has given outstanding masses, some most grotesque in form and appearance.

Permission was kindly given to visit the charming grounds of the Spa Hydropathic Establishment, which fronts Bishop's Down at the eastern extremity of the Common. In the grounds may be seen a good specimen of the beautiful little valleys which abound in the neighbourhood, and which, with the fine timber adorning both hills and valleys, render this district so attractive.

A little further to the east the Tunbridge Wells Sand is again characteristically seen on Rusthall Common, where the rocks are still more striking than at Mount Ephraim. One of these masses has received the name of the "Toad Rock," from its resemblance to that animal, and others, too, are known by distinct names. They are fine examples of rocks of various degrees of hardness, acted upon by atmospheric agencies.

Leaving Rusthall Common, the party crossed the "Happy Valley," having Wadhurst Clay in the bottom, to the well-known "High Rocks," again showing Tunbridge Wells Sand, here thrown up by a fault. After inspecting these huge masses of soft sandstone, with their remarkable clefts, Members made their way by the narrow valley along which runs one of the feeders of the Medway, the boundary between Kent and Sussex, to Tunbridge Wells Station, for the return to London.

ORDINARY MEETING.

JULY 4TH, 1879.

Prof. T. RUPERT JONES, F.R.S., F.G.S., President, in the Chair.

The Donations to the Library received since the previous meeting were announced, and the donors received the thanks of the Association.

The President having left the chair, it was taken by Prof. J. MORRIS, M.A., F.G.S., Vice-President, when

The following Paper was read:—

ON THE NATURE AND ORIGIN OF PEAT AND PEAT-BOGS.*

By PROF. T. RUPERT JONES, F.R.S., President
Geol. Assoc., &c., &c.

Abstract ; with Additions.

CONTENTS :—

§ I. Description.

1. General Description of Peat-bogs.
2. The Internal Structure of Peat-bogs.
3. The Surface of Peat-bogs.

§ II. Formation and Constituents of Peat.

1. Submerged Peat.
2. Emerged Peat.

§ III. Classification of Peat.

- I. Turf-moors and Heath-turf.
- II. Peat-bogs of Valleys.
 1. At the heads of Valleys.
 2. River-peat.
 3. Peat of river-bends.
 4. Peat-marshes along rivers.
 5. Special Peat-bogs and the Blackearth.
 6. River-deltas.
 7. Maritime Marshes.

§ IV. Conclusion.

Appendices I. and II.

§ I. This paper began with a description of Peat and Peat-bogs, noticing the former as a more or less brown or black, carbonized mass of vegetable matter, accumulated by the growth of plants in moist situations, either on high or low ground, mostly in temperate climates,† and presenting various muddy, spongy, and fibrous con-

* A paper by the author on the same subject is published in "Science for All," Cassell & Co., No. 23.

† The "Dismal Swamp" is a morass in the United States of North America, commencing south of Norfolk, in Virginia, and extending 30 miles into North Carolina. Area about 235 square miles. It is thickly covered with wood, has Lake Drummond in its centre, and is traversed by the Dismal-Swamp Canal, 23 miles in length.—K. Johnston's "Gazetteer." The Peat-deposits of Calcutta and Nepal are noticed by the Geological Surveyors in the "Indian Survey Records," and the "Manual of the Geology of India."

ditions, at different depths in the mass, or at different places of accumulation.

Bogs, Mosses, Turbaries, &c., were described as continuous or broken, flat, marshy, muddy, peaty, and watery tracts, here and there firm enough, either by a local rising of the soil, or with the tough entanglement of vegetable roots and fibres, to bear animals and men, but often dangerous sloughs, marked with a green coating of Bog-moss and other aquatic plants.

Walter Scott's description of the home of a Moss-trooper indicates these features with graphic force :—

"The ground upon which it (the tower) stood was gently elevated above the marsh for the space of about a hundred yards, affording an esplanade of dry turf, which extended itself in the immediate neighbourhood of the tower; but beyond which the surface presented to strangers was that of an impassable and dangerous bog. The owner of the tower and his inmates alone knew the winding and intricate paths, which, leading over ground that was comparatively sound, admitted visitors to his residence."

—"The Black Dwarf," Chap. viii. And in another instance ("Lay of the Last Minstrel," Canto iv.)—

"He led a small and shaggy nag,
That through a bog, from hag to hag,*
Could bound like any Bilhope stag."

Peat has been described in very many books and memoirs, as to its formative plants, its chemical constituents, and its economical uses. In this paper the conditions of accumulation, and the kind of vegetation concerned, were chiefly treated of; it being specially insisted on that "on both plateaux and plains, every gradation from puddles and ponds to lakes, and from marshes and fens to bogs, is found wherever the ground, being flat and impervious, can hold water on its surface." A ferruginous crust (called "Alois"), lying underneath sands in the Landes, near Bordeaux, stops the soakage of the water, and makes marshes; hence the common use of stilts there: and in Jutland, the "Jern-al" (iron-sand), from 2 to 4 feet thick, is a similar formation. See Reclus "Le Terre," Woodward's English Translation, 1871, p. 84 and p. 86.

At the bottom of the peat at Windlesham, near Bagshot, Surrey, 4 or 5 inches of porous limonite (bog-ironore) have been locally accumulated by the infiltration of irony water; just as the hard "Pan" or "Rust" is formed under gravel, stopping water and

* "The broken ground in a bog."

roots, to the injury of vegetation, until it is broken up in trenching the ground for cultivation.

In the "Geologist," 1863, Vol vi., p. 114, is an abstract from "Hameberg's Journal," of Dr. Mega's account of a kind of "Pan" in the heaths of Hannover in America, which is a hard and tough "peat-sandstone," that is, a quartzose sand cemented by peaty material by means of the bog-water.

The occurrence of clay under peat has often been noticed—see for late instances Dakyns, "Geological Magazine," Ser. 2, Vol. vi., p. 47; and T. R. Jones, "Transactions Newbury Field Club," Vol. ii., p. 132 *note*.

The growth of Alpine Mosses and Rushes in moist hollows, in tarns and other upland lakes, supplies both living and decomposing plant-material, which gradually takes the place of shallow water; and the streams have the brown or amber-coloured tint of bog-water in consequence. At lower levels, lakes, shelving river-banks, deserted river-bends, and maritime flats are invaded, and ultimately become choked by marsh-plants, that is—such as flourish either in the water or on wet ground. So also in cultivated lands, the ponds, old canals, ditches, neglected cuttings by the side of railways, and such like, are soon colonized, and in time wholly occupied, by similar water-plants. In turn, the areas of many natural lakes and of old beaver-ponds, replaced by peaty formations, are either used for the extraction of peat for fuel, or are drained and cultivated by modern agriculturists.

§ II. In the natural process of Peat-formation, there are—

(1.) Waterside plants, encroaching on the shelving mud, whether this be a deposit from flood-water, or formed of the soft clays of the lake- or river-bed.

The flora which mainly contributes, in our latitudes, to the formation of Peat has been noticed more or less fully by numerous writers. A list is given in APPENDIX I.

(2). Plants growing in the water itself, either rooted in the bottom, or floating on or below the surface. All these, as they die, go to make a vegetable deposit, or *Submerged Peat*. This gradually accumulating, and approaching the water-level, becomes an *Emerged Peat*, and affords a floor for the growth, first, of the marginal marsh-plants, and ultimately of such larger herbs, bushes, and trees, as keep their roots in wet ground only. Occasionally *Emerged Peat* takes the form of free floating islands in lakes, or of broad raft-

like crusts, which supply broken and rotten plant-matter to the lake. Such turf-islands or moss-islands have been frequently described :—for instance, those of Derwent Water, by Rennie, “Essays on Peat-mosses,” p. 454; of Holland and Wackhusen, *ib.*, p. 461; of the Cleveetz or Beel Lake, by J. F. Julius Schmidt, “Zeitsch. d. d. Geol. Ges.,” Vol. viii., p. 494, &c.

