in lakes and ponds	10
Plants concerned in formation of peat in moist depressions	15
Relation between the two types of peat deposits	16
Variable character of peat deposits	17
Present floras of peat bogs	17
Salt marshes	19
Origin	19
Economic value	21
The uses of peat	22
Introduction	22
Factors influencing the successful utilization of a peat deposit	22
Location	22
Transportation facilities	23
Market	23
Quantity and fuel value of the peat	24
Preliminary testing of peat and peat machinery	24
Contamination leading to high ash content	25
Prospecting and estimating bogs	26
Drainage	26
Character of the plant	27
Location and plan of the plant	28
Working capital and capitalization	29
Choice of machinery	29
Peat as fuel	30
Introduction	30
Cut peat	31
Machine peat	32
Briquetted peat	36
Peat powder	40
Peat coke and charcoal	40
Gas from peat	43
Conclusions	46

	Page.
The uses of peat—Continued.	
Peat as raw material for other than fuel manufacture	48
Introduction	48
Chemical by-products	49
Alcohol	49
Ammonium compounds	50
Nitrates	50
Paper	51
Woven fabrics	52
Artificial wood	52
Mattresses and sanitary appliances	52
Moss litter and mull	53
Packing material	54
Fertilizer filler	54
Conclusions	55
Peat in agriculture	56
Introduction	56
Soil for crops	56
Fertilizer	57
Absorbent and disinfectant	58
Bedding for stock	58
Protection for underground and exposed water pipes	58
Stock food	59
Packing material	59
Peat ashes	59
Conclusions	60
Methods of testing Maine bogs	60
Estimation of the tonnage of machine peat which a bog will yield	61
Explanation of analyses and analytic methods	62
Detailed descriptions of localities	64
Androscoggin County	64
Aroostook County	71
Cumberland County	73
Hancock County	75
Kennebec County	76
Knox County	84
Oxford County	84
Penobscot County	86
Piscataquis County	95
Somerset County	96
Washington County	99
York County	110
Summary and conclusions	113
Analyses	114
Composition of foreign and other domestic peats	122
Select bibliography	123
Index	125

ILLUSTRATIONS.

Page.

PLATE I. Map of Maine showing localities tested for peat ---------- In pocket.
II. A peat press in operation ---------- 34
III. *A*, Fellows's experimental peat factory, Farwell bog, near Lewiston; *B*, A portion of the Great Sidney bog near Augusta ---------- 60
FIGURE 1. Bog near Greene station, between Lewiston and Leeds Junction ---------- 65
2. Farwell or Garcelon bog, near the city of Lewiston ---------- 66
3. Bog south of No Name Pond, between Lewiston and Sabattus ---------- 69
4. Bog near Great Pond, 5 miles south of Portland ---------- 74
5. Bogs 3 to 4 miles north of Oakland ---------- 79
6. Great Sidney bog, 5 miles north-northwest of Augusta ---------- 80
7. Bogs near Benton Falls, in the town of Winslow ---------- 83
8. Bog near Hartford ---------- 85
9. Locations of test borings in bog on Charles Fogg place, about 3½ miles from Norway ---------- 86
10. Location of test borings in bog near Spragues station ---------- 87
11. Bogs near Hermon Pond and Hermon Center ---------- 90
12. Bog between North Bangor and Hermon Center ---------- 91
13. Pushaw Lake bog ---------- 93
14. Bog near East Orrington ---------- 95
15. Bog at northwest end of East Pond, Smithfield ---------- 98
16. Bogs in the town of Jonesboro ---------- 103
17. Bogs near Ayers Junction ---------- 105
18. Bog near South Trescott ---------- 109
19. Thermal values and ash percentages of Maine peats ---------- 120
20. Volatile combustible and fixed carbon in Maine peats ---------- 121

PEAT DEPOSITS OF MAINE

By Edson S. Bastin and Charles A. Davis.

PREFACE.

It is the purpose of this report to present an estimate of the extent and value of the more accessible peat deposits of Maine and to direct attention to their economic importance as an undeveloped source of fuel supply and as raw material for various other uses. The more general portions of the report are based upon an extended inquiry that is being conducted by the United States Geological Survey into the peat deposits of the United States.

The field studies of the Maine bogs were made principally by E. S. Bastin, of the United States Geological Survey, the expenses being shared equally by the Federal Survey and the Maine State Survey Commission. Field work extended over a period of about one and a half months in the summer of 1906. Because of the brief time available for the work and the undeveloped state of most of the deposits, it was considered best to investigate only those bogs whose character or situation was most favorable for future commercial development, especial attention being paid to bogs near the larger cities and convenient to transportation lines. The general floral characters of the bogs were noted, but the field work was directed principally to determining the approximate size of the bogs, the depths of peat in their different portions, and its general physical characters. Field examinations of a few of the Maine bogs were made by C. A. Davis during the summers of 1907 and 1908, principally for the purpose of determining what plants had been most active in the formation of the fresh-water and salt-water peats.

The locality descriptions and the summary for the State are by Mr. Bastin. The sections on the origin and uses of peat were prepared by Professor Davis and all determinations of fuel values were made under the auspices of the United States Geological Survey, as a part of more general investigations of the fuels of the United States.

Acknowledgments are due to Dr. Dana W. Fellows, of the Portland Society of Natural History, for the determination of most of the species of living plants collected from the Maine bogs, and to Dr. P. L. Ricker, of the United States Department of Agriculture, for the determination of some others. Mr. Edward B. Chamberlain, of New York City, kindly identified a number of the mosses collected.

FUEL IN NEW ENGLAND.

In the days of the early settlement of the New England States the country was heavily covered by forests, and wood for fuel and other purposes was abundant and cheap; it was used lavishly and as if it were drawn from an inexhaustible supply, as it was often said to be.

No natural resource, however, is actually inexhaustible, and as the country became more thickly populated the forests gave place to farms, and new and increasing demands arose for wood of all sorts. With the depletion of the supply it became an expensive fuel even with improved forms of heating appliances, and except in remote regions it was replaced to a large degree by coal, a substance of higher fuel value, which, because of its greater compactness, was more easily transported from the regions where it was mined to the points where it was needed for consumption. The limited supplies, and more especially the limited areas of production of coal, and the necessity of long hauls by rail to the consumers, have led of late to a steady advancement in prices. The coal trade has become so carefully organized that competition has become practically eliminated, but at the same time the increasing demand for fuel for industrial purposes indicates that present prices are unlikely to be lowered, even if competition among producers is again restored by legislation.

The problem of cheaper fuel, ever before the manufacturer and the householder, became even more prominent than usual during the strike of the coal miners of the anthracite region in the winter of 1902–3, when the whole country was brought face to face with the fact that it was almost entirely dependent on these miners and their employers for a great part of its fuel supply. At that time attention was called by various writers familiar with conditions in the countries of northern Europe to the fact that those countries, possessing a more severe climate than ours, were using great quantities of peat for fuel, and that peat was known to be very abundant in the northern part of the United States but, except in rare instances and in the crudest way, had never been prepared for use. Public interest was at once aroused, and during the next few months many experimental and speculative plants were established to convert peat into fuel. Unfortunately many of these attempts were financially unsuccessful, and as the strike was soon over and coal was again to be had at reasonable prices, and very little peat fuel was put on the market at any price, interest in peat waned, so that at the present time the public is apparently almost indifferent to it. In the few places where it can be purchased, however, it finds a ready sale and is thoroughly satisfactory for all domestic uses.

NATURE OF PEAT.

Peat is vegetable matter in a partly decomposed and more or less disintegrated condition; it is the dark-colored or nearly black soil found in bogs and swamps, commonly known as muck, although technically a distinction is usually made between peat and muck, the latter name being restricted to those forms of swamp deposits which are impure and contain too much mineral matter to burn freely. When dry, peat may be very fibrous and light-colored, or compact and structureless and dark brown or black. It is usually somewhat lighter in color when dry than when freshly dug. In the wet condition it contains, as a rule, from 80 to 90 per cent or more of water.

GENERAL CONDITIONS OF PEAT FORMATION.

Except in very moist and foggy climates, peat is formed only in wet places, either where the ground is saturated with water most of the time, or where it is permanently covered by it, as in ponds and wet swamps. Such situations furnish the two natural conditions most essential to peat formation—(1) restricted access of air and (2) abundance of water. Restricted access of air impedes the growth of decay-producing organisms that flourish only with an ample air supply. Abundance of water is essential to profuse plant growth, but, as shown below, too much is detrimental or even prohibitive.

CONDITIONS FAVORING PLANT DECAY.

Plant decay is accomplished largely through the agency of fungi and air-requiring bacteria, which enter into and break down the tissues, the process of decay involving a decrease in bulk, a darkening in color, the liberation of certain gaseous constituents, and many complex chemical changes. Both moisture and air are essential to this process. That moisture is required in the decay of vegetable matter is shown by the durability and freedom from decay of the wooden structures and utensils in every-day use; it is only when these are exposed to moisture for the greater part of the time that the wood rots through the activities of the rot-producing types of plants. That free access of air is essential to plant decay is demonstrated by the peat bogs themselves, in many of which occur accumulations 20 or 30 feet deep of only partly decayed plant remains. In ordinary moist woodlands, on the contrary, where there is an abundance of both moisture and air, the accumulating plant remains soon decay, even wood quickly losing its structure and becoming a part of the soil.

CONDITIONS OF GROWTH OF PEAT-FORMING PLANTS.

GENERAL OUTLINE.

From the above statements it is apparent that the rôle of water in peat formation is primarily that of a preservative of the vegetable matter, which, because of its protection, is able to form accumulations of very considerable thickness, and which continues to accumulate as long as the water covers it sufficiently to exclude the air to the necessary degree. It would seem at first thought, therefore, that extensive beds of peat would form in very deep water in lakes and ponds. Here, however, another factor must be taken into account, namely, the conditions of growth of the plants from which peat is formed. This is a complicated matter, involving consideration of the many relationships of plants to their environment and to each other. The most important principles involved are the following: All plants capable of sustaining themselves without the intervention of others—that is, living neither on other growing plants nor on the dead remains of other plants—require light, air, moisture, heat, and certain kinds of gaseous and dissolved mineral matter, as food. The requirements of each plant type for some or all of these essentials are different, but every green plant, from the lowest to the highest, must have all of them in some degree. On the other hand, too much of certain minerals, of water, air, light, or heat, acts injuriously on or entirely prevents the growth of many species. For each one there is a definite combination of conditions which favors its growth, and any wide departure from this combination will be prohibitive.

As an abundance of water is an essential to peat formation, and as peat is formed generally by the remains of plants which have died where they grew, it is of first importance in a consideration of the methods of peat accumulation to learn the kinds of plants which require or will tolerate an excess of water, either in the soil in which they grow or entirely surrounding them. As has already been pointed out, peat may form either in open lakes or ponds or in damp depressions or flat areas where no standing water exists. The plant types concerned in peat formation under these two sets of conditions are in the main different and will be separately discussed.

PLANTS CONCERNED IN FORMATION OF PEAT IN LAKES AND PONDS.

Among the lower orders of plants (those which propagate by means of spores instead of seeds) the algæ, certain mosses, and a few other scattered types grow entirely submerged in the water, either floating near or at the surface or attached to the bottom in relatively shallow water. These plants may become important peat producers.

In the fresh-water algæ the plant body is without differentiation into root, stem, and leaves, but consists of one or more cells, which perform the functions of all these organs. The most common and easily recognized of these plants are the bright-green "pond scums" which are so often found floating on still water during the summer. Many species of these plants are so minute as to be nearly or quite invisible to the unaided eye, but they sometimes occur in such numbers, especially in northern and mountain lakes, as to give a distinct green color to the water and by their death and partial decay to form very considerable deposits of soft structureless peat; they may also constitute an important part of peat formed in lakes and ponds where remains of the larger and more complex seed plants are also abundant and mask the algal material by their coarser structures.

Mud Lake, near Pushaw Lake (see fig. 13), north of Bangor, is such a body of water, and when visited by the writers its waters were teeming with some species of minute green floating plant organisms, too small to be easily distinguished by the naked eye but readily made out with a hand lens, and giving the water, if seen in the proper light, a distinct greenish tint. In the bottom of this lake and below the turf about its borders was a considerable deposit of yellowish, fine-grained structureless peat, which on examination proved to be made up of the remains of similar minute algæ. In northern Michigan there are several lakes that are nearly filled by the remains of such minute plants. In these lakes are forming beds of soft, light-colored peat, which differs so much from ordinary peat as to be easily distinguished by its fineness of grain and peculiarly soft, cheesy consistency. The importance of the mosses in peat formation will be discussed later.

The seed plants, or flowering plants, as they are often called, are much more complicated in structure than the algæ and are correspondingly more exacting in their requirements. With few exceptions they grow attached to the soil by their roots, a fact that imposes limitations of various sorts upon them in respect to the kinds of places in which they may grow. Because of these limitations most seed plants inhabit the land exclusively, only a few of them being able to live in water. There are, however, two well-marked groups of aquatic seed plants—(1) those which live wholly submerged, except for their flowers, which are usually sent to the surface, and (2) those a part or all of whose leaves reach the surface and either float upon it or rise above it. As they are attached to the bottom by their roots, each of these types is limited as to the depth of water in which it can grow by the distance to which sufficient light and heat can penetrate to enable the young plants to develop from the seed or by other means of propagation. The exact depth at which this is possible varies according to the clearness of the water, but rarely exceeds 15 to 18 feet, and very few species can establish themselves at such depths. As the shore is approached the number of individuals and species increases, and as each species has its restrictions as to the depth of water in which it will grow it is apparent that where the slope and character of the bottom are uniform the plants will arrange themselves around the depression in rings or zones the width of which will depend primarily on the angle of slope of the bottom.

The plants establishing themselves in deepest water have long, thin leaves which are entirely submerged; in slightly shallower water grow plants like the pond lilies, whose leaves rise to the surface and float upon it. These plants, because their leaves cut off the light below them to a considerable extent, monopolize the space which they occupy and prevent the plants with submerged leaves from dominating, and thus form a well-marked zone, to which they give character. The pond lilies grow well in rather shallow water, but not in shade, so that on the shoreward side they are limited to a certain degree by the depth at which those plants can grow whose stems and leaves rise above the surface of the water and can exert a shading influence. The bulrushes and some water-loving sedges and grasses, with other types, like the pickerel weed, are examples of such shade-producing plants that commonly invade shallow water along the margins of ponds and lakes. The lake bulrush, the plant of this type most tolerant of water, may grow in water 5 feet deep, or slightly more, and the shading of the pond lilies may begin where the water is of this depth. Thence shoreward the light is cut off from above by a constantly increasing number of plants, which crowd into the shallows and may completely occupy the bottom with strong, wide-spreading underground stems and numerous roots that gradually form a dense, thick mat, or turf. Finally this turf may become so strong as to build out a floating platform from the firmer bottom and gradually cover the entire open water. Each individual of the groups of aquatic seed plants described above contributes something to the accumulation beneath the water, and each also becomes loaded with algæ and with floating matter brought to it by currents and waves. At the end of its cycle of growth these accretions sink with its remains to the bottom.

In time, by the aggregation of dead plants, the bottom where these forms have established themselves is built up, thus enabling the shoreward forms to move farther out and crowd lakeward the aquatic plants that were previously in possession of the space. In the latter stages of this plant invasion appear the turf-forming sedges, which cover the material formed by the growth and decay of the other aquatic types, adding to it their own remains as generation after generation develops and dies, until, the process having been repeated again and again, the pond becomes a marsh, the water being entirely filled or covered by the peaty remains of the plants.

Peat that accumulates in lakes, ponds, or other depressions constantly filled with water is formed, then, by aquatic plants, including the minute algæ, which build up a deposit from the bottom and around the sides of the depression, principally within the zone where the water is less than 15 feet in depth. As the deposit is extended into the deeper parts of the basin and the bottom is built up sufficiently to permit the growth of aquatic seed plants, these establish themselves in zones characterized by (1) the pondweeds, *Potamogeton*, next to the deepest water; (2) shoreward of this the pond lilies, both white and yellow, *Castalia* and *Nymphæa;* (3) the lake bulrush, *Scirpus;* and (4) the amphibious sedges, *Carex*, *Eleocharis*, etc., but especially the turf-forming slender sedge, *Carex filiformis*, or species of similar habits. It must be pointed out, however, that any or all of the zones of these aquatic plants may be absent, for no apparent reason, from the whole or parts of lakes where they might be expected to occur, and that but few ponds in a given locality or region will show exactly the same species or the same abundance of individuals of the types present. Where the plant zones are adequately represented, however, the relative order is invariable, if the bottom has a normal slope not interrupted by shallows or deep holes.

The conditions of plant growth where the sedges have formed a floating mat of turf do not change much until the mat is given stability and a permanent position with regard to the water level by grounding or by becoming so thick that it no longer rises and falls with the water. It is always sufficiently buoyant, however, to prevent its sinking far, and even when very old and firm, with large trees growing upon its surface, it is rarely more than 4 or 5 feet thick, and is sharply differentiated in structure from the remains of the true aquatic plants below it. In its younger parts the mat is thinner and less compact, often less than 18 or 20 inches thick, and may have only clear water beneath it. Upon the surface of this mat, after it has become stable, other plants appear, also arranging themselves in zones according to their ability to endure water about their roots. Among the earliest of these are certain herbaceous plants, which establish themselves, even while the mat is still floating, upon drift accumulations at about high-water mark, or on slight elevations due to the shove of expanding ice in winter, forming islands among the sedge vegetation. The fact that such plants are found only upon these slight elevations above the general surface of the mat indicates plainly that they are less tolerant of water than the sedges.

Following closely the advance of these herbs, which are chiefly annuals, and therefore able to establish themselves quickly, certain shrubs of the heath and willow families will generally make their appearance on drier and firmer parts of the mat. The most common of the pioneer heath plants are the *Cassandra*, or leather leaf, *Andromeda*, and *Rhodora*. By sending out long underground stems, from which aerial leafy branches rise at short intervals, these shrubs are able to cover considerable areas quickly with a dense growth. Other shrubs appear at about the same time, together with the cranberries and herbs of a number of species and the so-called "peat moss," *Sphagnum*. Sphagnum is the coarse grayish-green, reddish, or whitish moss so common in bogs and swamps; its plants keep on growing at the top while they die below, and individual plants may be found which have made a growth of more than a foot before the lower part of the stem is lost in the disintegrating mass below. As the sphagnum plants approach the limit to which they can grow above water level they make very slow growth and appear stunted, and may finally die or be overgrown by other mosses or by well-known "reindeer moss," a lichen.

This association of plants, especially the moss, builds up the surface of the deposit rapidly, and by so doing increases the thickness of the peat. If, however, the water level remains constant, the amount of upbuilding is limited to the distance to which the water will rise through the accumulation and supply the growing plants at the surface with sufficient moisture.

On considering the effects of the invasion of the shrubs into the areas where only the sedges have previously grown, it will at once be apparent that a factor in plant growth, not previously important to the plants of the sedge mat, then becomes operative, for the shrubs reach a greater height than the sedges and other herbs and are thus able to deprive the latter of so much light that they can no longer maintain themselves, and gradually die out. The same law operates when the trees appear, for they grow taller than the shrubs, cast a heavy shade, and thus destroy many of the shrubs. Not uncommonly, in the North, the sedges are absent from the margins of the open water of lakes, and the floating mat is made up of the underground stems and roots of shrubs, especially *Cassandra* and *Andromeda*. In such places sphagnum is sometimes found growing close up to the water's edge, being supported by the unright stems of the shrubs at a suitable height above the water to enable it to grow. Peat deposits formed in the above manner in bodies of standing water may be termed filled-basin deposits, or lake fillings.

PLANTS CONCERNED IN FORMATION OF PEAT IN MOIST DEPRESSIONS.

Peat may be formed on moist, flat, or even sloping surfaces, in depressions not occupied by standing water, provided it is possible for the plant remains to be constantly saturated by water, which is necessary to preserve the vegetable matter from the decay-producing organisms. In such areas, however, the plants chiefly concerned in the formation of the peat are quite different from those which fill lakes and ponds. Of the groups which have been mentioned, only those which grow on the wet shore or the sedge mat, or still higher above the water, are likely to establish themselves. The plants most likely to appear first on such a surface are of the rush, grass, or sedge type—herbs with long slender stems and leaves and with wide-spreading, tough underground stems and long roots. These very soon form a turf, which, with the accumulation of dead stems and leaves, tends to hold back the water of the rainfall and prevent it from draining away even as freely as it did before, and which at the same time, by shading the soil and protecting it from winds, permits another portion of water which otherwise would be evaporated to remain in the soil or on its surface. The first effect of these causes is to make the water level rise and remain permanently higher. This, in turn, reacts upon the plants and kills off those most sensitive to water, which gives the plants just adapted to the situation a chance to spread over the whole area. Ultimately such a tract is covered by a growth made up of a large number of individuals of few kinds, which go on building up, generation after generation, as long as the water level keeps pace with the peat accumulation.

Regions of heavy rainfall and humid atmosphere are most favorable for the development of peat on flat surfaces; in those parts of the earth where the rainfall is not large and which are subject to periods of drought or of hot dry winds, peat never forms on such surfaces or on sloping areas, except where a continuous supply of water comes from springs or similar sources.

If the surface of the ground water does not keep pace with the upward movement of the vegetable deposit, other types of plants, such as the shrubs and trees, take possession of the area, after which the peat may be composed to considerable extent of the remains of woody plants. If at the outset the soil is not too wet, it is even possible for the initial vegetation to be characterized by woody species, and for the growth of the peat to be due, in large part, to such plants.

Again, if the combination of soil, water level, and climate are favorable, the vegetation from the start may consist of sphagnum moss and the plants which grow with it, chiefly sedges, shrubs of the heath family, and certain coniferous trees. In Maine the climatic conditions seem especially suitable to this association of plants, and in the course of the investigation on which this paper is based a very considerable percentage of the peat deposits were found to be formed entirely by the sphagnum-heath group of plants. It is evident that no body of standing water existed at such localities, but that the ground-water level has risen with the growth of the peat. As may be seen by referring to the description of the individual bogs, some of the peat formed by such growth was more than 20 feet deep.

It is apparent that where these great accumulations of peat start on a level surface they could not develop unless the surface were of wide extent and the drainage exceedingly poor; on the other hand, the accumulation might begin on the floor of a valley, and as the growing plants impeded the outflow of water, the sides of the valley, as well as the floor, might be invaded by the peat-forming plants.

If for any reason the peat is built up faster than the water level rises in it the vegetation may change and be replaced by a type suited to the changed conditions, and such variation will be recorded by difference in the structure of the peat, as will also a change from dry to wet conditions. From these statements it may be deduced that peat deposits of uniform structure will be formed only where the conditions are such that for long periods the same kinds of plants have been able to grow from generation to generation.

Peat deposits formed in the manner described above may be called built-up deposits or moist-depression fillings.

RELATION BETWEEN THE TWO TYPES OF PEAT DEPOSITS.

There are, then, two types of peat bogs—the filled basin, in which most of the material has been gathered below a permanent water level, and the built-up plain, on which the water level may be practically always below the surface of the peat, but in which it rises, either steadily or periodically, as the remains of plants collect. The peat developed in filled basins is uniform in structure below the original water level, whereas that of the built-up deposits may be irregularly stratified. As a rule it is not probable that peat will be formed more than 3 or 4 feet above the top of the zone of saturation or ground-water level.

Of the two types of deposit, the built-up bogs are the more likely to furnish peat which will be of fairly uniform character from top to bottom, but individual bogs of this type may be very shallow; or, while the peat may be of the same character throughout, it may also be filled with stumps and logs from the bottom up, because trees may form an important element of the vegetation from the beginning.

In filled bogs the upper 3 to 5 feet of the peat is nearly always of different structure and composition from that below.

When a depression is once filled and the surface of the peat rises above the water, if climatic conditions are favorable, the accumulation may continue exactly as in a built-up bog; in fact, in Maine and in other moist regions the composite type is common, the structure of the peat showing that the deepest part of the bog was laid down under water, but that after a time, the depression having been filled, the peat still continued to form on the flat, poorly drained surface thus developed, as if it had originally been a moist depression.

VARIABLE CHARACTER OF PEAT DEPOSITS.

The evidence gathered from this study of the origin of peat makes it apparent that the material may be variable in character, not only in deposits in different parts of the country, but in the same region and even in the same bog. Closely adjacent bogs may be different in origin, structure, chemical composition, and other properties. Moreover, it is the exception that the beds of one bog are uniform in these particulars, and as deep deposits are cut through from top to bottom the material will be normally seen to be different in origin at different depths.

PRESENT FLORAS OF PEAT BOGS.

From the foregoing discussion of the origin of peat it will be apparent that the vegetation growing to-day on the surface of a peat bog gives no certain indication of the types of plants from which the peat has developed. The correspondence is likely to be closest in built-up bogs, but in filled lakes and ponds it is rather the exception when the growing plants are the same as those which have formed most of the peat. Stated in other terms, the origin, texture, quality, and depth of the peat can not be certainly determined by the kinds of plants now growing on the surface of a peat bog. In general the heavily forested portions of the bogs are the oldest parts and the peat in them is usually more thoroughly decayed than that in the more open portions, and thus has a somewhat higher fuel value. The development of these portions of the bogs, however, entails cutting the timber and removing many roots and fallen trees. As a rule the only sure method of learning the quality of the peat is by carefully digging out samples from various depths below the surface; and before final plans are made for utilizing a deposit for any special purpose it should be carefully tested by methods similar to those described on pages 60–61.

By far the greater number of peat bogs examined in Maine now possess a typical heath flora consisting principally of several species of *Sphagnum* and *Hypnum* mosses, members of the heath family, and small black spruces and tamaracks. Of these the mosses are now the chief peat producers, though the plants of the heath family are also important.

Among the mosses *Sphagnum* is by far the most abundant, though several species of *Hypnum* also occur, and in many of the bogs, especially those which have been burned over, *Polytrichum commune* L. is abundant. In the northern part of the Great Sidney bog the last-named species is the only moss present in any abundance.

The most abundant plants of the heath family on the moss bogs are the small cranberry (*Vaccinium oxycoccus* L., n. n. *Oxycoccus oxycoccus* (L.) MacM.), the large cranberry (*V. macrocarpon* Ait., n. n. *Oxycoccus macrocarpus* (Ait.) Pers.), the sheep laurel (*Kalmia angustifolia* L.), the Labrador tea (*Ledum latifolium* Ait., n. n. *L. grœnlandicum* Œder.), *Rhodora canadensis* L., and the leather leaf (*Cassandra calyculata* Don., n. n. *Chamædaphne calyculata* (L.) Mœnch.). Plants of this family present on only a few of the heaths are *Andromeda polifolia* L., the creeping wintergreen (*Gaultheria procumbens* L.), and *Empetrum nigrum* L. The last was observed only on a few bogs in Washington County, growing abundantly among the moss plants in certain parts of the bogs.

The lichen *Cladonia rangiferina* is abundant among the moss plants on many of the heaths, and is an important agent of plant decay. The pitcher plant (*Sarracenia purpurea* L.) is another inhabitant of nearly all the moss heaths.

Grasses and sedges are moderately abundant on most of the heaths. A grass belonging to the genus *Poa* is abundant in scattered tufts 6 inches to a foot across on the Great Sidney and many other bogs. The grasslike *Triglochin maritima* L. and the sedge *Rhynchospora alba* Vahl. are about equally abundant on the Vassalboro bog. The cotton grass (*Eriophorum virginicum* L.) occurs in scattered tufts on many of the heaths.

The commonest bog trees are the black spruce (*Picea nigra* Link) and the American larch or tamarack (*Larix americana* Michx.). These are in general about equally abundant. Their profusion on individual bogs varies greatly, some heaths being very open while on others the growth is very close. The growth of spruces and larches is usually heavier near the borders than in the central portions of the bogs, and here too the gray birch (*Betula populifolia* Ait.) is abundant on many bogs. A few bogs which are open over most of their extent are very heavily forested near their borders. This is especially true of the Martin Stream bog (locality 25[a]), of the Etna bog (local-

[a] Numbers refer to localities marked on the map, Pl. I (in pocket).

ity 35), and of the bogs near Hermon Center (localities 37 and 38). Maples, yellow birches (*Betula lutea* Michx.), gray birches, cedars, spruces, black ash, and occasional white pines are the trees commonly found, and some of these may attain diameters of 1 to 1½ feet, though growing upon 10 to 15 feet of peat. The speckled or hoary alder (*Alnus* sp.) is usually abundant. The bottle sedge, *Carex utriculata* Boott., is abundant in the forested parts of the bog just west of Hermon Center. Among the lycopods found are *Lycopodium annotinum* L. and *L. clavatum* L., and among the ferns *Onoclea sensibilis* L., the sensitive fern. The moss *Dicranum bergeri* Bland. occurs sparingly on the bog south of No Name Pond (near Lewiston). On the bog between Hermon Center and North Bangor the mosses *Thuidium delicatulum* (L.) Mitt. and *Brachythecium rutabulum* (L.) B. and S., were found growing about the roots of the cedars. The winterberry (*Ilex verticillata* var. *tenuifolia*) also occurs here, and is conspicuous in the fall because of its bright-red berries. The mosses *Hylocomium triquetrum* (L.) B. and S. and *Hypnum schreberi* (Willd.) De Not. occur rarely.

Certain bogs like those near Greene station (locality 10 p.) and near Etna (locality 35 p.) have suffered a change of flora because the water level has been artificially raised by damming. On the Greene bog the sedge *Dulichium spathaceum* Pers. (n. n. *D. arundinaceum* (L.) Britt.) and the wool grass (*Eriophorum cyperinum* L., n. n. *Scirpus cyperinus* (L.) Kunth.) are abundant. The marsh shield fern (*Aspidium thelypteris* Schwartz, n. n. *Dryopteris thelypteris* (L.) A. Gray) and the flowering fern (*Osmunda regalis* L.) are present in considerable numbers. Among the angiosperms the following species were collected: The sweet gale (*Myrica gale* L.), the red-osier dogwood (*Cornus stolonifera* Michx.), the common meadow sweet (*Spiræa salicifolia* L.) and the button bush (*Cephalanthus occidentalis* L.). On the Etna bog the blue joint grass (*Calamagrostis canadensis* Beauv.) is the most abundant species.

SALT MARSHES.

ORIGIN.

Along the Maine coast, especially in the region southwest of Portland, are numerous broad expanses of salt marsh, in which are found beds of peat of considerable thickness, the origin of which merits brief discussion. These marshes may be characterized as poorly drained plains or very shallow basins which are daily or at frequent intervals overflowed by salt water. This flooding introduces a new and unfavorable factor into the environment of plants growing on such an area, since salt in excess in soil or water is fatally poisonous to most seed plants. The flora of the salt marshes is therefore restricted to plants that are able to tolerate the excess of salt water or that require salt in quantities. The number of such plants for the region is small, so that the flora of salt marshes is monotonous, being made up of great numbers of individuals of very few kinds.

The few types found in this habitat are distributed over the surface in associations which show an increase in simplicity directly proportional to the length of time in the growing season during which they are exposed to tidal overflow. The dominant types of plants on salt marshes of this region are grasses, sedges, and rushes, *Spartina*, a genus of grasses, furnishing the most common and characteristic species. Of these, the salt-meadow grass (*Spartina juncea* Ell., n. n. *S. patens* (Ait.) Muhl.), covers the surface of the marshes, at about high-tide level, over great areas and seems to be the chief species concerned in the formation of such peat as is developed. Associated with this plant, but usually occupying slightly higher regions of the marshes, is the black grass (*Juncus gerardi* Lois.) and less commonly the seaside sedge (*Carex maritima* Miller), the salt-marsh bulrush (*Scirpus maritimus* Torr., n. n. *S. robustus* Pursh, and related species), the slender glasswort (*Salicornia herbacea* L.), and other less abundant or conspicuous species.

It has been shown that in the filled-basin type of fresh-water bogs the deposit is not homogeneous from bottom to top, but is made up at different depths of the remains of somewhat different associations of plants adapted to progressively less and less moist conditions as the deposit was built up to the water surface and above it. In a similar way the normal salt marsh might be expected to show from bottom to top a progressive change in its plant remains, the plants adapted to stand frequent inundations of salt water having been replaced as the peat became higher by plants which could stand only occasional floodings, and finally by a fresh-water bog flora.

It is significant that the actual studies made in the salt marshes of Maine failed to reveal any such progressive change from salt-marsh to fresh-marsh conditions, the peat being either of fresh-water origin below a relatively thin stratum of salt-water peat, or else made up entirely of plants similar to those growing on the marshes to-day at about high-tide level. *Spartina patens* and its common associates, types which never grow where the marsh is long submerged, were the plants most frequently found.

It has been assumed by some observers that the deposits of fresh-water peat now buried beneath salt-water peat were formed in bays or inlets cut off from the ocean by barrier beaches of sand or gravel, and thus converted into fresh-water ponds, in which peat developed. Later, according to this explanation, some change in wave or current action caused the barriers to be at least partly removed, the sea was again admitted, and salt peat was deposited above the fresh-water peat. This explanation, however, is not satisfactory because the salt peat above the fresh and also that which is not associated with fresh-water peat are frequently of great thickness, though formed throughout of the remains of plants that will not live even a few inches below the level at which they now grow. It would be impossible for them under ordinary circumstances to build up the 3 feet or more of material made up wholly of their remains which is found in many marshes.

The explanation which best accounts for the observed character of these deposits involves the slow subsidence (probably not faster than a foot in a century) of a coast characterized by scattered fresh-water bogs, and the conversion of these and other low-lying tracts near the sea into salt marshes. The peat developed at about the rate at which the coast sank and thus furnishes a rough measure of the extent of recent subsidence and its rate. The fresh-water deposits in some places have below them peat which is clearly of salt-marsh origin, indicating a slight uplift of the coast previous to the subsidence, which is still in progress.

ECONOMIC VALUE.

As pointed out above, the peat that is to be found in salt marshes is of two distinct types, differing in origin and in potential fuel value. One type has been formed by the ordinary peat-making plants above sea level and has since been buried by salt-water deposits; the other type is entirely of salt-marsh origin. Buried beds of fresh-water peat, if easily accessible, could be made into fuel of some value. Where they are near railroads, as most of them are, they might well be tested on a practical scale, the chief difficulty in working them being to keep out the tidal waters and to dispose of the strippings of salt-marsh turf lying above them. Some of the buried beds, as that along the Kittery and York Beach Electric Railroad at Brave Boat Harbor, contain included pine and hardwood stumps and logs, but if the peat were consumed in a gas producer, these could easily be utilized.

Most of the peat that has been formed wholly by the growth of salt-marsh plants is too full of the fine silt and mud which have been deposited by the tides to have much fuel value, and it is probable that it will never be made into a marketable fuel product. It is possible, however, that the deposits in some areas of salt marsh about the heads of tidal creeks may be sufficiently free from mineral matter to permit their profitable use. The few analyses of salt-marsh peat made are included in the table on page 119 (Nos. 67–69).

THE USES OF PEAT.

INTRODUCTION.

Many factors must receive careful consideration before any deposit of peat can be successfully exploited on a commercial scale in spite of the obvious facts that properly prepared peat is a good and efficient fuel and that it may be used successfully as the basis for a number of manufacturing industries. Without doubt the failure to consider some or all of these factors in their interrelations accounts for most of the marked lack of success of the attempts to use peat in this country. In the cases of the sort which have come to the writers' notice the unfavorable outcome of the venture was not due to causes inherent in the material itself, or the product from it, but to easily preventable errors, of which the most common was failure to take advantage of the great store of experimental and business data accumulated in Europe during the last century.

So many mistakes have been made in selecting sites for building, in the laying out and construction of plants, in choosing processes of manufacture, and even in testing deposits to be worked that it will be helpful to prospective investors and others to preface this discussion by a short statement of the elementary economic principles underlying the establishment and development of such a business, and in this way to point out some dangers which may beset the path of the inexperienced.

FACTORS INFLUENCING THE SUCCESSFUL UTILIZATION OF A PEAT DEPOSIT.

LOCATION.

