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BY

SIR WILLIAM DAWSON, F. G. S.,

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PROFESSOR D. P. PENHALLOW, F. R. S. C.

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I. GEOLOGY OF THE DEPOSITS. BY SIR WM. DAWSON.

General Geology of the Pleistocene.

The Pleistocene deposits of Canada may be defined as consisting of three principal members, which may be characterized as follows, in ascending order:

1. The Till, or lower bowlder clay, a tough or sometimes sandy clay, containing local and traveled stones and bowlders, often glaciated. It usually rests on glaciated surfaces, but is sometimes underlain by stratified gravels or by old soil surfaces or peaty beds. These are, however, rare and local.* In the more maritime regions—*e. g.*, in the lower St. Lawrence—it contains marine shells of arctic species. Farther inland—*e. g.*, in western Ontario and in the plains west of Red river—it is not known to hold marine remains.

2. Stratified clays and sandy clays. In the more maritime regions these are the lower and upper *Leda* clays, holding many marine shells of boreal rather than arctic types, especially in the upper part. They also contain locally, drift plants, insects, and land or fresh-water shells, indicating the

* Acadian Geology, 1878, p. 63.

proximity of land clothed with vegetation. In the interior they are, so far as known, destitute of marine remains, but hold remains of land plants and even beds of peat with a few fresh-water shells. These beds are those known in the interior region as "interglacial." They seem to vary much locally in composition and thickness, and are sometimes absent. Where they are absent or replaced by bowlder clay, the latter occasionally contains drift trunks and branches of trees.

3. Sands, coarse clays, and gravels, often stratified, sometimes containing traveled bowlders throughout. In other cases there are bowlders at the base of the deposit and also at its surface, the intervening beds being destitute of bowlders. In the maritime regions these beds often contain marine shells and are the *Saxicava* sands and gravels. Inland they are unfossiliferous or have a few drift plants, sometimes of sufficient importance to be reckoned as a second or upper interglacial bed. These beds constitute the upper or newer bowlder formation. Their traveled bowlders are often of great size, and have been as a whole carried farther and deposited at higher levels than those of the older bowlder formation.

Above the third member are alluvial deposits, lake terraces, gravel ridges and eskers, prairie silt, peat beds, etc., which may be regarded as early modern or post-Glacial.

More detailed descriptions of the Pleistocene deposits of Canada will be found in the author's "Notes on the Post-Pliocene of Canada;"* also in his "Acadian Geology" and "Handbook of Canadian Geology."†

Fossil plants appear in these deposits in various places, from the Atlantic coast to the base of the Rocky Mountains and even in Queen Charlotte's islands; but the species are not numerous, and for the most part those now indigenous to the boreal regions of America, while their state of preservation is usually very imperfect.

As might be expected, vegetable remains in the Pleistocene are not confined to Canada, but occur very extensively in the United States. Whittlesey, Worthen, Andrews, Orton, Newberry, and others have referred to deposits of this kind in Illinois, Indiana, Ohio, and Minnesota; and in the "Proceedings of the American Association" for 1875 Professor N. H. Winchell has summed up what was known up to that date, and has noticed more than fifty localities of the "forest beds," as these accumulations are called. Professor Worthen has recognized two distinct forest beds in Illinois, one immediately below the loess, the other under till or true bowlder clay. The latter he says extends over nearly the whole of central and southern Illinois. Though I have had specimens kindly sent to me by Professor Worthen, Dr. Andrews, and others, I do not propose to enter into any details on these deposits in the United States, but merely to refer to their extension from Canada to the southward as important in a geological sense.

*Canadian Naturalist, new ser., vol. VI, 1871, p. 11, et seq. † Montreal, 1889.

The observed sequence of deposits may be understood by the subjoined sections, which represent respectively the arrangement in the St. Lawrence valley at and below Montreal as observed by the author; that on the north shore of Lake Ontario as given by Dr. J. G. Hinde;* and that in the vicinity of the Belly river, North West Territory, as noted by Dr. G. M. Dawson.†

	Montreal and lower St. Lawrence. J. Wm. Dawson.	*North shore of Lake Ontario.* J. G. Hinde.	*Belly river, North West Territory.* G. M. Dawson.
	I. Surface soil, post-Glacial alluvia and peat.	I. Surface soil, stratified sand, and gravel.	I. Surface soil and prairie alluvium.
Pleistocene.	II. Surface bowlders, *Saxicava* sand and gravel. Bowlders in and below sand.	II. Bowlders, sand, etc. Laminated clay. Bowlder deposit.	II. Upper bowlder deposit.
	III. Upper *Leda* clay, marine shells, and drift plants. Lower *Leda* clay, marine shells, and drift plants.	III. Stratified sand and clay, with fresh-water shells and plants.	III. Gray sand with ironstone nodules. Brownish sandy clay. Carbonaceous layers and peat. Gray sand and ironstone.
	IV. Lower bowlder clay or till. Many native and some traveled bowlders. A few marine shells of arctic species.	IV. Lower bowlder clay or till. Native and traveled bowlders.	IV. Lower bowlder clay. Many traveled bowlders.
	V. Paleozoic rocks, often striated.	V. Paleozoic rocks, often striated.	V. Probably Cretaceous beds.

The above sections show a general correspondence in the series of deposits, except that in the sections on Lake Ontario, especially in that at Scarboro' heights studied by Hinde, we find a division of the upper bowlder deposit not so evident in the other sections.

There is no reason to doubt that the three members of the Pleistocene indicated as II, III, and IV are approximately contemporaneous in the different districts, and that No. III represents the usual interglacial period throughout North America. At the same time it is to be observed (1) that

* Canadian Journal, 1877, p. 339, et seq. † Report Geol. Survey of Canada, 1884, p. 144 C, et seq.

these deposits occur at different levels in the East and in the West; (2) that the lower bowlder clay belongs more especially to the lower levels in the several localities, while the bowlders of the second bowlder period have been carried to higher points; (3) that there is evidence in the interglacial period of the local prevalence of sea and land, of lakes, bogs, and dry ground; (4) that these several conditions may in the course of elevation and subsidence have migrated from one level to another, and (5) that while there is thus a general correspondence, there may have been some local diversity of date and transference of certain conditions of deposit from one locality to another according to the progress of subsidence or elevation.

This is so well illustrated by the observations of Captain Fielden in Grinnell Land, that I quote a part of his statements on the subject, as probably illustrative of the condition of Canada in the Pleistocene period.*

"In Grinnell Land, from lat. 81° 40′ N. to lat. 83° 6′ N., no glaciers descend to the sea, no ice-cap buries the land; valleys from which the snow is in a great measure thawed during July and part of August stretch inland for many miles, and the peaked mountains, snow-clad during the greater portion of the year, in July and August have great portions of their flanks, which rise to an altitude of 2,000 feet, bared of snow.

"The opposite coast of Greenland presents a very different aspect. A mer-de-glace stretches over nearly its entire surface; its fiords are the outlets by which its great glaciers protrude into the sea. In Petermann Fiord the ice-cap, with its blue jagged edge lying flush with the face of the lofty cliffs, was estimated to be forty feet thick.

"When we turn to the flora and fauna of Grinnell Land the difference is equally astonishing; some fifty or sixty flowering plants are found in its valleys, and between latitudes 82° and 83° N. I have seen tracts of land so profusely decked with the blossoms of *Saxifraga oppositifolia* that the purple glow of our heath-clad moors was brought to my recollection.

"Musk oxen in considerable numbers frequent its shores; the Arctic fox, the wolf, and ermine, with thousands of lemmings, live and die there. The bones of these mammals, along with those of the ringed seal (*Phoca hispida*), are now being deposited in considerable quantities in the fluvio-marine beds now forming in the bays and at the outlets of all the streams, or rather summer torrents of Grinnell Land. With these bones will be associated those of birds, such as geese and sea-gulls. Numerous mollusca and crustacea, many species of rhizopods, with the remains of land and sea plants, will there find a resting place.

"Supposing that these beds were examined at some future period under conditions when the glacial epoch had disappeared from the surrounding area, it would be difficult to realize that they were contemporaneous with the beds formed under the Greenland ice-cap in the same parallel of latitude and on the opposite shore of a channel not twenty miles across.

"In the one case enormous thicknesses of till with ice-scratched stones have in all probability been deposited; in the other, fluvio-marine beds containing a comparatively rich assemblage of marine and land forms, with river-rolled pebbles, would be brought to light."

*Proceedings Royal Dublin Society, 1878; see also, Quart. Jour. Geol. Soc., vol. 34, 1878, p. 565, et seq.

Special Localities of Fossil Plants.

The plants referred to in Professor Penhallow's paper are derived in part from deposits belonging to each of the columns in the above table.

(1.) At Green's creek, on the Ottawa river, the *Leda* clay, there containing marine shells (*Leda arctica*, etc.) and bones of *Capelin* in nodules in the clay, has in its lower part nodules with leaves, seeds, and fragments of wood. These have been collected by the late Mr. Billings, Dr. R. Bell, the late Sheriff Dickson, of Kingston, the late Mr. J. G. Miller, and the writer, and were noticed in a paper by the writer on the "Evidence of fossil plants as to the climate of the Post-Pliocene in Canada," published in the Canadian Naturalist in 1866. These constitute a considerable part of the specimens described below. A few specimens of wood have also been found and noticed by the writer in the *Leda* clay of Montreal, and the available collections have been augmented since 1866 by additional specimens from Green's creek acquired by the Peter Redpath Museum of McGill University.

(2.) The interesting deposits at Scarboro' heights and elsewhere on Lake Ontario were described by Dr. J. G. Hinde in the Canadian Journal in 1877, and he notices the following plants as found by him:

Wood of pine and cedar.
Portions of leaves of rushes, etc.
Seeds of various plants.
Hypnum commutatum.
H. revolvens.
Fontinalis.
Bryum.
Chara, sp.

More recently Mr. J. Townsend, of Toronto, was so fortunate as to find leaves and fragments of wood with shells of *Melania* and *Cyclas*, in beds apparently of the same age, in excavations in progress on the River Don, at Toronto. These collections have been acquired for the Peter Redpath Museum. The section observed at this place is given as follows by Mr. Townsend:

The locality of the principal vegetable specimens was 150 feet from the bank of the Don, and in a cutting 70 feet deep. The section showed 26 feet of fine light-colored sand with layers of clay at bottom. Below this were 24 feet of tough stratified blue clay, the "Erie clay" of the region. At the base of this clay is a seam of reddish ferruginous sand about three feet thick, and with argillaceous nodules in which was the maple leaf described by Professor Penhallow. Below this sand were sixteen feet of alternating sand and dark-colored clay, with fresh-water shells and wood. Below this was the blue till resting on the surface of the Hudson river beds. In this section

the upper bowlder clay of Hinde's section is not represented, but only the groups III and IV as given in the table. The upper bowlder clay is, however, seen on higher ground in the vicinity.

Dr. J. W. Spencer, who has studied this locality, as well as the whole north shore of Lake Ontario, writes to me that he regards the earthy sand holding wood and fresh-water shells as equivalent to Hinde's "interglacial" beds at Scarboro' heights, and the overlying clay as the so-called "Erie clay," over which, as above stated, is the upper bowlder deposit which in the vicinity of Toronto has many Laurentian bowlders.

(3.) Many observations have been made on the interglacial beds by Dr. G. M. Dawson, and are recorded with sections in his reports on the 49th Parallel and on the geology of the Bow and Belly rivers, and in a paper on borings made in Manitoba and the North West Territories in Vol. IV of the Transactions of the Royal Society of Canada; and he has placed in our hands specimens of peat and wood from those regions. In one locality on the Belly river he finds a bed of interglacial peat hardened by pressure in such a manner as to assume the appearance of a lignite.

(4.) In addition to the vegetable remains found as above stated in the "forest beds" or "interglacial" deposits, trunks of trees and vegetable fragments occur in the bowlder clays themselves, indicating either the partial destruction of the older interglacial bed and the mixture of its débris with glacial deposits, or the enclosure of drift-wood in the latter in the manner now so common in the arctic regions and described by so many arctic explorers.* This raises very interesting questions respecting the origin of the bowlder clay, to be noticed in the sequel.

One of the most marked illustrations is that of the boring at Solsgirth, in Manitoba, on the Manitoba and Northwestern railway, and at an elevation of 1,757 feet above the sea.† At this place the section is as follows:

	Feet.
1. Loam	2
2. Hard blue clay and gravel	42
3. Hard blue clay and stones	10
4. Hard yellow "hard pan"	12
5. Softer bluish clay	16
6. " " "	74
7. Sand with water	--
8. Blue clay with stones	136
9. Gray clay or shale (Cretaceous?)	68
	360

Fragments of wood, more or less decayed and compressed, were obtained from depths of 96, 107, 120, and 135 feet from the surface. They were thus distributed through a considerable thickness of the clay rather than in a

* See Manual of the Natural History, Geology, and Physics of Greenland, by Professor T. R. Jones, issued by the Royal Society of London, 1875, index—"Driftwood."