Some floating masses originate at the sides of quiet lakes, where creeping Grasses and other plants push off their floating and matted growth from the banks, to be joined by Bog-moss, with the minute fibres of *Conferva*, *Batrachospermum*, *Bulbochæte*, and other filamentous simple plants, and with Duckweed, Watercrowsfoot, and such like floating vegetation. Thus turfy masses form at the surface. These, slowly sinking as they fade and decay, are thickened and covered by the growth of other water-plants, and the whole accumulates in time as peaty material in the water.

In course of time, if no change in the local drainage takes place, the mud and sand of floods have aided the marsh-plants, wet jungles, and damp forests, to raise the level still higher; and Man steps in to clear and cultivate the spots most suitable to his requirements.

In the wide shallow hollows on many table-lands and heathy plateaux, whether in the broad upper valleys, or in the natural depressions of the surface, an analogous series of conditions takes place with the local vegetation, which can scarcely form a *Submerged*, but grows at once as an *Emerged* or *Superficial* Peat, and soon coats itself with the entangled tissue of heath-roots and other fibrous material. This undergoes relatively little decomposition, and is best known, in some parts of England, as “Turf.”

§ III. Under these circumstances Peat may be classified thus (see “Science for All,” No. 23, p. 344)—

“I. Peat-bogs and Turf-moors on such plateaux as flat mountain-tops and wide hill-moors.

“II. Peat-bogs of valleys :—1. At the heads of valleys. 2. At the salient angles within river-curves. 3. In deserted bends of rivers. 4. In plains and lakes of expanded valleys. 5. Special Peat-bogs of Denmark, and the Black-earth of Russia. 6. River-deltas. 7. Maritime Peat-marshes, where certain valleys and plains (which are but broad valleys), open to the sea.”

I. In illustration of this division of the subject, (1.) the Highlands of Scotland were alluded to, where the general “turf” of

the higher surfaces passes into "peat" in the hollows.* (2). The Bog of Allen in the hollows of the great limestone flats in the middle of Ireland.

In that country "Turf" (Peat) is said to occupy 2,830,000 acres, or nearly one-seventh of the entire area.†

The Parliamentary Reports on the Bogs of Ireland, 1810, &c., contain much information. The following is the detailed description of a "Section of a Turf-bank in Timahoe Bog, in the Eastern District of the Bog of Allen,‡ in Co. Kildare," as given in "The first Report of the Commissioners appointed to enquire into the Nature and Extent of the several Bogs in Ireland, and the Practicability of Draining and Cultivating them. Ordered by the House of Commons to be printed 20th June, 1810." 4to.

No.	Depth in feet.	
1.	2	Dark reddish brown; mass compact; no fibres of Moss visible; surface of Bog decomposed by the atmosphere.
2.	3	Light reddish brown; fibres of Moss very perfect.
3.	5	Pale yellowish brown fibres of Moss very perceptible.
4.	8½	Deep reddish brown; fibres of Moss perceptible.
5.	3	Blackish brown; fibres of Moss scarcely perceptible; contains numerous twigs and small branches of Birch, Alder and Fir.
6.	3	Dull yellowish brown; fibres not visible; contains much empyreumatic oil; mass compact.
7.	10	Blackish brown; mass compact; fibres not visible; contains much empyreumatic oil.
8.	4	Black mass, very compact; has a strong resemblance to pitch or coal; fracture conchoidal in every direction, and lustre shining. (Depth of Bog, 38½ feet.)
9.	3	Marl; contains 64 pr. ct. of carbonate of lime.
10.	4	Blue clay.
11.		Clay mixed with limestone-gravel. (Depth unknown.)

H. Schinz-Gesner, writing on Peat in 1857, stated that in the great Moors in Bavaria the observed increase of peat in 45 years was 2 to 3 feet; in Oldenberg, in 100 years, only 4 feet; in Håmmelsmoor, Denmark, 2½ feet; and that in Alpine districts peat-pits have been observed to fill 4 to 5 feet in from 30 to 50 years.

* See, for instance, "Geol. Survey Memoirs, Explan. Sheet 24, Scotland," p. 22. Consult also James Geikie's "Memoir on the Peat-mosses of Scotland." (See APPENDIX II.)

† For some notices of the Irish Peat-deposits, see the "Geol. Surv. Memoirs, Ireland," Explan. Sheets 35, 49, 50, 61, 128, 142, 143, 153, &c.

‡ This Bog was also described by Prof. Jukes in the "Quart. Journ. Geol. Soc.," Vol. xviii., p. 379.

The Rev. Mr. Jenyns ("Report Brit. Assoc.," 1845, Sect. p. 75), was informed that in Cambridgeshire the peat-pits filled slowly at the rate of about 20 inches in 16 years. The pits in Speen Moor, Newbury, where *Equisetum* is a predominant plant, are said to fill at the rate of several inches every year (see above, p. 188).

II. (1). As a good illustration of upper-valley Peat, a picture of some mountains, by Crome, in the National Gallery, No. 1,037, entitled "Slate Quarries," was referred to. In this painting the condensing mountain-tops form the background, the lines of drainage are traceable, and the great brown areas of massive peat, with characteristic green patches of deceptive sward-like surface, are noticeable features. Chat-moss on a northern affluent of the Mersey, in Lancashire, was also mentioned.

To this series belongs the small upland lake or pond, choked with peat 14 feet thick, lying on sandy clay, bog-iron-ore, and marly sand, near Kildale, in Yorkshire, as described by Mr. A. G. Cameron, "Geological Magazine," 2nd ser., Vol. v., p. 351.

The bursting of bogs, when the wet spongy mass can no longer hold up by capillary attraction the black liquid mud above the horizontal line, was also spoken of. The model of a burst and sliding bog, near Slamannan, in Lanarkshire, made by Mr. Thomas Gibbs, and deposited in the Museum of Practical Geology, was alluded to.

II. (2 & 3.) The Peat formed at the alluvial tongues stretching into shallow water, opposite to the high and hollow cliffs at the turns of a winding river, was noticed; also the gradual infilling of lake-like waters left when such rivers have cut across the neck of semi-circular bends, and deserted them for the new channel.

Sir C. Lyell ("Second Visit to the United States," Vol. ii., p. 244), writing of the swamps on the alluvial slope of the Mississippi above and below the present head of the delta, states that sand and mud are deposited over the plain by the river and its tributaries, and most of the area consists of swamps, surrounded by luxuriant growths of timber, "interspersed with lakes, which are deserted river-bends. These lakes are slowly filling up, and every swamp is gradually becoming shallower, the substance accumulated in them being for the most part of vegetable origin, unmixed with earthy matter."