It has already been made apparent that the location of peat deposits is considered of paramount importance, as the bogs investigated were selected in the parts of the State which are most thickly populated and easily accessible. Of two deposits, one of which is to be selected for experimental development, the one more favorably situated for procuring a reasonable supply of labor, a market, and cheap transportation along routes already established should be chosen, if the quantity and quality of the material are such as to merit use at all, even though the rejected deposit be of greater size. The reasons for this preference are obvious when it is considered that the selling price of the product of the plant to be established must, of necessity, be low, and the margin of profit so small that, at least during the early days of the life of the plant, it should bear no unnecessary charges due to poor location, which in turn will bring high price of labor, added cost of transportation, and increased expense of maintenance.

TRANSPORTATION FACILITIES.

No peat deposit should be considered available for the commercial production of peat for fuel that is not sufficiently near an established railroad to insure a spur track by which direct connection may be established between the plant and probable markets, or else it should be located close to navigable water. Peat fuel is so bulky that the cost of carting it for any distance is prohibitive; accordingly, none but water or railroad transportation should be considered.

MARKET.

Of more importance than any other factor is the market. Normally this must be created, for peat is an unknown material in the markets of Maine, and people are unfamiliar with its qualities and use. The production of an unsalable commodity can not be made profitable. Hence it is essential to locate where a market may easily be created, and as cities and towns are the centers of fuel consumption, it follows that any peat-fuel factory should be so located that some town of considerable size may be developed as a market; if more than one town can be easily reached it will be even better. The creation of an adequate market then becomes a matter of skillful production and of advertising, but it is doubtful whether any considerable amount of peat fuel will be used in the first five years after it appears on a given market, and it would probably be a large estimate to make that, at the end of that time, 10 per cent of the entire fuel used in the area tributary to the proposed plant would be peat.

On the other hand, it must be considered that, as in all new industries, there must be a period of development of the plant during which the production of the finished material is slow and expensive. This should be coincident with the creation of a market and in most plants doubtless will be, so that by the time the fuel can be made in a satisfactory manner and at a profitable rate it can be marketed. The radius of the territory that a peat-fuel plant may expect to reach depends somewhat on the abundance and price of other types of fuel and on the conservatism of consumers, but it is doubtful if it will exceed 50 miles for many years to come.

It should be remembered that the markets must be sought and developed, as with other new products, as to whatever extent it is used, peat fuel must displace more familiar and quite satisfactory material, and must meet, therefore, certain and positive opposition from the closely organized producers of and dealers in these materials. To procure a market, the peat product must be advertised, demonstrated, and proved to be what it really is, and the fairer and more honest this presentation is the more satisfactory will be the financial returns from the effort.

QUANTITY AND FUEL VALUE OF THE PEAT.

The quantity of peat in the deposit and its fuel value are next in importance to the market. On the quantity of peat to be dug must be based the size of the plant, the investment of funds used in developing it, and the estimate of the life of the investment. On the fuel value of the peat must be based the reputation of the product and hence much of the profit of the enterprise after it is established.

As shown on pages 61–62, the quantity of peat in a deposit may readily be calculated, with enough accuracy for practical purposes, by obtaining its average depth and its area, and assuming that it will yield at least 200 tons of dry machine-made fuel per acre for each foot in depth. A concrete example may be cited to show how small an area may be considered profitable. In Sweden a gas plant, costing some thousands of dollars, has been built on a bog covering about 35 acres and having an average depth of 5 feet. The life of the plant is estimated at thirty years, and the quantity of fuel available, because of the thoroughly decomposed condition of the peat, at 44,500 tons, or about 330 tons per acre for each foot deep. It is evident, then, that it is unnecessary to look for deposits of large area or of great depth to get returns which will justify commercial exploitation, if the plans of the investor are not too ambitious, because the production of 1,000 or 1,500 tons of peat fuel per year will supply a considerable population with all of that class of fuel that it will use, and it might be some years before so large an amount would be produced by the plant or absorbed by the local markets.

The fuel value of different grades of peat and some of the factors affecting it are discussed elsewhere, but aside from this, the peat should have such physical properties that it will be easy to manufacture it into salable and transportable form. If the peat is to be converted successfully into machine peat for shipment, it should not be excessively fibrous or woody, but these qualities do not injure its value for local use.

PRELIMINARY TESTING OF PEAT AND PEAT MACHINERY.

Some of the most notable failures in the use of peat in this country have come from too great optimism in regard to its possibilities for some one definite use or process. The successful utilization of this material is not a matter of seeing only its good qualities. When it is to be used as the raw material for any manufacturing enterprise, its defects, the difficulties and cost of handling, the presence of the great amount of water which always occurs in it, and other features of similar character must be taken into account, and the more special the use the more carefully the scrutiny and tests must be conducted.

Factory tests should be made on not less than ton lots, and as much larger as possible, with the machinery which it is planned to install in the final operations. The samples chosen should be no better than the average and should be collected with care to include material from several parts of the deposit and from depths as great as can be reached with ordinary tools for digging. The cost of such tests may seem excessive, but in the end the results attained, whether satisfactory or not, are justified, especially so if the material thus tested proves unsatisfactory. In two cases already in the history of peat development in this country have investments of about $100,000 been made, only to find that the product contemplated could not be made from the peat selected with the machinery installed, so that it could be sold in the open market at a profit; and other smaller failures could easily be cited. These failures are due chiefly to insufficient testing.

CONTAMINATION LEADING TO HIGH ASH CONTENT.

In the preliminary examination of bogs to be utilized for fuel it must be remembered that high ash content injures the quality to a considerable extent by reducing the heating value. The mineral matter in peat deposits is brought in by the water in which the peat has been formed and that which reaches the bog in the form of overflow from streams, rain rills, springs, or the wave wash from exposed lake shores.

It is well, always, to look with suspicion on peat which dries gray, or with white and red spots in it, or which is gritty when tested between the teeth, as such peat generally runs high in ash. It will generally be found that peat from the flood plain of a stream subject to sudden freshets, or from the deltas of streams in lakes, or from terraces watered by springs, or from salt marshes will be more or less contaminated by mineral matter, and hence have its fuel value and salability reduced by high ash content. The peat formed in ponds without noticeable inlets may also be high in ash from the presence of plants which segregate in their tissues or on their vegetative organs the dissolved minerals brought in by springs and deposit them with other débris on the bottom at the end of the growing period. Lime, silica, and iron are thus taken from the water of lakes and deposited as ash-forming constituents in the peat.

The effects of wave action and current action on sandy or muddy shores of lakes must be taken into account, as it is often a source of deleterious matter, and bogs located where they receive such wash should be examined with unusual care before exploitation.

PROSPECTING AND ESTIMATING BOGS.

Peat deposits of large extent and large average depth are not common, and when found they may be unfavorably located for development, except as sources of power or gas production. Such bogs need little careful prospecting, as the quantity of peat is so large that a few hundreds or thousands of tons will make no important difference in the value of the deposit when developed. It is well in exploiting even such deposits, however, to have the depth and quality determined by a careful survey over that part to be utilized, in order that a sufficient supply of raw material may be assured.

With bogs of small area the need for more careful testing is greater and the probable expense less. Such a deposit should be carefully surveyed to determine its approximate area, and lines should then be laid out across it at definite distances apart, on which test holes should be dug of sufficient depth and size to show the character of the peat for several feet from the surface. The test holes should be regularly spaced and in final testing should be dug with a shovel where possible.

In preliminary testing, and for procuring samples for chemical analysis, the sampling tool described on page 61 may be used to advantage, as with it the depth and the general character of the peat at any depth can be accurately determined. The labor and time consumed in testing by this tool is slight when compared with that required in digging, but only the latter process can furnish the large samples which should be used in final tests.

In small bogs, filling lake basins and other depressions below the water level, there will probably be a substratum of very watery material below the firm upper layers. In testing such deposits, therefore, the extent and character of this substratum must be accurately determined, as it may be so extensive as to render working the bog unprofitable.

DRAINAGE.

According to the practice in Europe, where hand digging is the common means of excavating raw peat, the bog is carefully drained before work is begun. Aside from the greater convenience in digging which this operation insures, the draining frees the peat of a considerable amount of water, although owing to its peculiar water-holding properties not as much as would at first be supposed is carried off in this way. By reference to the table showing the percentage of water in peat relative to its weight (p. 37) it will be seen that a reduction of the water in peat from 90 to 80 per cent means a reduction of 50 per cent in the weight; hence the matter of drainage is important, if economy in handling is sought.

If excavating is to be done by machinery, however, it may be unnecessary or undesirable to plan for drainage, as the peat may be dug from dredges or by suction pumps and transported to the grinding machines by scows. If drainage is to be undertaken, the bog should be surveyed and levels taken to find the fall of the land and the distance and fall to the nearest main watercourse.

An important relation of the type of peat deposit, as indicated by structure, to the possibilities of draining should be pointed out here. Those bogs whose structure is uniform, or of such a character as to indicate that the peat has been built up by plants growing slightly above the water level, as that level has risen, can be drained to the bottom, or as far down as this structure is maintained. Conversely, those deposits which have been formed by the filling of depressions below the water level can not be readily drained except by expensive cutting through the lip of the basin containing the bog. Such deposits should be worked without draining, as the attempt to drain below a very few feet will usually not be successful. It is also necessary to avoid cutting ditches from the margin of a bog of the latter type to open water in its center without very careful leveling across the surface, for not uncommonly the water level in the pond is somewhat higher than the marginal area of the bog and the water will flow from the pond, not into it.

In general it is yet to be demonstrated in this country that drainage of bogs preliminary to working them for peat is necessary or will be feasible under existing economic conditions. If drainage is undertaken, excavation should, if possible, begin at the lowest part, or outlet end, of the area and proceed toward the higher parts. This will make the drainage relatively simple and will reduce it to the lowest possible amount, at the same time preventing drying out of the part of the tract not operated, and thus reducing to a minimum the chance of loss by fire.

CHARACTER OF THE PLANT.

The character of the plant will in large measure be determined by the size of the projected operations, by the process of preparation adopted, and by the available capital.

If machine peat is to be produced, the permanent buildings need not be more extensive than those of a sawmill, and may consist of a shed for protecting the boiler, engine, and grinding machinery and the storage bins. The type of construction should be the cheapest and simplest consistent with durability for the expected life of the plant, and as this material will usually be produced only during the summer, no provision against cold weather will be necessary. Many European plants for making peat fuel of this class are without permanent buildings of any kind, the machinery being all movable and housed temporarily at points on the surface of the bog as near as possible to the openings where excavating is being done, and the number of such units being increased as the necessity for them grows.

If briquetted peat is to be produced, the buildings will have to be somewhat more durable and extensive, but need not be of expensive construction. The buildings for a coking plant would require still more outlay for housing the greatly increased bulk of apparatus, especially if the by-products are to be utilized, and the same may be said of the buildings required for a plant utilizing the peat for gas. Even here, however, the expense of the construction can be reduced by exercising care to develop the simplest buildings which can be used for the purpose intended.

LOCATION AND PLAN OF THE PLANT.

The main structures of the plant should be so located with reference to the workable part of the deposit that the raw, wet peat, as it comes from the bog, will have to be transported the shortest possible average distance to the grinding and drying sheds. For this reason the center of the bog would be the ideal site for the factory, if it were to be permanently located; or a movable plant in the vicinity of the main openings would be still better. Practically, in most cases, it will not be possible to place the machinery on the bog, and the next best site will be on its margin, as close by as firm ground can be found to give the buildings and machinery a secure foundation, and at such a point that the hauls necessary to get the freshly dug peat to the buildings will average as short as possible during the whole life of the plant—that is, somewhere near midway of the margin on one of the long sides of the deposit, although the selection of the site may be affected by some other consideration, such as proximity to railroads or other transportation lines, or to a town, or to favorable drying grounds.

The laying out of the plant, the location of machinery in the buildings, and the placing of the drying grounds in relation to the buildings must all be carefully considered, to reduce the processes so far as possible to an automatic arrangement requiring the least possible amount of attention and labor. Every point where machines can replace human labor should be considered and, if possible, the machinery installed.

It must be remembered constantly that in peat-fuel production the problem is how to get from a ton of wet peat, as it comes from the bog, the approximately 225 pounds of salable material which it contains so cheaply that the cost of digging, transporting, preparing it for sale, and selling it will not exceed the price that can be obtained for the prepared material in open market. It is evident that the omission of any expenditures which can be avoided in the course of proper preparation will aid, by so much, the solution of this problem. It seems to follow also that the simpler and fewer the processes of preparation by which salable material can be put on the market the more likely the manufacture is to prove profitable.

WORKING CAPITAL AND CAPITALIZATION.

It is probable that no factor has been more fatal to successful development of peat industries in this country than failure to provide working capital. Apparently investors have been so sanguine of success that they have thought it necessary only to plan to make peat fuel and assemble a portion of the plant, after which the industry would establish itself and immediately give sufficiently large profits to pay dividends and go on with the manufacture indefinitely. These anticipations not having been realized, the investors have refused to advance further funds, long before the plant has passed through its experimental stage and reached that of commercial production. If, however, a sufficiently large part of the funds available at the outset had been reserved to develop the business, as is generally done in other industries, the amounts necessary to extend the plant, after its success was demonstrated, would have been available.

The amount of capital required will vary according to the process of manufacture adopted, the quantity of product to be manufactured, and other factors not requiring discussion here. In general, it may be said that large capitalization is not required nor desirable in peat enterprises, but that the more simple methods of manufacture can be established at small outlay as compared with those requiring heavier machinery, more handling, and stronger construction of buildings. Attention should also be called to the much larger paid-in capital required to develop a plant to the self-supporting stage with machinery specially designed for some new process of treating peat, than would be needed to do the same work with machinery that has been already thoroughly tested in actual manufacture of the product it is expected to make.

CHOICE OF MACHINERY.

As already indicated, the choice of machinery will depend largely on the product desired. The chief concern of the purchasing agent should be to thoroughly inform himself regarding the progress of peat utilization in Europe, where peat has been used for centuries as fuel, and where, for the last hundred years, keen, well-trained minds have been at work studying the possibilities of the material and the ways in which it may most economically and satisfactorily be treated to make salable products. With this accumulation of experimental and practical knowledge embodied in machinery already in successful operation, it is inadvisable to adopt new and untried machines, or so-called secret processes. In fact, the invention and development of new machinery should not be attempted until European literature, especially German and Swedish, relating to the subject has been carefully examined, for in this will be found the record of a great number of processes and machines that have been tried and proved to be failures. After this examination, if the inventor is still sanguine that his plan has merit, he should embody it in machinery on an experimental scale to try its actual efficiency, but until this trial has actually been made and the value of the machinery demonstrated, it should never be made the basis of a commercial plant from which immediate returns are required.

PEAT AS FUEL.

INTRODUCTION.

Peat has never been used extensively in America for fuel, although for many years experimental peat-fuel manufactories have been built in various parts of Canada, operated for a time, and closed indefinitely. A few have continued operations for a number of years, and there are now at least two such plants that are considered by their owners to be beyond the experimental stage of development, although still unable to reach the maximum production for which their market calls.

In the United States a large number of attempts have been made to manufacture peat fuel, of which but a few have had enough capital to carry the plans beyond the construction or early experimental stages. Of those that have had a fair trial, the nearest approach to success seems to have been attained by plants designed to produce machine peat, but none even of this type have yet reached the stage where the maximum output of finished product is assured.

In all of this experimental work the causes of failure have been those already discussed, and are not directly traceable to causes inherent in the peat itself. Stated in another way, some of these attempts have failed to become productive because too little capital was provided, others because they were provided with machinery that was not thoroughly tested before installation, others because they were managed by inexperienced men, and still others from lack of transportation facilities or of market.

Unlike coal and other fuels on the market, peat requires special treatment, including drying, before it can be used as fuel. As it comes from the bog it contains from 85 to 95 per cent of water—

namely, a short ton of wet peat rarely contains more than 300 pounds of dry peat and may have as little as 100 pounds. In the wet condition it is entirely noncombustible, and the various processes by which it is prepared for use or market consist principally in methods for ridding it of water quickly and cheaply and for increasing its fuel efficiency and transportability. The following brief discussion considers these methods in the order of their simplicity.

CUT PEAT.

The simplest and most ancient form of preparation of peat for fuel, and that still in use in Ireland and many other parts of Europe where peat is used for domestic purposes, is to cut it from the bog in the form of blocks. This is done with some special form of spade, the type in use in many parts of Europe being made by welding a narrow, sharp lug at right angles to the point of the blade of a long, narrow spade; this is called in England a slane. As fast as cut, the blocks are laid on the cleared surface of the bog, near by the opening, and after a few turnings become partially dry, after which they are loosely stacked for further drying and storage.

This form of peat fuel is entirely dependent on the structure of the peat for its texture, compactness, and efficiency, and as it can be cut only from the drained parts of peat beds, it is usually bulky, is easily broken and crumbled, and burns freely, but with considerable waste. On the other hand, the cost of production is small, and little equipment is required besides sheds for storing and possibly for drying the finished product. The cost of making cut peat ready for the market in Europe varies, according to a recent writer,[a] from about 50 cents to as much as $1.75 per ton of air-dried peat. These considerable differences are apparently caused by the different methods used and the efficiency and price of labor.

So far as can be judged, this form of peat fuel is not adapted for use in the American market because of its inefficiency and its bulkiness, but it could be produced by individual owners of small deposits for home consumption, where other fuels are high in price. The darker, thoroughly decomposed types of peat make better cut fuel than the lighter brown, more fibrous kinds found near the surface in many deposits. The cost of production of cut peat, including digging, drying, and stacking, under American conditions of labor, etc., should not exceed the European higher limit just quoted, after the force employed has been trained to the work.

[a] Nystrom, E., Peat and lignite; their manufacture in Europe: Canada. Dept. Mines, Ottawa, 1908.

MACHINE PEAT.

As the need arose for a fuel better than cut peat, in a more durable and transportable form, efforts were made to improve the texture and other qualities by treatment which rendered the material more compact. The earliest and the simplest process to be used consisted in adding water to the peat as dug, thoroughly kneading it by the trampling of men or animals, and turning the resulting pulp into molds to dry. This process is still in use in parts of northern Europe.

The name machine peat is given to all forms of the product made by grinding, mixing, or macerating the wet peat as it comes from the beds, so that it becomes less fibrous. In the process the included coarse material is broken up, and probably also some of the cellular structure of the peat is destroyed. Certain colloidal or gluelike substances are released or developed during the grinding, which act to cement the mass, and, as they are insoluble in water when dry, render the whole mass more or less waterproof.

A distinction is sometimes made between the product obtained by grinding peat to which sufficient water has been added to reduce the whole to a watery pulp, and drying the resulting slurry, or semifluid mass, in molds laid on the ground, and that made by macerating the peat about as it is dug, or with a slight admixture of water, and forming it into bricks of any desired size by cutting up the long prism of thoroughly ground peat as it issues from the orifice of the grinding machine. The bricks resulting from the latter method are sufficiently firm to retain their form when they come from the machine and are dried by exposure to the air on covered racks or on the ground without cover.

The production of peat fuel on any considerable scale by the crude process first mentioned is evidently not adapted to American conditions, as it involves the use of much manual labor in molding the peat and in handling it on the drying grounds. Abroad this process seems to be generally confined to small and isolated plants and to be displaced in the larger ones by the machine process, the product of which is sometimes also called condensed, machine-formed, or pressed peat. The last name is something of a misnomer, however, for only enough pressure is exerted upon the peat by the machinery to force it from the outlet in a stiff, pasty condition. In the United States the term "wet process" has been applied to distinguish it from briqueting, in which the peat is dried artificially before shaping it by pressure.

So far as indicated by present knowledge, based on many entirely trustworthy reports, the machine process is the only successful method of making fuel for general purposes from peat now in use in Europe, and for that reason it merits a somewhat full discussion here, especially as it is generally applicable to all types of peat and requires but a relatively small outlay of capital to establish a well-equipped plant and but little experience to run it.

The essential part of such a plant is the peat machine, of which many patterns are now on the market. Some excellent models of these have been designed and are built to order in the United States. In its simplest form, the peat machine is very similar to the clay "pug mill" of the brickmaker, and both brick and tile mills have been used in this country with peat of certain types for making peat fuel. The specially designed peat machine, however, consists of a vertical or horizontal cast-iron body, with a hopper attached above it, in which revolve one or two knife-armed shafts; these are provided also with spirally arranged flanges for moving the peat forward to the grinding knives and advancing it to the outlet after grinding. In some machines the edges of the screw flanges are sharp and work against knives set firmly in the cast-iron walls of the body of the machine; others have both fixed and revolving knives combined with screw flanges.

The main object of the whole construction is to thoroughly cut up, crush, and grind all the constituents of all types of peat into a homogeneous, pasty mass, without clogging or breaking the machine. The machine that will make uniformly compact, tough bricks from any type of peat, but especially from fibrous material, rapidly and continuously, without excessive consumption of power, is the one best adapted to Maine peats. The most successful peat machines are of very heavy construction and have adjustable knives, so that any kind of peat can be ground, and all parts subject to clogging and wear are easily accessible. The heavy construction is necessary because of the stumps and other woody matter, as well as stones, often found in peat beds.

Machines of foreign make may be had of all sizes and capacities, from those which can be run by a single horse and with the help of a few men have a capacity of 3 tons or more of air-dried fuel per working day, up to those which require a considerable force of men, powerful engines, and auxiliary machinery for excavating and handling the product, and have an estimated capacity of 50 tons or more of finished material per day of ten hours. (See Pl. II.)

For detailed description of the types of machines of this class made by many European manufacturers and reports as to their efficiency, the reader is referred to the excellent accounts by Nystrom[a] and to the catalogues of American and European manufacturers of peat machinery.

[a] Nystrom, E., op. cit., pp. 57 et seq.

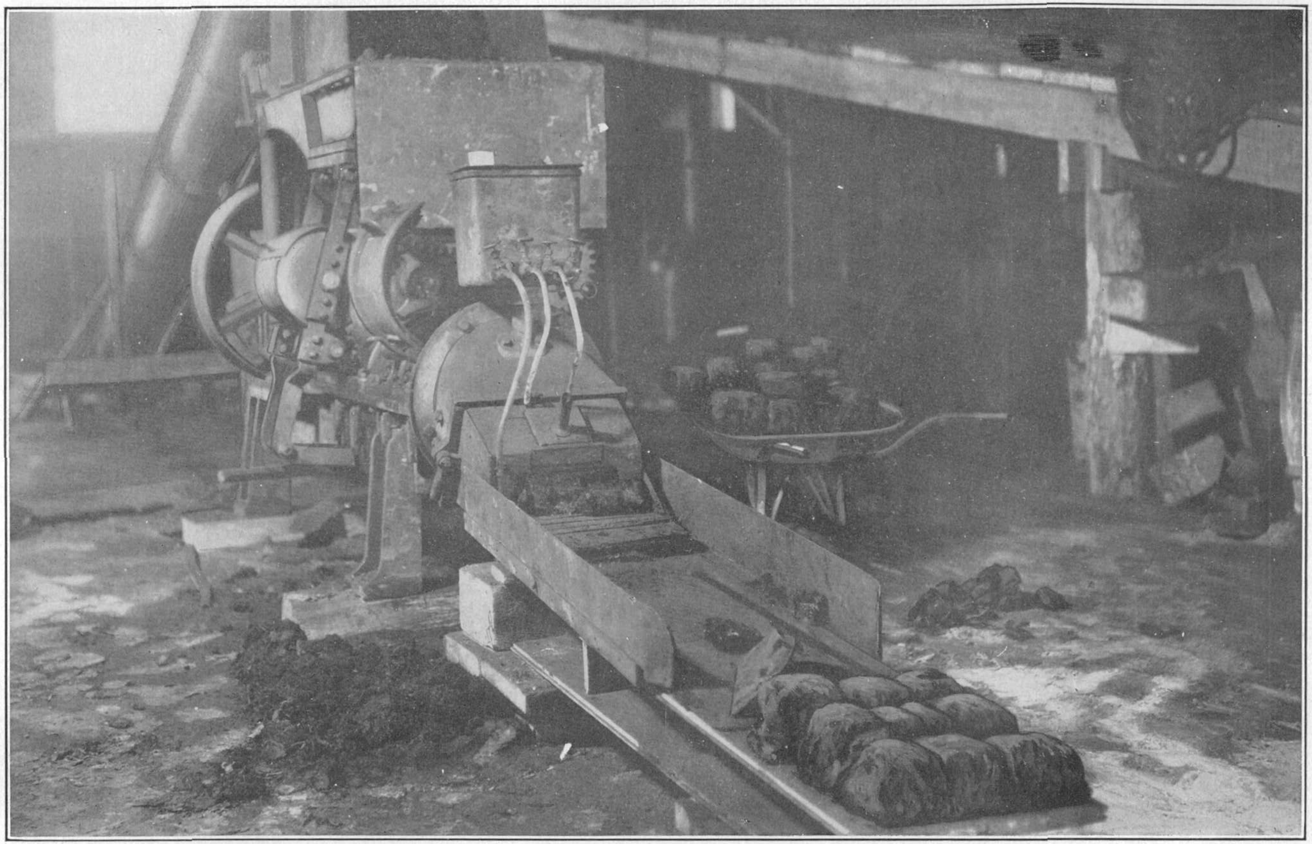
In addition to the peat machine, the equipment for making pressed peat consists of small cars, tracks, and other machinery for moving the product to the drying grounds and storage sheds, and, at most plants, to carry the raw peat from the bog to the peat machine.

The larger sizes of peat machines are usually provided with some form of mechanical elevator, which takes the peat to the hopper from the car, or from the top of the bog, or possibly from the bottom of the excavation, the arrangement being dependent on the location of the machine relative to the excavations.

The machine itself may be mounted directly on rails or on a movable platform by the side of the excavation, and follow the digging, thus saving the expense of moving the wet peat to some fixed point of grinding. In case this plan is adopted, the cleared part of the bog may be used for a drying ground, and only the dry material need be taken from the bog, a plan which saves the cost of transporting the large amount of water contained in the wet peat, at all stages of manufacture.

To the equipment mentioned must generally be added, under American conditions, some form of power digging machinery suitable for excavating as much peat per day as the machine can properly grind. Failure to do this involves the necessity of having a large force of men digging peat, as it is estimated that practically ten times the weight of material produced must be dug; that is, 500 tons for an average production of 50 tons per day. If such provision is not made, the producing portion of the plant will be idle part of the time. Sufficient drying ground and storage room must also be laid out and made ready for any contingency, or else again the plant will be idle at times when everything else is favorable for production.

The requirements for making the ordinary machine type of fuel from peat are, therefore, (1) a deposit of good peat; (2) some form of peat machine; (3) machinery for digging the peat; (4) adequate ground space and pallets, or short wooden boards, on which to dry the peat, and enough room for storage; (5) tramways and cars, or mechanical carriers of some description, for transporting the peat to and from the grinding plant, the drying grounds, and the storage bins. The cost of this outfit, exclusive of the land, naturally will vary widely according to the estimated productive capacity of the plant, the number and quality of the buildings erected, and the amount and kind of accessory machinery provided. The cost for a 5-ton plant will be not far from $1,000; one which will produce from 50 to 60 tons of finished peat fuel per day will probably cost from $8,000 to $10,000, if economy is used in laying out and constructing the buildings. To this must be added the cost of the land and the working capital. Such a plant can have its capacity increased at any time by adding the essential machinery. It is doubtful if it is wise



PEAT PRESS FOR MAKING 50 TONS OF MACHINE PEAT A DAY.

In operation at the Fuel-Testing Plant of the U. S. Geological Survey, Jamestown Exposition, Norfolk, Va., October, 1907.

to purchase a peat machine of more than 20 to 30 tons daily capacity for a newly established plant, as for a long time there will be some difficulty in keeping a larger one running at full capacity and still more difficulty in selling the product. It is far more easy to make a success of a small, thoroughly equipped plant, turning out a satisfactory product, than of one that has only a highly efficient peat machine of large capacity to which the plant is expected to grow at some time in the future, the accessories being at first insufficient.

The cost of production of machine peat is generally estimated, optimistically, at not over $1 per ton of air-dried fuel. This estimate is doubtless fair, if only the cost of labor is taken into account, as in Europe the labor cost generally falls below 75 cents per ton; but when loading, managerial, interest, maintenance, and amortization charges and the cost of the peat are properly apportioned the cost will be found to exceed $1.50 and, unless unusual skill in management is shown, will probably approach closely to $2 per ton.

At present it is impossible to forecast prices at which peat can be sold in the United States in open market. The little which has been made has been eagerly sought at high prices and more has been demanded after it has been tried, apparently largely as a matter of curiosity. It can hardly be expected that these prices will be maintained in competition with coal, and it is doubtful if a price above $3 per ton, for large lots, can be obtained; but if the production is large enough, this price would allow a tempting profit on the investment. If the producer is so situated that he can sell at retail, he can command a somewhat better price per ton than the wholesale buyer will pay, but he must meet the cost of delivery.

An objection often made to this method of preparing peat is that production must be confined to the season of no frosts, as freezing prevents the wet machine peat from properly compacting and drying hard; moreover, rainy or very humid weather checks operations entirely, because the peat will not dry out of doors in such weather. These conditions necessitate the suspension of work altogether during the winter and give irregular employment to the force and plant at all seasons; they also reduce the theoretical output. The same objections are valid, however, in many other successfully conducted industries, some of which require much larger capital for equipment. They therefore seem no certain bar to success in this new industry, which will have a season of production of more than one hundred days, possibly extending from the middle of April to the middle of September or first of October, even in eastern Maine.

Artificial drying by some simple and direct method after the bricks have been formed is the ideal sought by many inventors to replace the uncertainties and limitations which the present system of air drying imposes upon production, but no one has yet been able to overcome the fact that it takes more heat to dry a ton of wet peat as it comes from the bog or the peat machine than can be obtained from the fuel which the process yields. To this cost must be added all the charges of producing the material which is dried. Moreover, during the drying process the bricks crack and check, seriously impairing their value. It seems possible, however, that by utilizing waste heat in very efficient driers peat from which a considerable amount of water has already escaped may be dried sufficiently by artificial treatment to be stored, and that the limit of the season of production may be thus extended. Aside from the peculiar properties of the peat, the cost of the additional treatment and handling, as well as of extra equipment, must be taken into account, as these must be paid for by the material recovered.

It is evident, therefore, that the problem is a complicated one, and can be attacked only by trained and experienced men if it is to be brought to a successful issue. Successful artificial drying in any event will be accomplished only by utilizing what would otherwise be waste heat and fuel.

BRIQUETTED PEAT.

In Europe, where lignite and poor grades of coal have long been successfully briquetted and sold in large quantities, the attempt to briquet peat was made early in the development of the briquetting industry. In this form peat makes an efficient and easily transported fuel, and one that commands a ready sale at good prices for domestic uses because of its cleanliness, ease of handling, and other good qualities.

The briquets are of uniform size and of cylindrical, ovoid, prismatic, or other shape. Generally, although not invariably, they burn more slowly than peat prepared by the processes previously described.

In preparing the peat for briquetting, cut peat or pressed peat is air dried to about 40 or 50 per cent of moisture, then ground and screened and artificially dried to about 15 per cent of moisture; it is then conveyed to the briquetting press or stored. An improved method of air drying is in use near London, Ontario, where, instead of digging, grinding, and pulverizing the peat, as is generally done in Europe, the surface of the cleared bog is very lightly harrowed, and after an hour or more of exposure to the sun and wind the air-dried dust is collected by a special machine, constructed on the principle of the exhaust carpet cleaners and operated electrically from a track laid on the surface of the bog. As only the dry dust is picked up by the collector, the material reaches the storage bins with not more than 30 per cent of moisture. It is afterward pulverized still finer and dried to about 15 per cent of moisture in its passage to the briquetting press.

All forms of air drying out of doors are open to the objections that have already been stated, and more attempts have been made to produce driers for the production of peat briquets than can be recorded here. Nearly every principle applicable to the construction of machinery of this type has been tried, and as yet none has been found able to meet the need satisfactorily, so that the peat can be dug, ground, dried, pulverized, and briquetted without the intervention of a period of exposure to the air and the sun's heat. This has been the aim of all manufacturers of peat fuel, and especially of inventors, since the briquetting press was introduced, but whether they have tried driers alone or combinations of presses for squeezing out part of the water with driers of almost every conceivable type, using direct heat, steam heat, or electric devices, they have all been discarded after a time, because of the cost of maintenance as compared with the value of the output—namely, they have failed to pay operating expenses and a profit. This failure may be attributed beyond any doubt to the small value of the product and the small quantity of salable material obtained as compared with the raw peat treated, as shown in the table below.

Weight of water removed at 10 per cent stages from 1 ton of peat as excavated from the bog (90 per cent water) in drying to 10 per cent of water.

Percentage of water in the peat.	Dry peat content (pounds).	Water content (pounds).	Weight of water removed for each 10 per cent reduction (pounds).	Weight of material obtained for each 10 per cent reduction (pounds).	Total weight of water evaporated (pounds).
90	200	1,800	....	2,000	....
80	200	800	1,000	1,000	1,000
70	200	466.7	333.3	666.7	1,333.3
60	200	300	166.7	500	1,500
50	200	200	100	400	1,600
40	200	133.3	66.7	333.3	1,666.7
30	200	85.7	47.6	285.7	1,714.3
20	200	50	35.7	250	1,750
10	200	22.2	27.8	222.2	1,777.8

The cost of briquetting plants is six to ten times greater than that of plants of the types previously mentioned, probably involving a minimum expenditure of not less than $50,000 for the complete equipment, with buildings, necessary driers, engines, digging and other appliances, and a single briquetting press with a capacity of about 50 tons in twenty-four hours. This unit is mentioned because it is apparently as small as has been considered practicable for commercial purposes. The estimate is based on the quotations of German manufacturers of tried machinery and is likely to be exceeded in actual construction; it certainly will be if untried processes are adopted and newly invented machinery is installed. The greatly increased cost of the plant over that required for the manufacture of machine peat is easily understood in view of the heavier and more complicated machinery and the much greater amount of it, together with the larger and more powerful boilers and engines required, all of which entail heavier and more substantial construction of buildings.

In 1903 F. H. Mason,[a] then United States consul-general in Berlin, published the following estimate of the cost of a peat-briquetting plant equipped with European machinery, for artificial drying, with an estimated output of 50 tons of briquets a day:

Estimated cost of 50-ton peat-briquetting plant.

Buildings	$14, 280
Machinery	17, 850
Steam engine and fixtures	3, 570
Tramways	3, 570
	39, 270

Later estimates increase rather than diminish this sum, and it is doubtful if, when duties, higher price of labor, and other necessary charges are added, such a plant could be constructed in this country within the estimate first given.

If, however, the system of drying the peat on the bog is adopted, a certain undetermined deduction may be made, as a part of the drying machinery will not be needed. It may be said also that by increasing the surface from which air-dried material is collected and the number of collectors, a sufficient amount of peat dust may be gathered and stored to supply the briquetting press during unfavorable weather and even through the winter. If this is done, weatherproof storage houses of large capacity and of durable construction will have to be added to the equipment.

It is apparent also that if the price of production given for machine peat is a just approximation, that for briquetted peat at least must be increased by the interest charges on the greater investment required and by the maintenance and other expenses of running the more complicated and powerful machinery. Besides this, the added cost of artificial drying and of grinding and briquetting must be taken into account. It will hardly be possible, therefore, to make peat briquets with any machinery now on the European market for less than $3 per ton, and even this is hardly feasible except under very favorable conditions. What can be done with American machinery now in the process of development remains to be seen. The Canadian processes mentioned above have not yet reached the stage

[a] Special Consular Repts., vol. 26, 1903, p. 81.

where their inventors consider them fully perfected, although they are in operation on a factory scale; no figures relative to them can be quoted.

The fuel efficiency of briquetted peat should be at least one-third greater than that of machine peat of the same origin to warrant the added cost of production given above. Actually the increase in efficiency as given by Nystrom is only about 15 per cent. It is therefore apparent from business considerations that the increased cost of plant and the more complicated machinery and processes necessary to make peat briquets are not justified, especially when the cost of production is more likely to be 50 per cent greater that it is to be 33 per cent. Peat is somewhat more transportable in the form of briquets than in any other form because it is less bulky, and it might have somewhat greater sale on this account, but not in proportion to the increase in cost of manufacture.