† Dr. G. M. Dawson, Trans. Royal Society Canada, vol. IV, 1887, sec. IV, p. 91, et seq.

distinct interglacial deposit. It is to be observed, however, they were included within the central part characterized as a softer blue clay, between two beds apparently harder and more stony.

Additional specimens from this place have recently been obtained by Mr. J. B. Tyrrell, of the Geological Survey of Canada, and have been kindly communicated to us. Mr. Tyrrell has also found vegetable remains in a bed under the bowlder clay at Rolling river, Manitoba, which are noticed in Professor Penhallow's paper. They were accompanied with fresh-water shells of the following species, determined by Mr. Whiteaves, F. G. S., Palæontologist to the Geological Survey of Canada:

Lymnea catascopium ?, variety with very short spire.
Valvata tricarinata, and a keelless variety.
Amnicola porata ?
Planorbis parvus?
P. bicarinatus.
Pisidium abditum.
Sphœrium striatinum.

With these was the centrum of a vertebra of a small fish.

(5.) The most western locality of bowlder clay with plants is that described by Dr. G. M. Dawson in the vicinity of Skidegate, Queen Charlotte's islands. At this place hard bowlder clay is overlain by stratified sand and gravel, ten to fifteen feet in thickness. The bowlder clay in places shows bedding and holds a few marine shells (*Leda fossa*, etc.). In tracing the bed along the coast the shells disappear and the clay is found to contain fragments of decayed and partially lignitized wood. Specimens of this were collected, but appear to have been mislaid and could not be found in time for this paper.*

(6.) The most eastern locality from which I have collected Pleistocene plant remains is that on the northwest arm of the River Inhabitants in Cape Breton, described in "Acadian Geology," p. 63. This is a hardened peaty bed resting on a gray clay and overlain by twenty feet of till or bowlder clay, apparently the lower bowlder clay. It is quite hard and burns with flame in the manner of a lignite, and contains twigs and branches of coniferous trees and a great variety of fibrous and epidermal tissues apparently of swamp vegetation, which have been examined by Professor Penhallow. This locality is of special interest as showing a bed of vegetables evidently not drifted and under the till or bowlder clay. It shows that this was deposited on what had been a land surface and under circumstances which did not disturb a bed of soft vegetable matter. It indicates also a mild climate preceding the deposit of the bowlder clay rather than an interglacial period. There was no evidence in this case of any land-slip or other accidental disturbance, but rather of successive depositions.

* Report Geol. Survey of Canada, 1878–'9, p. 91B.

With reference to these I shall first refer to the district from the Atlantic to the head of Lake Ontario.

In this district and the eastern part of North America generally, it is, I think, universally admitted that the later Pliocene period was one of continental elevation, and probably of temperate climate. The evidence of this is too well known to require re-statement here. It is also evident, from the raised beaches holding marine shells, extending to elevations of 600 feet, and from bowlder drift reaching to a far greater height, that extensive submergence occurred in the middle and later Pleistocene. This was the age of the marine *Leda* clays and *Saxicava* sands found at heights of 600 feet above the sea in the St. Lawrence valley nearly as far west as Lake Ontario.

It is reasonable to conclude that the till or bowlder clay under the *Leda* clay belongs to the intervening period of probably gradual subsidence, accompanied with a severe climate and with snow and glaciers on all the higher grounds, sending glaciated stones into the sea. This deduction agrees with the marine shells, bryozoa, and cirripedes found in the bowlder deposits on the lower St. Lawrence, with the unoxidized character of the mass, which proves subaquatic deposition, with the fact that it contains soft bowlders, which would have crumbled if exposed to the air, with its limitation to the lower levels and absence on the hill-sides, and with the prevalent direction of striation and bowlder drift from the northeast.*

All these indications coincide with the conditions of the modern bowlder drift on the lower St. Lawrence and in the arctic regions, where the great belts and ridges of bowlders accumulated by the coast ice would, if the coast were sinking, climb upward and be filled in with mud, forming a continuous sheet of bowlder deposit similar to that which has accumulated and is accumulating on the shores of Smith's sound and elsewhere in the arctic, and which, like the older bowlder clay, is known to contain both marine shells and drift-wood.†

The conditions of the deposit of till diminished in intensity as the subsidence continued. The gathering ground of local glaciers was lessened, the ice was no longer limited to narrow sounds, but had a wider scope as well as a freer drift to the southward, and the climate seems to have been improved. The clays deposited had few bowlders and many marine shells, and to the west and north there were deposits of land plants, and on land elevated above the water peaty deposits accumulated.

The shells of the *Leda* clay indicate depths of less than 100 fathoms. The numerous foraminifera, so far as have been observed, belong to this range,

* Notes on the Post-Pliocene: Canadian Naturalist, op. cit.: also paper by the author on Bowlder Drift at Metis, Canadian Record of Science, Vol. II, 1886, p. 36, et seq.
† For references, see Royal Society's Arctic Manual, London, 1875, op. cit.

and I have never seen in the *Leda* clay the assemblage of foraminiferal forms now dredged from 200 to 300 fathoms in the Gulf of St. Lawrence.

I infer that the subsidence of the *Leda* clay period and of the interglacial beds of Ontario belongs to the time of the sea beaches from 450 to 600 feet in height, which are so marked and extensive as to indicate a period of repose. In this period there were marine conditions in the lower and middle St. Lawrence and in the Ottawa valley, and swamps and lakes on the upper Ottawa and the western end of Lake Ontario; and it was at this time that the plants described in this paper occupied the country. It is quite probable, nay certain, that during this interglacial period re-elevation had set in, since the upper *Leda* clay and the *Saxicava* sand indicate shallowing water, and during this re-elevation the plant-covered surface would extend to lower levels.

This, however, must have been followed by a second subsidence, since the water-worn gravels and loose, far-traveled bowlders of the later drift rose to heights never reached by the till or the *Leda* clay, and attained to the tops of the highest hills of the St. Lawrence valley, 1,200 feet in height, and elsewhere to still greater elevations. This second bowlder drift must have been wholly marine, and probably not of long duration. It shows no evidence of colder climate than that now prevalent, nor of extensive glaciers on the mountains; and it was followed by a paroxysmal elevation in successive stages till the land attained even more that its present height, as subsidence is known to have been proceeding in modern times.

The above sequence applies to the districts of Ontario, Quebec, the arctic coast, and the maritime provinces, and might be illustrated by a great accumulation of facts; but these may be found in papers published in the Canadian Naturalist and the Canadian Record of Science and in the reports of the Geological Survey, more especially those by Dr. G. M. Dawson, Mr. Chalmers, and the writer.

For the region between the great lakes and the Rocky Mountains and for the Pacific coast the sequence is similar, but either the interior region has experienced a greater elevation or the times must have been somewhat different. In the mountainous regions of the west, also, more especially in the interior of British Columbia, the evidence of great local glaciers is much more pronounced than on our lower mountains of the east.*

I am quite aware that the above sequence and the causes assumed are somewhat different from those held by many geologists with reference to regions south of Canada, but must hold that they are the only rational conclusions which can be propounded with reference to the facts observed from the parallel of 45° to the Arctic ocean.

* G. M. Dawson, Superficial Geology of British Columbia: Quart. Jour. Geol. Soc., vol. 34, 1878, p. 89, et seq.; ibid, vol. 37, 1881, p. 272, et seq.

One other point remains to be illustrated with reference to the local origin of the vegetable remains. Where these consist of trunks and branches and are contained in the bowlder-bearing beds, they may, like those found under similar conditions in the arctic, be drift-wood, derived from great distances and in a condition of partial submergence of the continent. The facility for such distribution must, in the Pleistocene age, have been greater than it now is in the arctic, where there is, according to the testimony of voyagers, not only a great quantity of such material on the shore, but mixed with clay and bowlders at some distance inland. There is reason to believe that throughout Canada such drift-wood may be found here and there in both the upper and lower bowlder deposits.

Where, however, we have leaves and other perishable parts, and especially where there are peat beds and peaty soils, or where the vegetable remains are associated with fresh-water shells, the case is different. We have in these circumstances evidence of the local flora, and cannot doubt that the climate must have been sufficiently mild to permit the growth *in situ* of the plants whose remains are found. So far as we know at present, evidence of this kind applies, *first*, to the land surfaces anterior to the earlier bowlder deposit; *secondly*, to the swamps and uplands of the *Leda* clay and "interglacial" period; and, *thirdly*, to the early modern time succeeding the upper bowlder drift. The plants specially referred to in the following notes are, so far as known, those of the second of the above periods.

In conclusion, it is deserving of notice that the plants indicated in Professor Penhallow's lists are not an arctic assemblage, but rather a part of the cold temperate flora. They scarcely indicate so much refrigeration as that evidenced by the plants from British interglacial beds as described by Carruthers.* Further, as the species referred to are either local or drifted by streams from the north, it follows that the arctic flora must have existed to the north of the Canadian localities referred to. This accords with the fact proved by arctic explorers and the officers of the Geological Survey of Canada,† that in the glacial period striation and driftage of bowlders point to drift toward the arctic basin as well as toward the south. Thus, when these plants flourished in Canada, there must have been open water and a land flora in the arctic basin—conditions, of course, altogether incompatible with the existence of a polar ice-cap, though not inconsistent with the occurrence of glaciers in the more elevated districts or those cooled by the cold arctic currents. That the climate was colder, locally at least, in the period of the bowlder clay need not be doubted, but there is reason to believe that the general difference of temperature in the so-called interglacial period as compared with that of the bowlder clay has been greatly exaggerated.

* British Association Report, 1886, pp. 683; Dawson, "Geological History of Plants," 1888, pp. 225.
† G. M. Dawson, Geology of Northern Part of Canada, Report Geological Survey of Canada, 1887, p. 51, et seq.

II. *NOTES ON THE PLEISTOCENE PLANTS. BY D. P. PENHALLOW.*

The Pleistocene plants submitted to the author by Sir William Dawson and described in this paper, are chiefly from collections made by Dr. G. M. Dawson and Mr. J. B. Tyrrell, of the Geological Survey of Canada, and by Mr. J. Townsend, with specimens from different localities in the collections of Sir William Dawson, now in the Peter Redpath Museum of McGill University. A few are donations from Messrs. Worthen and Andrews from localities in the United States. These latter will be but briefly referred to, as the precise formation in which they occurred is not wholly free from doubt. Some of the material is of recent collection and until now undescribed. Other specimens were collected at least twenty years ago, and have already been more or less fully described* by Sir William Dawson. These I have submitted to examination for the purpose of verification, and now present in the following statement.

Annotated List of Canadian Plants.

TAXUS BACCATA, L.

The material representing this species was embraced in several slides, which I have designated by the numbers 1, 2, and 3, and by specimens of wood, which have also been numbered as follows:

No. 1. A section taken from a specimen from the Don river, Toronto. The structure is fairly well preserved, and shows the characteristic structure of *Taxus*.

No. 2. A longitudinal section of a specimen from Solsgirth, Manitoba, taken from the bowlder clay of a well at a depth of 135 feet.† The structure is well preserved, and the taxine characters of the wood are more clearly recognizable than in the preceding.

No. 3. Transverse section of a specimen also from Solsgirth, Manitoba. The section is cut diagonally, but as the structure is well preserved the characters are recognizable.

No. 4. A fragment of wood about one and one-half inches square, much compressed, and evidently the nodal portion of a small stem or branch. It was collected in 1887 by Mr. Tyrrell from the till formation of the Solsgirth well. It is readily softened in hot potash, but the whole structure is badly decayed and much distorted by compression. It everywhere shows coniferous markings, and where more fully preserved the structure of *Taxus* is plainly seen.

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*Can. Nat., Vol. II, 1857, p. 522; ibid., New Ser., Vol. III, 1870, p. 69; ibid., Vol. VI, 1871, p. 403.
†Trans. Roy. Soc. Can., Vol. IV, Pt. IV, 1886, p. 92.

No. 5. A specimen from the same locality by the same collector as above. It represents the broken end of a branch or small trunk about two inches in diameter. The form has suffered little change, and to the surface there still adhere small pieces of bark. The preservation of this specimen is so distinct from that of the others as to lead to the supposition, upon external examination, that it is a distinct kind of wood. It shows everywhere the effects of advanced decay, and it is also impregnated to some extent with silica. This condition of preservation rendered it extremely difficult to obtain longitudinal sections and impossible to get transverse sections. The former, which were secured in small fragments, were sufficient to place the coniferous character of the wood beyond dispute, and in places the spiral structure of *Taxus* was evident.

In a recent communication, Mr. Tyrrell stated that specimen No. 4 was obtained from a depth of 360 feet, and that No. 5 was exceedingly soft when found; but the precise depth at which it occurred is not known, though probably one of those depths at which wood occurred as mentioned in the report of Dr. G. M. Dawson.*

No. 6. Embraces two small fragments of wood about one-half inch square and strongly compressed; also three slides of the same. This material was collected by Mr. J. B. Tyrrell, in 1887, from the drift of Rolling river, two miles above Heart hill, Manitoba.

Fresh sections were cut, but the material was in such an advanced state of decay that the treatment with potash had to be applied cautiously, and microscopical examination showed that it had also resulted in the removal of a large part of the structure of the cell walls, of which, in most cases, only the primary cell wall remained. The characteristic markings of coniferous wood were thus in many cases wholly removed, but in places, where the action of decay was more limited, the markings peculiar to *Taxus* were observed.