II. (4.) The enormous gorges in which the larger valleys originated were due probably to great earth-cracks; and after having

been fashioned by glacial and strong aqueous action, they were gradually choked with blocks, boulders, gravel, sand, and mud from glaciers and torrents, until the now existing alluvial plains were formed. These retain in their present rivers a mere trace of the original tumultuous drainage, which is occasionally imitated by devastating floods. These broad plains are sometimes grassy prairies, or extensive forests; but often they are "swampy flats, varied with desolate peat-bogs, rank cane-brakes, or sedgy moors, all characterised by the dead level of the former water-line." The river-freshets, from rain or snow, sometimes cover the peaty areas, just rising from lakes and backwaters, with heavy loads of gravel and sand; and thus make fresh clear lakes again. These are fit to be inhabited by many generations of freshwater Mollusca, which leave layers of their white decomposing calcareous exuviae in the "Shell-marl," often seen in cuttings in fens and in drained lakes.* The *Diatomaceæ*, too flourish until thick beds of their microscopic siliceous frustules accumulate as "Mountain-meal,"

* See H. Warburton, "On some Beds of Shell-marl in Scotland," 'Transact. Geol. Soc.,' Vol. iv., 1817, p. 305, &c.; Sir C. Lyell, "On a Recent Formation of Freshwater Limestone in Forfarshire, and on some Recent Deposits of Freshwater Marl," 'Transact. Geol. Soc.,' Ser. 2, Vol. ii., 1826, p. 73, &c.; W. Buckland, "Notice of the Shell-marl in the Valley of the Kennet," in a Memoir in the 'Transact. Geol. Soc.,' Ser. 2, Vol. ii., 1826, p. 128, &c.; W. J. Hamilton, "On the Occurrence of a Freshwater Bed of Marl in the Fens of Cambridgeshire," 'Quart. Journ. Geol. Soc.,' Vol. vi., 1850, p. 451; T. R. Jones, "Lecture on the Geological History of Newbury," 8vo., 1854, p. 40, &c.; "Memoirs of the Geological Survey, Explanation of Sheet 12," 8vo., 1862, p. 47, &c. Shell-marl associated with Peat in Ireland is noticed in several of the Explanations of Sheets of the Geol. Surv. Map. From the grey marl of an old lake-floor in a valley near Ape-thorp, not far from Stamford, on which a Roman Station (discovered in 1859) had been established, though subject to inundation, the following freshwater shells and other organisms were found by Mr. John F. Bentley. They were named by Dr. S. P. Woodward—

<i>Planorbis nautilus</i> ,	<i>Clausilia plicatula</i> ?
<i>Pl. spirorbis</i> ,	<i>Cl. laminata</i> ,
<i>Succinea patris</i> ,	<i>Cyclostoma elegans</i> ,
<i>Physa fontinalis</i> ,	<i>Zua lubrica</i> ,
<i>Bithynia tentaculata</i> ,	<i>Helicella crystallina</i> ,
<i>B. Leachii</i> ,	<i>H. cellaria</i> ,
<i>Limnæa peregra</i> ,	<i>H. radiatula</i> ,
<i>L. palustris</i> ,	<i>H. lucida</i> ,
<i>L. truncatula</i> ,	<i>Helix fulva</i> ,
<i>Valvata spirorbis</i> ,	<i>H. aculeata</i> ,
<i>Pupa muscorum</i> ,	<i>H. rufescens</i> ,
<i>Carychium minimum</i> ,	<i>H. hispida</i> ,
<i>Vertigo pygmæa</i> ,	<i>H. pulchella</i> ,
<i>V. pusilla</i> ,	<i>H. arbustorum</i> ,
<i>V. antivertigo</i> ,	<i>H. rotundata</i> ,
<i>Cionella acicula</i> ,	<i>Candona lucens</i> ,
<i>Acicula lineata</i> ,	Seed-vessels.

"Polishing-powder," &c. Submerged and emerged Peat again are formed, supplanting the lake; and, may be, land is gradually secured, and a forest-growth in time succeeds. The "Broads" of Norfolk, abounding with water-plants, and choked in places with vegetation, are probably hollows left in old river-valleys of the Post-Tertiary Period.*

The wooded valley-ground, which owed its constitution to the Peat, is time after time inundated by the flooded river, swollen by sudden increase in its head-waters, or checked by landslips, gravel-heaps, fallen timber, and other hindrance to the drainage; or perhaps the forest-fastness of an enemy has been drowned-out by the skilful interference of a destroying conqueror. Then the forests of the river-side, thus swamped, die and rot, and "the spongy Bog-moss, creeping up among their prostrate trunks and branches, raises its water-laden mass of rotten fibres and false green mask above the ancient forest-land" ("Science for All," No. 23, p. 346.)

Thus cane-brakes, jungles, and forests, one over another, are found in Peat-bogs, with or without intervening beds of alluvium and lake-deposits; the overloaded surface having frequently subsided and renewed itself again by the growth of peat. Where the arboreal vegetation has persistently retained the same character, no external change has led to specific differentiation through the long periods of peat- and forest-growths; but sometimes great climatal changes have brought about a succession of faunal and floral characteristics in the slowly passing ages.

Geological evidences of oscillations of level, and changes of superficial conditions have been frequently noted from sections exposed in peat-beds of various kinds. Such sections have been described, for instance, in Shropshire ("Proceed. Geol. Soc.," Vol. ii., p. 200); in South Wales ("Quart. Journ. Geol. Soc.," Vol. xii., p. 169); in Somerset (Vol. xxii., p. 1); Scotland (Vol. xxxiii., p. 196), &c.

II. (5.) "In Denmark, where Peat-mosses abound, there are some of great interest, though of limited extent, which have been formed in caldron-like cavities in the Boulder-clay. These great *pot-holes* are of obscure origin; they may have originated by great masses of ice, or of frozen mud, having been deposited and subsequently melted, letting down the overlying beds; or they may be due to

* "Quart. Journ. Geol. Soc.," Vol. xxv., p. 259.

the Boulder-clay having been laid down over fissures and pot-holes in the rock on which old glaciers had worked, and so sunk down. At all events, they have been the receptacles of lakes, with bed-clays retaining well preserved remains of true Arctic plants, such as *Betula nana*, *Dryas octopetala*, *Salix reticulata*, *S. polaris*, and *S. herbacea*, and with shell-marls, on which were formed various peat-beds in succession. On the margins of these, trees of successive forests grew and fell in. First *Populus tremula*, and then Pine-forests, with the *Stone* weapons of the aborigines; and succeeding Oaks, with *Bronze* weapons of another race of men; and Beeches at last, with the *Iron* implements of Historic Man; these are clearly seen there, one after another." ("Sc. for All," *l.c.*, Steenstrup's Memoirs "Transact. Acad. Sci., Copenhagen," Vol. ix., 1842, &c., &c.; and especially his paper, "Sur les Kjøkkenmøddings' de l'âge de la pierre et sur la faune et la flore pré-historiques de Danmark," Extr. des Bulletins du Congrès International d'Archéologie préhistorique à Copenhague en 1869. 8vo., Copenhagen, 1872. See also "Lecture on the Antiquity of Man," by T. Rupert Jones, 8vo., Van Voorst, 1877, pp. 10-18.)

The enormous stretch of country covered with the Black-earth (Tchernay-zem), in South Russia, was referred to as the result of long-continued decay of plants over a large area where the drainage has not allowed the permanent formation of watery peat.

II. (6). The *Deltas* of river-valleys, or partially filled gorges mentioned above, where they meet the sea-level, and the suspended mud falls in the slackened current, comprise many kinds of peat-forming water-areas. There are isolated *bends* and deserted *reaches* of devious watercourses, lakes in sunken hollows of the soil, "slakes" or stagnant side-waters of the river, and imprisoned back-waters and lagoons of the sea. These become choked with water-plants and silt, either continuously or in successive stages. Various kinds of morasses are thus formed, which here and there contain seams of sand, shells, and weeds left by the sea after stormy irruptions, or after quiet temporary possession.

Mr. A. G. Cameron has described in the "Geol. Mag.," Ser. 2, Vol. v., p. 351, a small maritime peat-deposit at West Hartlepool, consisting of eight feet of peat, with 32 inches of under-clay. The alluvial flats in Sussex are noticed in Dixon's "Geology of Sussex," new edition, 1878, Chapter viii.; and Mr. E. H. Butler's explana-

tion of the history of those near Hastings is alluded to at page 149.

The famous swamp in the Delta of the Nile, anciently known as "Iacus Serbonis," and subject to inundations from the Mediterranean, although not a true Peat-bog, comes under this division of deltaic morasses. Treacherous sands and mud, overgrown with reeds and reed-like plants (the "Sea of Reeds," in Hebrew, "Contemporary Review," Vol. xxxiv., p. 757), constitute—

"That Serbonian bog,
Betwixt Damietta and Mount Casius old,
Where armies whole have sunk."—Milton.