Electric processes of preparing peat for briquetting have been announced at various times and extensivly advertised. They have been based on the supposition that the cell structure of the plant remaining in the peat would be destroyed by the passage of electric currents, after which the water could be removed by pressure. None of these processes has been commercially successful and the theory on which they are based is of very doubtful value, as there is no evidence that the cellular structure will be in any way affected by the passage of the electric currents used.

The wet carbonizing process for preparing peat for briquetting, developed during the last five years by M. Ekenberg, of London, England, has a much greater value than any other from both theoretical and practical points of view. The process, as its name indicates, involves heating the wet peat under pressure to sufficiently high temperatures to carbonize or coke it. It consists essentially of superheating the peat, mixed with water in closed retorts, to a temperature slightly above 300° F. (150° to 155° C.), equivalent to a pressure of about 80 to 85 pounds to the square inch. Peat subjected to this treatment loses its structure and becomes amorphous, blackened, and so changed that the greater part of the water can be pressed from it. After the water has been removed the residue is artificially dried and briquetted. The briquets are very solid, are nonabsorbent, and in appearance and weight resemble coal. No considerable amounts of gases are given off during the carbonizing process.

The cost of a plant built on this system and with a daily capacity of about 100 tons of briquets is estimated to be somewhat more than $160,000, exclusive of the bog; and the price at which the briquets, which have a fuel value about equal to that of bituminous coal, can be produced, is about $2.25 per ton.

PEAT POWDER.

Peat in the form of fine powder, burned under a blast in a specially constructed burner, makes a very efficient fuel. The process of preparation is simple. The peat is cut or dug from the bog, and after being left on the surface through the winter to disintegrate, is gathered in a partially air-dried condition, dried artificially, and then pulverized. The resulting powder is dark colored, nonabsorbent, and very nearly as heavy as coal.

In firing with peat powder no smoke is developed, because the supply of air can be adjusted so that combustion is complete and rapid. The firing can be so regulated and controlled by the engine, after proper connections are made, that it becomes almost or quite automatic. In fact, peat used in this way burns and yields results like a gas. This is especially illustrated by the ease with which the temperature of the flame is regulated, and by the possibility of getting oxidizing and reducing flames at will by changing the quantity of air supplied to the flame.

The temperatures obtained and held by properly built peat-powder burners are sufficient to melt glass, iron, steel, and other metals, and the use of peat fuel of this type for burning brick, lime, and Portland cement should be widely extended in regions where peat is abundant. The collector which takes the peat from the bog in the form of air-dried powder should have special application to this product for fuel purposes, if it has sufficient capacity to warrant its use. With it the cost of gathering, completing the drying, and pulverizing should not exceed $2 per ton for the product ready for the market, and the cost of a well-equipped plant will be much less than for one intended for any type of briquetting.

PEAT COKE AND CHARCOAL.

A step further in the process of increasing the fuel value of peat and of rendering it more transportable is to convert it into coke or charcoal. It is said that charcoal was made from peat for use in the iron industry in Europe at a very early date. During the last half century or more repeated attempts have been made to produce from peat a material which would be comparable with hard-wood charcoal or coke in hardness and other properties. The experimenting has passed from the old method of coking in heaps covered with earth and sods, through a series of stages with artificial ovens of a number of types, to the use of closed retorts that are heated from the outside. In these retorts the gases are, so far as possible, condensed and redistilled and in this way a number of valuable by-products are recovered. These substances are practically identical with those obtained from the destructive distillation of wood in charcoal making by modern methods. They consist of (*a*) methyl or wood alcohol, ammonia or ammonia sulphate, and acetic acid or acetate of lime, which are obtained by treating the tar water or lighter distillates; and (*b*) illuminating oils, lubricating oils, paraffin wax, phenol (creosote oil and carbolic acid), and asphalt, which are obtained from the tar. The noncondensable gases are combustible and may be used in heating the retorts and in running the engines which furnish the motive power of the plant.

The most fully developed and most successful of the processes of coking peat, and apparently the only one which has reached the commercial stage, is that devised by Dr. Martin Ziegler and represented in Europe by three large and successful plants, two of which are operated in Germany and one in Russia. By this method the peat is dug and formed into bricks by peat machines and air dried exactly as if it were to be sold as machine peat. The peat bricks are then stacked in vertical cast-iron retorts with fire-brick lining, provided with air-tight openings for removing the finished coke and recharging with peat, and with flues for the escape of the gases formed. The retorts are surrounded by a double fire-brick wall, with flue spaces between, through which the combustion gases pass; these gases are further used by conducting them to driers, where the peat is dried before introducing it into the ovens.

At the beginning of the process fires are started in fire boxes at the base of the retorts, but when the cooking is well under way the lighter and uncondensable gases are conducted to the fire boxes, and furnish all the heat needed. The condensable gases are drawn by fans to the special recovery plant and there redistilled, a part of the necessary heat coming from that of the combustion gases, and a part being waste heat from the cooking retorts. As fast as a charge is sufficiently coked it is drawn off at the bottom into air-tight receivers in which the coke cools. At about the same time a fresh quantity of peat is put into the top of the retort through box openings provided for the purpose, thus making the process continuous.

The products of this treatment are peat coke and peat half coke, the latter not so thoroughly coked as the former, so that not all of the heavy volatiles are driven off. The peat coke is black, heavy, and hard, gives a metallic note when struck, is as strong as good charcoal, and is adapted to all the uses of charcoal, especially to the smelting and refining of metals. The half coke is less dense, and burns with a long, clear flame, making excellent fuel for use under boilers and for steam production generally.

For making peat coke of good quality the peat should be thoroughly ground and dried, and should be low in ash and other impurities. For the half coke poorer grades of peat with considerable ash may be used.

The amount of coke obtainable from peat of good quality by the Ziegler process is from 30 to 33 per cent, and of peat half coke (or peat coke No. 2) from 45 to 50 per cent of the weight of the dry peat used. A considerable portion of the remainder is recoverable as by-products, which are, it is claimed, sufficiently valuable to pay a considerable part, if not all, of the entire cost of production, leaving the peat coke as profit.

The coking plants are built on the unit system, a single retort, or, better, two retorts, constituting a unit, with the accessory mechanism and recovery plant. The cost of a unit with two retorts is about $50,000, and in it about 50 tons of air-dried peat could be coked daily, with a resulting product of 16½ tons of coke, or nearly 23 tons of peat half coke. The cost of production and of the recovery of by-products for the unit with one or two retorts is high compared with that for a larger number, as about the same general equipment, supervision, and number of men are necessary in either plant.

The cost of production of peat coke, including digging, machining and drying the peat, expenses of maintenance, etc., under conditions existing in America, is estimated to be from $3 to $3.50 per ton for small plants, and considerably less for large ones, if the by-products are recovered and sold at current market prices. The selling price of peat coke will probably vary according to the locality, the purpose for which it is to be used, the quality, etc., but it should approach that of charcoal of good quality, namely, from $6 to $12 or more per ton, as peat coke can replace charcoal in all its uses. In Europe it has been found to be especially valuable in the production of charcoal iron and in refining other metals. Peat charcoal in powdered form is also used in hardening steel and in the manufacture of calcium carbide. As a fuel it is reported to be and in all respects should be equal to hard-wood charcoal.

As yet no attempt to manufacture peat coke by the Ziegler process has been made in the United States. A few small ovens have been erected for making peat charcoal on an experimental scale, but so far as has appeared these ovens have not been sufficiently well equipped to get beyond an early stage of experimentation, and it is not known how the material will be received by consumers in this country. It will be essential, therefore, before a large plant is constructed, to have at least tentative contracts for the various possible products, for the large expenditure of capital required could hardly be justified on purely speculative grounds.

The rapid depletion of the supplies of wood for making charcoal should soon make the introduction of as good a product as the best peat coke no uncertainty, and after a single plant has demonstrated its value, others will doubtless be constructed in favorable places.

GAS FROM PEAT.

When peat is heated in a closed retort, or away from the air, large volumes of gas are given off. This gas is inflammable, burning with a bright flame, which develops much heat. In fact, its production produces the long, bright flames which characterize a peat fire when the fuel is thoroughly air dried.

The gas from any fuel—charcoal, coal, coke, wood, or peat—is generated on a commercial scale in some form of gas producer, commonly a vertical, hollow furnace, with a grate at the bottom and an air-tight device for supplying fuel at the top, so that it may be operated continuously. Gas producers for the development of illuminating gas are not here considered, as those in which "power gas," for use in internal-combustion gas engines, and fuel gas are made are of more special interest in this discussion.

An old type of power-gas producer still in general use is known as the "suction producer," and supplies gas directly to the engine, which develops its charge and draws it from the producer as needed by the suction of its own piston stroke. Producers of this kind are restricted to the use of anthracite, charcoal, and other fuels without bituminous matter, as the tars and similar substances from bituminous fuels would be carried over into the engine as gases and, condensing there, would clog up the valves and other working parts.

A second type is the pressure producer, which is so constructed that steam and air blasts cause the gas to be produced from the fuel under slight pressure. It can thus be stored under pressure in a suitable container until used, and as its production does not depend on the suction stroke of the engine, it can be cleansed on its way to the container before it is supplied to the engine. Gas producers of this kind, therefore, are adapted to the use of bituminous coal, lignite, and peat, and when used with such materials are provided with special attachments for cleansing the gas of ash and the condensable volatile matter, the gas being forced through these attachments as it is sent to the container. This type of producer was designed for large plants and, until recently, was run chiefly on anthracite.

A third form of power-gas producer is the downdraft type, in which the tarry products of distillation of the fuel are converted into permanent gases. This type seems to have been most satisfactory for use with peat abroad. The hot gases containing the volatilized tars and similar materials are drawn by exhaust fans from the top of the producer through the fuel bed, where the hydrocarbons are decomposed in contact with the hot carbon into simple, permanent gases, which are then cleansed and supplied to the engines.

Gas producers for using peat as a source of power gas have been made by several European manufacturers of gas engines. They have been for several years in successful operation in Sweden and Germany, and new plants are yearly added to the list.

The producer gas obtained from peat is large in quantity, as much as 48,000 cubic feet per ton of water-free peat substance, having a heat value of 152 British thermal units per cubic foot, being reported.[a]

The calorific value of producer gas from peat varies considerably, as does that of producer gas from coal and other fuels, the variations depending on the quality of peat used, the amount of air and steam introduced into the producer, and the type of producer used. Nystrom gives the results of carefully conducted European tests to determine the calorific value of producer gas from peat, as follows:

Calorific value of producer gas from peat.

	B. t. u. per cu. ft.
From a Koerting gas producer at Skabersjo, Sweden, specially constructed for using peat. Average of ten analyses made by testing commission. Peat used had 32 per cent moisture	132
From a Luther gas producer, built for using peat at Ofenfabrik Koefner, Nymphenburg	114
From a Mond producer of the type used for bituminous coal at Stockton, England (Caro's report)	145
From a Mond producer at Winnington, England (Caro's report)	152

In this country very few records of experiments with peat in gas producers have been published. Of these experiments the two made in 1905 and 1906 at the fuel-testing plant of the United States Geological survey[b] at St. Louis, Mo., are of importance chiefly because they were made in a large pressure producer constructed for anthracite coal and not for bituminous fuels. As in one of these experiments the amount of peat used was too small for a full-test run, they must be considered as incomplete. In the first test the gas obtained was made from air-dried machine peat from a point near Halifax, Mass., and its average calorific value was 166 British thermal units per cubic foot. The second test was one of fifty hours' duration, using air-dried machine peat obtained near Orlando, Fla., the average calorific value of the gas being 175 British thermal units per cubic foot. These values are about the same as those of the producer gas obtained from bituminous coal in tests made at the St. Louis testing plant during the same year, in the same gas producer, and by the same corps of testing engineers.

[a] Nystrom, E., Peat and lignite; their manufacture in Europe: Canada. Dept. Mines, Ottawa, 1908, p. 227.

[b] Bull. U. S. Geol. Survey No. 290, 1906.

Calorific value of producer gas from bituminous coal.

	B. t. u. per cu. ft.
Indiana coal, average	147
Kentucky coal, average	164
Illinois coal, average	143
Ohio coal	157
Pennsylvania coal	142
Virginia coal	157
North Dakota lignite	161

In the 50 tests from which the foregoing figures were obtained the gas in only five showed a greater calorific value than that of the Massachusetts peat; and that of the Florida peat was surpassed in but one test on coal, and that only by a single British thermal unit.

These comparisons show that the two samples of American peat and the foreign peats referred to above were as good fuel for the gas producer as the coals used in the tests cited. It should also be noted that while air-dried machine peat was used in the producer tests at the fuel-testing plant, it is quite possible to use peat with 30 to 40 per cent of moisture, and in the form of lumps of any size and shape, as dug from the bog, for manufacturing producer gas.

Another significant feature of the tests cited above is the fact that the single full-test run made with peat as fuel in the gas producer gave a greater horsepower than that obtained from the best of the coal used in the boiler tests. The same result was obtained in the shorter run on Massachusetts peat. Too much stress must not be laid on a single experimental run, but it seems safe to conclude that the value of peat as a fuel is greatly increased when it is converted into power gas in a gas producer, and that in the tests cited, under rigid conditions, the peat, with a fuel-value ratio to bituminous coal of 1:1.8, gave more power when gasified and used in a gas engine than an equal weight of coal used as fuel under a steam boiler. Apparently, therefore, the ideal way in which to use peat fuel for power purposes is to convert it into producer gas and use it in the gas engine, and that this can be successfully done has been demonstrated by a number of commercial operations abroad.

The cost of installing a plant with gas producers and gas engines is as yet somewhat greater than that of equipping with steam boilers and engines of the same horsepower, but these differences are decreasing. On the other hand, the cost of operating and maintaining the producer plant is about one-half that of the steam plant,[a] because a smaller amount of fuel, of much poorer quality, and a smaller firing force are required.

The weight of dry peat required per electrical horsepower per hour, as shown by the available records of experiments, averages from 2 to 3 pounds, and the gas obtained from the producer may be

[a] Bull. U. S. Geol. Survey No. 316, 1907, p. 457.

somewhat richer in hydrogen and lower in nitrogen than that from coal, although the hydrogen content would naturally depend on the degree to which the free hydrogen developed was consumed in the producer.

The principle governing the use of peat in gas producers as a source of power gas for use in gas engines may be applied to the production of fuel gas, in which form the energy of the peat may be economically and satisfactorily converted into heat units for firing steam boilers, ceramic kilns (brick, tile, pottery, etc.), lime and cement kilns, metallurgical furnaces, forges, foundries, and steel, muffle, glass, ore-roasting, and similar furnaces.[a]

Peat fuel in proper form is especially valuable for metallurgical work, being as a rule much lower in sulphur than coal or coke. Peat that has been subjected to salt or brackish water, however, seems to be an exception to this rule and may contain considerable sulphur, some of which appears in the gases produced from it.

The producer in which peat is to be converted into producer gas for any of the purposes indicated above must be designed to meet the peculiar requirements of the fuel, and to care for the considerable amounts of tar and other condensable matter that will be liberated as the gasification proceeds. The form of the kilns or furnaces in which the gas is to be burned and the method of firing them will also have to conform to the requirements of a gaseous fuel, and men will doubtless have to be specially trained to get the best practical results. In general, the attempt to develop plants for utilizing gas as fuel should be left to trained experts in gas firing and to concerns with large capital, because much experimental work usually needs to be done before such processes and the plants using them attain anything like their theoretical efficiency in actual practice. It may be said, however, that in individual plants nearly all the uses suggested as possible for producer gas as fuel have been tried on a commercial scale, either in Europe or in the United States, in some cases with marked success, and there seems no doubt that peat gas can be produced for any of these purposes very cheaply with a properly designed and well-constructed producer.

CONCLUSIONS.

But little has been said in this discussion relative to the value of peat as compared with coal and wood. In this country the records of practical tests for comparison are few, although the analyses which accompany this report (p. 114) give the number of heat units found for a considerable number of small samples of Maine peat. Peat

[a] Wyer, S. E., Producer gas and gas producers, New York, 1907.

has a theoretical heating value ranging from five-eighths to five-ninths of that of bituminous coal. It may be said, however, that the range of British thermal units in any considerable number of coal samples from different fields, or from different mines in the same field, is rather large. Thus in the tests made at the fuel-testing plant at St. Louis[a] the thermal value in a variety of bituminous coals from the eastern and central coal fields of the United States ranged from 9,360 British thermal units per pound for the poorest reported to 14,674 British thermal units for the best. Most of the coals of this class tested gave more than 12,000 British thermal units per pound, while the few samples of lignite tested had a range from 6.739 to 7,603 British thermal units per pound.

Under test conditions in Europe, in comparison with steam coal of good quality, peat when fired under boilers has been found to have about the ratio stated above—namely, a ton of good peat is worth about five-ninths of a ton of good coal. Under the usual methods of firing, however, there is likely to be a greater loss of heat units from the coal than from the peat, especially if the latter is in the form of air-dried machine peat. The peat does not clinker or give off any volatile matter in the form of black smoke. It burns up completely, leaving only a powdery, light ash, which is small in bulk compared with the original fuel. It makes a good fuel bed in the furnace, and burns with a long, bright, clear flame, without smoke or sulphurous gases, so that neither flues, grates, nor boiler plates are corroded or clogged. In burning peat it is of advantage not to stir the fire, which causes the fuel to break up and drop through the grate, or to give it too much draft, for then it burns with too great intensity.

As domestic fuel peat is clean, can be made to burn slowly or rapidly, as desired, by regulating the drafts, is very easily handled, and is so efficient that it commands a ready sale at good prices to all who have had opportunity to try it. It would seem, therefore, that there is a good field for its introduction and use in Maine, both for domestic and manufacturing purposes. In the districts covered by this report there are many small peat bogs, which, although too small for exploitation on a large scale, could be made to furnish fuel to a single small factory, or to a community for a long time. The principal points to be borne in mind in such exploitation are that the simplest equipment that is well designed to produce the desired quantity of a salable form of fuel is the one most likely to be successful, and that every added process of handling adds many times to the first cost of equipment and to the difficulties of producing an article which can be sold for sufficient to pay the cost of preparation.

[a] Bull. U. S. Geol. Survey No. 316, 1907, pp. 443–445.

It also seems probable, from present knowledge, that large peat deposits will be most efficiently and satisfactorily utilized by converting the peat into producer gas and using the gas for power to run gas engines, which, in turn, may be employed for manufacturing or for the generation of electricity. The production of gas may have added value where the form of the producer is such that at least the ammonia generated by gasifying the peat may be saved and sold as a by-product. This process, however, may not be feasible in small plants, for the installation and cost of maintenance is higher in proportion for small than for large units. For all plants requiring the use of more than 150 horsepower the use of producer gas, to be furnished from peat fuel, should be taken under serious consideration where peat beds are available.

It seems apparent, from consideration of its present status and of the long-established use of other and more familiar types of fuel, that peat will be somewhat slowly accepted as an auxiliary fuel, and that it is hardly probable that any large quantity will be demanded by any industry for some time to come. It is especially adapted for burning bricks, lime, and Portland cement, when used in the form of powder or machine peat, and for general power purposes and various metallurgical processes, when properly fired in the form of gas or coke. Its greatest use, however, will probably be in domestic consumption for heating and cooking, and from this source will apparently come the most steady and extensive demand after a supply can be had.

PEAT AS RAW MATERIAL FOR OTHER THAN FUEL MANUFACTURE.

INTRODUCTION.

The great quantities of partly decomposed vegetable matter in the peat beds of Europe, much of it with a fibrous structure, and the low cost at which it could be had have made these deposits for many years the subject of investigation to determine whether they could not be made into products that would replace those made from more expensive materials. It must be remembered that in the countries of northern Europe, where these experiments have been made, raw materials of vegetable origin of most sorts are scarce and bring a much higher price than similar materials in this country; hence the incentive to find substitutes is greater than with us. In the United States potentially valuable products are lavishly used, or go to waste because they have no commercial value and no use has been found for them; and it may be said that better material than peat for some of its proposed uses is at present wasted in large quantities in or near the peat-bearing parts of the country.

CHEMICAL BY-PRODUCTS.

In discussing the production of peat coke in the preceding chapter, the possibility of obtaining a variety of chemical substances of commercial value was mentioned. These materials are actually made on a commercial scale in Europe, by condensing and redistilling the heavier gaseous products given off during the coking of peat. In this country the same compounds are obtained as by-products of charcoal making and also to some extent recovered from coal-coking plants and illuminating-gas producers.

The recovery of chemical by-products from the destructive distillation of any fuel requires a carefully planned recovery plant, especially designed to handle automatically large quantities of liquids in which the percentage of salable material is very small, with the greatest possible economy of power and heat units. In addition, the cost of the supervision and skilled labor necessary for operating such recovery plants is considerably greater than it is for making less complicated products. For these reasons the manufacture of acetic acid and acetates, wood alcohol, formaldehyde, ammonia and its compounds, phenol and creosote compounds, and the products that can be derived from the tarry residues from peat distillation, such as illuminating and heavy oils, paraffin wax, and asphaltum, can be profitably undertaken only at large plants, properly designed and constructed, sufficiently capitalized, and carefully, skillfully, and economically managed. There seems to be no question whatever, from the reports published, that at such plants all the chemical compounds which have been mentioned can be profitably made from peat, and that there is a market for many of them in large and increasing quantities.

It is significant that several plants erected in connection with large lumbering operations for utilizing the waste wood in wood distillation and making the lighter compounds mentioned above have not been successfully operated. The reasons for failure have been, not that the products were not in demand at good prices nor that there was any inherent difficulty in any of the processes, but that, so far as could be learned, the margin of profit was so small and the expenses of maintenance so great that the owners have preferred to close the plants and waste the materials which they had attempted to save or convert to other uses.

ALCOHOL.

Recently there has been a revival of interest in a process by which ethyl or "grain" alcohol can be obtained from peat. It has long been known that cellulose could be broken down into sugar by proper chemical treatment, after which the sugar could be converted into alcohol by fermentation induced by yeasts, as in the ordinary production of alcohol from the commonly used cereals and fruits. The revival of this process has been reported from Denmark, Sweden, and France, where experimental factories have been established to test a newly discovered yeast, and from these factories have come the reports that alcohol can be made from the coarser and less decomposed types of peat at a total cost of 45 to 50 cents per gallon. The process, however, is apparently still in an experimental stage, and may never come into practical use in this country, where apples and other fruits rich in sugar, as well as sugary waste of many kinds, are allowed to decay in large quantities, though for a much smaller cost than would be involved in using peat for this purpose they might be converted into fuel alcohol.

AMMONIUM COMPOUNDS.

A process has been devised by A. Frank and N. Caro, of Charlottenberg, Germany,[a] for obtaining, as a by-product incidental to the development of producer gas from peat, a large part of the combined nitrogen of the peat, amounting in many cases to more than 2 per cent of its dry weight, in the form of ammonium sulphate. In this process the peat has to be superheated, under pressure, with an excess of steam, which decomposes the nitrogenous compounds of the peat. The steam and gases from the producer are conducted through pipes to a large vertical receiver filled with some porous material. This is kept wet with dilute sulphuric acid sprayed into the receiver at the top, while the hot gases are drawn through it from bottom to top. In the passage of these gases the free ammonia is brought into intimate contact with the sulphuric acid and converted into ammonium sulphate. The dilute solution is drawn off at the bottom from time to time and concentrated by evaporation, after which it may be filtered and further purified by crystallization.

Ammonium sulphate is in rapidly increasing demand because of its high value as a constituent of the best fertilizers, and the cost of equipping a plant of sufficient size to manufacture it profitably from peat on a commercial scale is the chief factor to be considered by those contemplating its production. By substituting other acids for sulphuric acid in the combining chamber other compounds of ammonia may be obtained, but probably the sulphate is the most cheaply prepared.

NITRATES.

It has been reported, also from Europe, that nitrates of commercial value, and possibly in commercial quantities, may be obtained by sprinkling a properly constructed culture bed of peat with a dilute

[a] Nystrom, E., Peat and lignite; their manufacture and uses in Europe: Canada. Dept. Mines, Ottawa, 1908, pp. 226–227.

solution (0.75 per cent) of ammonium sulphate and inoculating the peat with cultures of nitrifying organisms. By repeating the application of ammonium sulphate five times the amount of nitrates developed amounts to more than 4 per cent. This may be washed from the bed and purified. The peat may then be used for fuel or for distillation. Whether this process is adapted to the commercial production of nitrates on a large scale is not yet demonstrated, but it presents possibilities of great importance in view of the rare occurrence and meager supplies of these salts, so vitally important in agriculture.

PAPER.

Peat which contains much fibrous matter has been manufactured into paper, chiefly in a single factory established for the purpose at Capac, Mich. The machinery for this purpose was primarily invented in Europe, but has been brought to perfection in this plant, which is reported by the owners to be the only one in the world. The product thus far manufactured is cardboard of dark color but good quality, suitable for making boxes and similar purposes. The raw material can be bleached, but apparently the coloring matter of the peat is so durable as to render bleaching too expensive as a commercial practice.

The chief objections to using peat as paper stock can be briefly stated as follows: There is much waste material, including mineral matter, which must be handled and eliminated. Peat is usually uneven in structure and texture, and the fibrous matter present is small in quantity, was originally poor in texture, and has been weakened by subsequent decay. On this account the peat fiber often has to be enriched with wood pulp or other paper stock to produce even poor grades of paper. It is difficult to bleach, so that only coarse paper and cardboard can be manufactured. Most types of peat contain very little fiber and are too thoroughly decayed for use as paper stock.

It is probable that less than 10 per cent of the peat deposits of Maine are suitable for paper making. Probably the only kind of bog which should be considered suitable for this purpose is one which has been built up from the bottom by successive layers of grasslike plants to a considerable depth and over a large area. The bogs with a thin stratum, 3 to 4 feet in thickness, of mossy, fibrous, or woody peat at the top and structureless material below would be of small if any value for paper making; nor would those of small area be available, as the cost of equipping a paper mill is large.

Paper and pasteboard made from mixtures of varying amounts of peat fiber and wood pulp have been produced from time to time in several countries in Europe, but generally the manufacture has not been continued beyond the experimental stages, because of the high cost of reducing the peat fiber to a condition suitable for use.

WOVEN FABRICS.

The stronger fibers from the more fibrous kinds of peat may be separated and cleansed from the surrounding material, and, after treatment which renders them pliable, they may be woven into fabrics. The most successful experimental use for this kind of cloth has been as blankets for horses and other live stock.

It has been recently reported from Europe, also, that the fiber obtained from the remains of the sedges which frequently grow in moss bogs is collected by hand from the material as it is run through disintegrating machinery for making a fiber that is used in adulterating silk threads and fabrics, a purpose for which it is in growing demand.

ARTIFICIAL WOOD.

Closely resembling heavy paper is a material called "heloxyl," made by compressing fibrous types of peat and hardening the resulting material by special treatment into sheets, blocks, and other forms for structural purposes. The material is light, compact, waterproof, and a nonconductor of sound, vibrations, and heat, and could be made fireproof by the introduction of mineral matter; it is also readily glued, nailed, and painted, and because of these properties, as well as its strength and lightness, makes good finishing material.

Artificial wood, made by mixing fibrous peat with certain mineral cements and compressing it, has also been made in a small way in Germany. The material can be molded into any desired form, is noncombustible, does not absorb water, and is so tough and hard that it is said to make good and durable paving blocks and flooring, as well as a desirable substitute for wood in most of its ordinary uses.

MATTRESSES AND SANITARY APPLIANCES.

Moss peat and material which has been selected and cleansed of sticks and other coarse matter may be made into mattresses and dressing for wounds. The absorbent, deodorizing, and antiseptic properties of peat make it good material for these uses. The mattresses are said to be especially valuable for hospitals, for they are light in weight, resilient, soft, inodorous, and very cheap, so that they can be renewed at small cost.

The material used for dressing wounds needs more thorough preparation than that intended for mattresses, as it must be freed from all dirt and woody matter, and it is doubtful, on the whole, if it possesses sufficient superiority to substances now in general use for the same purpose to warrant the attempt to introduce it.

MOSS LITTER AND MULL.

A much more general use for the more fibrous kinds of peat in Europe is for bedding for stock, and in the form of powder or mull, for various absorbent and deodorizing uses.

Moss or peat litter is hardly to be classed as a manufactured product, as the common processes of preparing it consist chiefly of gathering the peat in a partly dried condition, tearing it up by the use of simple machinery, and after passing it through rotary screens to separate the finer material or mull from the coarser, drying it artificially, and packing it in bales. This material is capable of absorbing much larger amounts of moisture in proportion to its weight than any other substance in general use for stock bedding. It is a good deodorizer and almost entirely prevents the decomposition of the nitrogenous and other organic substances in the manure. In addition, it is reported to be springy and durable and to keep the feet of the animals which stand on it in perfectly healthy condition.

At the present time considerable litter of this sort is imported from Holland and other countries of northern and western Europe, amounting in 1905 to more than 8,000 tons. It has been made for several years past at a single plant at Garrett, Ind., and the demand for the product of this plant is rapidly increasing.

In 1895 an attempt was made to establish an industry of this sort in New Brunswick, not far from the eastern boundary of Maine, but unfortunately the plant was burned when near completion, and only recently has it been possible to plan for rebuilding. It is reported that the plant will be fully equipped and ready for operation in 1909.

Many of the peat bogs of Maine are favorably situated for manufacturing this material and the peat is admirably adapted for the use, to judge from the imported product, which is composed chiefly of poorly decomposed sphagnum moss and other herbaceous plants and is of a light-brown color when dry. The cost of equipping and establishing a plant for making moss litter is not large, as compared with that of the more complicated fuel-making plants, the machinery being inexpensive and of considerably lighter construction. For larger plants some form of efficient artificial drier should be provided to complete the drying of the peat after it is dried as much as possible on the surface of the bog. It will be entirely unnecessary to reduce the moisture below 15 to 18 per cent, however, before baling, as when dried below this point the peat will rapidly take up moisture until it contains as much as it can absorb from the air—from 15 to 25 per cent, according to the relative humidity of the air in the locality.

The litter after preparation is shipped in highly compressed, burlap-covered bales and brings a good price in the markets, generally much better than could be obtained for the fuel resulting from the same expenditure of time and the preparation of the same weight of peat.

Peat litter should not only have a large use in city stables, but ought to be used in dairy barns, where its deodorizing, absorbent, and disinfecting properties would make it much more valuable than any other material now commonly used for the purpose.

The mull, consisting of the finer parts of the peat screened out from the litter, is much used in those European countries where it is produced as an absorbent and wherever a cheap deodorizer is desired. It is very satisfactory for use in place of more expensive chemical substances for outhouses, earth closets, cesspools, and similar sanitary structures, where comprehensive sewer systems have not been constructed.

On the whole, these products, simple as they are and requiring no large outlay of capital, present the greatest possibilities for paying investment to owners of peat deposits in Maine, because they are easily and cheaply made, the peat is generally adapted to their manufacture, and they are already on the market and favorably known to many dealers and consumers.

PACKING MATERIAL.

Peat prepared in about the same way as the moss litter is largely used in Europe for packing fragile and perishable articles, and there seems no reason why it can not be used for the same purposes in this country, where much more expensive substances are now employed. Its use might be extended to include the packing of eggs and fruits for cold storage. The antiseptic power of the peat should add to its value for this purpose, although an exhaustive series of carefully planned experiments with the proposed packing material, in various forms and with varying water content, is needed before any considerable investment is made to produce it on a commercial scale. It is successfully used instead of sawdust for packing ice.

FERTILIZER FILLER.

The most extensive and successful use of peat as the base of a commercial product sold in large quantities in the open market in this country is as a "filler," or adulterant, in artificial fertilizers. This filler should not be regarded, however, as a harmful adulterant, but rather as a diluent, or in some cases perhaps as a necessary constituent of the mixture into which it is introduced, as it improves the whole, both mechanically and chemically. It also permits the use of many kinds of waste animal matter, rich in valuable nitrogenous compounds, which could not be used otherwise, because they absorb water from the air, give off offensive odors, and soon decay, their nitrogenous contents being dissipated as gases, especially ammonia. The advocates of its use claim that peat prevents the loss of nitrogen by checking the decomposition of organic compounds and by absorbing free ammonia, if this is developed; and that it also adds to the soil a small amount of organic matter, the slow decomposition of which furnishes plant food and increases water-holding capacity.

On the other hand, the peat adds to the fertilizer analysis a certain amount of nitrogen which is said not to be immediately available for plants, and, as nitrogen is the most costly constituent of all fertilizers, most agricultural chemists object to this feature. Recent experiments seem to show, however, that at least one-third of the nitrogen in peat is immediately available for plants.

The processes of preparation of peat filler are even simpler than those for peat litter. The peat is dug or plowed up, allowed to drain and become as nearly air dry as may be, after which it is dried artificially to a low moisture content, often in a rotary drier, ground into powder, and shipped in bags. The grinding may be done before the artificial drying and it is reported that in some plants suction collectors, mentioned above (p. 36), have been used very satisfactorily in gathering the peat from the properly prepared surface of the bog. The blacker, more highly decomposed peats are most in demand for this use, because they generally contain a larger percentage of nitrogen than others. It is probable that the peat may be improved in this respect by plowing it and allowing it to remain exposed to the air for a year, or at least through the winter.

The cost of fully equipping a plant for making peat into fertilizer filler is probably not less than that for making machine peat, but because of the established market a good product, of sufficient weight and of high nitrogen content, commands a ready sale at considerably higher prices than the machine peat would bring as fuel.

CONCLUSIONS.

Peat is available for any of the uses cited in this discussion and some others which have not been considered here, but it can hardly be classed as a satisfactory raw material for making the more complicated products, under the usual conditions existing in Maine, where other and established substances are already to be had in any desired quantity and at satisfactory prices. Moreover, these products can be obtained from peat only by large investment of capital, and as a rule they can not be manufactured before the plant has passed through a long experimental period, which must be properly provided for by a considerable fund established for this purpose.

The simpler products—peat litter, mull, mattresses, packing material, and fertilizer filler—have a much greater chance of being quickly made profitable, for some of them are already on the market and present uses for which the peat is especially adapted. Moreover, the processes of preparation are simple; a moderate expenditure will fully equip a plant for their manufacture with tested machinery; and it is unnecessary to provide for a long experimental development.

It is apparent, therefore, that the more fibrous kinds of peat, which are abundant in Maine, may be put to a number of profitable uses besides making them into fuel, and that the black, plastic types have other possibilities.

PEAT IN AGRICULTURE.

INTRODUCTION.

The utilization of peat in agriculture is very important in a State having such large areas of peat and swamp land as Maine. It can be fully discussed only after a large number of practical experiments, on a large scale, have been made, to determine the availability of this sort of land, under the existing climate, for various kinds of corps. In Europe these matters have been made the subjects of most careful and exhaustive study by trained specialists, generally working under the auspices of a society made up of farmers, landholders, and others who are interested, and aided by definite government appropriations. The work is carried on systematically at suitably located experiment stations, where tests of all kinds are made. Nothing of this sort has been attempted in the United States except at a few of the agricultural experiment stations.

SOIL FOR CROPS.

In the natural condition peat is too wet to be worked, and before any crop plant can be made to grow upon it the surface must be cleared and the water level lowered by effective ditching and draining. In general, after this has been accomplished, the surface layers of the peat are found to be coarse in texture and often full of partly decayed stumps, roots, and other woody débris, which must be removed. The coarse-textured peat dries out very readily and affords but a small amount of plant food, so that after a short time, or during unfavorable seasons, crops fail to grow upon it. Often swamps are cleared, drained, and cultivated for a brief period at considerable expense and then abandoned because they are, as a rule, unproductive.