7. Another specimen of *Taxus* from peat below bowlder clay on the River Inhabitants, Cape Breton, obtained by Sir William Dawson, and now in the collection of the Peter Redpath Museum, has been examined. It is a fragment of a branch about three-fourths of an inch in diameter and six inches long, much flattened by pressure. The structure shows it to be a *Taxus*, but presenting some aspects different from those of our modern species. These may have resulted from local conditions, since the wood rings show it to have grown very slowly, as if in a situation unfavorable to it. A more critical examination will be made later; for the present I refer it to *T. baccata* provisionally.

The modern Canadian species of *Taxus* are *T. brevifolia*, Nutt., and *T. baccata*, L., var. *Canadensis*, Gray. To the first, none of the specimens described

*Ibid.

can be referred, as they differ from it in a somewhat marked manner; but they do approach the latter species, to which I shall therefore refer them. *Taxus baccata* is now found extending from Newfoundland, Anticosti, and Nova Scotia, where it is abundant, through New Brunswick, Quebec, and Ontario. On the shore of Lake Huron it often forms impenetrable thickets. Passing to the west it still continues abundant north of Lake Superior, and at least to Lake Winnipeg, according to Macoun.*

ASIMINA TRILOBA, DUNAL.

The specimen of this fossil is from the Pleistocene of the Don river, Toronto, having been collected in 1887, by Mr. J. Townsend, from a cut at Jail hill, at a depth of sixty-six feet below the surface, and from below the Erie clay of that locality. It is about six inches long by two wide, and evidently was derived from a tree of small diameter, as indicated by the curvature of the growth rings. In its general aspect it bears a very strong resemblance to the wood of our modern *Asimina triloba*, with which it is also closely comparable in its minute structure. It presents certain differences in detail—*e. g.*, the development of the thyloses is much more strongly marked, the wood cells are of smaller diameter, and there are also certain differences in the markings of the vessels. Alteration under the conditions established by its long burial may account for some of these, and perhaps none of them are sufficient to mark a distinct species. I would therefore assign it for the present to our modern species of *A. triloba*.

The material was well preserved, and all the details of structure could be distinguished without difficulty. By boiling in potash, sections were as readily cut as if taken from fresh material.

At present *Asimina triloba*, the only species found within Canadian limits, occurs in Ontario, at Queenstown heights. It is very abundant at Point Pelée and in the townships bordering on Lake Erie between that point and Amherstburg. Doubtless it is not rare along Lake Erie, though not yet reported (Macoun).

ULMUS RACEMOSA, THOMAS.

This fossil is represented by two specimens, numbered 2 and 3.

No. 2 is twelve by six inches, and evidently derived from a somewhat large tree. It was obtained in 1887 from a cutting on the Don river, from beneath the Erie clay, at a depth of sixty-six feet from the surface, and associated with the previously described species.

The material is fairly well preserved, though showing the effects of decay in the exfoliation of the growth layers; while under the microscope the dis-

*The occurrence of *Taxus baccata* in the Pleistocene deposits of Manitoba has been noticed by Dr. G. M. Dawson in the Transactions of the Royal Society of Canada, vol. IV, part IV, 1886, p. 92.

torted structure shows the effect of compression, which has turned all the medullary rays off obliquely. This, together with compression of the vessels and wood parenchyma, has resulted in the groups of wood cells being distributed in the form of diamond-shaped masses, which are at first very misleading as to the true character of the wood. In consequence of these alterations it was impossible to cut truly radial or tangential sections. The material submits readily to the action of potash, whereby sections are easily cut.

No. 3 was obtained from the same locality as the preceding, and about two feet below a band of sand containing leaves. It appears to be one side of the stump of a small tree, as it shows the spreading base usually found at the point where the roots separate. It is four inches long by three and one-half wide at the widest part. Portions boiled in caustic potash gave very fine sections, and showed the structure to be not only well preserved, but also largely free from the effects of compression, so that the distribution of the tissues could be readily determined. The compactness of the structure, as well as the very small, thick-walled cells, shows it to have been a very hard wood. Both of these specimens (2 and 3) are identical. They present the unmistakable structure of the genus *Ulmus*, of which *U. fulva*, Michx., *U. americana*, L., and *U. racemosa* are at present found in Canada.

A close comparison with these different species shows that the fossils so nearly approach *U. racemosa* as to admit of referring them to that species.

Within Canadian limits, *U. racemosa* is rather rare in the eastern townships, Quebec, extending thence westward throughout Ontario, in the limestone areas. It seems to be confined to dry, gravelly soils, and is usually associated with sugar maple in such localities. It was formerly very common, according to Macoun.

GEN. AND SP. IND.

Three sections of wood—one transverse and two radial—from the interglacial at Solsgirth, Manitoba, collected by Dr. G. M. Dawson. The plant was evidently exogenous. It was either very soft in its original state, or, as seems more probable, the sections present the remnants of decayed tissue. At all events, the state of preservation was such as to prevent correct determination.

THUYA OCCIDENTALIS, L.

A small fragment of wood, about one-fourth of an inch in diameter and an inch and one-quarter long, from the *Leda* clays, Montreal (collection of Sir William Dawson). This species extends from New England, throughout Quebec and Ontario, northward to within twenty miles of Lake Mistassini, to James's bay and in the neighborhood of Moose factory. The northern

limit crosses the Albany at some distance from the sea, extending westward to a point about seventy-five miles southwest of Trout lake, thence southward to Lake Winnipeg and the United States boundary. It is one of the trees most likely to be found in this formation. This species has been recognized by Sir William Dawson in the drift of the Roseau river, Manitoba, and of Montreal (*Leda* clay) and the Ottawa river.*

ELODEA CANADENSIS (?), MICHX.

A specimen of soft stone bearing the impress of a small branching plant and the carbonized remains of another of the same kind. This was from the collection of Mr. Tyrrell, made in 1887, and obtained from Rolling river, Manitoba, two miles above Heart hill. A slide of the same plant and from the same locality, from Dr. G. M. Dawson, shows the plant to have been herbaceous, but with a distinctly vascular axis, the wood cells of which are thin walled and with rather blunt terminations. This vascular structure is surrounded on all sides by a distinctly parenchymatous structure. Associated with this plant are many diatomaceous remains belonging to fresh-water species, among which I have recognized *Navicula lata*, *N. legunen*, *Encyonema prostratum*, *Denticula lauta*, and various species of *Licmophori* (?) and *Cocconeis*. It is therefore clear that the plant is not a seaweed. The distinctly branching habit and the structure suggest *Elodea*, although the state of preservation is not such as to render exact comparison possible. I therefore refer it provisionally to our common Canadian species, *E. canadensis*, which is everywhere found in fresh water.

VALLISNERIA (?).

Several fragments of the same earthy material as above, bearing each a small fragment of a leaf. This is in each case linear, with a well-rounded apex, and usually about 2.5 mm. wide. The epidermis is apparent under a pocket lens. In fact the remains appear to consist wholly of the two epidermal layers, which may be separated readily. Under the microscope the epidermal cells are found to be well preserved. No stomata have been found, and this, together with the presence of fresh-water diatoms, would indicate that it must have been a submerged, aquatic plant. The structure strongly reminds one of *Vallisneria*, to which I shall provisionally refer it. This plant is everywhere common in fresh water, and is very likely to have occurred in such a locality as that from which the fossil was obtained.

CAREX MAGELLANICA, LAMARCK.

The Green's creek nodules contain an abundance of leaves, evidently of grasses and sedges. In one nodule from the Miller collection and in two

*Can. Nat., New Ser., Vol. III, 1868, p. 72; Report on 49th Parallel, 1875, p. 214; Notes on Post-Pliocene, op. cit., 1871, p. 404.

belonging to the collection of Mr. John Stewart, of Ottawa, there were found portions of old spikes devoid of seeds, but with the persistent glumes widely spread, evidently the remains of a *Carex*. In other nodules belonging to the Miller collection in the Peter Redpath Museum, there were found complete spikes containing the seeds, apparently the same as the preceding. In both cases the resemblance to *Carex magellanica* is so marked that I have ventured to refer them to it.

At present this species is found in peat bogs from Newfoundland to Vancouver.

BRASENIA PELTATA, PURSH.

This is evidently an undeveloped leaf, of which only one-half, embracing the stump of the petiole, is represented. The form and, to some extent, the venation show its probable relation to the species above named.

Brasenia peltata occurs at Rocky lake, Nova Scotia; Grand lake, New Brunswick; Point St. Charles, Montreal; River Range; and is abundant throughout the northern counties of Ontario, and about Rainy lake and Lake of the Woods, according to Macoun.

LARIX AMERICANA, MICHX.

Several small branches about three inches or less in length and from one-third to three-fourths of an inch in diameter, from the Geological Survey of Canada, through Sir William Dawson. They were collected by Mr. J. C. Weston from the *Leda* clays in Peel's clay pit, Montreal. The structure is fairly well preserved and recognisable without difficulty.

In its present distribution, *Larix americana* is common in all swampy ground from Newfoundland and Labrador, through the eastern provinces, to the foot of the Rocky Mountains; northward to latitude 65°.

POPULUS GRANDIDENTATA, MICHX.

Base of a small stem or branch about two and one-half inches long. The structure is quite well preserved and readily comparable with the above species. It was obtained from the *Leda* clays of Montreal by Mr. J. C. Weston, and transmitted to me from the Geological Survey of Canada by Sir William Dawson. Also in nodules from Green's creek, Ottawa, now in the collection of Mr. J. Stewart, small branches of this same species were found.

Populus grandidentata is common in Nova Scotia and New Brunswick, as also throughout Quebec and Ontario.

POTAMOGETON RUTILANS (?), WOLFGANG.

A single specimen in a Green's creek nodule from the collection of Mr. J. Stewart. It embraces the stem and several leaves.

This species is at present known only near Red Rock, Lake Superior, and on Twin island, James's bay; in marshes on Anticosti; and at the mouth of the Nipigon river (Macoun). It would therefore appear probable that it was more abundant in the past than at present.

EQUISETUM LIMOSUM (?), L.

E. SYLVATICUM (?), L.

Fragments of plants with lateral members in whorls were frequently met with and, although not satisfactorily referable to any modern genus, presented the closest resemblance to the two species of *Equisetum* above named, to which they are provisionally referred.

MENYANTHES TRIFOLIATA, L.

A specimen of the *Leda* clays from Montreal, now in the Peter Redpath Museum, shows the remains of a plant of which only the basal portion is preserved. This consists of a central axis from which rather stout lateral members are developed at right angles, and from which in turn are produced numerous fine roots. The specimens are of small diameter, but from their evidently shrunken character must represent the remains of plants approaching one-quarter of an inch in diameter. Although not clearly referable to any existing species, the resemblance to the stem of *Menyanthes trifoliata* is very striking, and in all probability it represents a similar underground stem with its roots developed at right angles to the axis of growth. The absence of leaves renders a more accurate determination at present impossible.

Description of New Species.

ACER PLEISTOCENICUM, SP. NOV.

This fossil was recently obtained by Mr. Townsend from the Pleistocene of the Don river, Toronto, and was purchased by Sir Willam Dawson with other specimens and presented to the Peter Redpath Museum. Though not perfect as to form, the leaf is beautifully cast in an argillaceous nodule, and shows several details of venation quite perfectly. A drawing, giving a restoration of the leaf, is herewith presented. From this it will be seen that the left half of the blade is nearly intact, while of the right half only about two-thirds remain, the lobes being entirely cut off by fracture of the matrix.

The leaf is evidently that of a maple, although of a type quite distinct from any of our existing forms. As will appear from the figure, the general

form and venation suggest *Platanus*, and a specific name indicating this resemblance would be appropriate, were not some of the existing species already so distinguished. It is to be regretted that this is the only specimen so far found in a fairly complete condition, since it is unsatisfactory to base conclusions upon a single specimen where there is opportunity for variation.

The modern maples with which the fossil is most nearly comparable are *Acer rubrum* and *A. platanoides*. In its general outline, the fossil is broadly

FIGURE 1.—*Acer pleistocenicum.*

ovate and, if we follow the same rule as in other maple leaves in respect to the number of lobes being determined by the palmate distribution of the principal veins, three lobed; but the terminal lobe has two prominent lateral lobes, while the others have each a small basal lobe, all somewhat strongly defined and making the leaf appear seven lobed. The lobes are all very

acute. The margin is entire with the exception of two teeth, one on each side and situated midway between each lateral lobe and its inferior lobe. The sinuses are open, shallow, and well rounded. In many of these respects it approaches *Acer platanoides*, from which it differs in its much broader terminal lobe and in the broader and more shallow sinuses.

The venation is most nearly comparable with that of *Acer rubrum*, where, as in the fossil, only two veins are arranged palmately with the midrib, and from these branch smaller veins which run to the small basal lobes.

The second and third veins, lateral to the midrib, run to the principal sinus of each side, where they terminate near the margin by repeated dichotomous branching. This, however, is common to several of the modern maples. The finer venation is essentially the same as in our modern maples.