II. (7.) Where the present sea-line intercepts the broadest valley-flats or alluvial plains, we have *Maritime Marshes*, often of vast extent, especially across the embouchure of several neighbouring rivers, formerly affluents of one great river, then running in its gorge-track, but now obliterated by the encroachment of a narrow sea, or lost in it by the subsidence of the country.

In Lyell's "Second Visit to the United States" (2 vols., 1850), it is stated at page 30, Vol. i., that partial subsidence of the land on the eastern coast within recent periods has formed swamps, with stumps of *Cupressus thyoides* still standing. Such cedar-swamps on the east side of Delaware Bay contain large prostrate trees to an unknown depth. In one case a tree with upwards of a thousand annual rings was found to lie over one of five hundred years' growth. See also Dr. Dawson's "Notices of the Modern Submerged Forests of Nova Scotia," *Quart. Journ. Geol. Soc.*, Vol. xi., p. 119, &c.; and "Acadian Geology," 2nd Edit., p. 28, &c.

The Fen-lands of England were referred to in illustration, especially the "Levels,"* in Cambridgeshire and neighbouring counties; also the low grounds of the ancient gulf of Poitou, the filled-up estuary of Flanders, the largest part of Holland, and of German and Danish Friesland.

"The Tundras of Northern Russia and Siberia, now permanently frozen below, and covered with snow nine or ten months of

* These are the—1, "North Level;" 2, "Middle Level;" 3, "South Level;" and 4, "Bedford Level." The sluice at St. Germain's, draining the "Middle Level," broke in 1862, and inundated more than a thousand acres of the "Marshland," between that and the sea. The "Marshland" was enclosed before the "Middle Level," which was drained between forty and fifty years ago.

the year, are also characteristic maritime swamps, involving the broad, low deltas of the great rivers that enter the Arctic Ocean. These extensive and melancholy flats are varied with lakes of salt and fresh water, and are green with coarse grass, rushes, and sedge, and with plots of bog-moss, during their short summer of nine or ten weeks. Whatever else the unsearchable Tûndras may contain, the ancient Mammoth and Rhinoceros, still preserved entire in their frozen muds, tell of long past changes in Northern Asia. But in Europe and the British Isles, where nature has pressed upon nature in forced emigrations, the Peat-bogs teem at places with recognisable relics of the past.

“§ IV. Weapons and tools of stone, bronze, and iron, besides the bones, garments, and ornaments of man, also his canoes, his crannoges or artificial island-forts, and his pile-structures once supporting huts, and even villages, in marshes and lakes, with the associated rude or finished implements and other belongings of his domestic life, are all found in Peat-bogs, and can be referred to different peoples. Thus, when fully studied, a Peat-bog often enables us to obtain an insight, not only into many geological changes in far back time, but also into the history of races of men who have left no written records, no buildings of brick or stone, to bear witness of their life, and nevertheless played an active part in founding the civilisation in the midst of which we now live” (“Science for All,” No. 23, pages 347, 348).

APPENDIX I.

A Catalogue of the more important British Plants that, living in wet and marshy places, in rivers and lakes, and on bogs, supply vegetable material for the formation of Peat.

I. CRYPTOGRAMS.

Of the many *Confervoid* *Algae* that abound in fresh water, we may take as types—*Lemania*, *Batrachospermum* (Knotweed), *Chætrophora*, *Conferva* (Crowsilk), *Zygnema*, *Bulbochæte* (Bristleweed), *Vaucheria*, *Oscillatoria* (Quickthread), and *Scytonema* (Leatherthread), *Nostoc*, *Desmidium*, *Diatoma*, and *Volvox*. See “Micrographic Dictionary,” Van Voorst, 1875.

In the remainder of this List of Aquatic Plants the names and

order given in S. F. Gray's "Natural Arrangement of British Plants," 8vo., 2 vols., 1821 (a very useful, though old-fashioned work), is mainly followed.

The affixed signs mean—

{	* growing in the water.
{	† growing on bogs.
{	‡ growing in wet situations.
{	§ growing in salt marshes.

<i>Filices.</i>	‡	<i>Osmunda regalis</i>	... Royal Flowerfern ; Water-fern.
"	‡	<i>Blechnum boreale</i>	... Northern Spicant ; Hard Fern.
<i>Lycopodiaceæ.</i>	†	<i>Lycopodium inundatum</i>	... Bog Wolfsclaw ; Creeping Club-moss.
"	‡	" <i>abietiforme</i>	... Firlike Club-moss (<i>Mountains</i>).
"	*	<i>Isoetes lacustris</i>	... Lake Quillwort (<i>Alpine lakes</i>).
<i>Marsiliaceæ.</i>	*	<i>Pilularia globulifera</i>	... Peppergrass ; Pillwort.
<i>Equisetaceæ.</i>	‡	<i>Equisetum fluviatile</i>	... Great or River Horsetail.
"	‡	" <i>hyemale</i>	... Winter Horsetail ; Dutch Rush.
"	‡	" <i>limosum</i>	... Mud Horsetail.
"	‡	" <i>variegatum</i>	... Variegated Horsetail.
"	†	" <i>palustre</i>	... Marsh Horsetail.
<i>Charadææ.</i>	*	<i>Chara vulgaris</i>	... Common Stonewort.
"	*	" <i>hispida</i>	... Hispid "
"	*	" <i>crinita</i>	... Hairy "
"	*	<i>Nitella flexilis</i>	... Flexible "
"	*	" <i>stellata</i>	... Starred "
<i>Musci.</i>		(Some <i>Hepaticæ</i> , especially <i>Jungermannia</i> .)	
"	†	<i>Sphagnum</i> (<i>Bogmoss</i>) <i>obtusifolium</i> , <i>squarrosum</i> , <i>acutifolium</i> , <i>cuspidatum</i> .	
"	††	<i>Splachnum</i> (<i>Glandmoss</i>) <i>tenue</i> (<i>Mountains</i>), <i>vasculosum</i> (<i>Alpine bogs</i>).	
"	††	<i>Dricanum</i> (<i>Forkmoss</i>), <i>adiantoides</i> , <i>cerviculatum</i> , <i>flexuosum</i> , <i>virens</i> and <i>strumiferum</i> (<i>Mountain bogs</i>), <i>squarrosum</i> , <i>crispum</i> .	
"	*	<i>Trichostomum aciculare</i>	... Needle-like Hairymouth.
"	*	<i>Orthotrichum rivulare</i>	... River Bristlemoss.
"	*	<i>Fontinalis antipyretica</i>	... Fireproof Springmoss ; Water-moss.
"	*	" <i>squamosa</i>	... Scaly " (<i>Alpine streams</i>).
"	†	<i>Batramia fontana</i>	... Grey or Spring Marshmoss.
"	†	" <i>arcuata</i>	... Bowed " (<i>Mountain bogs</i>).
"	†	<i>Hypnum stramineum</i>	... Straw Feathermoss.
"	†	" <i>stellatum</i>	... Starred "
"	†	" <i>cuspidatum</i>	... Bladed "
"	†	" <i>nitens</i>	... Shining "
"	*	" <i>fluitans</i>	... Floating "

<i>Musci.</i>	†	<i>Hypnum palustre</i>	... Marsh Feathermoss.
"	†	" <i>filicinum</i>	... Fern "
"	*	" <i>ruscifolium</i>	... Butcher's-broom-leaved Feathermoss.
"	†	" <i>aduncum</i>	... Crooked Feathermoss.
"	†	" <i>cordifolium</i>	... Heart-leaved "
"	†	" <i>scorpioides</i>	... Scorpion "
"	‡	" <i>riparium</i>	... Bankside "
"	*	" <i>molle</i>	... Soft " (<i>Alpine rivulets</i>).
"	†	<i>Bryum palustre</i>	... Marsh Threadmoss.
"	†	" <i>trichodes</i>	... Hair-leaved Threadmoss (<i>Mountain bogs</i>).
"	†	" <i>dealbatum</i>	... Whitened Threadmoss (<i>Mountain bogs</i>).
"	‡	" <i>triquetum</i>	... Three-edged Threadmoss.