Aside from the coarseness and consequent poverty in moisture and plant food of peat soils, an important cause of failure seems to be the attempt to grow crops which are not adapted to them. Extended observation in various parts of the country where peat soils are common apparently indicates that after one or two crops have been taken from newly cleared peat land grass is most likely to yield good crops for a number of years, until the surface layers are blackened and disintegrated into a fine-grained, homogeneous mass. Crops of various kinds may then be raised, but these should be such as can stand cold nights and early frosts without injury and will not be greatly harmed by drought. Some truck crops, such as celery, cabbage, and other vegetables, seem especially to thrive on well-blackened peat, and often yield large returns.

Peat soils generally need mineral fertilizers, as they contain little available mineral matter, and barnyard manure is often very effective in adding to their productiveness, both because it adds material which is lacking to the peat and because, apparently, it hastens the decomposition of the peat by introducing the fungi and bacteria that cause decay.

In some parts of the country peat soils are among the most productive of all, yielding large crops year after year with no more care than is required to obtain inferior production from other kinds of soil. In such places, however, the peat is of the thoroughly decomposed black type, and it seems generally true that the brown, fibrous kinds, such as are common in Maine, are not very fertile until they have been cultivated or, after draining, exposed to the weathering agents for some years.

FERTILIZER.

Muck, or peat, has been employed for a long time by the farmers of Maine as an auxiliary fertilizing material, either by applying it directly to the land or by using it in connection with other fertilizers, especially in composts with barnyard or stable manure. This practice is justified by the composition of the peat, which in many places contains from 2 to 3 per cent of combined nitrogen, besides other organic matter, and, when properly applied, adds to the humus and hence to the water-holding power of the soil.

To get the best results from peat for these purposes it should be dug and left on the bog for a time to dry out and disintegrate thoroughly. This not only gets rid of the water, but renders the peat more absorbent and in better form to be mixed with the soil. It also renders the nitrogenous matter more immediately available for the use of the growing crops. If dug wet and spread over the land in this condition, the peat may dry into hard, tough lumps that are of no more value to the land than stones or blocks of wood. Aside from this, it must be remembered that a ton of peat as it is taken wet from the bog contains only about 225 pounds of usable material, and that in this quantity there is not enough fertilizing substance to justify the labor of getting it. On the other hand, the dry material which may be obtained by digging out the peat in the fall and letting it lie on the bog until the next fall will yield excellent returns, especially if it is properly composted with coarse manure before applying it to the land. The composting should be done in the ordinary way, by stacking the peat in thin layers, alternating with layers of stable refuse to a depth of several feet, and allowing the heap to stand for several months, turning over the whole at least once during the time.

ABSORBENT AND DISINFECTANT.

The air-dried peat may be used to even better advantage as an absorbent of the valuable nitrogenous liquids of stables and barnyards, which are ordinarily allowed to go to waste. For this purpose the dried peat needs simply to be piled up under cover until used, when it may be spread over the barnyard in layers, as needed. If used in the stables, it will not only act as an absorbent of liquids, but, as it checks decomposition and absorbs gases, it will be a more or less effective deodorizer.

Dry, powdery peat may also be used for all the purposes for which peat mull is recommended above, and is greatly superior for most of them to lime, ashes, or the more expensive chemical compounds used for deodorizers and disinfectants. It is nearly an ideal material for use in earth closets and in other receptacles for moist, waste organic matter, and its value to every farm dweller for these and similar uses is far in excess of the cost of gathering and preparation.

BEDDING FOR STOCK.

Dry peat, if free from sticks and hard lumps, may be successfully used for bedding for all sorts of live stock, equaling for this purpose the more carefully prepared peat or moss litter, all of whose properties it possesses. When used for bedding, the thoroughly dried peat should be packed firmly on the floor of the stalls, or standing room, to a depth of 3 inches or more. If well prepared and kept clean, such a bed will last without renewal for several months, furnishing an elastic and spongy standing room and bed, which absorbs and keeps down the usual odors of the stable to a marked degree. Wet peat should not be used for this purpose.

PROTECTION FOR UNDERGROUND AND EXPOSED WATER PIPES.

As dry, fibrous peat is a good nonconductor of heat, it may be used satisfactorily to cover water pipes to protect them from freezing. Peat is probably superior for this purpose to straw and similar materials commonly used, being more durable and, if properly dried, more absorbent, so that it would not lose its protective properties so quickly when laid down in a wet place. The only preparation needed is drying, and it is evident that the tough, spongelike turf, or uppermost layers of moss peat, would be especially desirable for this use, as they afford large air spaces between the fibers and thus give better protection than more compact material. Such peat should also be good packing for insulation between the walls of refrigerators, ice houses, and similar structures.

STOCK FOOD.

In Europe peat mull and peat fiber, prepared from moss and sedge peat, have been used as the bases for the preparation of certain kinds of condimental stock foods. The chief ingredient in these preparations, besides the peat, is the uncrystallizable residue or molasses from beet-sugar factories. This molasses has a certain food value, but is difficult to feed because of its stickiness and liquid condition, and the peat is added to obviate these difficulties. Actual analyses by reputable agricultural chemists show that this material has a twofold use—it is eagerly eaten by the cattle, and thus stimulates them to eat more than they otherwise would of fattening food, and the peat itself adds a small amount of proteid substance to the food.

It must be said, however, that the weight of evidence gathered by the agricultural experiment stations in the United States seems to show that stock foods of this type are to be considered as more in the nature of condiments, or stimulants, than as true foods, and often do not give returns sufficient to warrant their use.

PACKING MATERIAL.

Air-dried peat could also be used to advantage for packing eggs, fruit, and vegetables for storage in bins, pits, cellars, or other receptacles. Its nonconducting properties would keep an even temperature and prevent freezing and the shrinkage due to evaporation, while any water given off would be absorbed. Perishable articles packed in this material would not be absolutely protected from decay, for this is caused by microscopic plants, the germs of which are generally introduced before the articles are packed. Uninfected fruit, however, would not be spoiled by contact with that already inoculated, as is often the case in the usual methods of packing, because peat is sufficiently antiseptic to prevent the growth of the rot-producing fungi through it, and the reproductive bodies could not pass from point to point as they do through air spaces.

PEAT ASHES.

A question is often raised as to the value of peat ashes. In general, it may be said that they are not nearly so valuable as those obtained from wood, as they contain a disproportionately large percentage of silica and a very small amount of phosphoric acid and potash. The silica probably comes from fine, silty sediments in the water in which the peat was formed; it has practically no value in plant growth, and is the most abundant constituent of most soils. The small proportion of other mineral constituents in peat ash is probably to be attributed to the lack of the remains of woody plants, inasmuch as the mosses and other herbaceous plants, which are the chief peat formers, usually accumulate less mineral matter in their cell walls than the shrubs and trees.

Therefore, although at times it may be advisable to burn over the surface of peat beds to remove quickly and cheaply the surface covering of vegetation, it is a great mistake to burn the peat for the sake of getting the ashes, which are almost worthless for agricultural purposes, compared with the high value of the peat itself for any of the uses which have been mentioned in this discussion.

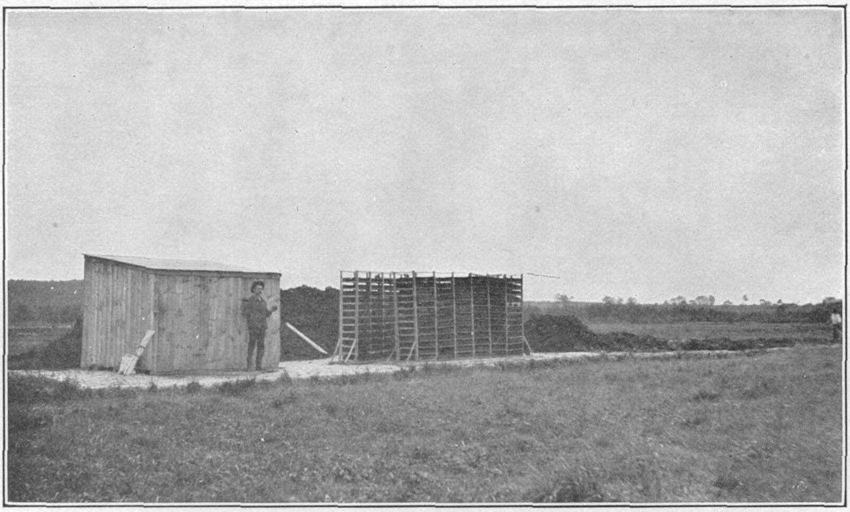
CONCLUSIONS.

Peat land may be profitably cultivated if the right crops are chosen, and if the peat is sufficiently drained, fertilized, and decomposed. Many peat swamps in Maine are, however, of a type which it would hardly pay to try to cultivate, as the peat is very poorly decomposed and would be a long time in reaching the state where it would be safe to use it for most crops.

On the other hand, even poorly decomposed peat may be very profitably used in many ways on the farm to increase the fertility of the land and incidentally to add indirectly to its productiveness, by conserving and preserving other more salable articles, or by absolutely saving valuable waste matter which could not otherwise be kept.

METHODS OF TESTING MAINE BOGS.

The methods and tools used in testing for peat during the field work covered by this report were very simple. In fixing the location of borings, distances were usually determined by pacing and bearings were taken with a Brunton pocket transit. The boring was done with an ordinary ship auger attached to 21 feet of ½-inch gas pipe. The pipe was in 3-foot lengths which could be connected by couplings. This facilitated handling the auger and permitted depths to be easily estimated by simply counting the number of lengths of pipe used. One foot of similar pipe attached at its middle point to a T-coupling served as a handle. A picture of the auger is shown in Plate III, *B*. It was found that by means of this auger peat samples could be collected from any desired depth up to 21 feet, the peat only rarely being too fluid to cling to the auger. The ship auger possesses an advantage over augers of the ordinary type in that the peat is much less liable to be pulled off as the tool is withdrawn and other peat



A. FELLOWS'S EXPERIMENTAL PEAT FACTORY, FARWELL BOG, NEAR LEWISTON.

Shows stock piles of crude peat and bricks of machine peat drying on racks in the open air. The peat machine and gasoline engine are in the shed.

B. PART OF THE GREAT SIDNEY BOG, NEAR AUGUSTA; A TYPICAL MOSS HEATH, WITH SCATTERED LARCHES AND SPRUCES.

Showing also the auger used in making test borings.

is less liable to be picked up from points higher in the hole. In most of the borings the 21 feet of piping were sufficient to reach the bottom of the peat deposit, and in nearly all the others the bottom slopes indicated by adjacent borings showed that the bottom would probably have been reached at a depth less than 30 feet. In a very few bogs the depth is probably greater than this figure. Three feet of tin piping slightly larger in diameter than the auger were found useful in keeping clear the mouth of the test hole. Most of the samples were collected in tin milk cans holding a pint. These cans were not air-tight, but sufficed to keep the peat in a moist condition for a number of months. No attempt was made to determine the percentage of water in the peat as it came from the bog, beyond its general description in the notes as firm, fluid, etc.

A lighter and better form of sampling tool, devised by C. A. Davis, is so constructed that samples can be obtained from any desired depth without danger of contamination. It consists of a short metal cylinder, sharpened at its lower rim, into which fits a metal plunger long enough to fill it completely. The upper end of the plunger is attached to a gas pipe similar to that used in the apparatus previously described. The plunger is provided with a spring catch so that it can be partly withdrawn from its inclosing metal cylinder and locked in that position. In collecting a peat sample the plunger is inserted in the cylinder so as to fill it completely and the apparatus is pushed down into the peat nearly to the depth from which the sample is desired. It is then given a short upward pull, which serves to withdraw the plunger from the inclosing metal cylinder. The apparatus is again pushed down, and the spring clamp prevents the plunger from reentering the cylinder, which becomes filled with peat. The apparatus may then be withdrawn from the bog and the sample ejected from the cylinder by again forcing in the plunger. The cylinder protects the sample completely from any mixture with other peat during withdrawal.

ESTIMATION OF THE TONNAGE OF MACHINE PEAT THAT A BOG WILL YIELD.

In describing the bogs tested it is considered desirable as a rule to present a rough estimate of the number of tons of manufactured peat which the bog is capable of yielding. These estimates are based on minimum estimates of area and of depth and a conservative reduction factor, as is shown below.

The specific gravity of two samples of dry, highly compressed peat, as given by Leavitt,[a] is 0.910 and 1.160. The specific gravity of peat coke, hard pressed, is given as 1.040 and that of less hard pressed

[a] Leavitt, T. H., Facts about Peat, 3d ed., 1867, p. 260.

coke as 0.913. These figures indicate that the specific gravity of the dry peat substance is slightly but not much greater than that of water. A cubic foot of water weighs 62.5 pounds. It is probable that a cubic foot of wet peat as it comes from the bog will weigh more than this, probably somewhat over 65 pounds, though that figure may be taken as a conservative estimate. The results of numerous tests show that many peats as they come from the bog contain 85 to 90 per cent of water by weight. In others the water percentage is lower, but for purposes of a conservative estimate it may be assumed that the vegetable matter constitutes only 10 to 15 per cent by weight of the wet peat. On this basis a cubic foot of wet peat would contain only 10 to 15 per cent of 65 pounds, or 6.5 to 9.75 pounds of vegetable material.

The water contained in air-dried machine peat will probably average about 25 per cent by weight, but a conservative estimate may assume that it constitutes only 20 per cent. A sample of air-dried machine peat from the Farwell or Garcelon bog near Lewiston weighed 52 pounds per cubic foot. According to W. E. H. Carter,[a] air-dried machine peat "often surpasses water (in weight), but commonly weighs 30 to 40 pounds per cubic foot." Forty pounds may be taken as an average figure. Of this about 80 per cent, or 32 pounds, would be vegetable material.

As each cubic foot of peat as it comes from the bog contains 6.5 to 9.75 pounds of vegetable matter, it would take $\frac{32}{6.5}$ to $\frac{32}{8.75}=5$ to 3.2 cubic feet of wet peat to make 1 cubic foot of air-dried machine peat. If we assume 4 cubic feet of wet peat as an average figure we have the following relations:

$$\frac{\text{Volume of wet peat in bog, in cubic feet}}{4\ \text{(number of cubic feet of wet peat equal to 1 cubic foot of machine peat)}} \times \frac{40\ \text{(average weight in pounds of 1 cubic foot of machine peat)}}{2{,}000\ \text{(pounds in short ton)}} = \frac{\text{Volume of wet peat in bog, in cubic feet}}{200} = \left\{ \text{Number of tons of air-dried machine peat which the bog can produce.} \right.$$

EXPLANATION OF ANALYSES AND ANALYTIC METHODS.

The general method used for proximate analyses was that adopted by the American Chemical Society's committee on coal analyses.[b] In determining the thermal value the Mahler bomb was used, 2 grams of peat being taken instead of the 1 gram used in coal analyses. The air drying was conducted in an oven at a temperature of about

[a] Twelfth Ann. Rept. Ontario Bur. Mines, 1904.
[b] Jour. Am. Chem. Soc., vol. 21, p. 1116.

35° C., the oven being so constructed that a warm current of air is carried over the fuel until it has dried to an approximately constant weight.

Three to five days were required for this thorough drying.[a] Drying at this low temperature is intended to prevent the loss of volatile combustible material known to occur when peat is dried at the higher temperatures of 100° to 105° C. The oven drying also gives more uniform results than open-air drying, because it is more largely independent of the humidity of the laboratory air at the time the analysis is made.

Moisture.—As the samples were not sealed when collected in the field, the moisture determinations are of no especial significance except as showing that in nearly all the wet samples water forms from 80 to 90 per cent by weight of the whole.

Thermal value.—The method of determining the thermal or heating value of a peat is to burn completely a small sample under such conditions that all the heat generated will be absorbed by a known volume of water. The rise in temperature of the water is observed and made the basis of the calculation.

Two heat units are in common use—(1) the calorie, which is the heat necessary to raise the temperature of 1 kilogram of water 1° C., and (2) the British thermal unit (abbreviated B. t. u.), which is the heat necessary to raise the temperature of 1 pound of water 1° F. British thermal units may be converted into calories by multiplying by 5/9, and calories into British thermal units by multiplying by 1.8. Both units are given in the tables of this report.

In order to satisfactorily compare the heating values of a number of peat samples it is essential that they should all be dried under closely similar conditions. This result can more nearly be attained by oven drying than by drying in the open air of the laboratory, where the humidity of the air is variable. The thermal values actually obtained were reduced to the theoretical basis of perfect freedom from moisture by the formula given on page 64. These moisture-free values are given in the tables and plotted in diagram 1, figure 19. In the actual manufacture of peat fuel on a commercial scale it is seldom possible under the climatic conditions prevailing in the northern United States to reduce the moisture content to less than 20 per cent. The thermal value with any assumed percentage of moisture between 0 and 35 per cent may be estimated approximately for any of the samples analyzed by deducting 1 per cent from the thermal value of the dry peat for every 1 per cent of moisture present. Thus a peat showing a thermal value of 10,000 British thermal units

[a] Bull. U. S. Geol. Survey No. 323, 1907, pp. 8–10.

for the dry peat would have a thermal value of approximately 8,000 British thermal units if it contained 20 per cent of moisture.

Volatile combustible.—The volatile combustible represents all the materials that are given off during a moderate heating of the peat. It includes oxygen, hydrogen, marsh gas, nitrogen, carbon dioxide, carbon monoxide, combined water, etc. Not all of these materials are volatile and not all are combustible, but all are driven off during such heating, and are included under this somewhat misleading heading, which is in rather general use. The percentages given in the tables on pages 114–119 and in diagram 3, figure 20, are recomputed to the basis of no moisture.

Coke or charcoal.—The amount of coke or charcoal is calculated from the weight of the residue left in the crucible after the volatile combustible material has been expelled. It includes both ash and fixed carbon. Its percentage is not given in the tables, but may be easily obtained by adding the percentages of ash and of fixed carbon.

Fixed carbon and ash.—The carbon of the peat coke, which was not expelled in moderate heating, is expelled on prolonged heating, leaving a residue composed wholly of ash. The percentage of fixed carbon is calculated from the difference between the weight of the ash and that of the peat coke (fixed carbon and ash). The values given in the tables on pages 114–119 and in diagram 4, figure 20, are recalculated to the moisture-free basis.

Reduction of analyses to water-free basis.—The percentages actually obtained in making both approximate and complete analyses, and also the thermal values, were reduced to the basis of total absence of water by the following formula:

$$\frac{\text{Thermal value or percentage of any component in sample as analyzed}}{\text{100 minus percentage of water in sample as analyzed}} \times 100 = \left\{\begin{array}{l}\text{Thermal value or}\\ \text{percentage of}\\ \text{same component}\\ \text{in moisture-free}\\ \text{peat.}\end{array}\right.$$

DETAILED DESCRIPTIONS OF LOCALITIES.

ANDROSCOGGIN COUNTY.

GREENE.

Locality 1.—Bog near Greene station, on Maine Central Railroad, between Lewiston and Leeds Junction. The location and outline of this bog are shown in figure 1.

Hole A. 100 yards N. 25° W. of the wagon road.	Feet.
Brown, firm fibrous peat	0–6
Softer brown peat	6–9
Blue-gray, firm clay	9

Hole B. 135 yards N. 25° W. of hole A and only 10 paces from the creek. Black peat full of grass fibers 11 feet, very fluid at the base, underlain by blue-gray clay.

Hole C. 100 yards west of east border of bog at point shown on map. Peat 1 foot, underlain by gray sand.

Hole D. 100 yards west of hole C. Dark-brown peat 4 feet, underlain by sandy peat.

Hole E. 100 yards east of road which follows western border of the bog, at locality shown on map. Dark-brown peat, firm and fibrous in upper layers but becoming more fluid below, 8 feet, underlain by clay.

Hole F. 100 yards east of hole E.

	Feet.
Dark-brown fibrous peat	0–7
Greenish-brown, somewhat clayey peat	7–9
Clay	9

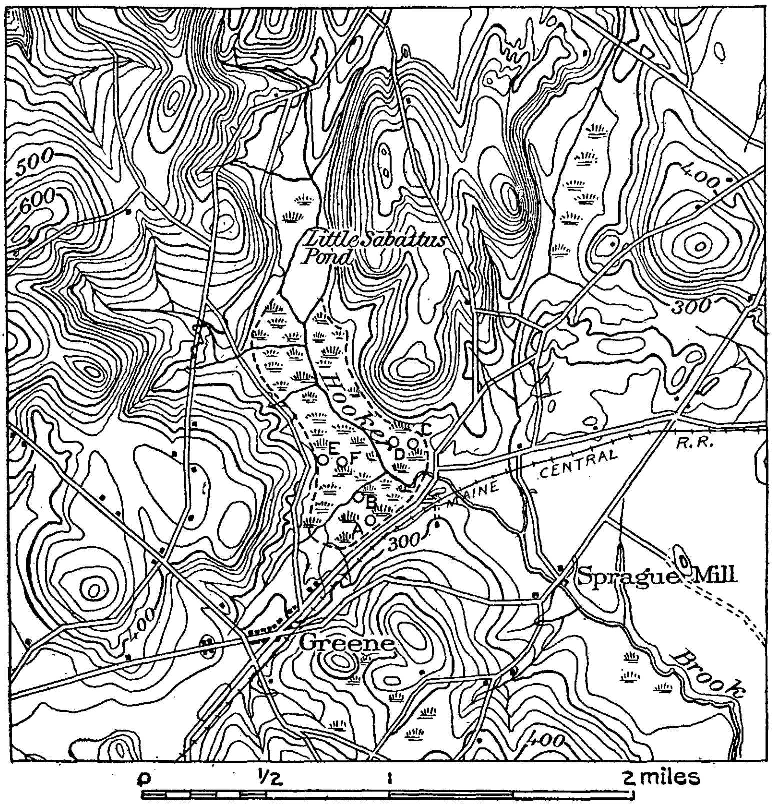


FIG. 1.—Map showing location and area of bog near Greene station, between Lewiston and Leeds Junction (locality 1), and locations of test borings.

Analysis 1, page 114, represents peat from this bog (hole F). As might be expected in a bog traversed by a stream and subject to occasional flooding and accession of silt, the percentage of ash is high and the thermal value only moderate. In spite of its favorable situation close to the railroad the peat is not of a quality to justify the erection of a large plant for the manufacture of fuel or other peat products. It may, however, eventually prove valuable for local consumption. On the assumption that the area of this bog is approximately 160 acres and its average depth the conservative figure of 7 feet, the bog should yield 250,000 short tons of air-dried machine peat. The level of the water in the bog has been artificially raised by a milldam, the removal of which would render the bog much drier.

LEWISTON.

Locality 2.—The Farwell or Garcelon bog, about 2 miles east of the city of Lewiston. The area of this bog is, approximately, 130 acres. Its form and dimensions are shown in figure 2 and on the Lewiston topographic sheet of the United States Geological Survey. A series of test borings were made in this bog at about the locations shown in the figure.

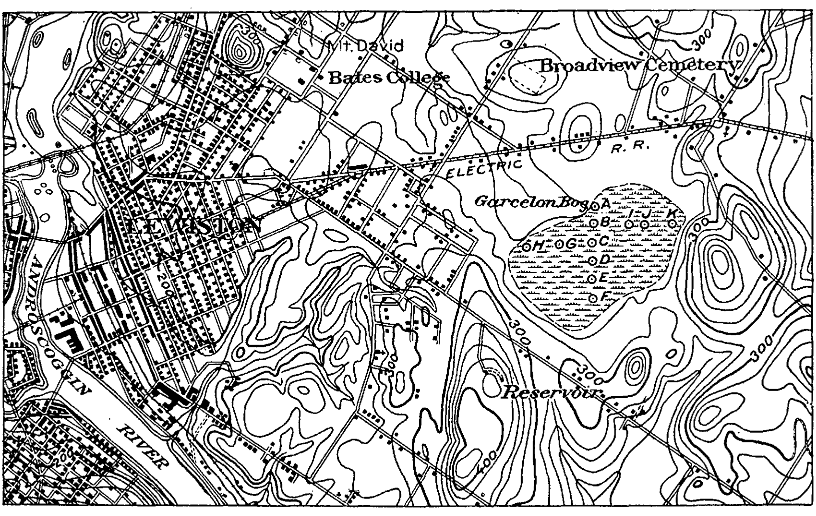


FIG. 2.—Map showing location and area of Farwell or Garcelon bog, near Lewiston (locality 2), and locations of test borings.

Hole A. 500 yards south of the Robert Stewart house on the Lewiston-Sabattus road. Black peat 4½ feet, underlain by blue-gray clay.

Hole B. 600 yards south of the road.

	Feet.
Brown, somewhat fibrous peat	0– 6
Darker brown, more fluid peat	6–17
Some clay admixture	17

Hole C. 700 yards south of the road. Brown peat, slightly fibrous above but becoming more fluid below, 18 feet, underlain by blue-gray clay.

Hole D. 800 yards south of the road. Brown peat 21 feet, the lower foot or so showing some admixture of clayey material. At a depth of 6 feet marsh gas was abundantly given off.

Hole E. 900 yards south of the road.

	Feet.
Brown peat	0–18
Clayey peat	18–21

Bottom not reached.

Hole F. 1,000 yards south of the road and within 80 yards of the southern border of the bog.

	Feet.
Firm, slightly fibrous peat	0–12
Soft, nonfibrous peat	12–16
Very liquid peat	16–21

Bottom not reached.

Hole G. 200 yards due west of hole C.

	Feet.
Firm, dark-brown peat	0–15
Clayey peat	15–17
Blue-gray clay	17

Hole H. 200 yards west of hole G and 100 yards from west border of the bog. Slightly clayey peat 5 feet, underlain by clay.

Hole I. 200 yards due east of hole B.

	Feet.
Firm dark-brown peat	0–12
Clayey peat	12–14
Blue-gray clay	14

Hole J. 100 yards east of hole I. Firm dark-brown peat 17 feet, underlain by clay.

Hole K. 150 yards east of hole J and 140 yards from east border of bog. Dark-brown peat, somewhat mucky at the surface, 9 feet, underlain by clay.

During the civil war, when the price of coal was high, N. W. Farwell, of Lewiston, used peat from this bog during one winter in running his bleachery. At the present time an experimental attempt to utilize the peat is being made by F. H. Fellows, of the Auburn Leather Board Supply Company. No peat was marketed during the year 1906, but some was used, with apparently satisfactory results, in the leather-board factory, where it was mixed with Cumberland coal; and some has been used in an experimental way for domestic purposes. Mr. Fellows planned to place it on the local market during 1907.

The small plant which has been erected is situated at the northern border of the bog just north of the locality of hole A. (See Pl. III, *A*.) It consists of a single peat machine constructed by Mr. Fellows on the model of those built by Heinen in Varel, Germany. In external form the machine is much like a small brick machine, being essentially a horizontal cylinder tapering near one end and provided at the other end with a hopper-like receiver. A central axle inside the cylinder bears several sets of auger blades which press the peat forward, and also long spikelike fingers which work between similar fingers projecting inward from the wall of the cylinder and thus tear the peat to pieces. The macerated peat issues as two continuous bars from a pair of small openings, each $3\frac{3}{4}$ by $3\frac{3}{4}$ inches in size, at the end of the cylinder, and is cut by hand into bricks about $4\frac{1}{2}$ inches in length. The bricks are placed on wooden racks to dry in the open air. The drying occupies several days, the exact time depending on the weather; and in the process the bricks shrink to about 3 by 3 by 4 inches. After the drying is well begun the bricks will stand a severe rain without disintegrating or absorbing any considerable amount of moisture. When thoroughly air dried the bricks are hard and should stand shipment without much crumbling.

The machine at this plant is driven by a gasoline motor and is said to be capable of turning out 5 tons of air-dried peat bricks a day. In order to produce this amount, however, a force of 5 or 6 men must be employed, which is an excessive proportion of labor to output.

Analyses 2 to 5, page 114, represent peat from this bog. The percentage of ash in all these samples is low and the thermal value high, except for No. 5. Among the samples taken from hole B, No. 3, from the intermediate depth, shows a higher thermal value than the peat nearer the surface or that near the bottom of the deposit. This superiority is probably in large part attributable to its lower ash content, although it is somewhat better decayed than No. 2 and differs from No. 4 in the character of the plants which form it. The relatively low thermal value of the sample of machine peat, No. 5, as compared with that of Nos. 2 to 4, is particularly to be noted, especially as its percentage of ash is lower than in the crude samples. This is perhaps attributable to a loss of volatile combustible matter during the briqueting process and during exposure to the air in stock piles, though unfortunately no analytical determination of the volatile combustible was made on this sample.

Most of the bog is an open moss heath with scattered larches and spruces. Near its eastern and western borders it is forested to some extent with small birches, alders, and willows, and a few maples and pines.

The total area of the bog is approximately 130 acres, and if the average depth of peat is 15 feet, the bog should yield about 400,000 short tons of air-dried machine peat.

Locality 3.—Bog south of No Name Pond, 4 miles east of the city of Lewiston. The location and outline of this bog are shown in figure 3 and on the Lewiston topographic sheet of the United States Geological Survey.

Hole A. 100 yards due south of south end of No Name Pond.	Feet.
Brown fibrous peat containing numerous small roots, mostly of heath plants	0–8
Much more fluid peat, slightly clayey in places	8–20
Clay	20

Hole B. 200 yards south of hole A.	Feet.
Brown fibrous peat	0– 6
Darker-brown, less fibrous peat	6–10
Dark-brown, fluid peat	10–15
Greenish-brown, slightly clayey peat	15–21

Hole C. 200 yards south of hole B, 45 paces west and 50 paces north of the creek forming the outlet of No Name Pond, which here bends nearly at right angles.

	Feet.
Brown fibrous peat	0– 6
Darker-brown, less fibrous peat	6–15
Greenish-brown, fluid, slightly clayey peat	15–20
Blue-gray clay	20

Hole D. 200 yards due west of hole C, in open grass land.	Feet.
Slightly clayey peat, but probably not too much so to be utilized	0– 4
Firm dark-brown peat	4–17
Soft blue-gray clay	17

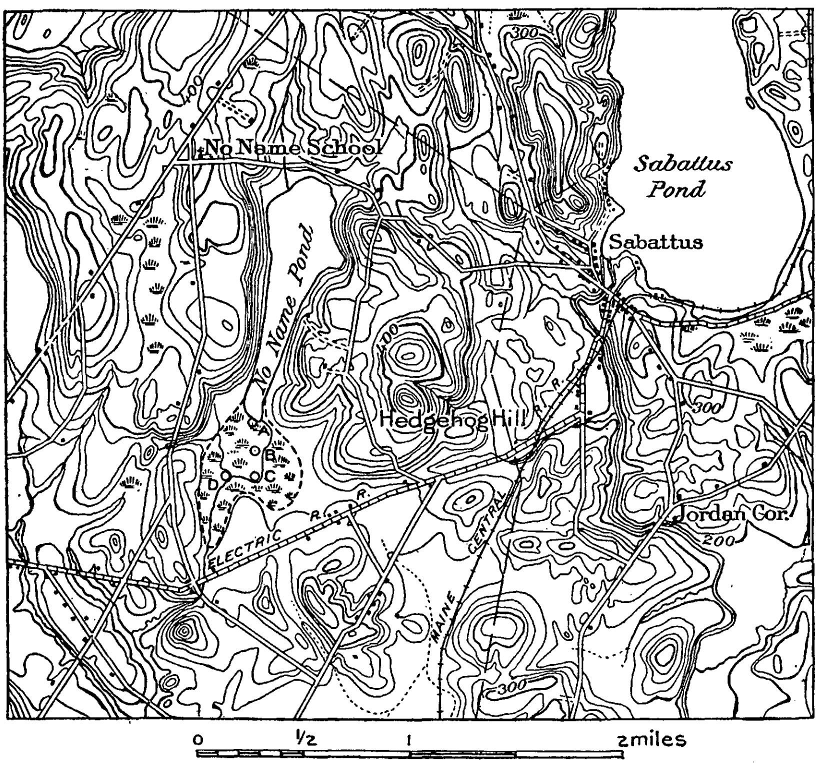


FIG. 3.—Map showing location and area of bog south of No Name Pond, between Lewiston and Sabattus (locality 3), and location of test borings.

The western border of the bog is 225 yards west of hole D. The bog continues southward to a point within about 200 yards of the Sabattus road, but the depth of peat decreases rapidly in this direction.

Analyses 6, 7, and 8, page 114, represent peat from this bog (hole B). The analyses show a low ash content and medium thermal value for No. 6, but a very high ash content and low thermal value for Nos. 7 and 8, obtained at a greater depth in the same hole. The high ash percentage indicates that the peat is somewhat clayey, a characteristic more commonly observed in bogs traversed by a stream, like this one, than in those which are not. The stream carries silt washed from the neighboring highlands and in times of high water may shift its course or flood the bog, and its load of silt would then be deposited with the peat. This process was probably more characteristic of the earlier stages of the growth of the bog than of the present, and the upper layers of peat are in consequence less clayey than the lower. It is possible that in other portions of the bog, even at the same depth, the percentage of ash in the peat may be less.

The most abundant plants now living on this bog are the sphagnum mosses and the typical plants of the heath family, with rather a heavy growth of spruces and larches. Over much of the bog young white birches, small white pines, and alders also grow.

The total area of this bog is approximately 125 acres. On the assumption of an average thickness of 15 feet of peat, the bog should yield over 400,000 short tons of air-dried machine peat. It is favorably situated on an interurban trolley line, within 1¼ miles of the Maine Central Railroad and within 4 miles of the city of Lewiston.

MECHANIC FALLS.

Locality 4.—Bog at the northeast end of Tripp Pond, 3 miles southwest of Mechanic Falls. An area of several acres at this locality is covered by black muck which in the past has been dug to some extent to spread on sandy farming land. Sphagnum and plants of the heath family are present in a few of the wetter portions, but most of the bog is forested with hard-wood shrubs and trees. A boring about 50 feet north of the northeast border of the pond, near some old pits where muck has been dug, showed 2½ feet of black clayey muck underlain by sand. A boring about one-fourth mile north of the pond along the brook to Hogan Pond showed 4 feet of greenish-black muck underlain by fine clayey sand. The peat of this bog is too clayey and too scanty in amount to be of commercial importance.

Locality 5.—A small muck deposit is located 1½ miles west of Mechanic Falls, along the north side of the Grand Trunk Railway, on the property of Otis Bailey. There are 5 or 6 acres of peat land here, mostly heavily forested. The auger went through 7 feet of nearly black, well-decayed nonfibrous peat underlain by blue clay. A number of partly decayed roots and logs were encountered. Peat has been dug here in the past for agricultural uses. It appears in most places to be rather clayey and its quantity is so small when compared with many other deposits in the State that it will probably be valuable only for local consumption.

Locality 6.—Bog 1 to 1½ miles north of Mechanic Falls, along Bog Brook. This bog supports an abundant growth of marsh grasses associated with much sphagnum moss in the wetter portions. Ten test borings were made, so distributed as to test all portions of the bog lying to the east of the brook. One boring showed 10 feet of only slightly clayey peat, but all other borings showed either blue or black clay or an alternation of clay beds with beds of clayey peat. The amount and purity of the peat are not such as to render the bog commercially important.

AROOSTOOK COUNTY.

CRYSTAL.

Locality 7.—Bog about 2 miles southwest of Crystal station along the Bangor and Aroostook Railroad. The bog shows the typical open heath flora, with some cedars and alders near the borders.

Hole A. On the northwest side of the railroad track, 200 yards from the southwest border of the bog. Dark-brown peat 7 feet, underlain by gray clay. This hole is 125 yards southwest of the post between sections 33 and 34 on the railroad.

Hole B. 200 yards northeast of hole A, on northwest side of the track. Dark-brown nonfibrous peat 6 feet, to rock bottom. The northeastern border of the bog is about 150 yards beyond this hole.

Hole C. About 500 yards northwest of the railroad track, along an old logging road which starts about 100 yards northeast of the post between railroad sections 33 and 34. Cedar swamp all the way. Peat 2 feet, to rock bottom.

Analysis 9, page 114, represents peat from this bog (hole B). The sample analyzed is low in ash, of high thermal value, and high in nitrogen.

This bog extends southeast as well as northwest of the railroad. Its total area is considerable, though the exact limits were not determined.

Locality 8.—Bog along the Bangor and Aroostook Railroad just southwest of Crystal station. Its southwestern border is about at the post on the railroad reading "96 miles from Oldtown." The plants are marsh grasses and sedges, with some sphagnum moss, numerous small larches, and here and there a black spruce.