It would appear from this that the fossil cannot be properly referred to any of our existing species, and it appears desirable to give it a distinctive name. I therefore propose to call it *Acer pleistocenicum*, as properly descriptive.

Revision of previously recorded Pleistocene Plants.

The following specimens from Green's creek, as referred to by Sir William Dawson in the preceding pages, have already been partially determined by him and published in 1868, with figures of some of the species.* The present revision shows a few changes and includes a few specimens not originally noted, and which have been acquired by the Redpath Museum from the collection of the late Mr. J. G. Miller since the publication of Sir William Dawson's paper.

DROSERA ROTUNDIFOLIA, L.

A nodule containing a single specimen of what appears to be a leaf of this plant, showing marginal projections and surface markings bearing somewhat close resemblance to the glandular hairs. Its association with the fertile spike of an *Equisetum* shows it to have been a habitant of moist places such as are usually favorable to its abundant development. It is a species very commonly distributed throughout Canada.

ACER SACCHARINUM, WANG.

A basal fragment of a leaf in a nodule. This specimen was originally designated † as *A. montanum*, Ait. (*A. spicatum*, Lamx). The only data on which a determination is possible are to be found in the angles at which the veins separate and in the number and distribution of such veins. With reference to the first, it is to be observed that the angles of the veins with

* Can. Nat., New Ser, Vol. III, p. 70 et seq.
† Ibid.

the midrib vary considerably in the same species, so that this cannot be regarded as a character of more than approximate value. The number and distribution of the veins offers a somewhat more reliable guide, since there is a constancy in this respect which is of value. The majority of our maples fall in one of two types. In the first case, four principal veins are arranged palmately with the midrib, and directly extend to as many distinct lobes of the leaf, the first pair usually extending horizontally or obliquely downward to the basal lobes. To this type can be referred such species as *Acer platanoides* and *A. saccharinum*. In the second case, only two principal veins are directly and palmately arranged with the midrib, while from each of them there springs a subordinate vein at a short distance from the base, which then extends to the corresponding basal lobe. Examples of this type are to be seen in *Acer rubrum* and *A. dasycarpum*, as well as in the fossil *A. plestocenicum*.

In the fossil under consideration there are four distinct veins palmately arranged with the midrib, two of which are large, and the other two running to the basal lobes. It will thus be seen that comparison with *Acer montanum* cannot be considered. A close comparison with the leaves of the first group shows that it approaches most nearly to *Acer saccharinum* in all those characters represented.

The present distribution of *A. saccharinum* covers a wide range throughout Canada, from Newfoundland and Nova Scotia to the western extremity of Lake Superior, and northward to Lake St. John and to the Long portage on the Michipicoten river.

POTENTILLA ANSERINA, L.

Two specimens and their reverses in nodules previously determined* as *Potentilla canadensis* and *P. norvegica*, and also a specimen and its reverse in Mr. Miller's collection in the Peter Redpath Museum. The leaves only are represented, but the venation is so distinctly preserved, as well as the general form and margin, as to leave little doubt as to their true character, although in one case they are so grouped by crushing as to bear a certain resemblance to the leaf of *P. canadensis*. In this species the veins run directly from the midrib of the leaflet to both teeth and sinuses. In *P. norvegica* the veins run to the teeth, taking a direction which tends to become parallel with the margin, and while the vein itself extends into a tooth it gives off a lateral which penetrates the tooth below, so that there are in reality twice as many teeth as veins. The fossils, which in this respect as in others are all similar, show the veins running directly to every tooth, veins and teeth being equal in number.

In this respect, as well as in the form of the leaflet, the shape and apices

* Can. Nat., New Ser., Vol. III, 1868, p. 70.

of the teeth and their inclination to the midrib, the fossil corresponds most closely with *P. anserina*, to which I therefore refer them. At present this species is very abundant along the eastern coast and on the margins of rivers and lakes throughout the interior and as far north as the Arctic sea.

GAYLUSSACIA RESINOSA, TORR. AND GRAY.

A well-preserved leaf in a nodule. This shows the form of the leaf, and the resinous dots are so perfectly seen as to render it readily determinable. This species is now found in rocky or sandy woodlands and in bogs, from Newfoundland and Nova Scotia to the Saskatchewan.

POPULUS BALSAMIFERA, L.

The material representing this species is embraced in leaves and fragments of branches contained in nodules. The former are in most cases well preserved and admit of easy identification. As noted in the original description, however, the leaves are all small, and assuming them to be mature this would indicate a cold climate or very exposed situations. At present *P. balsamifera* is of very wide distribution throughout Canada, extending northward to the mouth of the Mackenzie river, where it attains large size, and is an important source of fuel (Macoun).

POTAMOGETON PERFOLIATUS, L.

Portions of leaves and seeds in nodules. The venation is beautifully distinct, and it is without much doubt referable to the species named. This is one of our most common water weeds, being found everywhere in the streams of the northern United States and Canada.

POTAMOGETON PUSILLUS, L.

This is one of the most abundant plants contained in the nodules from Green's creek. The specimens all show a branching plant with narrow leaves. This species is now common in slow streams and ditches almost everywhere.

EQUISETUM SCIRPOIDES, MICHX.

Common in the nodules from Green's creek, and associated with *Potentilla anserina*. This is a widely distributed species, and would naturally occur among such plants as are found at the above locality.

There is also another nodule containing a portion of a stem cut longitudinally. It has the appearance of an *Equisetum*, and may possibly be referred to one of the larger species, such as *E. palustre* or *E. limosum*.

ORYZOPSIS ASPERIFOLIA, MICHX.

A fragment of a leaf and stem in a nodule, showing features which make them correspond closely with *Oryzopsis asperifolia*, and to which I therefore

refer them. This species is a widely extended one, being found from Newfoundland to the Rocky Mountains.

FUCUS.

A specimen of a seaweed in a nodule, evidently a *Fucus*. It is not strictly comparable with any of our modern species, and until more material is obtained it seems best not to assign any specific name to it, although *digitatus* would appear to be appropriate.

FONTINALIS.

Fragments of mosses are common in the nodules from Green's creek. These appear to be chiefly of the genus *Fontinalis*, or one nearly related to it.

In addition to the above there were also found in the Green's creek nodules various seeds. These require some further examination.

BROMUS CILIATUS, L.

A fragment of a leaf which shows a venation closely corresponding to *Bromus ciliatus*, to which I would for the present refer it. This is a very common species in thickets and damp places throughout Canada. The specimen was collected by Mr. J. G. Miller from Green's creek.

GEN. AND SP. UND.

Among the specimens sent us by Dr. G. M. Dawson was a seed collected by Mr. J. B. Tyrrell, in 1887, from the Rolling river, Manitoba, two miles above Heart hill. The form and size seem to indicate that it is the seed of a Conifer.

Lignites.

A sample of lignite or indurated peat, collected by Dr. G. M. Dawson from the interglacial deposits of Belly river, was presented in the form of balsam mounts and loose material, all of which had been treated with potash, nitric acid, sulphuric acid, or chromic acid. In all cases the material was found to be very finely divided, none of the fragments being of sufficient size to make reference to particular orders or genera possible. It was, however, quite possible to recognize fragments of sclerenchyma tissue, fragments of wood cells, spores of ferns, and what appeared to be the extine of pollen grains. These latter, together with the few spores, constituted the bulk of the recognizable material. There were also to be observed fragments of epidermis, apparently of three different kinds, and in one instance two stomata were found, though imperfectly preserved. The impression gained from a careful examination of a large amount of material is that the

peat consists of the remains of ferns and herbaceous or semi-woody plants. No more definite statement can be made until other material is examined.

A specimen of lignite from Cape Breton was also submitted to examination. This material was described some years since by Sir William Dawson,* and is also noted in the preceding pages of this paper by him. Boiled out in potash, there have been found in it an abundance of fungus hyphæ, the extine of coniferous pollen, bast cells, sclerenchyma tissue of ferns, epidermis apparently of ferns, wood cells showing a portion of a medullary ray, and fragments of endogenous stems. This is all that could be found after searching through a large amount of material, and the conclusion was reached that the lignite represents the remains of ferns and grasses with fragments of woody plants, possibly from a more elevated and less wet locality.

Woods from Illinois.

In addition to the specimens above described, I have also examined three slides of coniferous wood from Bloomington, Illinois.† These were found at depths of 100 and 107 feet from the surface, and were said to be at the bottom of the bowlder clay. They were provisionally designated as *Abies*, but a careful comparison with existing species of *Abies*, *Tsuga*, and *Picea* has led me to refer them to *Picea alba*, *Link*.

There were also two slides of *Taxus baccata* from the same locality, at a depth of 107 feet.

Synopsis.

The following summary of species and their distribution may be given:

1. *Asimina triloba*, Dunal. Don river, Toronto (Townsend).
2. *Brasenia peltata*, Pursh. Green's creek nodules (Miller).
3. *Drosera rotundifolia*, L. Green's creek, Ottawa (J. W. Dawson).
4. *Acer saccharinum*, Wang. Green's creek, Ottawa (J. W. Dawson).‡
5. *Acer pleistocenicum*, sp. nov. Don river, Toronto (Townsend).
6. *Potentilla anserina*, L.
   Green's creek, Ottawa (J. W. Dawson and Miller).
7. *Gaylussacia resinosa*, Torr. and Gray.
   Green's creek, Ottawa (J. W. Dawson).
8. *Menyanthes trifoliata*, L. *Leda* clays, Montreal.‡
9. *Ulmus racemosa*, Thomas. Don river, Toronto (Townsend).
10. *Populus balsamifera*, L. Green's creek, Ottawa (J. W. Dawson).‡

* Acadian Geology, 1878, p. 63.
† Presented to Sir William Dawson by Dr. Andrews and Professor Worthen, and now in the Peter Redpath Museum.
‡ Collection of Sir William Dawson in Peter Redpath Museum.

11. *Populus grandidentata*, Michx.
    Leda clays, Montreal (Weston).
    Green's creek nodules (Stewart).
12. *Picea alba*, Link. Bloomington, Ill. (Andrews).
13. *Larix americana*, Michx. *Leda* clays, Montreal (Weston).
14. *Thuya occidentalis*, L.
    Leda clays, Montreal (Sir William Dawson).
    Leda river, Manitoba (Dr. G. M. Dawson).
    Marietta, Ohio (Newberry).
15. *Taxus baccata*, L.
    Don river, Toronto (Townsend).
    Solsgirth, Manitoba (G. M. Dawson and Tyrrell).
    Rolling river, Manitoba (Tyrrell).
    Cape Breton (Sir William Dawson).
    Bloomington, Ill. (Andrews).
16. *Potamogeton perfoliatus*, L. Green's creek, Ottawa (J. W. Dawson).
17. *Potamogeton pusillus*, L. Green's creek, Ottawa (J. W. Dawson).
18. *Potamogeton rutilans* (?), Wolfgang. Green's creek nodule (Stewart).
19. *Elodea canadensis* (?), Michx. Rolling river, Manitoba (Tyrrell).
20. *Vallisneria* (?). Rolling river, Manitoba (Tyrrell).
21. *Carex magellanica*, Lamarck.
    Green's creek nodules, Ottawa (Miller and Stewart).
22. *Oryzopsis asperifolia*, Michx. Green's creek, Ottawa (J. W. Dawson).
23. *Bromus ciliatus* (?), L. Green's creek, Ottawa (Miller).
24. *Equisetum sylvaticum* (?), L. Green's creek nodules (Stewart).
25. *Equisetum limosum* (?), L. Green's creek nodules (Stewart).
26. *Equisetum scirpoides*, Michx. Green's creek, Ottawa (J. W. Dawson).
27. *Fontinalis* (?), sp. Green's creek, Ottawa (J. W. Dawson).
28. *Fucus*, sp. Green's creek, Ottawa (J. W. Dawson).
29. *Navicula lata*. Rolling river, Manitoba.
30. *Encyonema prostratum*. Rolling river, Manitoba.
31. *Denticula lauta*. Rolling river, Manitoba.
32. *Licmophora* (?). Rolling river, Manitoba.
33. *Cocconeis*. Rolling river, Manitoba.

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ON THE PLEISTOCENE FLORA OF CANADA

BY

SIR WILLIAM DAWSON, F. G. S.,

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(*Read by abstract before the Society December* 28, 1889.)

CONTENTS.

I. GEOLOGY OF THE DEPOSITS. BY SIR WM. DAWSON.

GENERAL GEOLOGY OF THE PLEISTOCENE.

The Pleistocene deposits of Canada may be defined as consisting of three principal members, which may be characterized as follows, in ascending order:

1. The Till, or lower bowlder clay, a tough or sometimes sandy clay, containing local and traveled stones and bowlders, often glaciated. It usually rests on glaciated surfaces, but is sometimes underlain by stratified gravels or by old soil surfaces or peaty beds. These are, however, rare and local.* In the more maritime regions—*e. g.*, in the lower St. Lawrence—it contains marine shells of arctic species. Farther inland—*e. g.*, in western Ontario and in the plains west of Red river—it is not known to hold marine remains.