2. PHANEROGAMS.

<i>Fluviatiles.</i>	*	<i>Zanichellia palustris</i>	... Marsh Pondweed.
"	*	" <i>dentata</i>	... Toothed "
"	§	<i>Ruppia maritima</i>	... Sea Tasselgrass.
"	*	<i>Potamogeton natans</i>	... Swimming Riverweed.
"	*	" <i>heterophyllum</i>	... Odd-leaved "
"	*	" <i>fluitans</i>	... Floating "
"	*	" <i>lucens</i>	... Shining "
"	*	" <i>crispum</i>	... Crisp "
"	*	" <i>lanceolatum</i>	... Spear-shaped Riverweed (<i>Mountain lakes</i>).
"	*	" <i>perfoliatum</i>	... Thorough-leaved Riverweed.
"	*	" <i>densum</i>	... Thick "
"	*	" <i>compressum</i>	... Flat "
"	*	" <i>pectinatum</i>	... Fennel-leaf "
"	*	" <i>gramineum</i>	... Grasslike "
"	*	" <i>pusillum</i>	... Small "
"	§	" <i>marinum</i>	... Maritime "
"	§	<i>Zostera marina</i>	... Sea Grasswrack.
<i>Lemnaceæ</i>	*	<i>Lemna trisulca</i>	... Three-lobed Duckmeat; Duck- weed.
"	*	" <i>minor</i>	... Smaller Duckmeat; Duckweed.
"	*	" <i>polyrhiza</i>	... Many-rooted "
"	*	" <i>gibba</i>	... Bunched "
<i>Typhaceæ.</i>	†	<i>Sparganium ramosum</i>	... Branched Burreed.
"	‡	" <i>simplex</i>	... Unbranched Burreed.
"	†	<i>Platanaria natans</i>	... Floating Ribandweed.
"	‡	<i>Typha latifolia</i>	... Broadleaved Reedmace.
"	‡	" <i>angustifolia</i>	... Narrowleaved "

<i>Cyperaceæ.</i>	†‡§	<i>Carex</i> (Grassrush)	dioica, Davalliana, pulicaris, teretiuscula, paniculata, vulpina, intermedia, divisa (<i>maritime</i>), ovalis, elongata, stellata, curta, axillaris, cæspitosa, stricta, acuta.
"	†‡§	<i>Trasus</i> (Sedge)	paniciflorus (<i>Alpine bogs</i>), hirtus, filiformis (<i>bogs</i>), vesicarius and ampullaceus (<i>bogs</i>), flavus and fulvus (<i>bogs</i>), distans (<i>maritime bogs</i>), riparius, paludosus, ustulosus (<i>mountains</i>), lævigatus, limosus (<i>bogs</i>).
"	†	<i>Cyperus longus</i>	... Sweet Cyperus; English Galin-gale.
"	§	<i>Cladium Germanicum</i>	... Picklerush; Prickly Bogrush.
"	†	<i>Chaetospora compressa</i>	... Flat Marshrush.
"	†	" rufa	... Reddish "
"	†	<i>Rhynchospora alba</i>	... White Beakrush.
"	†	" fusca	... Brown "
"	†	<i>Schoenus nigricans</i>	... Black Bogrush.
"	†	" ferrugineus	... Thorny " (<i>Mountain bogs</i>).
"	†	<i>Scirpus cæspitosus</i>	... Tufted Rush (<i>Turfy heaths</i>).
"	†	" paniciflorus	... Few-flowered " (<i>Hill bogs</i>).
"	†	" multicaulis	... Many-stemmed "
"	†	" lacustris	... Lake Bullrush.
"	†	" medius	... Middling Bullrush.
"	†	" carinatus	... Keeled "
"	§	" triqueter	... Three-sided "
"	§	" pungens	... Prickly "
"	§	" maritimus	... Seaside "
"	†	<i>Elæocharis acicularis</i>	... Needly Clubrush (<i>Wet heaths</i>).
"	†	" palustris	... Marsh "
"	†	<i>Isolepis fluitans</i>	... Floating Smoothrush.
"	†	" paniculata	... Panicked "
"	†	<i>Trichophorum alpinum</i>	... Alpine Harestail.
"	†	<i>Eriophorum capitatum</i>	... Headed Cottongrass (<i>Wet heaths</i>).
"	†	" vaginatum	... Sheathed Cottongrass.
"	†	" angustifolium	... Narrow-leaved Cottongrass.
"	†	" latifolium	... Broad-leaved "
"	†	" gracile	... Slender "
<i>Gramineæ.</i>	†	<i>Nardus stricta</i>	... Stiff Matgrass (<i>Wet heaths</i>).
"	†	<i>Poa aquatica</i>	... Water Meadowgrass.
"	§	" maritima	... Seaside "
"	§	" glauca	... Glaucous "
"	†	<i>Glyceria fluitans</i>	... Floating Maundgrass; Flote-grass.
"	†	<i>Arundo vallisoria</i> (phrag-mitis)	... Bankside Reed.
"	†	<i>Catabrosia aquatica</i>	... Water Sweetgrass.
"	†	<i>Phalaris arundinacea</i>	... Reedy Phalaris.

<i>Gramineæ.</i>	§	<i>Alopecurus bulbosus</i>	... Bulbous Foxtail.
"	‡	" <i>geniculatus</i>	... Kneed "
"	‡	" <i>fulvus</i>	... Reddish "
"	§	<i>Spartina stricta</i>	... Stiff Seagrass.
"	‡	<i>Vilfa alba</i>	... White Bent; Marsh Bentgrass.
"	§	" <i>maritima</i>	... Seaside Bent.
"	‡	<i>Apera ? palustris</i>	... Marsh Silkgrass.
"	‡	<i>Calamagrostis neglecta</i>	... Neglected Reedgrass.
"	§	<i>Polypogon littorale</i>	... Shore Beards.
<i>Restiaceæ.</i>	‡	<i>Eriocaulon septangulare</i>	... Sevenangled Pipewort (<i>Lakes, Hebrides</i>).
<i>Juncæ.</i>	‡	<i>Acorus undulatus (calamus)</i>	Wavy Sweetflag.
"	§	<i>Juncus acutus</i>	... Sharp Junk or Rush.
"	§	" <i>maritimus</i>	... Seaside "
"	§	" <i>cænosus</i>	... Mud "
"	‡	" <i>bufonius</i>	... Toad "
"	†	" <i>macer</i>	... Slender "
			(<i>Alpine bogs</i>).
"	†	" <i>trifidus</i>	... Three-cut Junk or Rush (<i>Alpine bogs</i>).
"	†	" <i>supinus</i>	... Downlying Junk or Rush.
"	‡	" <i>uliginosus</i>	... Woolly " (<i>Wet heaths</i>).
"	†	" <i>fluitans</i>	... Floating "
"	†	" <i>triglumis</i>	... Three-chaffed "
"	‡	" <i>subverticillatus</i>	... Whorled "
"	‡	" <i>acutiflorus</i>	... Sharp-flowered "
"	†	" <i>lampocarpus</i>	... Shiny-fruit "
"	‡	" <i>obtusiflorus</i>	... Blunt-flowered "
"	†	<i>Luzula congesta</i>	... Flaxen Rush; Crowded Lu- zula.
"	†	" <i>multiflora</i>	... Many-flowered Luzula.
"	†	<i>Abama ossifragum</i>	... Bonebreaking or Lancashire Bastard Asphodel.
<i>Colchicacæ.</i>	†	<i>Tofieldia palustris</i>	... Marsh Tofield; Scottish As- phodel (<i>Mountain bogs</i>).
<i>Irideæ.</i>	‡	<i>Iris palustris</i>	... Marsh Fleur-de-luce: Yellow flag; Seggs.
"	‡	" <i>variabilis</i>	... Changeable "
<i>Orchideæ.</i>	‡	<i>Orchis latifolia</i>	... Broad-leaved Orchis; Marsh Satyrium, &c.
"	†	<i>Listera cordata</i>	... Heart-leaved Twayblade.
"	‡	<i>Epipactis palustris</i>	... Marshy Helleborine.
"	†	<i>Malaxis paludosa</i>	... Marsh Twayblade.
<i>Alismacæ.</i>	†	<i>Sagittaria aquatica</i>	... Water Arrowhead.
"	‡	<i>Alisma major</i>	... Greater Water-plantain.
"	‡	" <i>natans</i>	... Floating " (<i>Alpine lakes</i>).