Hole A. On the northwest side of railroad track, 300 yards northeast of the above-mentioned mile post. Firm, dark-brown, somewhat fibrous peat 9 feet, to rock bottom.

The width of this bog along the railroad is about 550 yards. Its width from northwest to southeast is greater than this but was not measured.

HOULTON.

Locality 9.—Bog 1 mile southwest of Houlton, along the Bangor and Aroostook Railroad. This bog has an area of 30 to 40 acres and lies mainly on the northwest side of the railroad track. It is moss heath showing a rather abundant growth of larches and black spruces. A line of holes was run in a N. 65° W. direction across the central portion of this bog, starting from the railroad track.

Hole A. 50 yards from the railroad track. Firm, dark-brown peat 3 feet, underlain by yellow clay.

Hole B. 100 yards west-northwest of hole A. Dark-brown nonfibrous peat 6 feet, underlain by yellowish-gray clay.

Hole C. 100 yards west-northwest of hole B. Dark-brown peat 4 feet, underlain by clay. This hole is only 40 yards from the northwest border of the bog.

Analysis 10, page 114, represents peat from this bog (hole B). It shows a peat low in ash and of unusually high thermal value.

If 4 feet is the average depth of the peat in this bog, the total quantity of air-dried machine peat available will be somewhat over 25,000 tons.

SHERMAN.

Locality 10.—Bog between Sherman and Patten, along the Patten spur of the Bangor and Aroostook Railroad, one-half to three-fourths of a mile northwest of its junction with the main line. This bog is a typical cedar swamp, with some larches, spruces, and white pines, many of the pines of good size.

Hole A. On the southwest side of the railroad track, about 100 yards from the southeastern border of the bog. Firm, brown, slightly fibrous peat 7 feet, underlain by yellow clay. For 500 yards or so beyond this hole is higher land, followered again by bog.

Hole B. 600 yards northwest of hole A, on northeast side of track. Firm brown peat 12 feet, underlain by soft blue-gray clay.

Hole C. 150 yards northwest of hole B, on northeast side of track. Dark-brown nonfibrous peat 7 feet, underlain by clay. 150 yards northwest of this hole high land again comes in.

Analysis 11, page 114, represents peat from this bog (hole C). The sample analyzed shows a moderate ash content and a high thermal value. The percentage of nitrogen is also high.

This bog seems to have a very considerable extent to the northeast and to the southwest of the railroad track, though its exact limits could not be determined. It is favorably located on the railroad, but its heavily wooded character and the abundance of logs buried in the peat would considerably increase the cost of exploitation.

CUMBERLAND COUNTY.

BRUNSWICK.

Locality 11.—The College bog, located 2 miles east-southeast of Brunswick, on land owned by Bowdoin College. This bog has an area of about one-fourth of a square mile; its form and location are shown on the Bath sheet of the United States Geological Survey. It is a typical open heath tenanted by sphagnum mosses, plants belonging to the heath family, scattered larches and black spruces, and a few small pines. Three borings were made along a line running from the wagon road in a southerly direction across the central portion of the bog.

Hole A. 100 yards due south of the road. Peat 2 feet, underlain by sand.
Hole B. 100 yards S. 30° E. from hole A. Peat 4 feet, underlain by sand.
Hole C. 100 yards S. 30° E. from hole B. Peat 3 feet, underlain by sand.

The peat is brown and fibrous and moderately free from sandy or clayey material. It has been dug in small quantities and tried as a domestic fuel by Brunswick parties. The depth is not great enough to warrant extensive commercial development, though the deposit may prove valuable for local use.

CAPE ELIZABETH.

Locality 12.—Bog south and southwest of Great Pond, near Cape Elizabeth. Its area and outline are shown in figure 4, and on the Casco Bay topographic sheet of the United States Geological Survey. The northern part of the bog is open, and is tenanted by mosses, marsh grasses, sedges, and flags. The remainder of the bog is for the most part heavily forested with a mixed growth of evergreen and hard-wood timber. The small pond 1½ miles southwest of Great Pond is bordered on the southwest by typical open moss bog. The localities of all the borings are shown in figure 4.

Hole A. In northern part of the bog. Sandy peat 3 feet, underlain by sand.
Hole B. Dark-brown, slightly fibrous, slightly clayey peat 8 feet, underlain by clay.
Hole C. Nearly black, nonfibrous peat 5 feet, underlain by clay. Holes B and C are near some small pits from which peat was dug many years ago. It was burned to peat charcoal, which was used for disinfecting purposes.
Hole D. Dark-brown, only slightly fibrous, well-decayed peat 9 feet, underlain by clay.
Hole E. Dark-brown nonfibrous peat 13 feet, underlain by clay.
Hole F. Dark-brown peat 16 feet, underlain by clay.

Analyses of peat from this bog are given in Nos. 12 (hole B) and 13 (hole C) of the table (p. 15). It will be noted that the two samples are very similar in composition, the principal difference being in the lower ash content of No. 13. Both are of medium thermal value, and the ash content is moderate.

The total area of this bog is probably over 100 acres. If its average depth is 10 feet, it should yield at least 225,000 tons of air-dried machine peat. It is situated within a mile of unprotected tide water, and within 5 miles of the city and harbor of Portland.

Locality 13.—A considerable number of borings were made in the swampy land in and near the Rigby race track grounds, near Ligonia, a suburb of Portland. These holes were so distributed as to test a large area of this swampy land, but nowhere was more than 1 or 2 feet of peat encountered. The underlying material is sand.

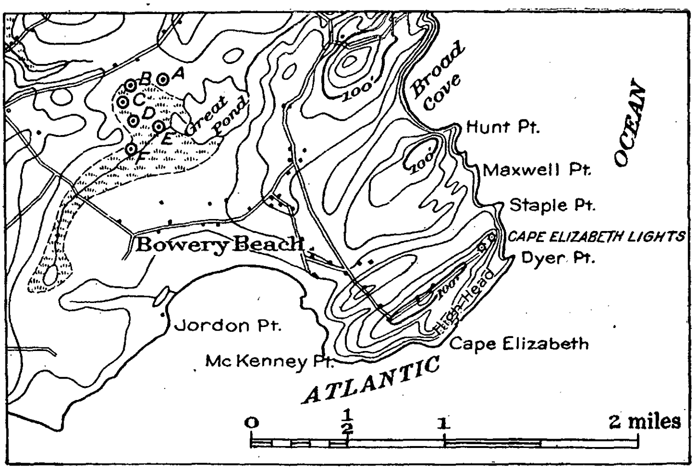


FIG. 4.—Map showing location and area of bog near Great Pond, 5 miles south of Portland (locality 12), and locations of test borings.

FALMOUTH.

Locality 14.—Bog 5¼ miles north of Cumberland Mills and one-half mile east of Duck Pond. This bog is the property of J. E. Warren, of Cumberland Mills. The vegetation is mostly of the typical open heath type; but certain portions of the bog are heavily forested, and white pines up to 8 or 10 inches in diameter occur here and there, even in the more open parts.

Hole A. 50 feet from western rocky border of bog and near the middle of its length from north to south. Dark-brown peat 17 feet, underlain by clay.

Hole B. In about the central part of the bog. Dark-brown, somewhat fibrous, well-decayed peat 17 feet, underlain by clay.

Hole C. 200 yards southwest of hole B. Dark-brown, nonfibrous, well-decayed peat 18 feet, underlain by clay.

Analyses 14 and 15, page 115, represent peat from this bog (hole B). Sample No. 14 is of medium thermal value with moderate ash content; No. 15 is of high thermal value and low ash content.

Taken as a whole, the peat of this bog is well decayed. Its character indicates that most of the deposit belongs to the "built-up" type. The area of the bog is between 80 and 100 acres. On the basis of 80 acres and an average depth of 15 feet, the bog should yield at least 250,000 tons of air-dried machine peat. The nearest point on the railroad is West Falmouth station, 4½ miles to the southeast.

SCARBORO.

Localities 15 and 16.—Tests of salt marshes were made a few miles southwest of Portland along Spurwink and New rivers. These bogs are shown on the Portland topographic sheet of the United States Geological Survey. The borings showed that the vegetable material throughout these marses was mixed with at least 50 per cent of clayey material and was therefore wholly unfit for use as fuel. There is every reason to believe that this is the usual relation in salt marshes except in the few places where a fresh-water bog has later been converted into a salt marsh or vice versa. (See p. 21.)

HANCOCK COUNTY.

BUCKSPORT.

Locality 17.—Bog near Mud Pond in the town of Bucksport. The area and location are shown in the Orland topographic sheet of the United States Geological Survey. This is a moss and heath plant bog which is nearly free from larches and spruces except near its borders.

Hole A. In the northeast part of the bog about a quarter of a mile due east of the north end of Mud Pond. Firm brown peat 12 feet, underlain by blue-gray clay.

Hole B. 200 yards north of hole A. Eleven feet of firm brown peat containing some small wood fragments.

Analysis 16, page 115, represents peat from this bog (hole B). It shows the peat to be low in ash and of medium thermal value. A small amount has been used in an experimental way for fuel in Bangor and appears to be of excellent quality.

The average depth is probably about 10 feet. The nearest point on the railroad is South Orrington, 5½ miles to the west.

ELLSWORTH.

Locality 18.—Bog about one-third of a mile north of Nicolin station, on the Bar Harbor branch of the Maine Central Railroad. This bog is about 500 yards long in a direction parallel to the railroad and 150 to 200 yards wide. Its borders support a young growth of birch, black spruce, and larches. The central portion is open moss bog.

Hole A. 50 yards west of a milepost on the railroad reading "158 miles to Portland and 29 miles to Bar Harbor."

	Feet.
Firm brown peat, some layers much more fibrous than others	0–15
Clayey peat	15–16
Blue-gray clay	16

Hole B. 150 yards from hole A, in a northwesterly direction parallel to the trend of the railroad.

	Feet.
Brown peat, firm and rather fibrous	0–13
Soft, pulpy peat, not adhering firmly to the auger	13–18

At 18 feet there begins to be some admixture of clay.

Analysis 17, page 115, represents peat from this bog (hole B). It shows the peat to be low in ash and of high thermal value.

The area of the bog is about 12 to 14 acres, and the average depth of peat is probably somewhat over 10 feet. With these dimensions it should yield at least 25,000 tons of air-dried machine peat. Its location along the railroad is favorable for commercial development.

KENNEBEC COUNTY.

AUGUSTA.

Locality 19.—Small bog in the southeast corner of the town of Augusta and 2 miles northeast of Togus. The location and area are shown on the Vassalboro sheet of the United States Geological Survey. The bog is traversed by a small creek flowing northwestward into one of the long lakes formed by the damming of Togus River. Several borings, so distributed as to test nearly all parts of this bog, were made, and most of them showed only 3 or 4 feet of somewhat impure peat underlain by clay. The best record was as follows:

	Feet.
Nearly black mucky peat	0 –1½
Dark-brown peat	1½–8
Blue-gray clay	8

Under the microscope the black mucky peat shows a considerable number of fine mineral grains mixed with the vegetable material; the dark-brown peat shows less mineral matter.

The vegetation of this bog includes sphagnum mosses, sedges, plants of the heath family, willows, alders, and yellow or poplar birches.

The analysis (No. 18, p. 115) shows the peat to be so high in ash and low in thermal value that it is of questionable commercial value for fuel, though superior to the purer varieties for agricultural purposes. The high ash content is what would be expected in a shallow bog traversed by a creek. (See p. 65.)

The bog is 2½ miles distant from Togus, the terminus of the Kennebec Central Railroad (narrow gage), and the site of the Soldiers' Home. The peat may possibly prove valuable for local use, but neither its quantity nor its quality would warrant extensive development.

BELGRADE.

Locality 20.—Bog at the southwest end of Messalonskee Lake, near Belgrade station. In the character of its vegetation this bog is wholly similar to many of the best peat bogs of the State, but six borings so distributed as to test all parts of the bog failed to show at any point more than 5 feet of peat, much of which was clayey. In most places clay bottom was reached at a depth of only 1 or 2 feet. The bog land apparently represents a delta deposit of clay carried into the lake by Belgrade Stream. This has been converted into bog through the raising of the lake waters by the dam at Oakland.

Locality 21.—Bog at northeast end of Great Pond. Its area and position are shown on the Norridgewock topographic sheet of the United States Geological Survey. Most of the swamp land, as indicated on this map, is forested low woodland which has been partly flooded as a result of a slight raising of the level of the lake by a dam at Belgrade Mills; but those portions of the bog nearest the lake are open and are tenanted by the typical moss-bog plants.

A line of holes was run due south from the first road north of the pond, starting 400 yards east of the point where this road crosses the creek between Great Pond and North Pond. For a distance of 1,200 yards south of the road no thicknesses of peat greater than 3 feet were encountered. At 1,400 yards south of the road 4 feet of brown peat was found and open moss bog was reached. Two holes in this open bog, within 50 yards or so of the extreme northeast shore of the lake, showed 7 and 14 feet of peat, the upper portions fibrous and not thoroughly decayed and the lower portions very fluid.

The region mapped as bog south of the extreme northeastern arm of the lake is also for the most part flooded low woodland, though there is some open bog next to the lake. A boring about 300 yards south of the lake shore in the wooded portion of the bog showed 7 feet of nearly black clayey peat underlain by clay.

These borings show that there are considerable areas of peat land along the shores of Great Pond, but much of the material seems to be not well decayed. It would probably have to be excavated by dredging, starting from the lake shore. The difficulty in digging, combined with the considerable distance of the deposit from the railroad, makes it improbable that it will ever be extensively worked. No analyses were made.

CHELSEA.

Locality 22.—Bog near Chelsea village, about 3 miles northeast of Gardiner. This bog is shown on the Vassalboro sheet of the United States Geological Survey, and is situated near the Kennebec Central, a narrow-gage railroad between Randolph and Togus. The area of bog land comprises only a few acres, most of the swamp land shown on the map being clay soil and wet only at certain seasons of the year. A boring made about one-half mile northwest of the corners at Chelsea in typical moss bog showed 14 feet of dark-brown, well-decayed peat underlain by clayey peat and clay. This bog may prove valuable for local use, but is not of sufficient size to supply a large plant, and much of the peat is probably rather clayey.

OAKLAND.

Locality 23.—Bog in the southwestern part of the village of Oakland, bordering a small pond. The area of this bog is estimated at about 8 to 10 acres. The portions nearest the small pond are open moss bog, but the southeastern part, which is crossed by the Maine Central Railroad tracks, is heavily forested with hardwood timber.

Hole A. On the west border of the small pond. Brown, well-decayed peat 18 feet, underlain by clay. The lower few feet of peat are so fluid as not to cling to the auger.

Hole B. 20 feet southeast of the railroad track near the southern border of the bog. Peat 18 feet, underlain by clay. The peat is brown, well decayed but somewhat fibrous, and unusually compact, probably as a result of the pressure exerted by the neighboring railroad embankment which crosses the bog. This portion of the bog is heavily forested.

The analysis (No. 19, p. 115) of a sample from hole A shows the percentage of ash to be low and the thermal value high. The material should be well suited for the manufacture of peat fuel.

The area of this bog is not great (only 20 to 30 acres), but the depth probably averages at least 15 feet and the peat is well decayed. The bog should yield at least 65,000 short tons of air-dried machine peat. The deposit should be valuable at least for local use, and its favorable situation on the railroad would probably insure a wider market.

Locality 24.—The Martin Stream bog, 3 to 4 miles north of Oakland and about 1 mile west of the bogs next described. The approximate outline and the location of borings is shown in figure 5 (the western of the two bogs shown) and on the Waterville topographic sheet of the United States Geological Survey. The borders of the bog are heavily forested with cedars, white pines up to 10 inches in diameter, and hardwood timber. The central portions are typical open heath.

Hole A. On the north side of the corduroy road which crosses the southern and heavily forested part of the bog. The auger went through 21 feet of chocolate-brown, well-decayed peat. Below a depth of 9 feet the peat was so fluid that it did not cling to the auger and samples could not be obtained.

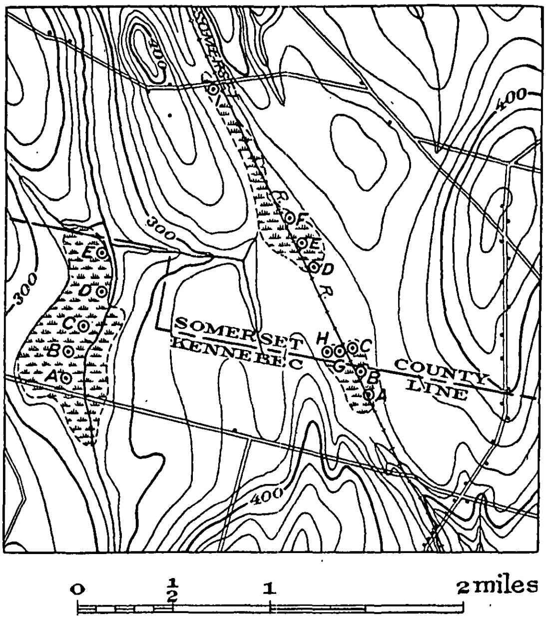


FIG. 5.—Map showing location and area of bogs 3 to 4 miles north of Oakland (localities 24 and 44) and locations of test borings.

Hole B. In open heath.

	Feet.
Chocolate-brown, firm, fibrous peat	0–10
Very fluid peat which did not cling to the auger	10–20
Rock bottom	20

Hole C. Firm chocolate-brown peat 20 feet, underlain by clay.

Hole D. 300 yards from hole C.

	Feet.
Firm brown peat	0–12
Very fluid peat	12–15
Soft blue clay	15

Hole E. 300 yards from hole D and about 30 yards west of the creek. Firm brown peat 6 feet, underlain by blue clay.

The analysis (No. 20, p. 115) shows that the sample from hole A, which is probably typical of much of the material of the bog, is well decomposed, low in ash, and of high thermal value.

It is probable that this bog includes nearly half a square mile of well-decayed peat with an average depth of 15 feet or over. With these dimensions it should yield at least 1,000,000 tons of air-dried machine peat. It is favorably located, within 1½ miles of the railroad.

SIDNEY.

Locality 25.—The Great Sidney bog, 5 miles north-northwest of Augusta, near West Sidney. The area is approximately 1 square mile. Its form and dimensions are shown in figure 6 and on the Augusta topographic sheet of the United States Geological Survey.

Sphagnum is the most abundant moss of the bog, but *Polytrichum* and the lichen *Cladonia* are usually associated with it. In certain of the dryer portions *Polytrichum* is the only moss present. The usual plants of the heath family are also represented with cranberry vines,

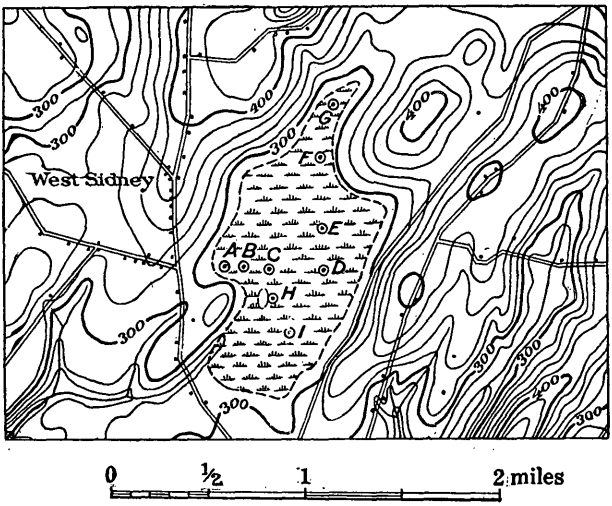


FIG. 6.—Map showing location and area of Great Sidney bog, 5 miles north-northwest of Augusta (locality 25), and locations of test borings.

pitcher plants, and scattered tufts of sedges. There is a scattered growth of small larches and black spruces and here and there a small white pine. Plate III, *B*, shows the character of the vegetation. A peculiar feature of this bog is the fact that its surface is far from level, the northeastern portion being considerably lower than the southern and western portions.

Hole A. 100 yards east of west edge of the bog.

	Feet.
Brown, fibrous peat	0–12
Brown peat, more fluid	12–15
Blue-gray sandy clay	15

Hole B. 300 yards east of west edge of the bog. Eight samples were collected from different depths in this hole. The auger penetrated 21 feet of brown peat without reaching the bottom. All of it is highly fibrous, small moss and root fragments one-fourth of an inch long being very abundant, and many much longer root fibers being found. The deeper portions are somewhat better decayed and darker in color than those nearer the surface.

Hole C. 500 yards east of west edge of bog. Brown fibrous peat 21 feet. Bottom not reached. Some evolution of marsh gas.

Hole D. 900 yards east of west edge of bog. Brown fibrous peat 21 feet. Bottom not reached.

Hole E. 300 yards north of hole D. Firm brown peat 20 feet, underlain by hard, clean blue clay.

Hole F. 600 yards north of hole E. Dark-brown fibrous peat 18 feet, underlain by clay.

Hole G. 500 yards N. 20° E. from hole F. Brown, firm, fibrous peat 19 feet, underlain by clayey peat and clay.

Hole H. About one-half mile from south end of bog and about 100 yards east of small island in bog. Brown fibrous peat 14 feet, underlain by clay.

Hole I. At locality shown in figure 6. Brown fibrous peat 17 feet, underlain by clay.

The series of analyses (Nos. 21 to 27, p. 115) was made with the view of determining the nature and magnitude of the variations in composition at different depths in the same test hole (hole B). These analyses show that the composition varies within rather narrow limits and that the variations are not at all regular. The peat is of excellent quality throughout, the ash percentage being very low except in sample 22, from a depth of 6 feet, and in sample 27, from a depth of 21 feet. Even in these the ash is moderate and not high enough to greatly injure the fuel value. The peat is less thoroughly decomposed than that in some of the other bogs of the State, as is shown by its physical characters and by the relatively high percentage of volatile combustible as compared with the percentage of fixed carbon. For this reason the thermal value of the peat, in spite of the low ash content, is less than that of peat from certain other Maine bogs—for instance, the Farwell bog near Lewiston. (Compare analyses 2 to 4, inclusive.) For some purposes, however, as in the manufacture of paper and paper board, the less decayed, more fibrous peat is preferable to the more decomposed varieties.

Fragments of small stems and roots resembling those of the plants of the heath family now growing in the bog were encountered in all parts of the bog and at all depths. In several holes pieces of wood which offered considerable resistance to the augur were encountered, and a few of them could not be penetrated. Some of these fragments were at depths as great as 18 feet. Marsh gas was evolved freely at a number of the holes and when ignited burned at the mouth of the hole with an unsteady blue flame.

On the assumption that the area of this bog is 1 square mile and the average depth of peat 20 feet, the amount of machine peat obtainable would be somewhat over 2,500,000 short tons. The bog could be partly and perhaps completely drained by deepening the bed of the creek which leaves it at its southwest end. The nearest railroad stations are Belgrade and Augusta, each about 5 miles distant.

VASSALBORO.

Locality 26.—Bog about 1½ miles southeast of Vassalboro station. Its area and form are shown on the Vassalboro sheet of the United States Geological Survey. At the north end of this bog is a small pond showing clay bottom and bordered by cat-tail marsh; to the south the vegetation consists largely of sphagnum moss, plants of the heath family, sedges, and cranberry vines. Two holes put down in the southern part of this heath showed 7 and 10 feet of dark-brown peat, underlain by blue-gray clay. The area and depth of this deposit are so small that it will probably be valuable only for local use.

WINSLOW.

Locality 27.—Bog 2½ miles southeast of Benton Falls. Its form and size are shown in figure 7 and on the Waterville topographic sheet of the United States Geological Survey. The bog shows great variety in its vegetation. About the borders and in the southern part of it sedges and marsh grasses, with alders, willows, and small birches, predominate, but considerable areas in the north-central part of the bog have a typical flora of sphagnum, plants of the heath family, small larches, and small black spruces.

Hole A. 300 yards south of a small culvert on the road running north of the bog; lies close to the east border of the bog. Nearly black, firm, slightly clayey peat 3 feet, underlain by gravel.

Hole B. 500 yards south of the road and about 100 yards west of the east border of the bog. It is somewhat east of south from hole A. Brown peat 20 feet, below which there is a noticeable admixture of clay.

Hole C. 100 yards west of hole B, in very springy sphagnum bog.

	Feet.
Sphagnum moss not much decayed (apparently floating bog)	0– 6
Water or peat so fluid that auger dropped through it and no samples could be brought up	6–15
Nearly black firm peat	15–21

Bottom not reached.

Hole D. 50 yards east of the creek. Brown, well-decayed peat 8 feet, then some admixture of blue-gray clay begins.

Hole E. Near northeast bank of creek. Brown peat 5 feet, underlain by clayey peat.

The borings show that a large part of this bog is underlain by considerable depths of peat, the greatest thickness being in the northern part. The sample analyzed from hole E (No. 28, p. 115) shows a high ash content and low thermal value. Other portions of the deposit may be found to be purer, but, as in most bogs traversed by a stream, the chances are that much of the peat will be found to be somewhat clayey, and hence high in ash. Benton, the nearest station on the railroad, is about 4½ miles distant. Water power is available at Benton Falls, 2½ miles away.

Locality 28.—Bog 1 mile south of Benton Falls in the town of Winslow. The location and area of this bog are shown in figure 7 and on the Waterville topographic sheet of the United States Geological Survey. Much of the bog is forested with a small growth of yellow birch, and alders abound near the borders. Other common plants are the ordinary brake fern, the wild rose, two species of dogwood, *Cassandra calyculata*, or leather-leaf, sedges of several species, and the small shrub *Myrica*.

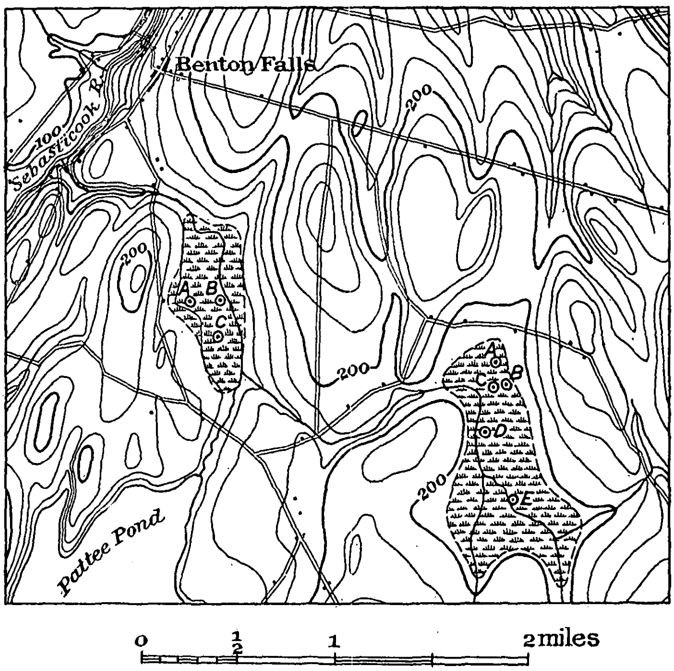


FIG. 7.—Map showing location and area of bogs near Benton Falls, Winslow (localities 27 and 28), and locations of test borings.

	Feet.
Hole A. 200 yards east of the road and 150 yards east of the bog.	
Marly black mucky peat	0–2
Brown peat, more fibrous	2–7
Clay	7
Hole B. 200 yards east of hole A.	Feet.
Dark-brown, somewhat fibrous, mucky peat	0–3
Dark-brown, well-decayed nonfibrous peat	3–20
Clay	20

Hole C. About 10 feet of well-decayed peat, underlain by clay.

As in most of the bogs traversed by creeks, certain portions of this bog are composed of comparatively pure peat; other portions, especially near the present or former courses of the stream, show an admixture of clayey material. The sample analyzed from hole B (No. 29, p. 115) appeared in the field to be one of the less clayey varieties from this bog, but on analysis showed 22.04 per cent of ash and a low thermal value. It is probable that here, as in other bogs traversed by streams, the ash percentage is high in much of the peat. The bog should not, however, be condemned as a source of fuel peat without further field tests and analyses. The nearest railroad station is Benton, about 3½ miles distant. Waterpower is available at Benton Falls, 1 mile from the bog.

KNOX COUNTY.

ROCKLAND.

Locality 29.—Bog 2½ miles northwest of the city of Rockland, shown on the Rockland topographic sheet of the United States Geological Survey. This is a typical open moss bog, and probably belongs to the built-up type.

Hole A. In southeast portion of the bog, about one-fourth mile northwest of the wagon road from Mount Battux to Thomaston. Firm brown peat 10 feet, underlain by clayey peat.

Hole B. 200 yards due west of hole A.

	Feet.
Firm brown fibrous peat	0– 9
Clayey peat	9–11
Rock bottom	11

Hole C. 100 yards north and 200 yards west of hole B. Firm brown fibrous peat 10 feet, underlain by clayey peat.

Hole D. About 400 yards north of hole C, near the center of the bog from east to west. Brown fibrous peat 13 feet, underlain by clay.

The analyses (p. 116) show that No. 30, from the upper part of hole B, is low in ash and of moderately high thermal value, and that No. 31, from hole D, near the bottom of the bog, is, as might be expected, high in ash and of low thermal value. Its percentage of nitrogen is higher than that of any other sample analyzed from the State.

The northern part of this bog was not tested, but the total area of peat land certainly exceeds 1 square mile. The bog is located within 2½ miles of the railroad and within 3 miles of tide water at Rockland, and the possibility of utilizing the peat for generating producer gas to be used in burning the lime quarried near Rockland and Rockport is worthy of careful consideration.

OXFORD COUNTY.

HARTFORD.

Locality 30.—Bog just north of Hartford, along the Maine Central Railroad. The form and area of this bog are shown in figure 8. The vegetation consists of sphagnum mosses, plants of the heath family, marsh grasses, and sedges, with a few alders, small willows, etc.

Hole A. 200 yards southwest of northeast border of bog, on southeast side of railroad track. Dark-brown, nonfibrous peat 3 feet to rock bottom.

Hole B. 300 yards southwest of northeast border of bog, on southeast side of track. Dark-brown, well-decayed peat 18 feet, underlain by clayey peat. The upper 10 feet is firmer and more fibrous than that below.

Hole C. 100 yards S. 55° E. from hole B.

	Feet.
Dark-brown, only slightly fibrous peat	10–18
Clayey peat	18–20
Clay	20

Hole D. 700 yards southwest of northeast border of bog, on southeast side of track. Dark-brown, nonfibrous peat 7 feet, underlain by clay.

The thermal value of the sample analyzed from hole C (No. 32, p. 116) was low, owing to the very high ash content. The sample was rather clayey, although it was taken from a depth of 12 to 13 feet. On the basis of a single analysis it is not safe to say that peat from other parts of the bog, especially the southern portion, may not be much lower in ash than the sample analyzed, but the fact that the bog is bordered by high land and traversed by a stream renders it probable that the ash content in much of the peat will be found to be high, though not necessarily so high as to prevent commercial utilization.

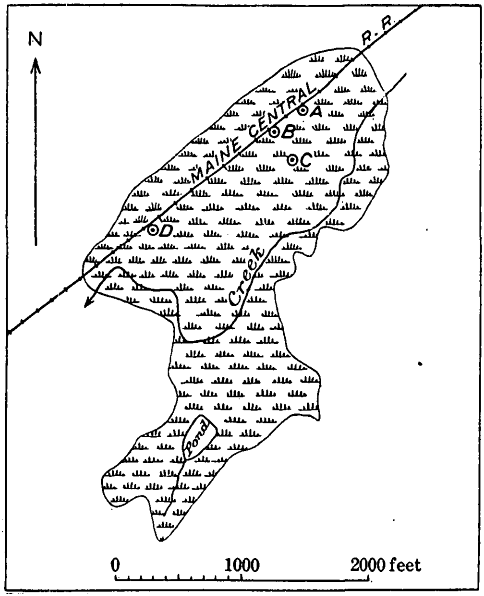


FIG. 8.—Map showing outline and area of bog near Hartford (locality 30) and locations of test borings. From map loaned by Mr. Walter H. Sawyer, of Lewiston.

The situation of the bog along the railroad is most favorable. Its total area is somewhat over 80 acres. On the basis of 10 feet as a conservative estimate of its average depth, the bog is capable of yielding 175,000 tons of air-dried machine peat.

NORWAY.

Locality 31.—Bog in the northern part of Norway village, along the Norway spur of the Grand Trunk Railway. This bog supports an abundant growth of sphagnum moss and scattered larches and spruces. Six borings so distributed as to test all portions of the bog showed everywhere less than 2 feet of peat underlain by clay.

Locality 32.—Bog on the Charles Fogg place, about 3½ miles nearly due north of Norway village, along the road to Cobble Hill. A small creek flows through the southern portion of the bog. The area was not determined, but is at least 3 or 4 acres. The vegetation of most of the bog is sphagnum moss, plants of the heath family, and scattered larches and spruces, but some portions are occupied by a heavy growth of hardwood timber. The locations of the test borings are shown in figure 9.

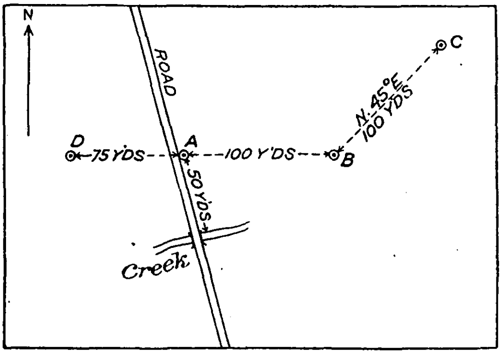


FIG. 9.—Diagram showing locations of test borings in bog on Charles Fogg place, 3½ miles nearly due north of Norway (locality 32).

Hole A. (Location shown in fig. 9.)

	Feet.
Black muck	0 – 1½
Brown, firm, but only slightly fibrous peat, containing some wood fragments	1½– 3
Brown peat, somewhat more fluid than the above, much very soft material being forced up when auger is withdrawn	3 – 8
Brown peat, fibrous and somewhat difficult to bore through	8 – 9
Lighter-brown, firm, fibrous peat	9 –12
Greenish-brown, somewhat clayey peat	12 –18
Blue-gray clay	18

Hole B. Peat 11 feet, underlain by blue clay.

Hole C.

	Feet.
Black clayey loam	0–1
Brown, somewhat clayey peat	1–3
Sand	3

Hole D. Brown peat, fibrous in upper part, but well decayed below, 21 feet; bottom not reached.

Analysis 33, page 116, represents peat from hole A of this bog. This peat deposit is of good quality and the quantity is considerable. The ash content is low and it possesses medium thermal value. Its location, 3½ miles from the railroad, would constitute the principal drawback to its commercial development.

PENOBSCOT COUNTY.

ALTON.

Locality 33.—Bog bordering Holland Pond about 1½ miles north of Alton station on the Bangor and Aroostook Railroad. This is a typical open heath. Two test holes were put down in the bog along a line running N. 45° W. from the milepost on the railroad reading "10 miles from Oldtown." The railroad skirts the border of the bog.

Hole A. 200 yards N. 45° W. from the railroad track. Firm, dark-brown, rather fibrous peat 9 feet, to rocky bottom.

Hole B. 300 yards N. 45° W. of hole A. Dark-brown, rather fibrous peat 15 feet, to rock bottom.

The sample analyzed, from hole B (No. 34, p. 117), shows a low ash content and medium thermal value.

Bog land occurs on the east, north, and west sides of the pond, the total area being probably close to 1 square mile. Unless Holland Pond could be drained, it would be necessary to excavate the peat by pumping or dredging.

ALTON AND ARGYLE.

Locality 34.—A large bog extends from the vicinity of Pea Cove station to South La Grange, a short distance east of the Bangor and Aroostook Railroad. This bog, which lies along Birch Stream, appears to be mainly a clay flat with only small amounts of peaty accumulations on the surface. Attempts have been made to farm various parts of the bog and nearly everywhere the plow penetrates through the humus into clay. It is possible that over certain small areas the depth of peat may be greater.

DREW.