2. Stratified clays and sandy clays. In the more maritime regions these are the lower and upper *Leda* clays, holding many marine shells of boreal rather than arctic types, especially in the upper part. They also contain locally, drift plants, insects, and land or fresh-water shells, indicating the

* Acadian Geology, 1878, p. 63.

proximity of land clothed with vegetation. In the interior they are, so far as known, destitute of marine remains, but hold remains of land plants and even beds of peat with a few fresh-water shells. These beds are those known in the interior region as "interglacial." They seem to vary much locally in composition and thickness, and are sometimes absent. Where they are absent or replaced by bowlder clay, the latter occasionally contains drift trunks and branches of trees.

3. Sands, coarse clays, and gravels, often stratified, sometimes containing traveled bowlders throughout. In other cases there are bowlders at the base of the deposit and also at its surface, the intervening beds being destitute of bowlders. In the maritime regions these beds often contain marine shells and are the *Saxicava* sands and gravels. Inland they are unfossiliferous or have a few drift plants, sometimes of sufficient importance to be reckoned as a second or upper interglacial bed. These beds constitute the upper or newer bowlder formation. Their traveled bowlders are often of great size, and have been as a whole carried farther and deposited at higher levels than those of the older bowlder formation.

Above the third member are alluvial deposits, lake terraces, gravel ridges and eskers, prairie silt, peat beds, etc., which may be regarded as early modern or post-Glacial.

More detailed descriptions of the Pleistocene deposits of Canada will be found in the author's "Notes on the Post-Pliocene of Canada;"* also in his "Acadian Geology" and "Handbook of Canadian Geology."†

Fossil plants appear in these deposits in various places, from the Atlantic coast to the base of the Rocky Mountains and even in Queen Charlotte's islands; but the species are not numerous, and for the most part those now indigenous to the boreal regions of America, while their state of preservation is usually very imperfect.

As might be expected, vegetable remains in the Pleistocene are not confined to Canada, but occur very extensively in the United States. Whittlesey, Worthen, Andrews, Orton, Newberry, and others have referred to deposits of this kind in Illinois, Indiana, Ohio, and Minnesota; and in the "Proceedings of the American Association" for 1875 Professor N. H. Winchell has summed up what was known up to that date, and has noticed more than fifty localities of the "forest beds," as these accumulations are called. Professor Worthen has recognized two distinct forest beds in Illinois, one immediately below the loess, the other under till or true bowlder clay. The latter he says extends over nearly the whole of central and southern Illinois. Though I have had specimens kindly sent to me by Professor Worthen, Dr. Andrews, and others, I do not propose to enter into any details on these deposits in the United States, but merely to refer to their extension from Canada to the southward as important in a geological sense.

*Canadian Naturalist, new ser., vol. VI, 1871, p. 11, et seq. †Montreal, 1889.

The observed sequence of deposits may be understood by the subjoined sections, which represent respectively the arrangement in the St. Lawrence valley at and below Montreal as observed by the author; that on the north shore of Lake Ontario as given by Dr. J. G. Hinde;* and that in the vicinity of the Belly river, North West Territory, as noted by Dr. G. M. Dawson.†

	Montreal and lower St. Lawrence. J. Wm. Dawson.	*North shore of Lake Ontario.* J. G. Hinde.	*Belly river, North West Territory.* G. M. Dawson.
	I. Surface soil, post-Glacial alluvia and peat.	I. Surface soil, stratified sand, and gravel.	I. Surface soil and prairie alluvium.
Pleistocene.	II. Surface bowlders, *Saxicava* sand and gravel. Bowlders in and below sand.	II. Bowlders, sand, etc. Laminated clay. Bowlder deposit.	II. Upper bowlder deposit.
	III. Upper *Leda* clay, marine shells, and drift plants. Lower *Leda* clay, marine shells, and drift plants.	III. Stratified sand and clay, with fresh-water shells and plants.	III. Gray sand with ironstone nodules. Brownish sandy clay. Carbonaceous layers and peat. Gray sand and ironstone.
	IV. Lower bowlder clay or till. Many native and some traveled bowlders. A few marine shells of arctic species.	IV. Lower bowlder clay or till. Native and traveled bowlders.	IV. Lower bowlder clay. Many traveled bowlders.
	V. Paleozoic rocks, often striated.	V. Paleozoic rocks, often striated.	V. Probably Cretaceous beds.

The above sections show a general correspondence in the series of deposits, except that in the sections on Lake Ontario, especially in that at Scarboro' heights studied by Hinde, we find a division of the upper bowlder deposit not so evident in the other sections.

There is no reason to doubt that the three members of the Pleistocene indicated as II, III, and IV are approximately contemporaneous in the different districts, and that No. III represents the usual interglacial period throughout North America. At the same time it is to be observed (1) that

* Canadian Journal, 1877, p. 339, et seq. † Report Geol. Survey of Canada, 1884, p. 144 C, et seq.

these deposits occur at different levels in the East and in the West; (2) that the lower bowlder clay belongs more especially to the lower levels in the several localities, while the bowlders of the second bowlder period have been carried to higher points; (3) that there is evidence in the interglacial period of the local prevalence of sea and land, of lakes, bogs, and dry ground; (4) that these several conditions may in the course of elevation and subsidence have migrated from one level to another, and (5) that while there is thus a general correspondence, there may have been some local diversity of date and transference of certain conditions of deposit from one locality to another according to the progress of subsidence or elevation.

This is so well illustrated by the observations of Captain Fielden in Grinnell Land, that I quote a part of his statements on the subject, as probably illustrative of the condition of Canada in the Pleistocene period.*

"In Grinnell Land, from lat. 81° 40′ N. to lat. 83° 6′ N., no glaciers descend to the sea, no ice-cap buries the land; valleys from which the snow is in a great measure thawed during July and part of August stretch inland for many miles, and the peaked mountains, snow-clad during the greater portion of the year, in July and August have great portions of their flanks, which rise to an altitude of 2,000 feet, bared of snow.

"The opposite coast of Greenland presents a very different aspect. A mer-de-glace stretches over nearly its entire surface; its fiords are the outlets by which its great glaciers protrude into the sea. In Petermann Fiord the ice-cap, with its blue jagged edge lying flush with the face of the lofty cliffs, was estimated to be forty feet thick.

"When we turn to the flora and fauna of Grinnell Land the difference is equally astonishing; some fifty or sixty flowering plants are found in its valleys, and between latitudes 82° and 83° N. I have seen tracts of land so profusely decked with the blossoms of *Saxifraga oppositifolia* that the purple glow of our heath-clad moors was brought to my recollection.

"Musk oxen in considerable numbers frequent its shores; the Arctic fox, the wolf, and ermine, with thousands of lemmings, live and die there. The bones of these mammals, along with those of the ringed seal (*Phoca hispida*), are now being deposited in considerable quantities in the fluvio-marine beds now forming in the bays and at the outlets of all the streams, or rather summer torrents of Grinnell Land. With these bones will be associated those of birds, such as geese and sea-gulls. Numerous mollusca and crustacea, many species of rhizopods, with the remains of land and sea plants, will there find a resting place.

"Supposing that these beds were examined at some future period under conditions when the glacial epoch had disappeared from the surrounding area, it would be difficult to realize that they were contemporaneous with the beds formed under the Greenland ice-cap in the same parallel of latitude and on the opposite shore of a channel not twenty miles across.

"In the one case enormous thicknesses of till with ice-scratched stones have in all probability been deposited; in the other, fluvio-marine beds containing a comparatively rich assemblage of marine and land forms, with river-rolled pebbles, would be brought to light."

*Proceedings Royal Dublin Society, 1878; see also, Quart. Jour. Geol. Soc., vol. 34, 1878, p. 565, et seq.

Special Localities of Fossil Plants.

The plants referred to in Professor Penhallow's paper are derived in part from deposits belonging to each of the columns in the above table.

(1.) At Green's creek, on the Ottawa river, the *Leda* clay, there containing marine shells (*Leda arctica*, etc.) and bones of *Capelin* in nodules in the clay, has in its lower part nodules with leaves, seeds, and fragments of wood. These have been collected by the late Mr. Billings, Dr. R. Bell, the late Sheriff Dickson, of Kingston, the late Mr. J. G. Miller, and the writer, and were noticed in a paper by the writer on the "Evidence of fossil plants as to the climate of the Post-Pliocene in Canada," published in the Canadian Naturalist in 1866. These constitute a considerable part of the specimens described below. A few specimens of wood have also been found and noticed by the writer in the *Leda* clay of Montreal, and the available collections have been augmented since 1866 by additional specimens from Green's creek acquired by the Peter Redpath Museum of McGill University.

(2.) The interesting deposits at Scarboro' heights and elsewhere on Lake Ontario were described by Dr. J. G. Hinde in the Canadian Journal in 1877, and he notices the following plants as found by him:

Wood of pine and cedar.
Portions of leaves of rushes, etc.
Seeds of various plants.
Hypnum commutatum.
H. revolvens.
Fontinalis.
Bryum.
Chara, sp.

More recently Mr. J. Townsend, of Toronto, was so fortunate as to find leaves and fragments of wood with shells of *Melania* and *Cyclas*, in beds apparently of the same age, in excavations in progress on the River Don, at Toronto. These collections have been acquired for the Peter Redpath Museum. The section observed at this place is given as follows by Mr. Townsend:

The locality of the principal vegetable specimens was 150 feet from the bank of the Don, and in a cutting 70 feet deep. The section showed 26 feet of fine light-colored sand with layers of clay at bottom. Below this were 24 feet of tough stratified blue clay, the "Erie clay" of the region. At the base of this clay is a seam of reddish ferruginous sand about three feet thick, and with argillaceous nodules in which was the maple leaf described by Professor Penhallow. Below this sand were sixteen feet of alternating sand and dark-colored clay, with fresh-water shells and wood. Below this was the blue till resting on the surface of the Hudson river beds. In this section

the upper bowlder clay of Hinde's section is not represented, but only the groups III and IV as given in the table. The upper bowlder clay is, however, seen on higher ground in the vicinity.

Dr. J. W. Spencer, who has studied this locality, as well as the whole north shore of Lake Ontario, writes to me that he regards the earthy sand holding wood and fresh-water shells as equivalent to Hinde's "interglacial" beds at Scarboro' heights, and the overlying clay as the so-called "Erie clay," over which, as above stated, is the upper bowlder deposit which in the vicinity of Toronto has many Laurentian bowlders.

(3.) Many observations have been made on the interglacial beds by Dr. G. M. Dawson, and are recorded with sections in his reports on the 49th Parallel and on the geology of the Bow and Belly rivers, and in a paper on borings made in Manitoba and the North West Territories in Vol. IV of the Transactions of the Royal Society of Canada; and he has placed in our hands specimens of peat and wood from those regions. In one locality on the Belly river he finds a bed of interglacial peat hardened by pressure in such a manner as to assume the appearance of a lignite.

(4.) In addition to the vegetable remains found as above stated in the "forest beds" or "interglacial" deposits, trunks of trees and vegetable fragments occur in the bowlder clays themselves, indicating either the partial destruction of the older interglacial bed and the mixture of its débris with glacial deposits, or the enclosure of drift-wood in the latter in the manner now so common in the arctic regions and described by so many arctic explorers.* This raises very interesting questions respecting the origin of the bowlder clay, to be noticed in the sequel.

One of the most marked illustrations is that of the boring at Solsgirth, in Manitoba, on the Manitoba and Northwestern railway, and at an elevation of 1,757 feet above the sea.† At this place the section is as follows:

	Feet.
1. Loam	2
2. Hard blue clay and gravel	42
3. Hard blue clay and stones	10
4. Hard yellow "hard pan"	12
5. Softer bluish clay	16
6. " " "	74
7. Sand with water	--
8. Blue clay with stones	136
9. Gray clay or shale (Cretaceous?)	68
	360

Fragments of wood, more or less decayed and compressed, were obtained from depths of 96, 107, 120, and 135 feet from the surface. They were thus distributed through a considerable thickness of the clay rather than in a

*See Manual of the Natural History, Geology, and Physics of Greenland, by Professor T. R. Jones, issued by the Royal Society of London, 1875, index—"Driftwood."

†Dr. G. M. Dawson, Trans. Royal Society Canada, vol. IV, 1887, sec. IV, p. 91, et seq.

distinct interglacial deposit. It is to be observed, however, they were included within the central part characterized as a softer blue clay, between two beds apparently harder and more stony.

Additional specimens from this place have recently been obtained by Mr. J. B. Tyrrell, of the Geological Survey of Canada, and have been kindly communicated to us. Mr. Tyrrell has also found vegetable remains in a bed under the bowlder clay at Rolling river, Manitoba, which are noticed in Professor Penhallow's paper. They were accompanied with fresh-water shells of the following species, determined by Mr. Whiteaves, F. G. S., Palæontologist to the Geological Survey of Canada:

Lymnea catascopium ?, variety with very short spire.
Valvata tricarinata, and a keelless variety.
Amnicola porata ?
Planorbis parvus?
P. bicarinatus.
Pisidium abditum.
Sphærium striatinum.

With these was the centrum of a vertebra of a small fish.