<i>Alismaceæ.</i>	†	<i>Alisma ranunculoides</i>	... Ranunculus-like Water-plantain.
„	†	<i>Damasonium Dalechampii</i> ...	Starhead.
<i>Butomaceæ.</i>	†	<i>Butomus umbellatus</i>	... Umbelled Gladiole.
<i>Juncagineæ.</i>	†	<i>Scheuchzeria palustris</i>	... Marsh Scheuchzer.
„	†	<i>Triglochin palustre</i>	... Spiked Watergrass; Marsh Arrowgrass.
„	§	„ <i>maritimum</i>	... Saltmarsh Watergrass; Sea Arrowgrass.
<i>Hydrocharideæ.*</i>		<i>Hydrocharis asarifolia</i> (<i>morsus-ranæ</i>)	... Asarum-leaved Frogbit.
„	§	<i>Stratiotes aloides</i>	... Aloe-like Watersoldier.
<i>Gentianeæ.</i>	†	<i>Menyanthes palustris</i>	... Marsh Buckbean.
<i>Boragineæ.</i>	†	<i>Myosotis palustris</i>	... Marsh Mouse-ear; Forget-me-not.
<i>Droseraceæ.</i>	†	<i>Drosera rotundifolia</i>	... Round-leaved Sundew.
„	†	„ <i>longifolia</i>	... Long-leaved „
„	†	„ <i>anglica</i>	... English „
<i>Nymphæaceæ.*</i>		<i>Nuphar luteum</i>	... Yellow Watercan or Water-lily.
„	*	„ <i>minimum</i>	... Smallest „
„	*	<i>Nymphæa alba</i>	... White Waterlily.
<i>Ranunculaceæ.†</i>		<i>Caltha palustris</i>	... Marsh Marygold.
„	*	<i>Ranunculus sceleratus</i>	... Wicked Crowfoot.
„	†	„ <i>reptans</i>	... Creeping Crowfoot (<i>Alpine lakes</i>).
„	†	„ <i>flammeus</i>	... Flame Crowfoot; Banewort.
„	†	„ <i>longifolius</i> (<i>lingua</i>)	... Long-leaved Crowfoot; Great Spearwort.
„	*	<i>Batrachium hederaceum</i>	... Ivy-like Water-crowfoot.
„	*	„ <i>tripartitum</i>	... Three-parted „
„	*	„ <i>obtusifolium</i>	... Blunt-petaled „
„	*	„ <i>heterophyllum</i>	... Odd-leaved „
„	*	„ <i>pantothrix</i>	... Trimmed „
„	*	„ <i>cæspitosum</i>	... Tufted „
„	*	„ <i>fluviatile</i>	... River „

APPENDIX II.

Besides the books and memoirs mentioned in the foregoing paper, the following list of published works treating of Peat may be useful to some who wish to study the subject. They are mentioned not as forming by any means an exhaustive catalogue, but as the titles of, and notes on such as occurred to me whilst looking up lecture-notes on the subject.

1810. Essays on the Natural History and Origin of Peat Moss : the peculiar qualities of that substance ; the means of improving it as a soil ; the methods of converting it into a manure ; and the other economical purposes to which it may be made subservient. By the Rev. R. Rennie, D.D., &c. 8vo. Edinburgh, 1810.

Essay I. treats of ligneous plants : the former abundance of forests, their destruction, and origin of Peat-mosses therefrom. II. On aquatic plants : the part they play in forming Peat-mosses in lakes, &c. III. On the changes and combinations by which vegetable matter is converted into Peat-moss. IV. On the simple and compound substances that may be expected, and are really found in Peat-moss. V. On the alliance between Peat, Surturbrandt, Coal, and Jet. VI. On the alliance between Peat and other Bituminous Substances. VII. The distinguishing qualities of Peat-moss. VIII. The sterility of Peat-moss in its natural state, and causes of it. IX. The different kinds and classification of Peat-moss.

The outlines of four "Practical Essays on Peat-moss as a Soil, Manure, Fuel," &c., are appended to the volume, but these do not appear to have been published. Numerous observers and writers are referred to and quoted in Rennie's Essays, which are full of local and general information about Peat, which was then better known as "Moss" (from the Celtic *Mos* ; see Essay III., p. 240), whilst the word "Peat" referred only to the piece dug out for fuel. (Dr. James Geikie has kindly given me notes on the contents of Nos. I. and II., which are wanting in some published volumes of the "Essays.")

[?] In his "Practical Treatise on Peat," Dr. Anderson tried to show that Peat is a plant *sui generis* ! It is a useless, preposterous, and absurd book, and looks as if meant for a kind of heavy joke. (J. Geikie, in a letter).

1811. A Treatise on the Origin, Qualities, and Cultivation of Moss-earth, with directions for converting it into Manure. By William Airtton, Writer (lawyer), Strathaven, Lanarkshire. 8vo. Ayr., 1811.

He concludes that Moss-earth has been produced by plants in a climate of low temperature with excess of moisture ; and he classifies the different sorts found in Britain as—1. Hill-moss ; on hill-tops and hilly acclivities, where Heather and the Mosses—Hypnum, Bryum, Polytrichum, and Sphagnum form a kind of thin half-peat. 2. Bent-moss, much thicker, on the sides and skirts of hills,

and composed largely of the coarse grasses (Bent, &c.), mixed with the usual bogforming mosses. 3. Flow-moss, or quaking-bog, composed chiefly of *Sphagnum*, filling old lakes, and covering overthrown forests. (From Dr. James Geikie).

1821. J. Templeton, of Belfast, "On the Formation of Peat-bogs," in a letter to Dr. Berger, "Transactions Geological Society," Vol. v., pp. 608, &c. 4to., London, 1821.

This was written from observations made whilst doubts still existed with some geologists and mineralogists as to the origin and formation of Peat. Mr. Templeton states—"No bog is ever formed without an abundant stock of moisture. . . . The greatest mass of bog almost uniformly derives its origin from impediments intercepting the flow of water from a valley. A lake is thus formed, in whose waters is only nourished, if in mountain regions, the *Lobelia Dortmanni*, and sometimes the *Sparganium natans*, with a few straggling stunted plants of *Scirpus lacustris*. If in the lowlands a greater variety appear—we may observe the curious *Conserva echinulata*, floating like powdered verdigris; immersed at even greater depths grow Sponges, the *Charæ*, the *Ceratophyllæ*, with numerous *Conservæ*; and around the shores, gradually approaching the centre as their annual decay lessens the depth of water, we find various species of *Potamogeton*, the *Nymphæa alba*, *N. lutea*, the *Lobelia Dortmanni* (if the shore is composed of sand or gravel)," and upwards of thirty enumerated water-loving plants. To these plants succeed those which require to have themselves altogether uncovered with the water, or their roots fixed in a watery or soft mud, as the fourteen Mosses then enumerated. Among these Mosses grow other plants that like moisture, and "when the bog rises higher and is somewhat drier" another group of plants flourish until a firmer and fibrous kind of plant is formed. Sound conclusions are drawn by the author.