Locality 35.—Bog near Spragues station, on the Maine Central Railroad. Its extent along the railroad and the position of test holes are shown in figure 10. The plants of this bog are of the typical heath variety. Over most of the bog larches and spruces are present in considerable abundance and, especially near the borders of the bog, may reach diameters of 6 or 8 inches.

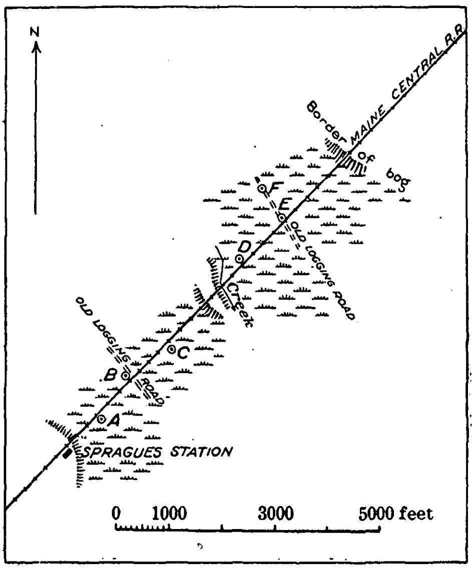


FIG. 10.—Map showing location of test borings in bog near Spragues station (locality 35).

Hole A. Near the southwest border of the bog and within 250 yards of the railroad station. Brown peat 3 feet, underlain by blue-gray clay.

Hole B. 550 yards northeast of Spragues station, on the northwest side of the railroad track. An old logging road crosses the railroad at this point. Brown peat 9 feet, underlain by blue-gray clay.

Hole C. 850 yards northeast of Spragues station, on the southeast side of the railroad track. Firm dark-brown peat 7 feet, underlain by clay. The vegetation here includes a few cedars and small white pines, with willows and alders. About 300 yards northeast of hole C high land is reached and continues for 200 yards along the railroad. At the eastern border of this strip of high land, and 500 yards from hole C, a small creek crosses the track.

Hole D. On the north side of the railroad, 700 yards northeast of hole C and 200 yards from the above-mentioned creek. Dark-brown peat 10 feet, underlain by blue-gray clay.

Hole E. On the northwest side of the railroad track, 350 yards northeast of hole D, at a point where an old logging road crosses the railroad. Firm dark-brown semifibrous peat 10 feet, underlain by blue-gray clay. This hole is located at about the middle point of the eastern part of this bog.

Hole F. 250 yards northwest of the railroad, along the above-mentioned logging road. Dark-brown semifibrous peat 12 feet, underlain by clay. The northeast border of the bog is located about 500 yards beyond this logging road.

The analyzed sample, from hole E (No. 35, p. 117), is low in ash and of high thermal value.

The total width of the bog along the railroad track at this locality is somewhat over 1¼ miles. Its extent northwest and southeast from the railroad track appears to be almost equally great, so that the total area of bog land must be several square miles, though the exact limits were not determined. The location along the railroad is favorable for commercial development.

ETNA.

Locality 36.—Bog along the Maine Central Railroad, 1 mile west of Etna station. Much of this bog has been flooded as the result of the damming of the outlet of Etna or Carmel Pond at Damascus Mills. The bog lies mainly to the north of the railroad track. Its exact area was not determined, but is probably between one-fourth and one-half of a square mile.

During the construction of this part of the railroad the track was first laid somewhat north of its present position, but so much trouble was experienced because of the sinking of the road bed that it was necessary to abandon this location and adopt a new one near the southern border of the bog. This bog contains very little moss, the flora consisting mainly of alders, young willows, and small yellow birch, with marsh grass, sedges, brake ferns, *Myrica*, and in the wetter portions flags and cat-tails. The marginal portions are rather heavily forested with hard-wood trees, many of which are of considerable size.

Hole A. About one-fourth of a mile north of the railroad track and within 50 yards of the west border of the bog. Peat 7 feet, underlain by gravel.

Hole B. In what appeared to be about the central portion of the bog, along the north side of the abandoned railroad embankment. Firm brown well-decayed peat 21 feet; bottom not reached.

Hole C. North of hole B and within 100 yards of the artificial lake formed by the raising of the waters of Etna Pond. Peat more than 21 feet, the upper 10 feet or so firm and fibrous, the lower portions soft though containing numerous small fibers.

Hole D. 150 yards from the west border of the bog and between hole A and the old railroad embankment.

	Feet.
Black mucky peat	0– 1
Dark-brown, well decayed, only slightly fibrous peat	1– 9
Slightly clayey peat	9–10
Clay	10

The sample analyzed, from hole D (No. 36, p. —), was of low ash content and high thermal value. The nitrogen percentage is unusually large. The borings indicate that this is an immense bog with an unusual depth of well-decayed peat. It has been flooded by a milldam at the outlet of Etna Pond and could be at least partly drained. The peat could also be excavated by dredging or pumping.

HERMON.

Locality 37.—Bog just west of Hermon Center, along the Maine Central Railroad. The form and location are shown in figure 11 and on the Bangor sheet of the United States Geological Survey.

Hole A. 200 yards east of west border of bog, along the railroad right of way. Firm nonfibrous dark-brown peat 7 feet, underlain by blue clay. The western part of the bog near this hole is covered with a young forest growth of maples and yellow and gray birches, with alders, small firs, and a few cedars. The larger trees have been cut, some stumps being a foot in diameter.

Hole B. 400 yards east of west border of bog, along railroad right of way. Firm nonfibrous dark-brown peat 7 feet, underlain by blue clay. Some cedars, black spruces, and flags occur near this hole.

Hole C. 600 yards east of west border of bog, along right of way. Firm brown peat 3 feet, underlain by blue-gray clay. East of this hole the bog becomes an open moss heath.

Hole D. 800 yards east of west border of bog, along railroad right of way. Peat 1 foot, underlain by blue clay. The vegetation here is of the characteristic moss-bog type, differing in no respect from that of the much-deeper portions of the bog farther east.

Hole E. 900 yards east of west border of bog and 100 yards north of the railroad. Peat $1\frac{1}{2}$ feet, underlain by hard clay.

Hole F. 1,100 yards east of west border of bog, along railroad right of way. Firm brown peat 6 feet, underlain by clay.

Hole G. 300 yards north of hole F. Brown peat, firm and fibrous, 9 feet, underlain by clay.

Hole H. 200 yards north of hole G. Firm fibrous peat 12 feet, underlain by blue-gray clay. Peat is chocolate-brown when first brought up but darkens rapidly when exposed to the air.

Hole I. 1,700 yards east of west border of bog, along railroad right of way, and about 500 yards from point where wagon road crosses the railroad near the east border of the bog. Firm brown peat 17 feet, underlain by blue-gray clay.

Open moss bog extends for a considerable distance north-northwest from hole H. The exact limits of the bog in this direction and to the south of the railroad track were not determined, though they probably correspond nearly to the limits indicated by the swamp symbol on the map. It is worthy of note that the peat from hole B, in the forested portion, is much more thoroughly decayed and is probably somewhat older than the fibrous peat from the typical open moss bog near holes D to H.

Both of the samples analyzed (Nos. 37, from hole B, and 38, from hole I, p. 117) show a low percentage of ash, a moderately high thermal value, and a high percentage of nitrogen.

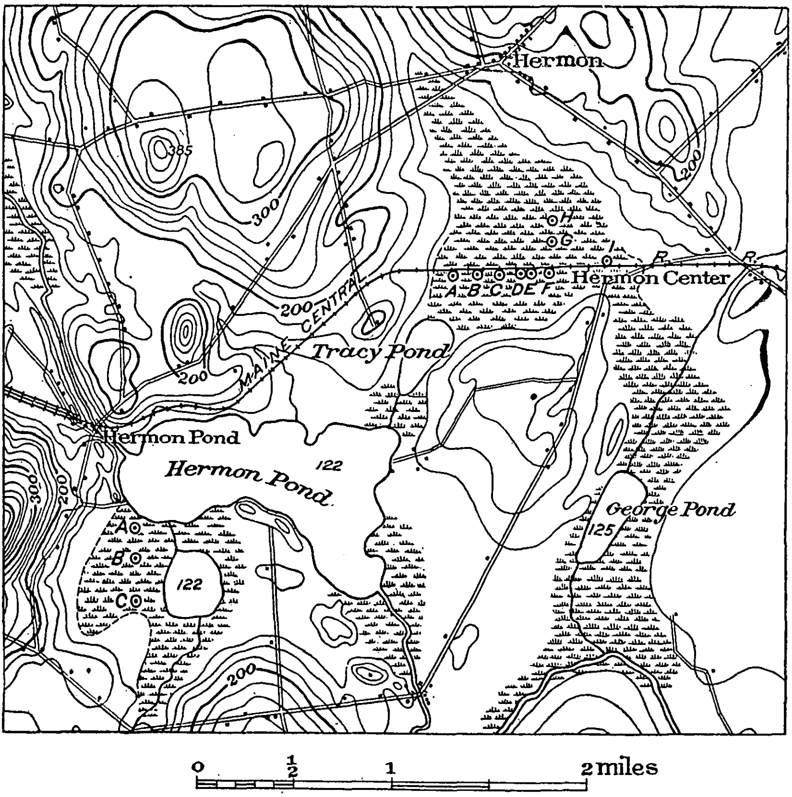


FIG. 11.—Map showing location and area of bogs near Hermon Pond and Hermon Center (localities 37 and 39) and locations of test borings.

The bog is conveniently situated and should furnish a large amount of peat of good quality. Six feet may be assumed as a conservative figure for the average depth and on this basis the bog should yield at least 600,000 tons of air-dried machine peat.

Locality 38.—Hermon bog, between North Bangor and Hermon Center. The area and outline are shown in figure 12 and on the Bangor sheet of the United States Geological Survey. A line of holes was run westward across a part of this bog, starting on the

Bangor and Aroostook Railroad 3,500 feet south of the point where the railroad crosses the road from Bangor to Snow Corner.

Hole A. 100 yards west of railroad track. Firm brown peat 15 feet, to rock bottom.

Hole B. 300 yards west of railroad track. Firm brown peat which contains numerous small partly decayed wood fragments and a few logs. Most of the logs are so rotten that they yield before the auger, but one struck at a depth of 19 feet could not be penetrated. The maximum depth of peat here is probably nearly 19 feet.

Hole C. 500 yards west of the railroad. Firm brown peat 21 feet; bottom not struck. In the upper portions of the deposit here there are numerous logs; four different holes were sunk, and but one place was found where the auger was not impeded by logs.

The central portion of this bog for some distance north, west, and south of hole C is open moss bog showing a scattered growth of small larches and black spruces. The border portions near holes A and B

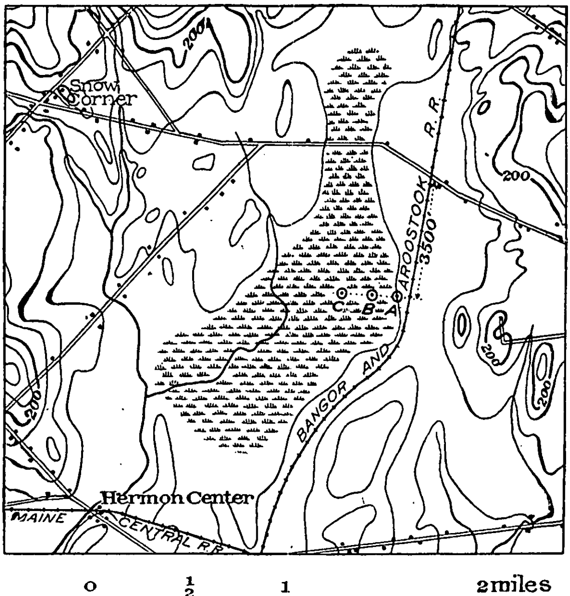


FIG. 12.—Map showing location and area of bog between North Bangor and Hermon Center (locality 38) and locations of test borings.

are forested with small larches and cedars and a few maples and white pines, with an undergrowth of alders, ferns, etc.

The total area of this bog is probably nearly 1 square mile and the average depth is probably at least 15 feet. With these dimensions the total quantity of machine peat available would be about 2,000,000 tons. No analyses were made. The bog is favorably located near the Bangor and Aroostook and the Maine Central railroads.

Locality 39.—Bog just southwest of Hermon Pond. Its approximate outline and area are shown in figure 11 and on the Bangor topographic sheet of the United States Geological Survey. A line of test holes was put down in this bog along a north-south line starting at the lake shore 100 yards southeast of the dance hall at the picnic grounds.

Hole A. 100 yards south of the lake shore.

	Feet.
Reddish brown peat	0–15
Brown clayey peat	15–21

Hole B. 300 yards south of lake shore.

	Feet.
Brown, highly fibrous peat	0–15
Brown, better decayed, but somewhat clayey peat	15–21

Bottom not reached.

Hole C. 600 yards south of the lake shore. Nearly black, mucky peat 4 feet, underlain by sandy clay.

The central portion of this bog, near hole B, is typical moss bog with an unusual abundance of larches and spruces. In the northern part, near the lake shore, alders, flags, sedges, and marsh grasses abound; the southern part is forested with cedars and some hardwood timber, in addition to larch and spruce.

The analysis of a sample from hole B (No. 39, p. 117) shows the peat to be low in ash and of high thermal value.

The average depth of the bog is probably not far from 10 feet and its area at least 160 acres. With these dimensions it should yield at least 350,000 short tons of air-dried machine peat.

NEWPORT.

Locality 40.—Bog about three-fourths of a mile east of the railroad station at Newport, along the south side of the railroad. This is an open moss bog. A line of holes was run due south from the railroad tracks across its central portion.

Hole A. 100 yards south of railroad track. Brown peat 2 feet, underlain by brown sandy clay.

Hole B. 200 yards south of railroad track. Brown peat 6 feet, underlain by blue-gray clay. The peat at this point is in places somewhat clayey.

Hole C. 300 yards south of railroad track. Brown highly fibrous peat 7 feet, underlain by blue-gray clay.

Hole D. 400 yards south of railroad track. Firm dark-brown peat 8½ feet, underlain by blue-gray sandy clay.

Hole E. 500 yards south of railroad track and 100 yards from the south border of the bog. Peat 7 feet, underlain by gravelly clay.

The analysis of a sample from hole C (No. 40, p. 117) shows this peat to be low in ash and of high thermal value.

The bog is nearly circular in outline, its diameter from east to west and from north to south being about 600 yards. On the basis of an estimated average depth of only 5 feet, the bog is capable of furnishing somewhat over 125,000 short tons of machine peat. It can be easily drained and is favorably situated on the railroad.

OLDTOWN.

Locality 41.—Bog east of Pushaw Lake, 6 to 10 miles north of Bangor. This is one of the largest bogs in the State, but was tested only at a few points near roads which crossed the bog. Its location and form are shown in figure 13.

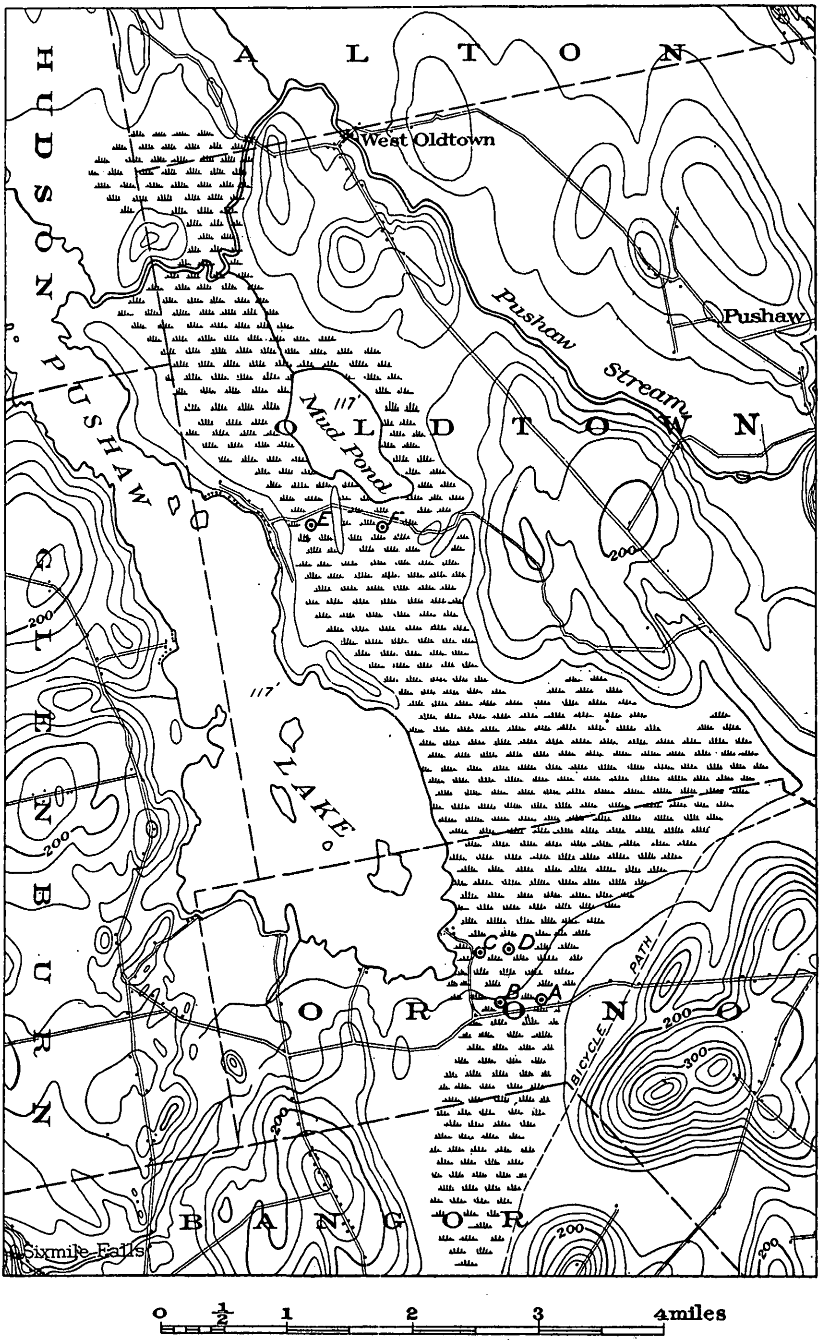


FIG. 13.—Map showing location and area of Pushaw Lake bog (locality 41) and locations of test borings.

Hole A. Near the east border of the bog, on road running due west from Orono. Firm brown peat 15 feet, underlain by clay. All of this peat is well decayed and most of it is rather fibrous. The deepest portions are nonfibrous and nearly black.

Hole B. Struck clay almost at the surface.

Hole C. At roadside. Black mucky peat 3 feet, underlain by blue-gray clay.

Hole D. 300 yards east of hole C. A narrow strip of high land intervenes between these two holes. Dark-brown peat 4 feet, underlain by blue-gray clay.

Hole E. Near wagon road to summer colony, on the east shore of the lake. Firm brown peat, not very fibrous, 14 feet, passing below into clayey peat.

Hole F. Firm brown peat 20 feet, underlain by blue-gray clay.

The bog where crossed by the road leading due west from Orono is forested with larches, black spruces, and a few maples and small birches, but the stumps of spruces 6 to 8 inches in diameter remain. The smaller plants include alders, ferns, and *Sphagnum* and *Polytrichum* mosses. The northern part of the bog encircling Mud Pond for some distance south of the wagon road to the summer colony is open moss bog showing scattered small larches and black spruces.

These borings, though covering only a small portion of the bog, are sufficient to show that in many places the depth of this deposit is very considerable. Not all the territory mapped as swamp land in figure 13 is underlain by peat, but the bog is undoubtedly one of the largest and best peat deposits in this part of the State. The more easterly portion of the bog, extending within 1 mile of Stillwater village, was not tested but is probably in large part underlain by peat.

Analyses 41 and 42, page 117, represent peat from this bog (hole A). Sample 41, from a depth of 3 feet, is low in ash and of high thermal value; sample 42, obtained near the bottom of the bog, is clayey, showing a high ash content and only moderate fuel value. The nitrogen content is high in both samples. The complete drainage of the bog would probably be impracticable, as it would involve the draining of Pushaw Lake. The peat will therefore have to be excavated by dredging or by pumping. The nearest shipping point on the railroad is Stillwater, 2 to 4 miles east.

Locality 42.—A small open heath on Orson Island, about 3 miles northwest of Oldtown along the Bangor and Aroostook Railroad. Several test holes so distributed as to test all parts of this bog showed nowhere over 2 feet of peat underlain by clay.

ORRINGTON.

Locality 43.—Bog just south and east of East Orrington village, along Sedgeunkedunk Stream. The area and outline of this bog are shown in figure 14 and on the Bucksport and Orland sheets of the United States Geological Survey.

Hole A. In the western part of this bog just west of the creek. Dark-brown, nonfibrous peat 12 feet, underlain by soft blue-gray clay; certain layers of the peat are slightly clayey.

Hole B. In the eastern part of the bog, within a quarter of a mile of Fields Pond.

	Feet.
Brown, slightly clayey peat	0– 3
Brown peat apparently free from clay	3–12
Clayey peat	12–20
Blue-gray clayey peat	20

The vegetation of this bog consists of grasses, sedges, some sphagnum, and plants of the heath family, with a few willows and *Myrica*. In the eastern part of the bog cranberry vines are very abundant.

This bog contains a considerable area and depth of peat, though in many places the percentage of clayey material is sufficient to some-

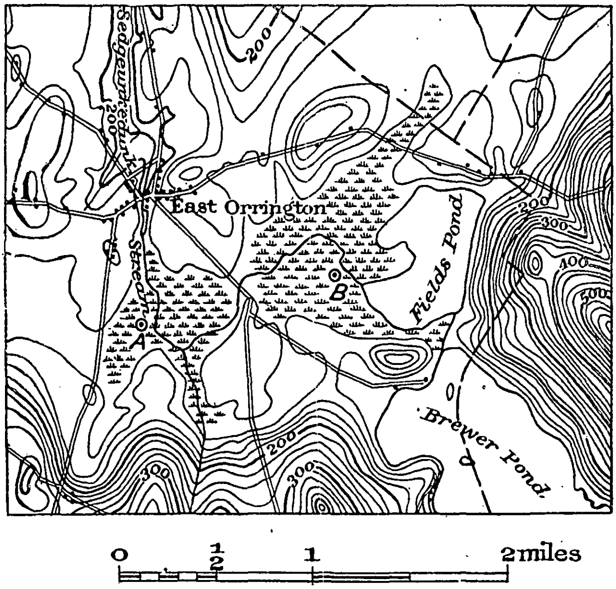


FIG. 14.—Map showing location and area of bog near East Orrington (locality 43) and location of test borings.

what injure its value as a fuel. The sample transmitted for analysis was lost in transit, but some of the peat appears to be of good quality and its amount is amply sufficient for local needs. The nearest shipping point on the railroad is 3 miles to the west.

PISCATAQUIS COUNTY.

BROWNVILLE.

Two open moss bogs of considerable area were observed from the train about 4 to 5 miles northeast of Brownville, along the Bangor and Aroostook Railroad. They were some distance from any station or settlement and were not tested. It is probable that they contain a considerable amount of peat.

SOMERSET COUNTY.

FAIRFIELD.

Locality 44.—Bogs along the Somerset Railway 3 to 4 miles north of Oakland, near the Somerset-Kennebec county line. Most of this bog land is forested with larches, small white pines, maples, and yellow birches. Some of the birches are 5 inches in diameter. In the more open portions alders, sedges, marsh grasses, *Myrica*, plants of the heath family, and sphagnum occur. In places small cedars are abundant. The outlines of these bogs as shown in figure 5 are only approximate.

Hole A. On railroad right of way, 765 yards north of point where the South Smithfield road crosses the railroad. Firm brown peat 8 feet, underlain by clay.

Hole B. 200 yards north-northwest of hole A, along right of way. Chocolate-brown well-decayed peat 16 feet, underlain by clay.

Hole C. 200 yards north-northwest of hole B, along right of way. Muck 1 foot, underlain by sandy clay. Beyond this for 750 yards along the railroad is high bowlder-covered land, then bog land again.

Hole D. 800 yards north-northwest of hole C, along right of way. Brown, well-decayed peat 10 feet, underlain by sand.

Hole E. 200 yards north-northwest of hole D, on right of way.

	Feet.
Black to chocolate-colored firm peat	0–3
Chocolate-brown, highly fibrous peat, difficult to bore through	3–6
Brown peat, not as fibrous as the above	6–10
Rock bottom	10

Hole F. 200 yards north-northwest of hole E, along right of way. Brown peat 4 feet, underlain by gravel. High ground again begins 50 yards beyond hole F.

Hole G. 100 yards due west of hole C. Chocolate-brown, well-decayed peat 5 feet, underlain by sandy peat.

Hole H. 200 yards due west of hole G. Sand almost at the surface.

Hole I. About three-fourths of a mile northwest of hole F, in a strip of bog only 200 yards wide which probably connects with that tested farther south along the railroad. The bog here is tenanted by sphagnum, plants of the heath family, and small larches and black spruces. The boring showed 8 feet of nonfibrous mucky peat, underlain by gravel.

Analyses 43 and 44, page 117, represent peat from this bog (hole B). Analysis 43 shows the peat from a depth of 6 feet to be well decayed, low in ash, and high in thermal value. Analysis 44, of peat near the bottom of the bog, was made for the purpose of verifying the opinion, formed in the field, that the greenish peat commonly found near the bottom of bogs is more clayey than the normal. The analysis bears out this conclusion by showing 25 per cent of ash in the air-dried sample.

The amount of well-decayed peat of good fuel value contained in these bogs is very large, and they are advantageously located along the Somerset Railway.

Locality 45.—Bog along Martin Stream, 5 miles south-southeast of South Norridgewock. This bog is shown on the Norridgewock topographic sheet of the United States Geological Survey. Most of it is heavily forested with larches up to 8 inches in diameter, yellow birches, ash, cedars, alder brush, etc. Three borings at various points in this bog showed at no place over 7 feet of mucky peat. The quantity and quality of material are not such as to make the deposit valuable for other than local use.

PITTSFIELD.

Locality 46.—Bog 1 mile southeast of Pittsfield. This is an open moss bog about 2,000 yards across from north to south and about 1,500 yards across from east to west. A line of holes was run due south across the central portion of the bog from a point near the road between Pittsfield and Detroit.

Hole A. 100 yards south of north border of bog. Firm dark-brown, not very fibrous peat 7 feet, underlain by bluish sandy clay.

Hole B. 400 yards south of north border of bog. Firm brown peat 14 feet, underlain by blue-gray clay.

Hole C. 900 yards south of north border of bog.

	Feet.
Firm fibrous brown peat	0–15
Fluid peat which did not cling to auger	15–21

Bottom not reached.

Hole D. 1,400 yards south of north border of bog. Firm dark-brown fibrous peat 8 feet, underlain by blue-gray clay.

Hole E. 1,600 yards south of north border of bog, and about 400 yards from its southern border. Firm dark-brown peat 6 feet, underlain by hard blue-gray clay.

Analyses 45 and 46, page 117, represent moss and peat from this bog (holes C and D, respectively).

Both the moss near the surface and the well-decayed peat from a depth of 9 feet are low in ash. The extremely low percentage of fixed carbon (33 per cent) in the pure peat is indicative of the slight degree of decay, as is also its rather low thermal value. The thermal value of the sample collected at a depth of 9 feet is high, and it is probable that most of the peat in this bog is of good quality for fuel purposes. The upper, more fibrous portions could be utilized for litter or in the manufacture of paper, etc.

The area of this bog is about 500 acres. The southern portion is somewhat shallower than the northern, but the average depth of the whole bog is probably at least 10 feet. On these assumptions the bog is capable of yielding over 1,250,000 tons of air-dried machine peat. Excavation could begin at the border of the bog and proceed inward, the hard floor furnishing a firm foundation for excavating machinery, etc. The bog is favorably located within 1 mile of the railroad and near a prosperous town.

SMITHFIELD.

Locality 47.—Bog at northwest end of East Pond. Its form and location are shown in figure 15 and on the Norridgewock topographic sheet of the United States Geological Survey. Most of the area mapped as swamp is open moss bog, but in the portions nearest of the lake sedges and marsh grasses are abundant and the northern portions are rather heavily forested with black spruces, larches, and small white pines.

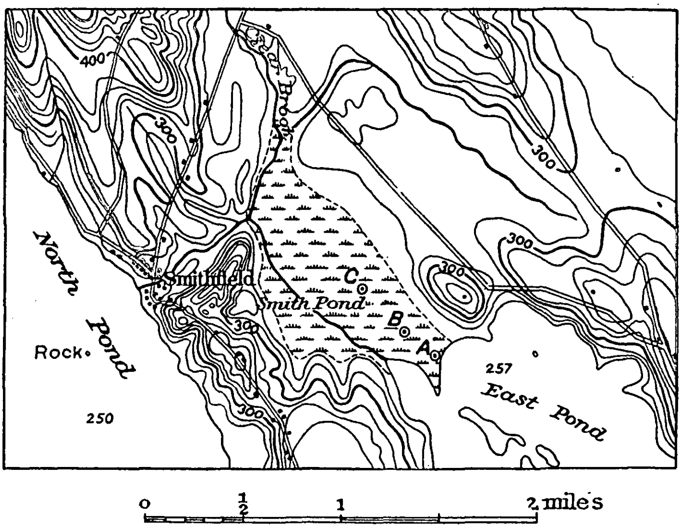


FIG. 15.—Map showing location and area of bog near East Pond, Smithfield (locality 47), and locations of test borings.

Hole A. Within 30 yards of the shore of the pond: Brown peat 14 feet, underlain by clayey peat. The peat is mostly firm and fibrous, but a part is so fluid as not to cling to the auger.

Hole B. 300 yards N. 45° W. from hole A. Firm dark-brown, somewhat fibrous peat 11 feet, underlain by clean blue-gray clay.

Hole C. 500 yards N. 45° W. of hole B. Brown peat 20 feet, underlain by clay. Upper 12 feet firm and somewhat fibrous, but lower 8 feet so fluid as not to cling to auger.

Lack of time made it impossible to put down test holes in the northern part of the bog, but it is highly probable that the deposit continues in considerable thickness and of good quality for at least one-fourth mile northwest of hole C.

The analysis of a sample from hole B (No. 47, p. 117) shows this peat to be low in ash and of higher thermal value than any other peat analyzed from Maine. The deposit is of excellent quality for fuel purposes. The total area of this bog is probably about half a square mile and the average depth seems to be not less than 15 feet. With these dimensions the bog should yield not less than 1,000,000 tons of air-dried machine peat. It would be impossible to drain the bog without also draining East Pond, but the peat could be pumped or excavated by dredges. The nearest point on the railroad is South Norridgewock, 5 miles to the north.

WASHINGTON COUNTY.

ALEXANDER.

A large bog is said to be located near Alexander post-office in the town of Alexander, northwest of Meddybemps Lake, but this locality is distant from the railroad and was not visited.

CHARLOTTE.

A small bog was observed along the Washington County Railway, about 1 mile northeast of Charlotte station. It lies on the northwest side of the railway track and is only 300 yards or so in its greatest dimension. It contains a small island and is probably very shallow. The plants are of the usual moss-bog type. This bog was only observed from the train, no tests being made.

CHERRYFIELD.

Locality 48.—Bog 3½ miles northeast of Cherryfield, on the west side of the road to Schoodic Lake. This is an open moss bog. Its area and form are shown on the Cherryfield sheet of the United States Geological Survey. A line of holes was run due west across the widest portion of this bog.

Hole A. 100 yards west of the east border of the bog. Firm brown peat 7 feet, underlain by brown clay.

Hole B. 100 yards west of hole A. Dark-brown, somewhat fibrous peat 9 feet, underlain by blue-gray sandy clay.

Hole C. 200 yards west and 200 yards north of hole B. Firm dark-brown fibrous peat 9 feet, underlain by clay.

Analysis 48, page 118, represents peat from this bog (hole B). The sample analyzed is moderately low in ash and of medium thermal value.

The total width of the bog from east to west is about 500 yards and the diameter from north to south is about the same. The area is thus about 40 acres. If the average depth is 6 feet the bog will be capable of yielding over 50,000 tons of air-dried machine peat.

COLUMBIA AND TOWNSHIP NO. 18.

Locality 49.—Bog along Pleasant River, 7 to 10 miles northeast of Cherryfield. This bog is shown on the Cherryfield sheet of the

United States Geological Survey, and covers more than 5 square miles. It lies in a depression formerly occupied by a tongue of glacial ice, and is bordered to the southwest and to the southeast by a glacial outwash plain. The vegetation is largely of the open moss-bog type, with the addition of sedges and some marsh grasses. Only the western portion of the bog, between Pleasant River and Schoodic Lake, was tested, but six test holes put down at various points in this portion failed to show more than 3 feet of mucky peat. The underlying material is a yellowish-gray clay. It is possible, though hardly likely, that in other parts of the bog the depth of the peat may be greater.

EAST MACHIAS.

Locality 50.—Bog about 7 miles north of East Machias, near Southern Inlet, a small flag station on the Washington County Railway. The bog lies about one-fourth of a mile southwest of the point where the wagon road crosses the railroad, and is mostly on the west side of the track. The plants are those of the typical open moss bog. A line of holes was run westward across the central portion of the bog in a direction at right angles to the railroad track.

Hole A. 50 yards west of railroad. Firm brown peat 9 feet, underlain by sandy clay.

Hole B. 200 yards west of hole A. Firm brown peat, in part rather fibrous, 17 feet, underlain by blue-gray clay.

Hole C. 150 yards west of hole B, and about 150 yards from the west border of the bog. Firm brown peat 13 feet, underlain by blue-gray clay.

The peat is comparatively solid, none being fluid enough to be forced up in extracting the auger, and considerable suction being developed at some of the holes when the auger was withdrawn.

Analysis 49, page 118, represents peat from this bog (hole B). It shows a peat low in ash and of moderate thermal value.

The bog is about 450 yards across from east to west and 600 yards from north to south. The area is approximately 50 acres and with an assumed average depth of 10 feet the bog should yield at least 100,000 short tons of air-dried machine peat.

Locality 51.—Bog east and northeast of watering tank at Southern Inlet, a small flag station on the Washington County Railway between East Machias and Marion. This bog is crossed by the railroad but lies mostly southeast of the track.

Hole A. 195 yards southeast of the railroad track, measured from a point 360 yards northeast of the watering tower. Dark-brown, firm, somewhat fibrous peat 20 feet, underlain by blue-gray clay.

Hole B. In the southeastern part of the bog, midway between the northeast and southwest borders. Firm fibrous peat 13 feet, underlain by clay.

This is a typical open moss bog which, near its border, shows a number of rocky "islands" and in certain portions shows an abundance of grasses and sedges.

Analysis 50, page 118, represents peat from this bog (hole A). The sample analyzed is low in ash and of high thermal value.

The length of the bog is about 1 mile in a northwest-southeast direction and the average width is about 500 yards. The average depth probably exceeds 10 feet. With these dimensions the deposit should yield at least 350,000 short tons of air-dried machine peat.

FOREST.

Locality 52.—Bog just northwest of Forest station, along the Maine Central Railroad. This bog begins on the southwest side of the railroad track about 300 yards northwest of Forest station, and thence extends northwestward about parallel to the railroad for nearly 1,500 yards, with an average width of 100 to 150 yards. The vegetation is of the open moss bog type.

Hole A. 400 yards northwest of Forest station and 50 yards southwest of the railroad track. Brown peat 15 feet, underlain by clay.

Hole B. 800 yards northwest of the depot and 50 yards southwest of the railroad track. Dark-brown semifibrous peat 17 feet, underlain by sand. The peat in places is somewhat fluid. The total width of the bog here is only about 100 yards.

Hole C. 1,500 yards northwest of Forest station and 80 yards southwest of the railroad track. Firm brown peat 11 feet, underlain by sand.

Analysis 51, page 118, represents peat from this bog (hole B). It shows a peat low in ash and of high thermal value.

The total area of the bog is not far from 30 acres, and the average depth is at least 10 feet. With these dimensions it should yield over 65,000 tons of air-dried machine peat.