(5.) The most western locality of bowlder clay with plants is that described by Dr. G. M. Dawson in the vicinity of Skidegate, Queen Charlotte's islands. At this place hard bowlder clay is overlain by stratified sand and gravel, ten to fifteen feet in thickness. The bowlder clay in places shows bedding and holds a few marine shells (*Leda fossa*, etc.). In tracing the bed along the coast the shells disappear and the clay is found to contain fragments of decayed and partially lignitized wood. Specimens of this were collected, but appear to have been mislaid and could not be found in time for this paper.*

(6.) The most eastern locality from which I have collected Pleistocene plant remains is that on the northwest arm of the River Inhabitants in Cape Breton, described in "Acadian Geology," p. 63. This is a hardened peaty bed resting on a gray clay and overlain by twenty feet of till or bowlder clay, apparently the lower bowlder clay. It is quite hard and burns with flame in the manner of a lignite, and contains twigs and branches of coniferous trees and a great variety of fibrous and epidermal tissues apparently of swamp vegetation, which have been examined by Professor Penhallow. This locality is of special interest as showing a bed of vegetables evidently not drifted and under the till or bowlder clay. It shows that this was deposited on what had been a land surface and under circumstances which did not disturb a bed of soft vegetable matter. It indicates also a mild climate preceding the deposit of the bowlder clay rather than an interglacial period. There was no evidence in this case of any land-slip or other accidental disturbance, but rather of successive depositions.

* Report Geol. Survey of Canada, 1878–'79, p. 91B.

With reference to these I shall first refer to the district from the Atlantic to the head of Lake Ontario.

In this district and the eastern part of North America generally, it is, I think, universally admitted that the later Pliocene period was one of continental elevation, and probably of temperate climate. The evidence of this is too well known to require re-statement here. It is also evident, from the raised beaches holding marine shells, extending to elevations of 600 feet, and from bowlder drift reaching to a far greater height, that extensive submergence occurred in the middle and later Pleistocene. This was the age of the marine *Leda* clays and *Saxicava* sands found at heights of 600 feet above the sea in the St. Lawrence valley nearly as far west as Lake Ontario.

It is reasonable to conclude that the till or bowlder clay under the *Leda* clay belongs to the intervening period of probably gradual subsidence, accompanied with a severe climate and with snow and glaciers on all the higher grounds, sending glaciated stones into the sea. This deduction agrees with the marine shells, bryozoa, and cirripedes found in the bowlder deposits on the lower St. Lawrence, with the unoxidized character of the mass, which proves subaquatic deposition, with the fact that it contains soft bowlders, which would have crumbled if exposed to the air, with its limitation to the lower levels and absence on the hill-sides, and with the prevalent direction of striation and bowlder drift from the northeast.*

All these indications coincide with the conditions of the modern bowlder drift on the lower St. Lawrence and in the arctic regions, where the great belts and ridges of bowlders accumulated by the coast ice would, if the coast were sinking, climb upward and be filled in with mud, forming a continuous sheet of bowlder deposit similar to that which has accumulated and is accumulating on the shores of Smith's sound and elsewhere in the arctic, and which, like the older bowlder clay, is known to contain both marine shells and drift-wood.†

The conditions of the deposit of till diminished in intensity as the subsidence continued. The gathering ground of local glaciers was lessened, the ice was no longer limited to narrow sounds, but had a wider scope as well as a freer drift to the southward, and the climate seems to have been improved. The clays deposited had few bowlders and many marine shells, and to the west and north there were deposits of land plants, and on land elevated above the water peaty deposits accumulated.

The shells of the *Leda* clay indicate depths of less than 100 fathoms. The numerous foraminifera, so far as have been observed, belong to this range,

*Notes on the Post-Pliocene: Canadian Naturalist, op. cit.; also paper by the author on Bowlder Drift at Metis, Canadian Record of Science, Vol. II, 1886, p. 36, et seq.

†For references, see Royal Society's Arctic Manual, London, 1875, op. cit.

and I have never seen in the *Leda* clay the assemblage of foraminiferal forms now dredged from 200 to 300 fathoms in the Gulf of St. Lawrence.

I infer that the subsidence of the *Leda* clay period and of the interglacial beds of Ontario belongs to the time of the sea beaches from 450 to 600 feet in height, which are so marked and extensive as to indicate a period of repose. In this period there were marine conditions in the lower and middle St. Lawrence and in the Ottawa valley, and swamps and lakes on the upper Ottawa and the western end of Lake Ontario; and it was at this time that the plants described in this paper occupied the country. It is quite probable, nay certain, that during this interglacial period re-elevation had set in, since the upper *Leda* clay and the *Saxicava* sand indicate shallowing water, and during this re-elevation the plant-covered surface would extend to lower levels.

This, however, must have been followed by a second subsidence, since the water-worn gravels and loose, far-traveled bowlders of the later drift rose to heights never reached by the till or the *Leda* clay, and attained to the tops of the highest hills of the St. Lawrence valley, 1,200 feet in height, and elsewhere to still greater elevations. This second bowlder drift must have been wholly marine, and probably not of long duration. It shows no evidence of colder climate than that now prevalent, nor of extensive glaciers on the mountains; and it was followed by a paroxysmal elevation in successive stages till the land attained even more that its present height, as subsidence is known to have been proceeding in modern times.

The above sequence applies to the districts of Ontario, Quebec, the arctic coast, and the maritime provinces, and might be illustrated by a great accumulation of facts; but these may be found in papers published in the Canadian Naturalist and the Canadian Record of Science and in the reports of the Geological Survey, more especially those by Dr. G. M. Dawson, Mr. Chalmers, and the writer.

For the region between the great lakes and the Rocky Mountains and for the Pacific coast the sequence is similar, but either the interior region has experienced a greater elevation or the times must have been somewhat different. In the mountainous regions of the west, also, more especially in the interior of British Columbia, the evidence of great local glaciers is much more pronounced than on our lower mountains of the east.*

I am quite aware that the above sequence and the causes assumed are somewhat different from those held by many geologists with reference to regions south of Canada, but must hold that they are the only rational conclusions which can be propounded with reference to the facts observed from the parallel of 45° to the Arctic ocean.

* G. M. Dawson, Superficial Geology of British Columbia: Quart. Jour. Geol. Soc., vol. 34, 1878, p. 89, et seq.; ibid, vol. 37, 1881, p. 272, et seq.

One other point remains to be illustrated with reference to the local origin of the vegetable remains. Where these consist of trunks and branches and are contained in the bowlder-bearing beds, they may, like those found under similar conditions in the arctic, be drift-wood, derived from great distances and in a condition of partial submergence of the continent. The facility for such distribution must, in the Pleistocene age, have been greater than it now is in the arctic, where there is, according to the testimony of voyagers, not only a great quantity of such material on the shore, but mixed with clay and bowlders at some distance inland. There is reason to believe that throughout Canada such drift-wood may be found here and there in both the upper and lower bowlder deposits.

Where, however, we have leaves and other perishable parts, and especially where there are peat beds and peaty soils, or where the vegetable remains are associated with fresh-water shells, the case is different. We have in these circumstances evidence of the local flora, and cannot doubt that the climate must have been sufficiently mild to permit the growth *in situ* of the plants whose remains are found. So far as we know at present, evidence of this kind applies, *first*, to the land surfaces anterior to the earlier bowlder deposit; *secondly*, to the swamps and uplands of the *Leda* clay and "interglacial" period; and, *thirdly*, to the early modern time succeeding the upper bowlder drift. The plants specially referred to in the following notes are, so far as known, those of the second of the above periods.

In conclusion, it is deserving of notice that the plants indicated in Professor Penhallow's lists are not an arctic assemblage, but rather a part of the cold temperate flora. They scarcely indicate so much refrigeration as that evidenced by the plants from British interglacial beds as described by Carruthers.* Further, as the species referred to are either local or drifted by streams from the north, it follows that the arctic flora must have existed to the north of the Canadian localities referred to. This accords with the fact proved by arctic explorers and the officers of the Geological Survey of Canada,† that in the glacial period striation and driftage of bowlders point to drift toward the arctic basin as well as toward the south. Thus, when these plants flourished in Canada, there must have been open water and a land flora in the arctic basin—conditions, of course, altogether incompatible with the existence of a polar ice-cap, though not inconsistent with the occurrence of glaciers in the more elevated districts or those cooled by the cold arctic currents. That the climate was colder, locally at least, in the period of the bowlder clay need not be doubted, but there is reason to believe that the general difference of temperature in the so-called interglacial period as compared with that of the bowlder clay has been greatly exaggerated.

* British Association Report, 1886, pp. 683; Dawson, "Geological History of Plants," 1888, pp. 225.
† G. M. Dawson, Geology of Northern Part of Canada, Report Geological Survey of Canada, 1887, p. 51, et seq.

II. *NOTES ON THE PLEISTOCENE PLANTS. BY D. P. PENHALLOW.*

The Pleistocene plants submitted to the author by Sir William Dawson and described in this paper, are chiefly from collections made by Dr. G. M. Dawson and Mr. J. B. Tyrrell, of the Geological Survey of Canada, and by Mr. J. Townsend, with specimens from different localities in the collections of Sir William Dawson, now in the Peter Redpath Museum of McGill University. A few are donations from Messrs. Worthen and Andrews from localities in the United States. These latter will be but briefly referred to, as the precise formation in which they occurred is not wholly free from doubt. Some of the material is of recent collection and until now undescribed. Other specimens were collected at least twenty years ago, and have already been more or less fully described* by Sir William Dawson. These I have submitted to examination for the purpose of verification, and now present in the following statement.

Annotated List of Canadian Plants.

TAXUS BACCATA, L.

The material representing this species was embraced in several slides, which I have designated by the numbers 1, 2, and 3, and by specimens of wood, which have also been numbered as follows:

No. 1. A section taken from a specimen from the Don river, Toronto. The structure is fairly well preserved, and shows the characteristic structure of *Taxus*.

No. 2. A longitudinal section of a specimen from Solsgirth, Manitoba, taken from the bowlder clay of a well at a depth of 135 feet.† The structure is well preserved, and the taxine characters of the wood are more clearly recognizable than in the preceding.

No. 3. Transverse section of a specimen also from Solsgirth, Manitoba. The section is cut diagonally, but as the structure is well preserved the characters are recognizable.

No. 4. A fragment of wood about one and one-half inches square, much compressed, and evidently the nodal portion of a small stem or branch. It was collected in 1887 by Mr. Tyrrell from the till formation of the Solsgirth well. It is readily softened in hot potash, but the whole structure is badly decayed and much distorted by compression. It everywhere shows coniferous markings, and where more fully preserved the structure of *Taxus* is plainly seen.

*Can. Nat., Vol. II, 1857. p. 522; ibid., New Ser., Vol. III, 1870, p. 69; ibid., Vol. VI, 1871, p. 403.
†Trans. Roy. Soc. Can., Vol. IV, Pt. IV, 1886, p. 92.

No. 5. A specimen from the same locality by the same collector as above. It represents the broken end of a branch or small trunk about two inches in diameter. The form has suffered little change, and to the surface there still adhere small pieces of bark. The preservation of this specimen is so distinct from that of the others as to lead to the supposition, upon external examination, that it is a distinct kind of wood. It shows everywhere the effects of advanced decay, and it is also impregnated to some extent with silica. This condition of preservation rendered it extremely difficult to obtain longitudinal sections and impossible to get transverse sections. The former, which were secured in small fragments, were sufficient to place the coniferous character of the wood beyond dispute, and in places the spiral structure of *Taxus* was evident.

In a recent communication, Mr. Tyrrell stated that specimen No. 4 was obtained from a depth of 360 feet, and that No. 5 was exceedingly soft when found; but the precise depth at which it occurred is not known, though probably one of those depths at which wood occurred as mentioned in the report of Dr. G. M. Dawson.*

No. 6. Embraces two small fragments of wood about one-half inch square and strongly compressed; also three slides of the same. This material was collected by Mr. J. B. Tyrrell, in 1887, from the drift of Rolling river, two miles above Heart hill, Manitoba.

Fresh sections were cut, but the material was in such an advanced state of decay that the treatment with potash had to be applied cautiously, and microscopical examination showed that it had also resulted in the removal of a large part of the structure of the cell walls, of which, in most cases, only the primary cell wall remained. The characteristic markings of coniferous wood were thus in many cases wholly removed, but in places, where the action of decay was more limited, the markings peculiar to *Taxus* were observed.

7. Another specimen of *Taxus* from peat below bowlder clay on the River Inhabitants, Cape Breton, obtained by Sir William Dawson, and now in the collection of the Peter Redpath Museum, has been examined. It is a fragment of a branch about three-fourths of an inch in diameter and six inches long, much flattened by pressure. The structure shows it to be a *Taxus*, but presenting some aspects different from those of our modern species. These may have resulted from local conditions, since the wood rings show it to have grown very slowly, as if in a situation unfavorable to it. A more critical examination will be made later; for the present I refer it to *T. baccata* provisionally.