1826. Natural and Agricultural History of Peat-moss or Turf-bog, to which are annexed corroborative writings, correspondence, and observations on the qualities of Peat or Fen-earth, as a soil and manure, and on the methods used in Scotland for converting Moss-soils into arable and pasture grounds, plantation of trees, &c. By Andrew Steele, Esq., &c. Edinburgh, 8vo., 1826.

Very many references to other writers and practical observers are herein made; the special flora of Peat mosses is mentioned, with the common names of the plants (p. 299, &c.), and at p. 399

&c., are Prof. Robert Jameson's "Observations on Peat," from his "Mineralogical Travels through the Hebrides," &c.

1826. Gordon. Trans. Geol. Soc., ser. 2, Vol. ii., p. 140.

A notice of three successive forests of Fir in a Peat-moss.

1841. The History and Description of Fossil Fuel, the Collieries, and the Coal-trade of Great Britain. [By — Holland]. 2nd edit., 8vo., London, 1841. Chapter III., Peat, p. 40., &c.

1841. Practical Geology and Mineralogy, &c. By Joshua Trimmer. 8vo., London, 1841, p. 413, &c. Turf-moors and Peat-bogs.

Chief authors mentioned : Peat between vegetable matter and lignite : growth of *Sphagnum* : Peat over ruined forests : Antiquities in Hatfield Moss : human bodies, &c., in Peat.

1847. Lesquereux. "On the Formation of Peat in the North of Europe." Bulletin Soc. Sci. Nat. Neufchatel, 1847, vol. i., p. 472 ; and Quart. Journ. Geol. Soc., Vol. iv., Miscell., p. 29.

The formation of (1) *Immersed* or *Submerged Peat*, (2) of *Emerged* or *Superficial Peat*, (3) *Superficial Peat* sinking to form *Bottom Peat*, is noticed ; and some different Peat-bogs are compared. The passage from peat to lignite and coal, and the great quantity of successive forests in some Peat-bogs is noticed.

1853 (?). D. T. Ansted's "Physical Geography and Geology." (Orr's Circle of Sciences.) 8vo., London, 1853 (?), p. 219, &c.

1855. In Rowland and Richardson's "Chemical Technology," 2nd edition, 2 vols., 8vo., 1855, the changes of wood into peat, &c., or the process of transformation from living and dead vegetable fibre to compact lignite, jet, and coal—or carbonization by the process of hystolysis (retrograde decay), are treated of in some detail.

1856. Studi sopra alcuni Torbe Veronesi. Rapporto della Commissione incaricata della ricerca della torba nella Provincia di Verona. 8vo., Verona, 1856, pp. 37.

1857. Der Torf, seine Entstehung, Natur und Benutzung, nebst Aufforderuung durch Bearbeitung desselben einen zu weitem Transport und zu jeder Art von Feuerung zeeigneten Brennstoff darzustellen. Von H. Schinz-Gessner. Zurich, 1857, 8vo., pp. 43.

1860. In the Article "Turf," in the "Aide-mémoire to the Military Sciences," Vol. ii., 1860, pp. 175 *et seq.*, J. E. Portlock (*afterwards* General) enumerated the Alt-Warmbrücher Moor ; Franzensbad ; Ireland ; Banks of North Sea ; Gördauer Lake ;

East Sea; San Paulo, Brazils; Langensalza; Wittgendorf. He also refers to marine remains in alluvium, and to antiquities in the alluvium of Sweden; a Roman bridge in peat, and the buried hut in Galway.

1860. Pokorny. On Peat and Brown-coal. Proceed. Imp. Geol. Instit., Vienna, 1860; Transact. Vienna Zoolog.-Botan. Soc., 1860; and Quart Journ. Geol. Soc., Vol. xvii., Miscel., p. 6.

Prof. Pokorny, in publishing the results of his examination of the principal Peat-bogs of the Austrian Empire, groups his materials under these headings:—1 Vegetables in progress towards conversion into Peat. 2. Peat of the plains and of the mountain-moors. 3. Resinous substances, such as the dopplerite of the Aussee in Styria, and analogous substances from Switzerland and Berchtesgaden, described by Deicke and Gumbel. 4. Half-peat, with much inorganic matter, but combustible.

1862. F. Senft. Die Humus-, Marsch-, Torf- und Limonit-Bildungen als Erzeugungsmittel neuer Erdrindlagen [für Geognosten, Bergleute, Forst- und Landwirthe]. Von Dr. Ferdinand Senft, &c. 8vo., Leipzig, 1862.

In this useful work the following grouping is adopted (p. 126, &c.):—

1. Moos-torf, consisting of *Sphagnum* chiefly.
2. Gras- oder Wiesen-torf (Darg). *Cyperaceæ*, &c.
3. Haide- or Hochmoor-torf (Hagetorf). *Erica*, *Calluna*, &c.
4. Blätter- or Wald-torf. Yellowish, flaky; made of needles of Pines and leaves of Alder, Birch, Willow, Aspen, and sometimes Elm, Maple, &c.
5. Algen- (oder Meeres-)torf. Of *Algæ*, as at Flensburg, Ose-land, Trelleberg, &c.

1862. In the Official Catalogue of the Mining and Metallurgical Products, Zollverein Department of the International Exhibition, 1862, MM. von Dechen and Wedding gave some valuable information on the German Peat at pp. 26, 27.

1864. T. Sterry Hunt: "Peat and its Uses," 8vo., in the "Canadian Naturalist and Geologist," 1864. See also the Reports of the Geological Survey of Canada.

1866. James Geikie, "On the Buried Forests and Peat-mosses of Scotland, and the Changes of Climate they indicate." Transactions R. Soc. Edinb., Vol. xxiv., 1866, p. 363, &c.

Full of both detailed and generalized information, and rich with

references to other writers and observers. Two kinds of Peat-bog are particularly distinguished—1. The ordinary Peat-moss, due to the upgrowth of *Sphagnum* and its associates from the soil, and often including timber. 2. The Flow-moss, formed of floating intermatted vegetation over a basin of water, which receives, and may be filled by, a thick deposit of rotting plants from the bottom of the raft-like Moss. The former great extent of the Mosses, their antiquity, and the changes of climate connected with their history, are also treated of in full.

1866 (?). Peat and its Uses as Fertilizer and Fuel. By Samuel W. Johnson, Professor at Yale College. Illustrated, 8vo., New York, 1866 (?).

At page 168, &c., the origin and varieties of Peat are treated of; also the floating islands of turfy material in Germany, &c. The constituent Plants mentioned at page 12 are—*Sagittaria*, *Pantederia*, *Lemna*, *Potamogeton*, *Polygonum*, *Nymphæa*, and *Nuphar*.

1867. Prof. Archibald Geikie, has favoured me with the following copy of Title-pages :—

1. "Facts about Peat, as an article of Fuel, with remarks upon its Origin and Composition, the Localities in which it is found, the Methods of Preparation and Manufacture, and the various uses to which it is applicable; together with many other matters of practical and scientific interest. To which is added a Chapter on the Utilization of Coal Dust with Peat, for the production of an excellent fuel at moderate cost, specially adapted for steam service. By T. H. Leavitt. 3rd edition, revised and enlarged. Boston: Lee and Shepard, 1867."