JONESBORO.

Locality 53.—Bog 1¾ to 2 miles west of Whitneyville, along the Washington County Railway. This is an open moss bog having a diameter from north to south and from east to west of about 500 yards. It lies mainly on the north side of the railroad. A line of holes was run due north across the center of the bog, starting from the railroad.

Hole A. 50 yards from the railroad. Firm brown peat 7 feet, underlain by blue-gray clay.

Hole B. 100 yards north of hole A, in about the middle portion of the bog. Firm, fibrous, dark-brown peat 10 feet, underlain by yellowish-gray clay.

Hole C. 150 yards north of hole B and about 100 yards from the north side of the bog. Firm brown peat 9 feet, underlain by clay.

Analysis 52, page 118, represents peat from this bog (hole B). The sample analyzed was low in ash and of moderate thermal value.

Another smaller moss bog lies just northwest of the one described above and is connected with it by a narrow strip of bog land. It is about 250 yards wide from north to south and 350 yards from east to west. Hole D, put down in its central portion, showed 10 feet of firm dark-brown peat underlain by clay.

These bogs are situated near the summit of a steep grade on the railroad and have already been partly drained by the railroad at this point. They could be completely drained by a slight deepening of the ditch at the side of the present track or by the construction of a new ditch only 500 feet or so in length. If the average depth of these two bogs is 8 feet, they are capable of yielding nearly 100,000 tons of machine peat.

Locality 54.—Bog about one-half mile northeast of the head of Pond Cove, in the town of Jonesboro. Its location and area are shown in figure 16. A line of holes was run northward across the central portion of this bog.

Hole A is 100 yards, hole B 200 yards, and hole C 300 yards north of the wagon road. Each of these borings showed 6 feet of firm dark-brown, somewhat fibrous, peat underlain by clay. Hole D is 150 yards west of hole C in the western part of the bog and also showed 6 feet of peat underlain by clay.

The area of this bog is at least 40 acres. If the average depth is 5 feet, the bog is capable of yielding about 45,000 tons of air-dried machine peat. It is located within a quarter of a mile of Pond Cove, but the waters of this cove are very shallow for a considerable distance from the shore and for water shipment it would probably be necessary to transfer the peat in lighters to larger vessels.

Locality 55.—Bog along the west side of the road from Rogues Bluff post-office to Jonesboro, and about one-half mile northeast of Shoppees Point. Its location and form are shown in figure 16. This bog is about 400 yards wide from east to west and 500 to 600 yards long from north to south. It is a typical open heath.

Hole A. 120 yards west of the road and near the eastern border of the bog. Brown peat 6 feet, underlain by clay.

Hole B. 100 yards due west of hole A, and about 100 yards east of the west border of the bog. Firm dark-brown peat 6 feet, underlain by clay.

Hole C. 150 yards north of hole B and within 100 yards of the northern border of the bog. Dark-brown peat 8½ feet, underlain by yellowish-gray clay.

The analysis of a peat sample of hole B (No. 53, p. 118) shows a low percentage of ash and a moderate thermal value.

The area of this bog is probably not far from 15 acres. If the average depth is 5 feet the bog is capable of yielding over 15,000 tons of air-dried machine peat. It is distant only about one-half mile from salt water.

Locality 56.—Bog three-quarters to 1 mile south of Rogues Bluff post-office, in the town of Jonesboro. This bog lies between Black Head and Englishman River, on the north side of the wagon road, its location and area being shown in figure 16. The vegetation is of

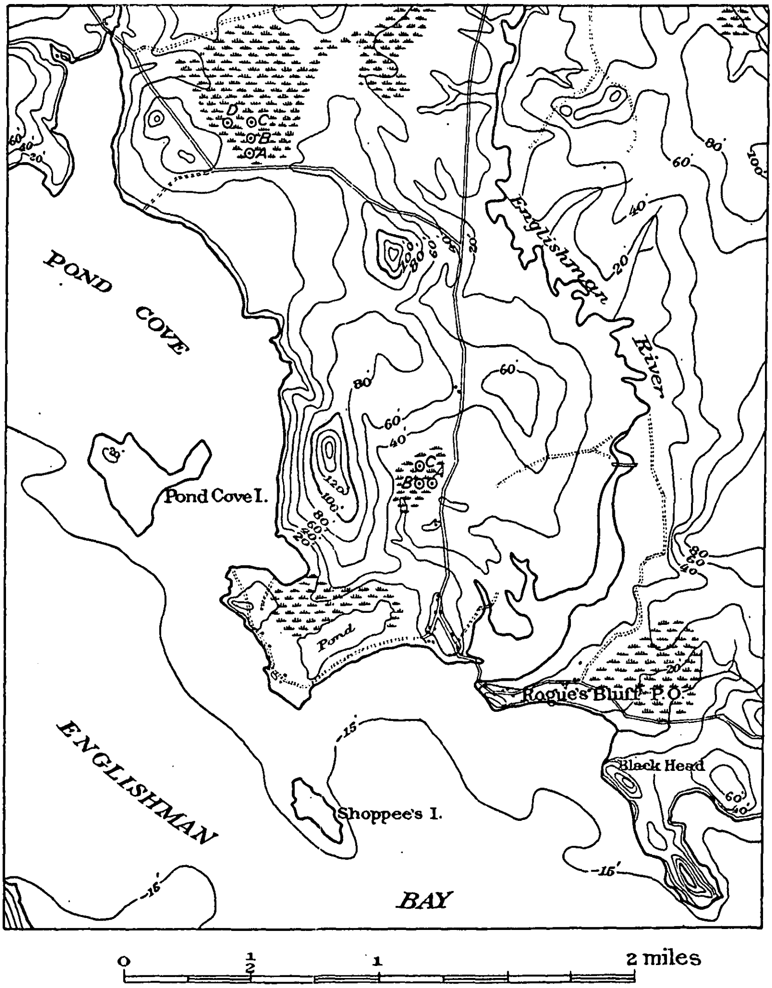


FIG. 16.—Map showing location and area of bogs in town of Jonesboro (localities 54, 55, and 56) and locations of test borings.

the typical open moss bog type. In all eight holes were put down, so distributed as to test all portions. The southern and southeastern parts are very shallow, the peat averaging not over a foot or so in depth, though in one place reaching 6 feet. In the northern part, however, from 7 to 12 feet of slightly fibrous peat are found.

Analysis 54, page 118, represents peat from this bog. It shows a peat low in ash and of moderate thermal value.

It is estimated that over an area of 15 acres the depth of the bog will average 10 feet. Upon this assumption the bog would yield somewhat over 30,000 tons of air-dried machine peat. The southern border of this bog is not more than 500 or 600 feet from the shore of Englishman Bay. The water for some distance offshore is, however, very shallow and the peat would probably have to be loaded first onto lighters and then transferred to larger vessels.

LUBEC.

Locality 57.—Bog occupying nearly all of the neck of land three-quarters of a mile southeast of South Lubec, connecting West Quoddy Head with the mainland. It is a typical open moss heath, with larches and black spruces only in its northeast portion. On its south side it is protected from the action of the ocean waves by a broad sand beach, but on the north side it is now being cut into by the waves and is exposed as a peat cliff from 5 to 10 feet high, which affords the best section of a peat bog to be found anywhere in the State. The plant remains making up the peat show that the deposit is of fresh-water and not of marine origin. It was probably formed in the depression between two beaches, the northern one having subsequently been removed through the shifting of the ocean currents so as to expose the peat deposit to destruction on that side. Within the memory of some of the older residents of South Lubec, this bog extended nearly one-fourth mile farther north than it now does.

The peat throughout consists largely of the remains of sphagnum, sedges, and plants of the heath family, and was plainly built up, layer upon layer, in a moist depression where no lake existed. The basal layers contain numerous roots and stems of a conifer, probably *Picea*, and of a slow-growing, broad-leaved shrub, possibly a birch; but the finer material associated with these wood fragments is chiefly sphagnum moss, with a few fragments of roots and branches of shrubs and the epidermis of sedges. Above the basal layers, which are somewhat clayey, the deposit consists of an alternation of layers composed almost entirely of sphagnum moss with thinner layers which contain some moss remains, but consist mainly of remains of sedges and of plants of the heath family and the root stocks of ferns. The moss layers vary from 1 to 4 inches in thickness, the layers poorer in moss remains from one-fourth to 1 inch. Many single bands may be traced laterally for 3 or 4 yards. Some of the thinner and less mossy layers are nearly black.

Analysis 55, page 118, represents peat collected 3 feet below the surface of this bog.

The area of this bog is about 20 to 25 acres. On the assumption that 5 feet is its average depth, it should yield at least 25,000 short tons of air-dried machine peat. Although located on the coast, the facilities for water shipment are poor, the coast to the south being unprotected, and the bay to the north being very shoal for long distances from the shore. The deposit would be available largely for local use.

PEMBROKE.

Locality 58.—Bog about 1½ miles southwest of Ayers Junction, along the Washington County Railway. Its form and area are

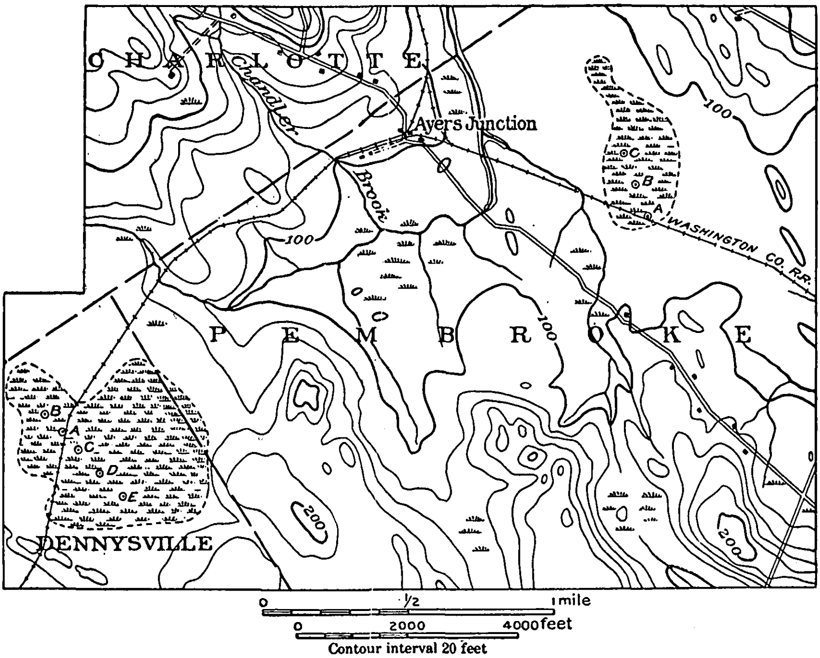


FIG. 17.—Map showing location and area of bogs near Ayers Junction (localities 58 and 59) and locations of test borings.

shown in figure 17. A line of test holes was run across the central portion of this bog in a direction at right angles from the railroad track, starting from a point 200 yards southwest of the northeast border of the bog.

Hole A. On the northwest side of the railroad, within 15 feet of the track.

	Feet.
Firm, dark-brown, slightly fibrous peat	0–12
Clayey peat	12–13
Blue-gray clay	13

Hole B. 150 yards northwest of hole A. Firm brown peat 12 feet, underlain by clayey peat and clay. The edge of the bog lies 150 yards northwest of this hole.

Hole C. 100 yards southeast of the railroad along this same line. Firm, rather fibrous brown peat 9 feet, underlain by 1 foot of clayey peat, and then by blue-gray clay.

Hole D. 200 yards southeast of hole C. Firm brown peat 19 feet, underlain by clay.

Hole E. 200 yards southeast of hole D. Brown peat 13 feet, underlain by clayey peat and clay. Here a small amount of fluid peat was forced up in withdrawing the augur, though most of the material is very firm. This hole is 200 yards from the southeast border of the bog.

The surface of this bog shows a noticeable inclination, hole D being at about the highest portion. The plants are of the typical moss-bog variety. The central portions of the bog show only here and there a larch or black spruce, but these trees are abundant near the borders.

Analyses 56 (hole C) and 57 (hole D), page 118, represent peat from this bog. They show both samples to be of very similar composition, low in ash, and of high thermal value.

The area of this bog is approximately 160 acres, and the average depth is probably not far from 15 feet. With these dimensions the bog will be capable of yielding at least 500,000 short tons of machine peat. The percentage of water is much less than in most other deposits. In many of the holes a considerable suction was noticed when the auger was withdrawn, indicating rather unusual firmness and coherence.

Locality 59.—Bog one-half mile east of Ayers Junction, along the Eastport branch of the Washington County Railway. The form and area are shown in figure 17 and on the Eastport topographic sheet of the United States Geological Survey. A line of holes was run in a northwesterly direction across the central, widest part of the bog, starting from the railroad.

Hole A. Within a few feet of the railroad track. Firm brown peat 7 feet, underlain by sandy clay.

Hole B. 200 yards north-northwest of hole A. Firm dark-brown, nonfibrous and slightly clayey peat 7 feet, underlain by blue-gray clay.

Hole C. 200 yards north-northwest of hole B, and about 200 yards from the northwest border of the bog. Firm brown peat 4½ feet, underlain by clay.

The plants of this bog are mainly of the typical moss-bog variety, but sedges are also abundant. The peat of this bog, like that of the bog southwest of the junction, is much dryer than that of most of the other bogs tested. A considerable suction was developed at many of the holes when the auger was being withdrawn.

Analysis 58, page 118, represents peat from this bog (hole B). It shows a peat rather low in ash and of unusually high thermal value. The sample is more woody than any other collected in the State and shows unusually thorough decomposition.

The approximate area of this bog is estimated at at least 50 acres, but the average depth will probably not exceed 5 feet, and some of this material is slightly clayey. With the above dimensions the bog should yield at least 60,000 tons of air-dried machine peat.

Locality 60.—Bog 1 mile northwest of Falls Point and due east of Wilbur Neck. Its form and location are shown on the Eastport topographic sheet of the United States Geological Survey. The bog is for the most part a typical open heath, with the usual flora of sphagnum, plants of the heath family, and scattered larches and black spruces. The western portion is a typical cedar swamp. Starting from the southwest border of the bog a line of test holes was run in a direction N. 45° E. across its central portion.

Hole A. 100 yards N. 45° E. from southwest border of bog.

	Feet.
Mossy peat	0–3
Dark-brown well-decayed peat	3–13
Clayey peat encountered at	13

Hole B. 100 yards northeast of hole A, near center of open portion of bog.

	Feet.
Firm, somewhat mossy peat	0–3
Better decayed, more fluid peat, containing some wood fragments	3–13
Clayey peat	13–14

Hole C. 100 yards northeast of Hole B. Brown, well-decayed peat 13 feet, underlain by clayey peat.

Hole D. 300 yards northwest of hole B, in typical cedar swamp. Dark-brown, well-decayed peat 7 feet, underlain by clayey peat.

Analyses 59 and 60, page 118, represent peat from this bog (hole B). Analysis 59 shows a peat remarkably low in ash; No. 60 is also low. The thermal values of these two samples were not determined, but by comparison of the percentages of volatile combustible, fixed carbon, and ash with those of other analyses, the thermal value of No. 60 should lie between 8,500 and 9,000, and that for No. 59 should be between 9,000 and 9,700.

The total area of the bog is about 35 acres. On the assumption of an average depth of 10 feet, the bog should yield at least 78,000 short tons of air-dried machine peat. Although located only one-fourth mile from salt water, shipment of the peat, except in small vessels, would be difficult, because of numerous shoals and rapid tidal currents. The bog would, however, furnish a large supply of excellent peat for local use.

PERRY.

Locality 61.—Bog 3 miles south of Perry village and one-half mile east of Leach Point. A line of test holes runs S. 45° W. across the bog, starting from the point where the wagon road north of the bog crosses the creek that flows into the bog. This line of holes traverses the central and most open portion of the area. The present flora of the bog is of the typical moss-heath variety, the central part being rather open, with only scattered larches and black spruces, while the borders carry an abundant growth of alder.

Hole A. 100 yards southwest of road. Muck 2½ feet, underlain by blue-gray clay.

Hole B. 100 yards southwest of hole A. Muck 4 feet, underlain by blue-gray clay.

Hole C. 100 yards southwest of hole B.

	Feet.
Peat moss	0–3
Well-decayed peat	3–6
Clay peat	6–7
Blue-gray clay.	

Hole D. 200 yards southwest of hole C and 150 yards from the southwest border of the bog.

	Feet.
Peat moss	0–1
Clayey peat	1–3
Blue-gray clay.	

These tests show that the quantity of peat in the bog is not large, though probably sufficient for local use as fertilizer or fuel. No analyses were made.

TRESCOTT.

Locality 62.—Bog 1 mile south of South Trescott, near Haycock Harbor. Its form and location are shown in figure 18 and on the Eastport topographic sheet of the United States Geological Survey.

Hole A. 300 feet northeast of house just southwest of bog. Dark-brown, well-decayed peat 10 feet, underlain by soft blue-gray clay. Upper layers of peat moderately fibrous.

Hole B. 200 feet northeast of Hole A. Dark-brown, well-decayed peat 9 feet, underlain by soft blue-gray clay.

Hole C. 300 feet northeast of Hole B and about 50 feet southwest of the low creek valley traversing the bog. Dark-brown nonfibrous peat 4 feet, underlain by blue-gray clay. The surface of the bog descends notably between hole A and the creek valley, but northeast of the creek begins to ascend again.

Hole D. 400 feet northeast of Hole C. Dark-brown peat 8 feet, underlain by blue-gray clay.

Hole E. 400 feet northeast of hole D. Dark-brown peat, slightly fibrous and well decayed, 14 feet, underlain by blue-gray clay.

Hole F. 650 feet southeast of hole E. Dark-brown peat 16 feet, underlain by blue-gray clay.

The bog is a typical moss heath with a few scattered small larches and black spruces. It has been burned over locally to stimulate the growth of blueberries, and in such places the moss *Polytrichum* now dominates over the sphagnum.

Analyses 61 and 62, page 118, represent peat from this bog (holes D and F, respectively).

The area of the bog is probably at least 160 acres. On the basis of 8 feet as a conservative figure for its average depth, the bog should yield at least 280,000 short tons of air-dried machine peat. Its location is remarkably favorable for cheap handling of the material,

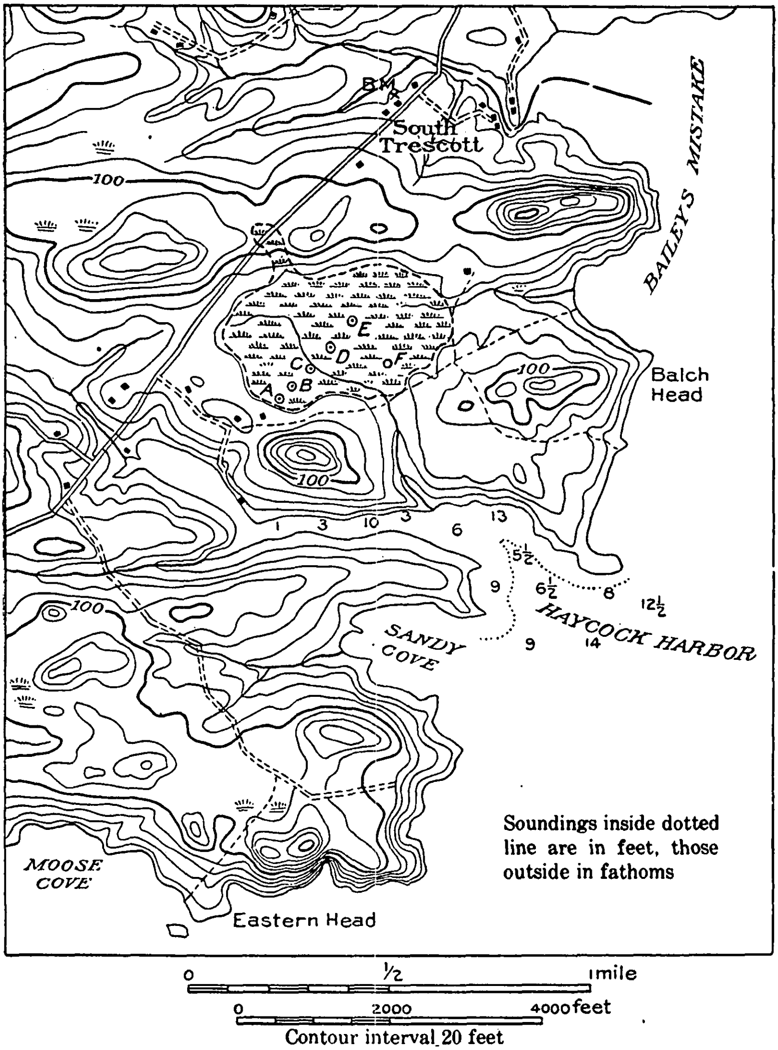


FIG. 18.—Map showing location and area of bog near South Trescott (locality 62) and locations of test borings.

which could be carried by gravity from a factory located on the border of the bog to the shore of Haycock Harbor, and thence shipped in small vessels, for which the harbor affords good protection.

VANCEBORO.

Locality 63.—Bog extending along the Maine Central Railroad for about 2 miles west of Vanceboro. The boundaries are irregular and were not accurately determined, but the bog is known to cover several square miles. The vegetation is mainly of the typical open-heath type, though certain portions near the borders of the bog are forested with hard-wood timber.

Hole A. On the south side of the railroad track about 2¼ miles west of Vanceboro station. Brown, fibrous peat, 12 feet.

Hole B. Near hole A, but on the opposite side of the railroad track. Showed a similar depth and character of peat.

Hole C. 50 feet north of the railroad at a point 500 yards west of the railroad depot at Vanceboro. Brown fibrous peat 9 feet to rock bottom.

Hole D. 950 yards west of hole C, along the railroad and just opposite the mile-post reading "250 miles from Portland." Dark-brown fibrous peat, some of it rather fluid, 10 feet, underlain by clay.

Hole E. 50 feet north of the railroad track, opposite a point 350 yards west of hole D. Brown fibrous peat 4 feet, to rock bottom. About 600 yards west of this hole along the railroad is a narrow ridge of high land which separates this portion of the bog from the portion in which holes A and B are located.

Analyses 63 (hole B) and 64 (hole D), page 118, represent peat from this bog. Both of the samples analyzed contain low and nearly equal percentages of ash. The thermal value of No. 63, from the lesser depth, is moderate; that of No. 64, from the greater depth, is high. The greater heating value of No. 64 is probably due to its larger percentage of volatile combustible matter.

This bog includes an immense area of peat with considerable depth and is favorably situated along the railroad.

WHITNEYVILLE.

Locality 64.—Bog just north of west of Whitneyville station, on the Washington County Railway. This is a typical open moss bog similar in appearance to many bogs which have a considerable depth of peat, but four holes so distributed as to test all portions of it showed nowhere more than 2 feet of peat.

YORK COUNTY.

ELIOT.

Locality 65.—Bog 60 rods southeast of Rosemary Junction on the Dover and York Beach division of the Atlantic Shore Line electric railway, and about one-half mile east of Eliot station, on the Boston and Maine Railroad. The bog lies in the valley of a brook flowing into Piscataqua River. The area was estimated to be about 70 acres and the bog is now so near the level of the river that the high tides affect the outlet stream nearly to the present surface of the bog, although apparently the salt water does not yet invade the bog itself.

Hole A. 300 feet from the north margin of the bog, where a cart track enters the cleared area.

	Feet.
Blackish, compact, somewhat fibrous but well decomposed peat	0– 2
Brown, compact, plastic, well-decomposed, finely divided peat	2– 3
Yellowish and greenish-brown, compact, plastic, well-decomposed, finely divided peat	3– 7
The bottom layers of the peat are silty and merge gradually into fine, silty, greenish or yellowish gray clay, with an abundance of plant remains	7–11

Hole B. Near junction of a small ditch on swampward side of cleared area, with main brook about 10 rods from edge of wooded part of swamp; 400 feet southeast of hole A.

	Feet.
Nearly black fibrous but plastic peat with thin silty layers	0– 2
Dark-brown, fibrous, plastic, sedgy peat	2– 2½
Brown, fibrous, nonplastic, woody peat, with twigs and bits of wood, becoming wetter and less woody in the lower part of the stratum	2½– 7½
Yellowish-brown, plastic, fine-grained peat, containing seeds and fragments of leaves and stems of water plants in abundance	7½–12
The material becomes finer toward the bottom and its color very gradually changes to a greenish or yellowish gray, indicating high silt and clay content	12–15
Greenish-gray silty clay containing quantities of plant remains	15

Hole C. About 500 feet southeast of hole B, well within the borders of the uncleared part of the bog.

	Feet.
Blackish, thoroughly decomposed, somewhat fibrous, fine-grained, plastic peat	0 – 3½
Light-brown, coarsely fibrous, nonplastic, sedgy peat	3½– 4½
Brown, fibrous, somewhat plastic, well-decomposed peat, becoming wetter and more plastic toward the bottom of stratum	4½– 7
Greenish-brown, soft, plastic, well-decomposed peat, becoming nearly structureless toward the bottom of stratum	7–11
Grayish-brown, structureless, soft, plastic ooze, somewhat clayey, grading imperceptibly, at about 14 feet, into a greenish clay, which is darkened by plant remains.	

The part of this bog which has been cleared and drained was at one time used as a cranberry bog, but is no longer cultivated as such and is covered by coarse sedges, which are cut for hay. The cranberry vines still cover the portions that are not too closely mown, although alders and willows, with tall herbaceous plants, are fast encroaching on such areas.

The uncleaned portion of the bog is covered by a growth of stunted red maples (*Acer rubrum* L.), with a dense undergrowth of alders (*Alnus incana* (L.) Willd.), willows (*Salix* spp.), and the royal fern (*Osmunda regalis* L., n. n. *O. spectabilis* Willd.). The fern forms dense tufts or stools, the tops of which rise a foot or more above the general level, and which stand so close together that the fronds touch each other and completely shade the wet ground between. These stools support a number of tall herbaceous plants and a few species of shrubs; the ground between has a sparse flora, consisting chiefly of sphagnum and other mosses, which grow more luxuriantly on the sides of the stools.

No exact information as to the area of this bog was obtained, but it was estimated to contain at least 50 acres in the part which had peat 8 feet or more deep. On the basis of an average depth of 8 feet of workable peat in this area, the deposit would yield 80,000 tons of machine peat.

The facts that this bog is bounded on one side by the Boston and Maine Railroad and touched on two others by the electric lines, and that it is within a short distance of the navigable waters of Piscataqua River, make it very favorably located for exploitation. The analyses, however (Nos. 65 and 66, p. 119), show the samples collected to be extremely high in ash and of low thermal value, and exploitation for fuel purposes should not be attempetd until further tests and analyses have been made. If the quality of any of the peat is such as to warrant utilization it must be further remembered that the surface is now but very slightly above the mean high-water level, and that deepening the outlet for drainage will permit the inflow of salt water. The bog, therefore, will have to be worked wet, a condition which, if some form of mechanical excavator is used, need be no bar to success.

KITTERY, OLD ORCHARD, AND WELLS.

Localities 66 to 70.—A number of test borings were made in the salt marshes at Kittery Point (localities 69 and 70) and Cutts Island (locality 68), in Kittery, and samples were analyzed with the results shown in analyses 67, 68, and 69, on page 119. As shown by these analyses, most of the peat contained so much clay as to be wholly valueless commercially. The purer peat, represented by analyses 69, appeared to be of very meager extent. A number of test borings made in the salt marshes back of Old Orchard (locality 67) and Wells (locality 66) beaches showed that nearly everywhere the peat was mixed with at least 40 or 50 per cent of clay and was therefore valueless for most purposes. There is reason to believe that this high clay content is common along the coast of Maine, except in the few places where salt marsh has succeeded fresh-water bog or vice versa.

SUMMARY AND CONCLUSIONS.

The field tests and analyses recorded in this report show that Maine possesses immense resources of peat of excellent quality for fuel and other purposes. In the southern and eastern parts of the State deposits of good quality are most abundant in Androscoggin, Kennebec, and Penobscot counties, and especially in Washington County. In the northern part of the State tests were made only in Aroostook County along the Bangor and Aroostook Railroad. Peat resources as great as or greater than those of southern Maine undoubtedly are to be found in the forested lake districts of the northern part of the State. Their utilization is so remote that testing them for the purposes of this report was not warranted, but they must be given due consideration in estimating the total peat resources of the State. These resources, except for a single experimental plant near Lewiston, are at present undeveloped.

The area of peat land actually tested in preparing this report is estimated at 25 square miles. The average depth of the peat is about 10 feet. It is calculated that the bogs tested are capable of yielding at least 34,000,000 short tons of air-dried machine peat, which, at $3 a ton, would represent a value of more than a hundred million dollars. It is probable that the deposits tested form only one-tenth to one-fifth of the total peat resources of the State.

In most of the bogs which show any considerable amounts of peat the material is sufficiently decayed for use as a fuel, but in a few places, as at locality 3, south of No Name Pond, in Lewiston, and at locality 21, at the northeast end of Great Pond, in Belgrade, the peat is in the main not well decayed and is so fibrous that it is better suited for such uses as the manufacture of paper, moss litter, etc., than for fuel.

In other bogs, as at localities 12 (Cape Elizabeth), 2 (the Farwell bog, Lewiston), 23 (Oakland), and 36 (Etna), the peat is mainly well decayed and not notably fibrous, being therefore not available for the uses in which a fiber is desired; it will probably find its main use as peat fuel. In still other bogs, as at localities 25 (the Great Sidney bog), 41 (east of Pushaw Lake, in Oldtown), 46 (Pittsfield), and 63 (Vanceboro), both fibrous and well-decayed peat occur in different sections of the bog and at different depths.

ANALYSES.

The results of the analyses of samples of Maine peats are given in the following table. The samples as received at the laboratory were not sealed and contained varying amounts of moisture. All the analyses have therefore been reduced to a moisture-free basis.

Analyses of peat specimens from Maine.

ANDROSCOGGIN COUNTY.

Analysis No.	Locality No.	Hole.	Depth (feet).	Volatile combustible.	Fixed carbon.	Ash.	Sulphur.	Nitrogen.	Fixed carbon in pure peat.	Thermal value.	
										Calories.	B. t. u.
1	1	F.......	6	56.01	31.30	12.69	0.59	1.78	56	4,859	8,746
2	2	B.......	3	....	....	6.71	.12	1.16	....	5,159	9,286
3	2	B.......	6	60.22	33.79	5.99	.15	1.00	56	5,238	9,428
4	2	B.......	17	59.83	31.01	9.16	.50	1.63	52	5,057	9,135
5	2	Machine peat from factory.	2–3	....	....	4.48	.49	1.33	....	3,256	7,861
6	3	B.......	1½–3	....	....	5.38	.16	1.12	....	4,900	8,820
7	3	B.......	9	51.46	26.03	22.51	.18	1.15	51	4,060	7,308
8	3	B.......	15	55.20	27.50	17.30	.34	1.38	50	4,309	7,864

1. Dark-brown, only slightly fibrous, well-decomposed, plastic peat, composed largely of moss and sedge remains with well-decayed fragments of wood and bark.
2. Light-brown, somewhat fibrous peat, composed principally of remains of sphagnum mosses and the common bog plants of the heath family.
3. Dark-brown, plastic, fibrous, but well-decayed peat, composed principally of remains of sphagnum mosses, sedges, and some woody fragments mainly from heath plants.
4. Yellowish-brown to dark-brown, rather fibrous peat. Fibers fine and rootlike but of an unrecognized plant. Some fragments of shrubs and sedges. This peat was evidently formed at the bottom of a shallow pond, as shown by the presence in it of diatoms and the seeds of pond lilies.
5. This sample was taken in the wet condition from the peat machine. After digging and before being fed into the machine it had been exposed to the air for some time in the stock pile and had lost a part of its moisture. It was dug from a depth of 2 to 3 feet near the northern border of the bog.

In general the character of samples 2 to 5 shows that pond conditions prevailed during the first stages in the formation of this deposit, but that the pond early became converted into a moss heath. The open-heath plants by their gradual growth and decay formed the great bulk of the deposit.

6. Rather light brown, partly decayed, fairly fibrous peat, composed mainly of remains of the typical moss-heath flora.
7. Dark-brown, slightly fibrous, fairly well decayed peat, composed of remains of mosses, sedges, and plants of the heath family.
8. Dark-brown, fibrous, nonplastic, fairly well decayed peat, composed of remains of the typical moss-heath flora.

AROOSTOOK COUNTY.

Analysis No.	Locality No.	Hole.	Depth (feet).	Volatile combustible.	Fixed carbon.	Ash.	Sulphur.	Nitrogen.	Fixed carbon in pure peat.	Thermal value.	
										Calories.	B. t. u.
9	7	B.......	4–5	....	....	9.41	0.27	1.54	....	5,093	9,167
10	9	....	....	....	....	5.99	.16	1.28	....	5,411	9,740
11	10	C.......	4–5	59.84	28.80	11.36	.72	2.03	48	5,203	9,365

9. Nearly black, nonfibrous, well-decayed peat. Shows remains of sedges, mosses, and woody fragments, probably mostly of heath plants.
10. Dark-brown, slightly fibrous, well-decayed peat. Shows remains of sedges and heath plants and some moss remnants.
11. Dark-brown nonfibrous peat. Shows numerous very small woody fragments.

Analyses of peat specimens from Maine—Continued.

CUMBERLAND COUNTY.

Analysis No.	Locality No.	Hole.	Depth (feet).	Volatile combustible.	Fixed carbon.	Ash.	Sulphur.	Nitrogen.	Fixed carbon in pure peat.	Thermal value.	
										Calories.	B. t. u.
12	12	B.......	5–6	57.47	30.07	12.46	0.99	1.84	52	4,961	8,930
13	12	D.......	4–6	57.39	31.81	10.80	1.09	....	55	Not determined.	
14	14	B.......	3–4	60.11	28.89	11.00	.11	.78	48	4,656	8,381
15	14	B.......	9–10	61.67	31.41	6.92	.10	.77	51	5,005	9,009

12. Dark-brown, somewhat fibrous, well-decomposed, plastic peat, made up chiefly of fine roots, scales, and leaves of sedges, with some remains of pond weeds and a few fragments of wood, mostly roots and branches of hard-wood trees and shrubs.

13. Similar to No. 12 in its general appearance, but freer from wood fragments. The material is distinctly less subaquatic than No. 12, sedge remains being much more abundant. Remains of conifers, possibly spruces, are present.

14. Dark-brown, only slightly fibrous, fairly well decayed peat, composed principally of the remains of sphagnum mosses, sedges, and heath plants.

15. Similar in general to No. 14, but shows a greater abundance of sedge remains and is somewhat more thoroughly decomposed.

HANCOCK COUNTY.

Analysis No.	Locality No.	Hole.	Depth (feet).	Volatile combustible.	Fixed carbon.	Ash.	Sulphur.	Nitrogen.	Fixed carbon in pure peat.	Thermal value.	
										Calories.	B.t.u.
16	17	B.......	3	....	....	5.21	0.14	....	....	4,800	8,640
17	18	B.......	1½–3	58.63	34.88	6.49	.14	0.94	60	5,126	9,227

16. Brown, somewhat fibrous, partly decayed peat, composed largely of the remains of sphagnum and sedges.

17. Dark-brown in color; seems to be made up of the remains of the same species of typical heath plants which now inhabit the bog. The moss fibers are rather thoroughly decayed. *Vaccinium* is abundant and gives the peat a semifibrous character.

KENNEBEC COUNTY.