The modern Canadian species of *Taxus* are *T. brevifolia*, Nutt., and *T. baccata*, L., var. *Canadensis*, Gray. To the first, none of the specimens described

* Ibid.

can be referred, as they differ from it in a somewhat marked manner; but they do approach the latter species, to which I shall therefore refer them. *Taxus baccata* is now found extending from Newfoundland, Anticosti, and Nova Scotia, where it is abundant, through New Brunswick, Quebec, and Ontario. On the shore of Lake Huron it often forms impenetrable thickets. Passing to the west it still continues abundant north of Lake Superior, and at least to Lake Winnipeg, according to Macoun.*

ASIMINA TRILOBA, DUNAL.

The specimen of this fossil is from the Pleistocene of the Don river, Toronto, having been collected in 1887, by Mr. J. Townsend, from a cut at Jail hill, at a depth of sixty-six feet below the surface, and from below the Erie clay of that locality. It is about six inches long by two wide, and evidently was derived from a tree of small diameter, as indicated by the curvature of the growth rings. In its general aspect it bears a very strong resemblance to the wood of our modern *Asimina triloba*, with which it is also closely comparable in its minute structure. It presents certain differences in detail—*e. g.*, the development of the thyloses is much more strongly marked, the wood cells are of smaller diameter, and there are also certain differences in the markings of the vessels. Alteration under the conditions established by its long burial may account for some of these, and perhaps none of them are sufficient to mark a distinct species. I would therefore assign it for the present to our modern species of *A. triloba*.

The material was well preserved, and all the details of structure could be distinguished without difficulty. By boiling in potash, sections were as readily cut as if taken from fresh material.

At present *Asimina triloba*, the only species found within Canadian limits, occurs in Ontario, at Queenstown heights. It is very abundant at Point Pelée and in the townships bordering on Lake Erie between that point and Amherstburg. Doubtless it is not rare along Lake Erie, though not yet reported (Macoun).

ULMUS RACEMOSA, THOMAS.

This fossil is represented by two specimens, numbered 2 and 3.

No. 2 is twelve by six inches, and evidently derived from a somewhat large tree. It was obtained in 1887 from a cutting on the Don river, from beneath the Erie clay, at a depth of sixty-six feet from the surface, and associated with the previously described species.

The material is fairly well preserved, though showing the effects of decay in the exfoliation of the growth layers; while under the microscope the dis-

*The occurrence of *Taxus baccata* in the Pleistocene deposits of Manitoba has been noticed by Dr. G. M. Dawson in the Transactions of the Royal Society of Canada, vol. IV, part IV, 1886, p. 92.

torted structure shows the effect of compression, which has turned all the medullary rays obliquely. This, together with compression of the vessels and wood parenchyma, has resulted in the groups of wood cells being distributed in the form of diamond-shaped masses, which are at first very misleading as to the true character of the wood. In consequence of these alterations it was impossible to cut truly radial or tangential sections. The material submits readily to the action of potash, whereby sections are easily cut.

No. 3 was obtained from the same locality as the preceding, and about two feet below a band of sand containing leaves. It appears to be one side of the stump of a small tree, as it shows the spreading base usually found at the point where the roots separate. It is four inches long by three and one-half wide at the widest part. Portions boiled in caustic potash gave very fine sections, and showed the structure to be not only well preserved, but also largely free from the effects of compression, so that the distribution of the tissues could be readily determined. The compactness of the structure, as well as the very small, thick-walled cells, shows it to have been a very hard wood. Both of these specimens (2 and 3) are identical. They present the unmistakable structure of the genus *Ulmus*, of which *U. fulva*, Michx., *U. americana*, L., and *U. racemosa* are at present found in Canada.

A close comparison with these different species shows that the fossils so nearly approach *U. racemosa* as to admit of referring them to that species.

Within Canadian limits, *U. racemosa* is rather rare in the eastern townships, Quebec, extending thence westward throughout Ontario, in the limestone areas. It seems to be confined to dry, gravelly soils, and is usually associated with sugar maple in such localities. It was formerly very common, according to Macoun.

GEN. AND SP. IND.

Three sections of wood—one transverse and two radial—from the interglacial at Solsgirth, Manitoba, collected by Dr. G. M. Dawson. The plant was evidently exogenous. It was either very soft in its original state, or, as seems more probable, the sections present the remnants of decayed tissue. At all events, the state of preservation was such as to prevent correct determination.

THUYA OCCIDENTALIS, L.

A small fragment of wood, about one-fourth of an inch in diameter and an inch and one-quarter long, from the *Leda* clays, Montreal (collection of Sir William Dawson). This species extends from New England, throughout Quebec and Ontario, northward to within twenty miles of Lake Mistassini, to James's bay and in the neighborhood of Moose factory. The northern

limit crosses the Albany at some distance from the sea, extending westward to a point about seventy-five miles southwest of Trout lake, thence southward to Lake Winnipeg and the United States boundary. It is one of the trees most likely to be found in this formation. This species has been recognized by Sir William Dawson in the drift of the Roseau river, Manitoba, and of Montreal (*Leda* clay) and the Ottawa river.*

ELODEA CANADENSIS (?), MICHX.

A specimen of soft stone bearing the impress of a small branching plant and the carbonized remains of another of the same kind. This was from the collection of Mr. Tyrrell, made in 1887, and obtained from Rolling river, Manitoba, two miles above Heart hill. A slide of the same plant and from the same locality, from Dr. G. M. Dawson, shows the plant to have been herbaceous, but with a distinctly vascular axis, the wood cells of which are thin walled and with rather blunt terminations. This vascular structure is surrounded on all sides by a distinctly parenchymatous structure. Associated with this plant are many diatomaceous remains belonging to fresh-water species, among which I have recognized *Navicula lata*, *N. legumen*, *Encyonema prostratum*, *Denticula lauta*, and various species of *Licmophora* (?) and *Cocconeis*. It is therefore clear that the plant is not a seaweed. The distinctly branching habit and the structure suggest *Elodea*, although the state of preservation is not such as to render exact comparison possible. I therefore refer it provisionally to our common Canadian species, *E. canadensis*, which is everywhere found in fresh water.

VALLISNERIA (?).

Several fragments of the same earthy material as above, bearing each a small fragment of a leaf. This is in each case linear, with a well-rounded apex, and usually about 2.5 mm. wide. The epidermis is apparent under a pocket lens. In fact the remains appear to consist wholly of the two epidermal layers, which may be separated readily. Under the microscope the epidermal cells are found to be well preserved. No stomata have been found, and this, together with the presence of fresh-water diatoms, would indicate that it must have been a submerged, aquatic plant. The structure strongly reminds one of *Vallisneria*, to which I shall provisionally refer it. This plant is everywhere common in fresh water, and is very likely to have occurred in such a locality as that from which the fossil was obtained.

CAREX MAGELLANICA, LAMARCK.

The Green's creek nodules contain an abundance of leaves, evidently of grasses and sedges. In one nodule from the Miller collection and in two

*Can. Nat., New Ser., Vol. III, 1868, p. 72; Report on 49th Parallel, 1875, p. 214; Notes on Post-Pliocene, op. cit., 1871, p. 404.

belonging to the collection of Mr. John Stewart, of Ottawa, there were found portions of old spikes devoid of seeds, but with the persistent glumes widely spread, evidently the remains of a *Carex*. In other nodules belonging to the Miller collection in the Peter Redpath Museum, there were found complete spikes containing the seeds, apparently the same as the preceding. In both cases the resemblance to *Carex magellanica* is so marked that I have ventured to refer them to it.

At present this species is found in peat bogs from Newfoundland to Vancouver.

BRASENIA PELTATA, PURSH.

This is evidently an undeveloped leaf, of which only one-half, embracing the stump of the petiole, is represented. The form and, to some extent, the venation show its probable relation to the species above named.

Brasenia peltata occurs at Rocky lake, Nova Scotia; Grand lake, New Brunswick; Point St. Charles, Montreal; River Range; and is abundant throughout the northern counties of Ontario, and about Rainy lake and Lake of the Woods, according to Macoun.

LARIX AMERICANA, MICHX.

Several small branches about three inches or less in length and from one-third to three-fourths of an inch in diameter, from the Geological Survey of Canada, through Sir William Dawson. They were collected by Mr. J. C. Weston from the *Leda* clays in Peel's clay pit, Montreal. The structure is fairly well preserved and recognisable without difficulty.

In its present distribution, *Larix americana* is common in all swampy ground from Newfoundland and Labrador, through the eastern provinces, to the foot of the Rocky Mountains; northward to latitude 65°.

POPULUS GRANDIDENTATA, MICHX.

Base of a small stem or branch about two and one-half inches long. The structure is quite well preserved and readily comparable with the above species. It was obtained from the *Leda* clays of Montreal by Mr. J. C. Weston, and transmitted to me from the Geological Survey of Canada by Sir William Dawson. Also in nodules from Green's creek, Ottawa, now in the collection of Mr. J. Stewart, small branches of this same species were found.

Populus grandidentata is common in Nova Scotia and New Brunswick, as also throughout Quebec and Ontario.

POTAMOGETON RUTILANS (?), WOLFGANG.

A single specimen in a Green's creek nodule from the collection of Mr. J. Stewart. It embraces the stem and several leaves.

This species is at present known only near Red Rock, Lake Superior, and on Twin island, James's bay; in marshes on Anticosti; and at the mouth of the Nipigon river (Macoun). It would therefore appear probable that it was more abundant in the past than at present.

EQUISETUM LIMOSUM (?), L.

E. SYLVATICUM (?), L.

Fragments of plants with lateral members in whorls were frequently met with and, although not satisfactorily referable to any modern genus, presented the closest resemblance to the two species of *Equisetum* above named, to which they are provisionally referred.

MENYANTHES TRIFOLIATA, L.

A specimen of the *Leda* clays from Montreal, now in the Peter Redpath Museum, shows the remains of a plant of which only the basal portion is preserved. This consists of a central axis from which rather stout lateral members are developed at right angles, and from which in turn are produced numerous fine roots. The specimens are of small diameter, but from their evidently shrunken character must represent the remains of plants approaching one-quarter of an inch in diameter. Although not clearly referable to any existing species, the resemblance to the stem of *Menyanthes trifoliata* is very striking, and in all probability it represents a similar underground stem with its roots developed at right angles to the axis of growth. The absence of leaves renders a more accurate determination at present impossible.

Description of New Species.

ACER PLEISTOCENICUM, SP. NOV.

This fossil was recently obtained by Mr. Townsend from the Pleistocene of the Don river, Toronto, and was purchased by Sir Willam Dawson with other specimens and presented to the Peter Redpath Museum. Though not perfect as to form, the leaf is beautifully cast in an argillaceous nodule, and shows several details of venation quite perfectly. A drawing, giving a restoration of the leaf, is herewith presented. From this it will be seen that the left half of the blade is nearly intact, while of the right half only about two-thirds remain, the lobes being entirely cut off by fracture of the matrix.

The leaf is evidently that of a maple, although of a type quite distinct from any of our existing forms. As will appear from the figure, the general

form and venation suggest *Platanus*, and a specific name indicating this resemblance would be appropriate, were not some of the existing species already so distinguished. It is to be regretted that this is the only specimen so far found in a fairly complete condition, since it is unsatisfactory to base conclusions upon a single specimen where there is opportunity for variation.

The modern maples with which the fossil is most nearly comparable are *Acer rubrum* and *A. platanoides*. In its general outline, the fossil is broadly

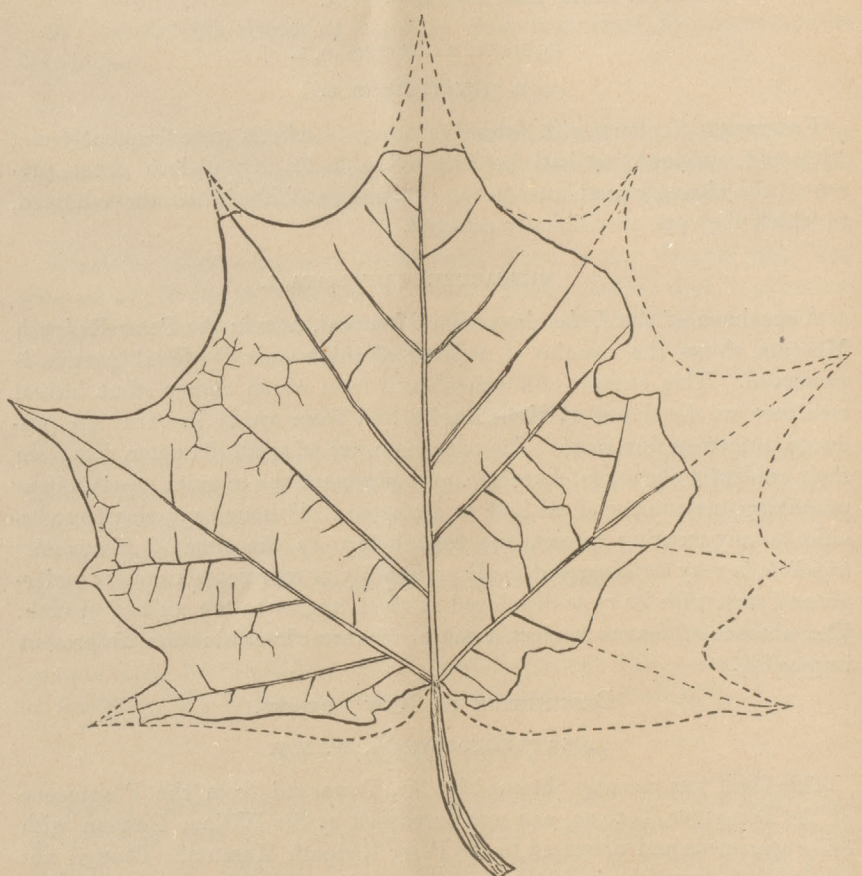

FIGURE 1.—*Acer pleistocenicum.*

ovate and, if we follow the same rule as in other maple leaves in respect to the number of lobes being determined by the palmate distribution of the principal veins, three lobed; but the terminal lobe has two prominent lateral lobes, while the others have each a small basal lobe, all somewhat strongly defined and making the leaf appear seven lobed. The lobes are all very

acute. The margin is entire with the exception of two teeth, one on each side and situated midway between each lateral lobe and its inferior lobe. The sinuses are open, shallow, and well rounded. In many of these respects it approaches *Acer platanoides*, from which it differs in its much broader terminal lobe and in the broader and more shallow sinuses.