2. "Leavitt's Peat Journal: a Newspaper devoted especially to the dissemination of information relating to Peat, its preparation and use as an article of Fuel, and generally to all that pertains to the economical production and use of fuel of all kinds. Issued monthly, by Leavitt and Hunnewell, 49, Congress Street, Boston. Price fifty cents. per annum. For sale by all newsmen."

1868. "The Observations on the Formation of Peat, in Lyell's "Principles," 10th ed., 1868, pages 496, &c., deal with the growth of Peat and preservation of Vegetable and Animal Remains therein; the analysis of Peat; Peat abundant in cold and humid climates (North and South); extent of surface covered with Peat; supposed recent origin of some Peat-mosses; source

of Bog-iron-ore; Preservation of animal substances in Peat; cause of the antiseptic property of Peat; the miring of Quadrapeds; Solway Moss; bursting of Peat-mosses; bones of Herbivorous Quadrapeds in Peat, and the Great Dismal Swamp, p. 505.

1868. J. W. Dawson, in his "Acadian Geology," 2nd ed., p. 33, 1868, treats of Freshwater Alluvia, "River intervalles," and deposits forming in the beds of lakes; Intervalles on the banks of streams; Soil on gravel; Lake-beds; Diatomaceous earths; Bogs and peaty swamps, p. 35, numerous in Nova Scotia in the rocky districts of the Atlantic coast.

1870. *Traité complet de la Tourbe formation, gisement et composition des diverses espèces, extraction, desiccation naturelle et artificielles, travaux mécaniques, carbonisation, &c. Culture des tourbières, roselières, rizières et engrais. Législation des marais et des Tourbières. Benzine, acide phénique, etc. Emploi de la tourbe en metallurgie.* Par Ernest Bosc. Paris, 8vo., 1870, pp. 242. 20 figs. in the text.

1871. On the economical production of Peat and Peat-charcoal, with incidental reference to the processes pursued at the Redmoss Works (Peat-engineering and Sewage-filtration Company Limited), Horwich, near Bolton, Lancashire. Liverpool, 8vo., 1871, pp., 24.

1874. "Die Turfmoore Oesterreichs und der angrenzenden Lander, ihre Wichtigkeit für Staats-Ökonomie und Industrie. Nebst einem Anhang: Ueber die Darstellung der Anilinfarben." Von Georg Thenius. Wien, 1874, 8vo., pp. 202.

In this work we have a plan and several sections of a part of the great Bûrhmoos.

1876. "The Geology of England and Wales." By H. B. Woodward, F.G.S. 8vo., London, 1876. Alluvial deposits, p. 326, &c. Peat, p. 357, &c. Mr. Alfred Gillett's list of water-plants, p. 358-9.

1876. Oswald Heer. "Primeval World of Switzerland." English Translation by W. S. Dallas, edited by J. Heywood. 2 vols., 8vo., London, 1876.

In Vol. i., p. 24, &c., the following points are especially referred to:—Origin and formation of Peat; stagnant water; bottom impervious; Algae and other plants; Sphagnum, &c. Peat of rivers and lakes; Peat of Gonten and Oberburgen; Pfäffikon, Wetzikon, Robenhausen, Katzenssee, &c. Drowned forests; general statement; p. 29, formation and action of acids; changes in Peat; paper-coals; Peat of Virginia and Carolina (Lesquereux).

1877. Report of the Geological Survey of Wisconsin. 1877. Peat deposits, p. 29, p. 241, &c. Marsh Vegetation, p. 181.
 1877. The Danish Peat (after Steenstrup), in T. Rupert Jones's "Antiquity of Man." 8vo., London, 1877, pages 10 to 17.

On hills.	{	Lyngmose (Heath), Svampmose (Spongy), Høermose (Flax-like, from the superficial dead Mosses); Denmark.
		Heidenmoor (Heath), Hockmoor (High); North Germany.
		Moor-turf, Hill-moss; Britain.
In valleys.	{	Kjermose (Marsh), Engmose (Meadow); Denmark.
		Wiesenmoor (Meadow); Germany.
		Peat-moor, Peat-moss, Bent-moss, Marsh, &c.; Britain.
In forests.	{	Skovmose; Denmark.
		Woldmoor; Germany.
		Forest-bog; Britain.

1877. S. B. J. Skertchley, Geology of the Fenlands: Memoirs of the Geological Survey of Great Britain, &c., 1877.

1878. S. H. Miller and S. B. J. Skertchley. The Fenlands Past and Present. 8vo., 1878.

1. In the Peat.—The Animal remains (p. 340):—Man, Celtic shorthorned Ox (*Bos longifrons*), a variety (*B. euryceros*), *Bos (Urus) primigenius*, Wolf, Fox, Goat, Beaver, Roe, Stag, Irish Deer (*Megaceros hibernicus*), Reindeer, Otter, Marten, Brown Bear, Wild Boar, Horse; Bittern, Wild Swan (*Cygnus masicus*), Tame Swan (*C. olor*), Coot, Pelican, Crested Grebe, Teal; Tortoise; Pike; Insects; Molluscs—*Bithinia*, *Helix*, *Limnææ*, *Planorbis*, *Physa*, *Cycas*, *Valvata*, *Pisidium*.

The Plants found in the Peat (p. 341):—

<i>Betula nana</i> .	<i>Hypnum fluitans</i> .
<i>Fagus sylvatica</i> .	———— <i>filicinum</i> .
<i>Fraxinus</i> .	<i>Juncus aquaticus</i> .
<i>Salix capra</i> .	<i>Lastrea</i> .
———— <i>repens</i> .	<i>Sphagnum</i> .
<i>Quercus robur</i> .	<i>Confervæ</i> .
<i>Pinus sylvestris</i> .	<i>Polyporus fomentarius</i> .
<i>Taxus baccatus</i> .	———— <i>squamosus</i> .
<i>Ulmus</i> .	<i>Sphæria (?) concentrica</i> .
<i>Hydrodictyon utriculum</i> .	

2. In the Silt (marine) below the Peat :—

Walrus.

Cockles.

Grampus.

Mussels.

1878. T. Mellarde Reade, in the Quart. Journ. Geol. Soc., Vol. xxxiv., p. 447, on the submarine forest at Altmouth; and at p. 808, on Glazebrook Moss, Lancashire.

1878. Transactions of the Newbury District Field Club, Vol. ii., 1878; Dr. S. Palmer on the Antiquities found in the Peat of Newbury, p. 123, &c., and Appendix by T. Rupert Jones; reprints of Dr. Collet's and Dean Buckland's descriptions of the Peat-formation in the Valley of the Kennet, and various notes on the Newbury Peat; p. 135, p. 138, p. 141, &c.

1879. A. Bailey: Overflow of a Peat-bog* in the Falkland Islands. Quart. Journ. Geol. Soc., Vol. xxxv., p. 96.

1879. I combustibili minerali d' Italia. W. Jervis. 8vo., 89 pp. Turin, 1879; The Peat of Italy, in the Alpine Region, Apennine Region, and Islands, pp. 64-89.

EXCURSION TO TUNBRIDGE WELLS AND CROWBOROUGH BEACON.

MONDAY, JULY 12TH, 1879.

FIFTH OF THE WEALD SERIES.

Director.—J. LOGAN LOBLEY, Esq., F.G.S.

(*Report by* WILLIAM FAWCETT, Esq., B.Sc.)

On alighting from the train at Tunbridge Wells, the Members proceeded by way of the Common, where the Director explained the route to be followed, then to the Parade to taste the waters, to the Pump Room, and, after crossing the boundary of Kent and Sussex, to Broadwater Down. Here, with almost the whole of Tunbridge Wells in view, Mr. Lobley pointed out that the town was built just at the junction of two valleys. The higher ground is Tunbridge Wells Sand, with outlying patches on Rusthall

* In the Museum of Practical Geology, Jermyn-street, is a good model of a burst Bog in Lanarkshire.