Analysis No.	Locality No.	Hole.	Depth (feet).	Volatile combustible.	Fixed carbon.	Ash.	Sulphur.	Nitrogen.	Fixed carbon in pure peat.	Thermal value.	
										Calories.	B. t. u.
18	19	....	6	....	....	32.95	0.83	1.60	....	3,905	7,029
19	28	A.......	9	....	....	6.86	.41	1.51	....	5,120	9,216
20	24	A.......	9	63.11	31.99	4.90	.17	1.11	51	5,402	9,724
21	25	B.......	1½	70.02	24.74	5.24	.16	1.05	35	4,706	8,471
22	25	B.......	6	65.11	24.63	10.26	.81	....	38	....	....
23	25	B.......	9	68,05	26.98	4.97	.92	....	40	....	....
24	25	B.......	12	65.93	27.84	6.23	.26	....	42	....	....
25	25	B.......	15	67.97	27.45	4.58	.13	....	40	....	....
26	25	B.......	18	67.63	28.53	3.84	.16	1.28	42	4,780	8,604
27	25	B.......	21	62.30	30.35	7.35	.72	....	49	....	....
28	27	E.......	3	43.38	27.70	28.92	.74	1.97	64	3,980	7,164
29	28	B.......	6	....	....	22 04	.67	2.06	....	4,214	7,585

18. Dark brown, nonfibrous, thoroughly decayed, clayey peat. Shows sedge remains and almost no woody material.

19. Dark brown, only slightly fibrous, well-decayed peat. Shows remains of sphagnum moss and sedges and a few small woody fragments and root fibers.

20. Dark brown, very fibrous, nonplastic to slightly plastic peat. The fibers are principally stems of sphagnum moss with a few fern rhizomes. There are also some fragments of sedge leaves and rhizomes and woody fragments from shrubs.

21. Coarsely fibrous light-brown peat. About 95 per cent of the material consists of the remains of sphagnum mosses with *Polytrichum* the next most important plant; contains also fragments of shrubs and bits of bark. The sample as a whole is probably as pure sphagnum moss as it would be possible to obtain without picking out the sphagnum

Analyses of peat specimens from Maine—Continued.

from the other materials. In addition to the components given in the table, the analysis shows, in the dry sample, 38.19 per cent of oxygen and 5.24 per cent of hydrogen.

22. Coarse textured and composed chiefly of sphagnum moss with a few bits of wood from shrubs and fine roots. Is rather darker than No. 21 and contains more fine material, composed largely of leaves of sphagnum.

23. Chiefly stems and branches of sphagnum moss with some stems of *Polytrichum* and bits of blackened and decayed shrub wood. The fine parts of the sample are made up of the leaves and cortex of sphagnum moss and fine branching roots. The sample is darker than No. 22 and varies from light brown to nearly black.

24. Much coarser and more woody than the preceding samples. Sphagnum moss is still the most abundant material, but there are also considerable quantities of sedge remains, the leaves and wood of shrubs, and the roots and rootstocks of ferns. The wood is of at least three species of shrubs besides the cranberry. The finer material has an abundance of sphagnum leaves in it.

25. Coarse nonplastic rather dark-brown peat. The coarse material consists of shrub stems, twigs, and roots, cranberry stems, sedge rootstocks, and fragments of sedge roots and leaves. All these are abundant and but little blackened or changed. A considerable number of fine long fibers from the leaves and stocks are present in the coarser parts; the finer portions contain leaves of sphagnum, bits of roots, and sedge epidermis and fibers.

26. Medium fine nonplastic yellowish-brown peat. The coarser matter has twigs and roots of shrubs. Sedge leaves and bits of sedge epidermis and rootstocks are more abundant than in No. 25. Leaves of sphagnum are abundant, but all are small fragments. The finer portions of the material consist chiefly of leaves and bits of stems of sphagnum, fragments of the roots and other parts of the higher plants, and some fine material without recognizable structure. In addition to the components given in the table, the analysis showed in the dry sample 34.52 per cent of oxygen and 5.28 per cent of hydrogen.

27. Coarse nonplastic peat, dark brown to nearly black in color. Abundant shrub remains and fragments of cranberry stems. Sedge remains somewhat abundant, and coarse pieces of sphagnum and fine roots and sedge fibers. Wood fragments of five or six species, chiefly shrubs, and one conifer were found. These were all very soft and friable and more or less disintegrated. Finer material, mostly sphagnum fragments with some fine pieces of wood, fern stipes, and cranberry stems. These plant remains indicate distinctly a more complicated flora than any of the other samples, their condition showing a somewhat higher elevation above the water level before they were finally submerged.

In general the character of samples 21 to 27 shows that this locality was never occupied by a lake, but that the peat deposit was of the built-up or moist-depression type, and that the plants which formed it were very similar in character at all stages in its history.

28. Dark brown nonfibrous well-decayed peat. Shows sedge remains, some wood fragments, and a few root fibers.

29. Dark brown nonfibrous well-decayed peat. Contains abundant sedge remains and small root fibers. A few woody fragments.

KNOX COUNTY.

Analysis No.	Locality No.	Hole.	Depth (feet).	Volatile combustible.	Fixed carbon.	Ash.	Sulphur.	Nitrogen.	Fixed carbon in pure peat.	Thermal value.	
										Calories.	B. t. u.
30	29	B.......	3-4	66.12	29.74	4.14	0.22	0.87	45	4,956	8,921
31	29	D.......	10-12	....	....	19.70	.50	3.10	....	4,374	7,873

30. Dark brown fibrous peat, consisting of partly decayed sphagnum with some remnants of sedges and the stems and leaves of the common bog-peat plants belonging to the heath family.

31. Differs from No. 30 only in being more thoroughly decayed and in the much greater abundance of the runners of *Vaccinium.*

OXFORD COUNTY.

Analysis No.	Locality No.	Hole.	Depth (feet).	Volatile combustible.	Fixed carbon.	Ash.	Sulphur.	Nitrogen.	Fixed carbon in pure peat.	Thermal value.	
										Calories.	B. t. u.
32	30	C.......	12-13	56.84	19.13	24.03	0.27	1.36	34	4,336	7,805
33	32	A.......	3	57.66	33.91	8.43	.35	1.55	59	4,938	8,888

32. Dark-brown, well-decayed peat full of small root fibers, probably of sedges, but containing no recognizable moss remains. The peat at all depths in this hole appeared similar to the sample analyzed.

33. Dark-brown, nonfibrous, well-decayed peat, composed largely of the roots and leaves of sedges, with numerous woody fragments, among which a small fragment of birch was recognized. Below a depth of 9 feet the peat is made up in the main of the remains of typical moss-heath plants with some wood fragments, probably of spruce and larch.

Analyses of peat specimens from Maine—Continued.

PENOBSCOT COUNTY.

Analysis No.	Locality No.	Hole.	Depth (feet).	Volatile combustible.	Fixed carbon.	Ash.	Sulphur.	Nitrogen.	Fixed carbon in pure peat.	Thermal value. Calories.	Thermal value. B. t. u.
34	33	B	4-5			8.34	0.11	0.88		4,720	8,496
35	35	E	6-8			7.20	.17	1.20		5,120	9,216
36	36	D	6			8.68	.65	2.28		5,085	9,153
37	37	B	3			11.09	.52	2.14		5,015	9,027
38	37	I	6-9			9.77	.51	2.12		4,987	8,977
39	39	B	12	63.06	31.21	5.73	.36	2.09	49	5,350	9,630
40	40	C	3			7.56	.14	1.18		5,108	9,194
41	41	A	3			8.43	.31	1.99		5,134	9,241
42	41	A	15			18.46	.62	2.01		4,517	8,131

34. Brown, rather fibrous, peat not very perfectly decayed. In it are recognizable the remains of *Sphagnum, Polytrichum, Cladonia,* and roots, stems, and leaves of plants of the heath family.
35. Dark-brown, moderately well-decayed peat, composed largely of sphagnum and the roots, stems, and leaves of plants of the heath family.
36. Dark-brown nonfibrous peat, fairly well decayed; shows remains of sphagnum, sedges, and plants of the heath family. Samples from all depths at this hole show the same plant characters.
37. Nearly black, nonfibrous, well-decayed peat; shows sedge remains and some woody fragments.
38. Dark-brown, well-decayed, and nonfibrous peat; contains some woody fragments.
39. Dark-brown peat. A part of the sample was very fibrous and contained remains of sedges and water lilies and remains doubtfully referred to the common bulrush and cat-tail. Sphagnum was also abundant. This peat plainly represents a marsh flora. The remainder of the sample was of different character and was composed of the wood of shrubs and cranberry and leaves of *Cassandra* and other heath plants, with sedge and sphagnum remains. This represents a shrub stage in the development of the bog and evidently came from a stratum at a different level from the rest of the sample.
40. Brown semifibrous peat, consisting principally of remains of sphagnum, sedges, and plants of the heath family.
41. Dark-brown, nonfibrous, well-decayed peat; shows remains of sphagnum, sedges, and heath plants.
42. Dark-brown, nonfibrous, thoroughly decayed peat; shows remains of sedges and small stems and root fragments probably of heath plants.

SOMERSET COUNTY.

Analysis No.	Locality No.	Hole.	Depth (feet).	Volatile combustible.	Fixed carbon.	Ash.	Sulphur.	Nitrogen.	Fixed carbon in pure peat.	Thermal value. Calories.	Thermal value. B. t. u.
43	44	B	6			4.89	0.18	1.28		5,330	9,594
44	44	B	15			25.03	.67	1.59		4,082	7,348
45	46	C	1	70.29	23.02	6.69	.11	.99	33	4,518	8,132
46	46	D	9			6.31	.20	.99		5,064	9,115
47	47	B	6			4.45	.29	1.36		5,832	10,498

43. Dark-brown, nonfibrous, well-decayed peat; shows a few small root fibers and some stem and leaf fragments, apparently of heath plants.
44. Greenish-brown nonfibrous peat containing some clayey material. Leaf of *Cassandra* recognized and some stem and root fibers, probably also of heath plants.
45. Mainly composed of sphagnum moss, from a depth of 1 foot just below the present surface of the bog. The complete analysis of this peat moss shows in the dry sample 5.26 per cent of hydrogen, 48.36 per cent of carbon, and 38.59 per cent of oxygen.
46. Dark-brown, somewhat fibrous but well-decayed peat, apparently composed largely of plants similar to those now growing on the bog.
47. Dark-brown, only slightly fibrous, fairly well decayed peat; shows remains of sedges, sphagnum, and heath plants.

Analyses of peat specimens from Maine—Continued.

WASHINGTON COUNTY.

Analysis No.	Locality No.	Hole.	Depth (feet).	Volatile combustible.	Fixed carbon.	Ash.	Sulphur.	Nitrogen.	Fixed carbon in pure peat.	Thermal value.	
										Calories.	B. t. u.
48	48	B	4–5			9.62	0.11	0.80		4,559	8,206
49	50	B	12–13			5.42	.12	.60		4,850	8,730
50	51	A	4–5			4.14	.19	.77		5,000	9,000
51	52	B	12–13			5.72	.20	1.20		5,221	9,398
52	53	B	3–4			5.35	.21	.72		4,918	8,852
53	55	B	3–4			7.71	.28	.70		4,642	8,356
54	56		5–6			5.29	.22	.77		4,934	8,881
55	57		3	66.61	29.59	3.80	.26	.78	44	4,953	8,915
56	58	C	3–4			5.36	.16	.89		5,303	9,545
57	58	D	10–11			5.60	.17	.85		5,191	9,344
58	59	B	3–4	59.95	31.93	8.12	.47		53	5,433	9,779
59	60	B	3–4	69.34	28.71	1.95	.20		41		
60	60	B	9–10	64.78	30.98	4.24	.24		48		
61	62	D	6–8			6.51				4,696	8,455
62	62	F	6			22.87				4,375	7,876
63	63	B	3–4			8.05	.12	.71		4,734	8,521
64	63	C	8–9	61.16	30.43	8.41	.19	1.26		5,179	9,322

48. Light-brown, semifibrous, only partly decayed peat, largely sphagnum and heath-plant remains.

49. Brown, somewhat fibrous peat, composed largely of sphagnum and heath-plant remains.

50. Brown, somewhat fibrous, partly decayed peat, composed largely of the remains of sphagnum and heath plants.

51. Dark-brown, somewhat fibrous peat, containing moss and sedge remains and roots and stems of heath plants.

52. Light-brown, somewhat fibrous, only partly decayed peat, consisting largely of remains of sphagnum with some fragments of heath plants.

53. Brown, somewhat fibrous peat, composed largely of sphagnum and heath-plant remains.

54. Dark-brown, somewhat fibrous, partly decayed peat, composed largely of remains of sphagnum and heath plants.

55. Almost the entire sample made up of the remains of a single species of sphagnum whose leaves are well preserved. There is a trifling admixture of the roots of shrubs.

56. Dark-brown, only slightly fibrous, well-decayed peat, composed largely of remains of sphagnum and heath plants.

57. Brown, semifibrous, partly decayed peat, composed of remains of sphagnum and heath plants.

58. Dark-brown, plastic, very thoroughly decomposed, woody peat. Most of the woody material was spruce bark in fine scales. Fragments of wood of a conifer and a shrub were recognized. There were no sedge fragments and but little moss.

59. Fibrous plastic brown peat, composed chiefly of well-decomposed sphagnum moss. The coarsest material was wood of three species of shrubs, bits of bark and roots, pieces of sedge epidermis, and moss stems. The finer material was made up of moss stems and tips of branches and the roots and epidermis of sedges; quantities of fine rootlets and leaves of sphagnum were present also.

60. Brown fibrous peat, rather woody, but with a large amount of very fine, thoroughly disintegrated matter. In the coarser portion five species of shrubby wood were found, mainly fibrous fragments, roots, and epidermis of the leaves of sedges, and pieces of sedge rootstocks; stems of sphagnum were abundant and showed little decomposition. The finer matter was made up of sedge epidermis and rootlets and fibers of leaves, together with bits of sphagnum stems, small branches, and leaves.

61. Blackish, silty, nonplastic, somewhat woody and fibrous, but well-decomposed peat, containing small fragments of coniferous wood, cranberry vines, sedges, fibrous roots, and the leaves and branches of sphagnum.

62. Brown nonplastic peat, made up almost entirely of poorly decomposed sphagnum remains.

63. Rather light-brown peat, clearly made up of the remains of the ordinary bog plants, sphagnum predominating. The sphagnum is not very thoroughly decayed and renders the peat still somewhat fibrous.

64. Well-decayed peat, not notably fibrous, though composed of plant remains of the types recognized in No. 61.

Analyses of peat specimens from Maine—Continued.

YORK COUNTY.

Analysis No.	Locality No.	Hole.	Depth (feet).	Volatile combustible.	Fixed carbon.	Ash.	Sulphur.	Nitrogen.	Fixed carbon in pure peat.	Thermal value. Calories.	Thermal value. B. t. u.
65	65	Composite sample.	Upper 8 feet.	48.05	25.66	26.29	1.54	....	....	4,130	7,434
66	65	Composite sample.	Lower 8 feet.	36.06	16.97	46.97	1.46	....	....	2,955	5,319
67	68	....	....	36.13	21.66	42.21	1.84	....	....	2,805	5,049
68	69	....	....	29.88	12.31	57.81	2.19	....	....	2,019	3,634
69	70	....	....	56.73	29.36	13.92	2.24	....	....	4,701	8,462

65. Composite sample of well-decomposed, usually somewhat fibrous peat from upper 8 feet at various parts of this bog.
66. Composite sample of well-decomposed grayish to greenish-brown, somewhat clayey peat, from lower 8 feet at various parts of this bog.
67 to 69. Gray fibrous clayey peat from salt marshes.

In figures 19 and 20 the relations between the more important factors in the foregoing analyses are shown graphically. On first inspection diagrams 2, 3, and 4 seem to show no regularity whatever, and to bear no relation to each other or to the thermal value as expressed in diagram 1. Closer study, however, shows certain well-defined relations which may be summarized as follows:

Diagram 1. The thermal values are expressed in British thermal units and the diagram shows that in most of the samples the value lies between 8,100 and 9,800. Thirty out of the 54 determinations lie between 8,500 and 9,500. In all samples that fall below 8,000 the low thermal value is traceable to a high ash content, as is seen by comparison with diagram 2. The remarkably high value of 10,498 British thermal units shown by peat from a bog at the northwest end of East Pond in Smithfield (locality 47) may be due to its unusually well decomposed condition combined with a low percentage of ash. The low thermal value of machine peat (analysis 5, indicated in diagrams by ⊗) from locality 2, the Farwell bog, near Lewiston, is especially to be noticed because of the low ash content of this sample. It is attributed mainly to deterioration of the peat through escape of volatile combustible materials while it lay in the stock pile before the machining process.

Diagram 2: As shown by this diagram, 45 out of the 54 samples analyzed showed less than 15 per cent of ash and 39 showed less than 10 per cent. Only 9 fell below 5 per cent. An imperfect parallelism is traceable between the distribution of the crosses in diagram 2 and those in diagram 1. If we exclude from diagram 2 the values surrounded by the broken line, practically all of which represent the ash content of *poorly decomposed* peats, this parallelism becomes more noticeable. The diagram therefore brings out the fact, already well known, that, other things being equal, an increase in ash means a decrease in thermal value. The decrease in thermal value appears from this diagram to be at the rate of 80 to 90 British thermal units for every 1 per cent increase in ash content. As the thermal values

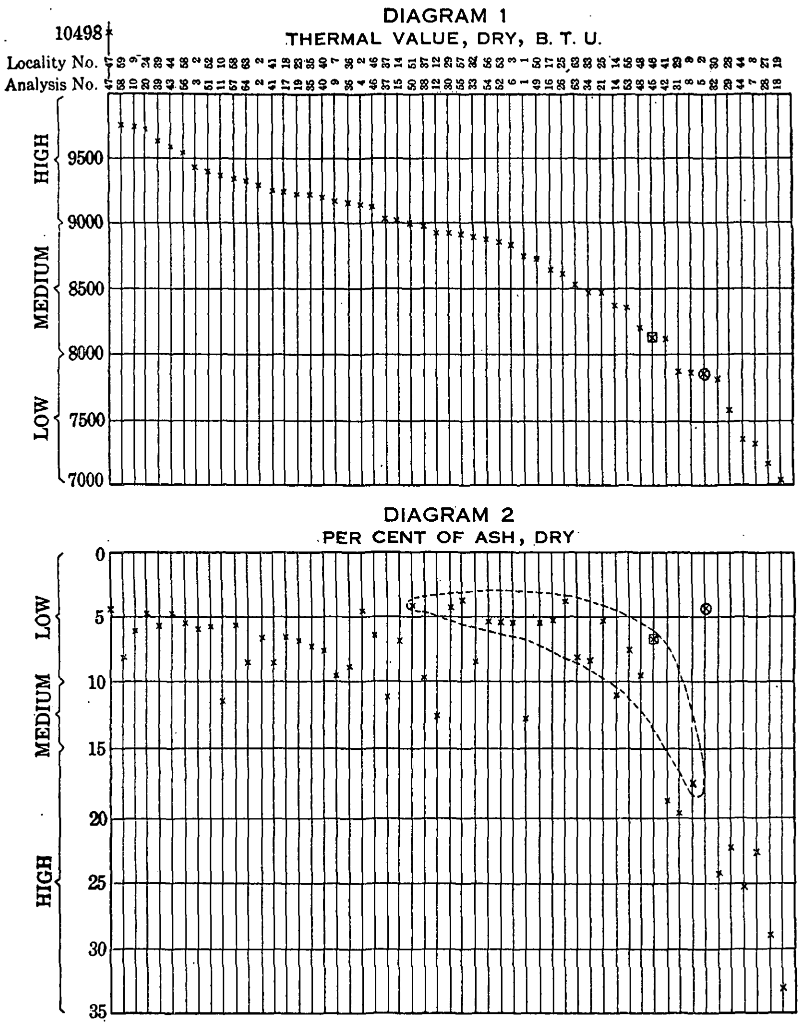


FIG. 19.—Thermal values and ash percentages of Maine peats. Diagram 1, Thermal values of 54 samples of Maine peat, arranged in order of descending magnitude. Values are in British thermal units, and are computed on a water-free basis. Diagram 2, Percentage of ash in the same 54 samples of Maine peat, calculated on a water-free basis.

of most of the peats analyzed lie between 8,000 and 9,000 British thermal units, this decrease would be at the rate approximately of 1 per cent of the thermal value for every increase of 1 per cent in ash. As shown on page 63, a difference of 1 per cent in moisture also causes a difference of about 1 per cent in the thermal value. Thus within the common limits of variation for ash and water in air-dried peats, their effect on the thermal value is about the same.

Diagrams 3 and 4: Determinations of volatile combustible matter were not made for every sample, but so far as the determinations go

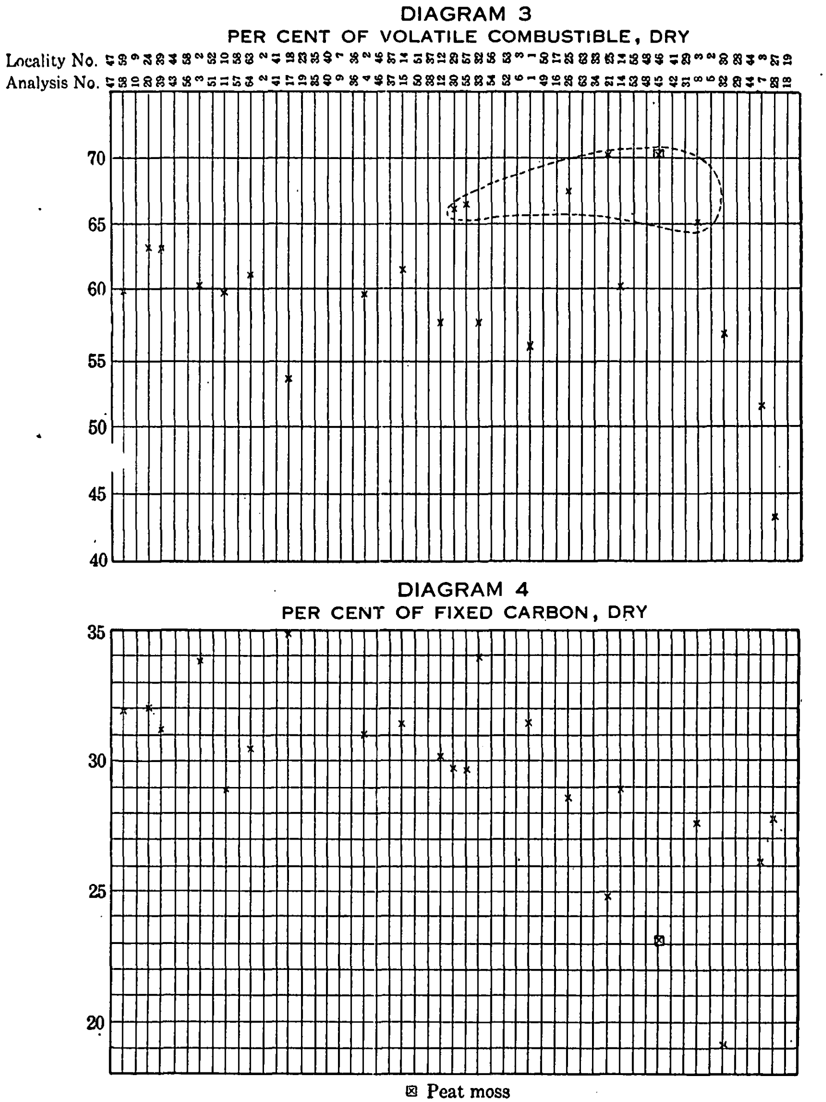


FIG. 20.—Volatile combustible and fixed carbon in Maine peats. Diagram 3, Percentage of volatile combustible, determined in 22 out of the 54 samples of peat, reduced to a water-free basis. Diagram 4, Percentage of fixed carbon in 22 out of the 54 samples of peat, reduced to a water-free basis.

the samples which were abnormally low in ash in proportion to their thermal value (those inclosed in the broken line in diagram 2) are also high in volatile combustible and fall within the broken line in diagram 3. They represent specimens not thoroughly decomposed.

With respect to most of the analyses, diagrams 3 and 4 are reciprocal, a high percentage of volatile combustible being accompanied by a low percentage of fixed carbon and vice versa. This means simply that in well-decayed peats the percentage of fixed carbon is high relative to the percentage of volatile combustible, and that in poorly decomposed peats the reverse is true. In most of the samples the percentage of volatile combustible lies between 50 and 70 and that of fixed carbon between 25 and 35.

COMPOSITION OF FOREIGN AND OTHER DOMESTIC PEATS.

For comparison with the above results the scale used by the government engineers in Sweden in comparing dry peats of different qualities is given below:

Swedish scale for comparing dry peats.

FUEL VALUE.

	Very high.	High.	Average.	Low.	Very low.
Calories per kilogram	5,600	5,300	5,000	4,700	4,400
British thermal units per pound	10,080	9,540	9,000	8,460	7,920

ASH.

	Low.	Average.	Comparatively high.	High.	Very high.
Per cent, approximate	2	5	8	11	14

In 29 samples of Indiana peat[a] the thermal values are distributed as follows:

The thermal values of Indiana peats.

		British thermal units.
High	3 exceed	10,000
	6 lie between	9,500 and 10,000
	5 lie between	9,000 and 9,500
Medium	5 lie between	8,500 and 9,000
	5 lie between	8,000 and 8,500
Low	1 lies between	7,500 and 8,000
	1 lies between	7,000 and 7,500
	3 lie below	7,000

The ash percentages as determined in 5 samples range from 4.14 to 13.82.

In 18 samples of peat from Michigan reported by C. A. Davis, the percentage of ash ranges from 1.3 to 18.8, and 19 determinations of thermal value were distributed as follows:

[a] Thirty-first Ann. Rept. Dept. Geol. and Nat. Resources, Indiana, 1906, p. 111.

Thermal values of Michigan peats.

		British thermal units.
High	5 exceed	10,000
	3 lie between	9,500 and 10,000
	1 lies between	9,000 and 9,500
Medium	3 lie between	8,500 and 9,000
	5 lie between	8,000 and 8,500
Low	1 lies between	7,500 and 8,000

Samples containing over 20 per cent of ash were not analyzed and none of the determinations of thermal value fell below 7,500.

The analyses quoted are sufficient to show that in thermal value and in ash content the peats of Maine are not greatly different from those found elsewhere. The Scandanavian peats appear to average somewhat lower in ash and consequently a little higher in thermal value, but the difference is not great. The resemblance of the Maine peats in ash and thermal value to those from Indiana and Michigan is even closer.

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INDEX.

A. Page.

Acknowledgments to those aiding........... 8
Agriculture, use of peat in................... 56-60
Alcohol, production of....................... 49-50
Alder, occurrence of......................... 19
Alexander, bog near.......................... 99
Algæ, character of........................... 11
Alton, bogs in............................... 86-87
Ammonium compounds, production of...... 50
Andromeda, growth of....................... 14
Androscoggin County, bogs in............... 64-71
peat from, analyses of................. 114
Argyle, bog in............................... 87
Aroostook County, bogs in.................. 71-72
peat from, analyses of................. 114
Artificial wood, manufacture of.............. 52
Ash, chart showing........... 25, 59-60, 119-121, 122
data on................................ 120
Ashes, peat, value of........................ 59-60
Augusta, bog near............................ 76
bog near, view of...................... 60
Ayers Junction, bogs near................. 104-107
bogs near, map of...................... 105

B.

Bastin, E. S., work of....................... 7
Belgrade, bogs in............................ 77-78
Benton Falls, bogs near..................... 82-84
bogs near, map of...................... 83
Bibliography................................. 123-124
Birch, occurrence of......................... 18-19
Birch Stream, bog on........................ 87
Bog Brook, bog on........................... 71
Briquets, cost of............................ 37-38
fuel value of........................... 39
manufacture of...................... 28, 36-39
Brownville, bogs near...................... 95
Brunswick, bog near......................... 73
Bucksport, bog in............................ 75
Bulrushes, growth of........................ 13
By-products, recovery of.................... 49

C.

Cape Elizabeth, bogs near.................. 74-75
map of.................................. 75
Capital, necessity for....................... 29
Carbonizing, use of.......................... 39
Carex, growth of............................ 13
Cassandra, growth of........................ 14
occurrence of........................... 18
Castalia, growth of.......................... 13
Charcoal, manufacture of, from peat......... 40
Charlotte, bog near.......................... 99
Chelsea, bog near............................ 78
Chemical by-products, recovery of........... 49
Cherryfield, bogs near...................... 99-100

Page.

Coal, demand for............................. 8
Coke, manufacture of, from peat............. 40-42
manufacture of, cost of................. 42
College bog, description of.................. 73
Columbia, bog in............................ 99-100
Cranberry, occurrence of.................... 18
Crystal, bogs near........................... 71
Cumberland County, bogs in 73-75
peat from, analyses of................. 115
Cumberland Mills, bog near................. 74-75
Cut peat, cost of............................ 31
use of.................................. 31
Cutts Island, bogs on 112

D.

Davis, C. A., device of...................... 61
work of................................. 7
Duck Pond, bog near........................ 74-75

E.

East Machias, bogs near.................. 100-101
East Orrington, bog near.................... 94-95
bog near, map of....................... 95
East Pond, bog at........................... 98
Ekenberg process, description of............ 39
Electricity, generation of, by peat.......... 48
Electric processes, use of................... 39
Eleocharis, growth of........................ 13
Elliot, bog near............................ 110-112
Ellsworth, bog in............................ 76
Etna, bog near.............................. 88-89

F.

Fabrics, woven, production of............... 52
Fairfield, bogs in............................ 96-97
Falls Point, bog near....................... 107
Falmouth, bog in............................ 74-75
Fellows plant, view of....................... 34
Ferns, occurrence of......................... 19
Fertilizer filler, production of.............. 54-55
Fertilizing, use of peat for.................. 55-56
Field work, nature of........................ 7
Flora of bogs, description of................ 18-19
Forest, bog near............................ 101
Fuel, use of peat for..................... 8-9, 30-48
Fuel in New England, history of............ 8-9
Fuel value, determination of................ 24-25
importance of........................... 24-25

G.

Garcelon bog, description of................ 66-68
map of.................................. 66
Gas, calorific value of...................... 44-45
manufacture and use of................. 43-46
cost of............................. 45

Page.

Gas producers, types of 43–44
use of peat in 44–46
Grass, occurrence of 18, 19, 20
Great Pond (Cumberland County), bog near. 73–74
bog near, map of 74
Great Pond (Kennebec County), bog at 77–78
Great Sidney bog, description of 80–81
map of 80
view of 60
Greene, bog near 64–66

H.

Hancock County, bogs in 75–76
peat from, analyses of 115
Hartford, bog near 84–85
bog near, map of 85
Heath, occurrence of 18
Hermon, bogs in 89–92
Hermon Center, bogs near 89–91
bogs near, map of 90
Hermon Pond, bogs near 89–92
bogs near, maps showing 90, 91
Houlton, bog near 72
Hypnum, occurrence of 18

I.

Indiana, peat of 122

J.

Jonesboro, bogs in 101–104
bogs in, map showing 103

K.

Kennebec County, bogs in 76
peat from, analyses of 115–116
Kittery, bogs in 112
Kittery Point, bog near 112
Knox County, bogs in 84
peat from, analyses of 116

L.

Labrador tea, occurrence of 18
Laurel, occurrence of 18
Lewiston, bogs near 66–70
bogs near, maps of 66, 69
plant at, view of 34
Lichen, occurrence of 18
Literature, list of 123–124
Location, importance of 22
Lubec, bog in 104–105

M.

Machine peat, cost of 34
manufacture of 32–34
use of 32
Machinery, character of 27–28
choice of 29
cost of 34–35
description of 33–34
testing of 24–25
view of 34
Map of Maine, showing location of peat bogs. Pocket.
Maple, occurrence of 19
Markets, proximity of 23
Martin Stream, bogs on 78–80, 97

Page.

Mattresses, manufacture of 52
Mechanic Falls, bogs near 70–71
Messalonskee Lake, bog at 77
Metallurgy, use of peat in 46
Michigan, peat of 122–123
Moist depressions, growth in 15–16
Moss, growth of 14
occurrence of 18, 19
Moss litter, production and value of 53–54
Mud Pond, bog near 75
Mull, production of 53–54

N.

Newport, bog near 92
New River, bog on 75
Nicolin, bog near 76
Nitrates, production of 50–51
No Name Pond, bog near 68–70
bog near, map of 69
North Bangor, bog near 90–91
bog near, map of 91
Norway, bogs near 85–86
bogs near, map of 86
Nymphœa, growth of 13

O.

Oakland (Kennebec County), bogs near 78–80
bogs near, map of 79
Oakland (Somerset County), bog near 96
Old Orchard, bog at 112
Oldtown, bogs in 92–94
Orrington, bog in 94–95
Orson Island, bog on 94
Oxford County, bogs in 84–86
peat from, analyses of 116

P.

Packing material, use of peat for 54, 59
Paper, manufacture of 51
Pea Cove, bog near 87
Peat, amount of 24, 113
analyses of 114–122
analysis of, nature of 62–64
composition of 122–123
conclusions on 113
contamination of 25
deposits of, character of 17
types of 16–17
drying of 35–38
formation of, conditions of 9–17
See also Plant decay; Peat-forming plants.
fuel value of 24–25, 46–48, 63–64, 122
See also Thermal value.
manufacture of, capital needed for 29
factors in 22–30
machinery for. *See* Machinery.
plant for 28–29
nature of 9
quality of 113
resources of 113
testing of 24–25
use of, as fuel 8–9, 30–48
uses of, miscellaneous 22–60
volume and weight of, relations of 62
water in 26, 30–31, 37, 62

	Page.
Peat bogs, drainage of	26-27
floras of	17
See also Peat-forming plants.	
location of, map showing	Pocket.
profitable size of	24
prospecting of	26
testing of	17, 26, 60-61
tools for	60
types of	16-17
yield of, estimation of	61-62
Peat-forming plants, character of	17-19
growth of, in water	10-14
in depressions	15-16
Peat powder, cost of	40
use of	40
Peat press, view of	34
Peat soils, value of, for agriculture	56-57
Pembroke, bog in	105-107
Penobscot County, bogs in	86-95
peat in, analyses of	117
Perry, bog near	107-108
Pipes, protection of	58
Piscataquis County, bogs in	95
Pittsfield, bog near	97-98
Plant decay, conditions favoring	9-10
Pleasant River, bog on	99-100
Pond Cove, bog near	102
Pond lilies, growth of	13
Pondweeds, growth of	13
Portland, bogs near	74, 75
Potamogeton, growth of	13
Pushaw Lake, bog at	92-94
bog at, map of	93

R.

Rhodora, growth of	14
Rogues Bluff, bog near	102-104

S.

Salt marshes, origin of	19-21
peat from, analyses of	°
value of	21
Sanitary materials, manufacture of	52
Scarboro, bog in	75
Scirpus, growth of	13
Scope of report	7
Sedge, growth of	13
occurrence of	18, 19, 20
Sherman, bog near	72
Sidney, bogs in	80-81
Smithfield, bog in	98-99
Soils, peat, character of	56-57
Somerset County, bogs in	96-99
peat from, analyses of	117
Southern Inlet, bogs near	100-101
South La Grange, bog near	87
South Lubec, bog near	104-105
South Norridgewock, bog near	97
South Orrington, bog near	75
South Trescott, bog near	108-109
bog near, map of	109
Spagnum, growth of	14
occurrence of	18
Spartina, occurrence of	20
Spragues, bog near	87-88
bog near, map of	87
Spruce, occurrence of	18
Spurwink River, bogs on	75
Stable disinfectants, use of peat in	58
Stock, bedding for	58
peat as food for	59
Subsidence, progress of	21

T.

Tamarack, occurrence of	18
Tar, abundance of, in peat gas	43, 46
Thermal value, chart showing	120
data on	119-121
Togus, bog near	76-77
Transportation, necessity of	23
Trescott, bog in	108-109
Tripp Pond, bog at	70

V.

Vanceboro, bog near	110
Vassalboro, bog near	82
Volatile combustible, chart showing	121
data on	121-122

W.

Washington County, bogs in	99-110
peat from, analyses of	118
Water, plant growth in	10-14
Wells, bogs near	112
West Sidney, bog near	80-81
bog near, map of	80
Whitneyville, bog near	101-102, 110
Winslow, bogs in	82-84
Winterberry, occurrence of	19
Wintergreen, occurrence of	18
Wood, artificial, manufacture of	52
exhaustion of	7

Y.

York County, bogs in	110-112
peat from, analyses of	119

Z.

Ziegler process, description of	41-42

O