The venation is most nearly comparable with that of *Acer rubrum*, where, as in the fossil, only two veins are arranged palmately with the midrib, and from these branch smaller veins which run to the small basal lobes.

The second and third veins, lateral to the midrib, run to the principal sinus of each side, where they terminate near the margin by repeated dichotomous branching. This, however, is common to several of the modern maples. The finer venation is essentially the same as in our modern maples.

It would appear from this that the fossil cannot be properly referred to any of our existing species, and it appears desirable to give it a distinctive name. I therefore propose to call it *Acer pleistocenicum*, as properly descriptive.

Revision of previously recorded Pleistocene Plants.

The following specimens from Green's creek, as referred to by Sir William Dawson in the preceding pages, have already been partially determined by him and published in 1868, with figures of some of the species.* The present revision shows a few changes and includes a few specimens not originally noted, and which have been acquired by the Redpath Museum from the collection of the late Mr. J. G. Miller since the publication of Sir William Dawson's paper.

DROSERA ROTUNDIFOLIA, L.

A nodule containing a single specimen of what appears to be a leaf of this plant, showing marginal projections and surface markings bearing somewhat close resemblance to the glandular hairs. Its association with the fertile spike of an *Equisetum* shows it to have been a habitant of moist places such as are usually favorable to its abundant development. It is a species very commonly distributed throughout Canada.

ACER SACCHARINUM, WANG.

A basal fragment of a leaf in a nodule. This specimen was originally designated † as *A. montanum*, Ait. (*A. spicatum*, Lamx). The only data on which a determination is possible are to be found in the angles at which the veins separate and in the number and distribution of such veins. With reference to the first, it is to be observed that the angles of the veins with

* Can. Nat., New Ser, Vol. III, p. 70 et seq.
† Ibid.

the midrib vary considerably in the same species, so that this cannot be regarded as a character of more than approximate value. The number and distribution of the veins offers a somewhat more reliable guide, since there is a constancy in this respect which is of value. The majority of our maples fall in one of two types. In the first case, four principal veins are arranged palmately with the midrib, and directly extend to as many distinct lobes of the leaf, the first pair usually extending horizontally or obliquely downward to the basal lobes. To this type can be referred such species as *Acer platanoides* and *A. saccharinum*. In the second case, only two principal veins are directly and palmately arranged with the midrib, while from each of them there springs a subordinate vein at a short distance from the base, which then extends to the corresponding basal lobe. Examples of this type are to be seen in *Acer rubrum* and *A. dasycarpum*, as well as in the fossil *A. plestocenicum*.

In the fossil under consideration there are four distinct veins palmately arranged with the midrib, two of which are large, and the other two running to the basal lobes. It will thus be seen that comparison with *Acer montanum* cannot be considered. A close comparison with the leaves of the first group shows that it approaches most nearly to *Acer saccharinum* in all those characters represented.

The present distribution of *A. saccharinum* covers a wide range throughout Canada, from Newfoundland and Nova Scotia to the western extremity of Lake Superior, and northward to Lake St. John and to the Long portage on the Michipicoten river.

POTENTILLA ANSERINA, L.

Two specimens and their reverses in nodules previously determined* as *Potentilla canadensis* and *P. norvegica*, and also a specimen and its reverse in Mr. Miller's collection in the Peter Redpath Museum. The leaves only are represented, but the venation is so distinctly preserved, as well as the general form and margin, as to leave little doubt as to their true character, although in one case they are so grouped by crushing as to bear a certain resemblance to the leaf of *P. canadensis*. In this species the veins run directly from the midrib of the leaflet to both teeth and sinuses. In *P. norvegica* the veins run to the teeth, taking a direction which tends to become parallel with the margin, and while the vein itself extends into a tooth it gives off a lateral which penetrates the tooth below, so that there are in reality twice as many teeth as veins. The fossils, which in this respect as in others are all similar, show the veins running directly to every tooth, veins and teeth being equal in number.

In this respect, as well as in the form of the leaflet, the shape and apices

* Can. Nat., New Ser., Vol. III, 1868, p. 70.

of the teeth and their inclination to the midrib, the fossil corresponds most closely with *P. anserina*, to which I therefore refer them. At present this species is very abundant along the eastern coast and on the margins of rivers and lakes throughout the interior and as far north as the Arctic sea.

GAYLUSSACIA RESINOSA, TORR. AND GRAY.

A well-preserved leaf in a nodule. This shows the form of the leaf, and the resinous dots are so perfectly seen as to render it readily determinable. This species is now found in rocky or sandy woodlands and in bogs, from Newfoundland and Nova Scotia to the Saskatchewan.

POPULUS BALSAMIFERA, L.

The material representing this species is embraced in leaves and fragments of branches contained in nodules. The former are in most cases well preserved and admit of easy identification. As noted in the original description, however, the leaves are all small, and assuming them to be mature this would indicate a cold climate or very exposed situations. At present *P. balsamifera* is of very wide distribution throughout Canada, extending northward to the mouth of the Mackenzie river, where it attains large size, and is an important source of fuel (Macoun).

POTAMOGETON PERFOLIATUS, L.

Portions of leaves and seeds in nodules. The venation is beautifully distinct, and it is without much doubt referable to the species named. This is one of our most common water weeds, being found everywhere in the streams of the northern United States and Canada.

POTAMOGETON PUSILLUS, L.

This is one of the most abundant plants contained in the nodules from Green's creek. The specimens all show a branching plant with narrow leaves. This species is now common in slow streams and ditches almost everywhere.

EQUISETUM SCIRPOIDES, MICHX.

Common in the nodules from Green's creek, and associated with *Potentilla anserina*. This is a widely distributed species, and would naturally occur among such plants as are found at the above locality.

There is also another nodule containing a portion of a stem cut longitudinally. It has the appearance of an *Equisetum*, and may possibly be referred to one of the larger species, such as *E. palustre* or *E. limosum*.

ORYZOPSIS ASPERIFOLIA, MICHX.

A fragment of a leaf and stem in a nodule, showing features which make them correspond closely with *Oryzopsis asperifolia*, and to which I therefore

refer them. This species is a widely extended one, being found from Newfoundland to the Rocky Mountains.

FUCUS.

A specimen of a seaweed in a nodule, evidently a *Fucus*. It is not strictly comparable with any of our modern species, and until more material is obtained it seems best not to assign any specific name to it, although *digitatus* would appear to be appropriate.

FONTINALIS.

Fragments of mosses are common in the nodules from Green's creek. These appear to be chiefly of the genus *Fontinalis*, or one nearly related to it.

In addition to the above there were also found in the Green's creek nodules various seeds. These require some further examination.

BROMUS CILIATUS, L.

A fragment of a leaf which shows a venation closely corresponding to *Bromus ciliatus*, to which I would for the present refer it. This is a very common species in thickets and damp places throughout Canada. The specimen was collected by Mr. J. G. Miller from Green's creek.

GEN. AND SP. UND.

Among the specimens sent us by Dr. G. M. Dawson was a seed collected by Mr. J. B. Tyrrell, in 1887, from the Rolling river, Manitoba, two miles above Heart hill. The form and size seem to indicate that it is the seed of a Conifer.

Lignites.

A sample of lignite or indurated peat, collected by Dr. G. M. Dawson from the interglacial deposits of Belly river, was presented in the form of balsam mounts and loose material, all of which had been treated with potash, nitric acid, sulphuric acid, or chromic acid. In all cases the material was found to be very finely divided, none of the fragments being of sufficient size to make reference to particular orders or genera possible. It was, however, quite possible to recognize fragments of sclerenchyma tissue, fragments of wood cells, spores of ferns, and what appeared to be the extine of pollen grains. These latter, together with the few spores, constituted the bulk of the recognizable material. There were also to be observed fragments of epidermis, apparently of three different kinds, and in one instance two stomata were found, though imperfectly preserved. The impression gained from a careful examination of a large amount of material is that the

peat consists of the remains of ferns and herbaceous or semi-woody plants. No more definite statement can be made until other material is examined.

A specimen of lignite from Cape Breton was also submitted to examination. This material was described some years since by Sir William Dawson,* and is also noted in the preceding pages of this paper by him. Boiled out in potash, there have been found in it an abundance of fungus hyphæ, the extine of coniferous pollen, bast cells, sclerenchyma tissue of ferns, epidermis apparently of ferns, wood cells showing a portion of a medullary ray, and fragments of endogenous stems. This is all that could be found after searching through a large amount of material, and the conclusion was reached that the lignite represents the remains of ferns and grasses with fragments of woody plants, possibly from a more elevated and less wet locality.

Woods from Illinois.

In addition to the specimens above described, I have also examined three slides of coniferous wood from Bloomington, Illinois.† These were found at depths of 100 and 107 feet from the surface, and were said to be at the bottom of the bowlder clay. They were provisionally designated as *Abies*, but a careful comparison with existing species of *Abies*, *Tsuga*, and *Picea* has led me to refer them to *Picea alba*, *Link*.

There were also two slides of *Taxus baccata* from the same locality, at a depth of 107 feet.

Synopsis.

The following summary of species and their distribution may be given:

1. *Asimina triloba*, Dunal. Don river, Toronto (Townsend).
2. *Brasenia peltata*, Pursh. Green's creek nodules (Miller).
3. *Drosera rotundifolia*, L. Green's creek, Ottawa (J. W. Dawson).
4. *Acer saccharinum*, Wang. Green's creek, Ottawa (J. W. Dawson).‡
5. *Acer pleistocenicum*, sp. nov. Don river, Toronto (Townsend).
6. *Potentilla anserina*, L.
   Green's creek, Ottawa (J. W. Dawson and Miller).
7. *Gaylussacia resinosa*, Torr. and Gray.
   Green's creek, Ottawa (J. W. Dawson).
8. *Menyanthes trifoliata*, L. *Leda* clays, Montreal.‡
9. *Ulmus racemosa*, Thomas. Don river, Toronto (Townsend).
10. *Populus balsamifera*, L. Green's creek, Ottawa (J. W. Dawson).‡

* Acadian Geology, 1878, p. 63.
† Presented to Sir William Dawson by Dr. Andrews and Professor Worthen, and now in the Peter Redpath Museum.
‡ Collection of Sir William Dawson in Peter Redpath Museum.

11. *Populus grandidentata*, Michx.
    Leda clays, Montreal (Weston).
    Green's creek nodules (Stewart).
12. *Picea alba*, Link. Bloomington, Ill. (Andrews).
13. *Larix americana*, Michx. *Leda* clays, Montreal (Weston).
14. *Thuya occidentalis*, L.
    Leda clays, Montreal (Sir William Dawson).
    Leda river, Manitoba (Dr. G. M. Dawson).
    Marietta, Ohio (Newberry).
15. *Taxus baccata*, L.
    Don river, Toronto (Townsend).
    Solsgirth, Manitoba (G. M. Dawson and Tyrrell).
    Rolling river, Manitoba (Tyrrell).
    Cape Breton (Sir William Dawson).
    Bloomington, Ill. (Andrews).
16. *Potamogeton perfoliatus*, L. Green's creek, Ottawa (J. W. Dawson).
17. *Potamogeton pusillus*, L. Green's creek, Ottawa (J. W. Dawson).
18. *Potamogeton rutilans* (?), Wolfgang. Green's creek nodule (Stewart).
19. *Elodea canadensis* (?), Michx. Rolling river, Manitoba (Tyrrell).
20. *Vallisneria* (?). Rolling river, Manitoba (Tyrrell).
21. *Carex magellanica*, Lamarck.
    Green's creek nodules, Ottawa (Miller and Stewart).
22. *Oryzopsis asperifolia*, Michx. Green's creek, Ottawa (J. W. Dawson).
23. *Bromus ciliatus* (?), L. Green's creek, Ottawa (Miller).
24. *Equisetum sylvaticum* (?), L. Green's creek nodules (Stewart).
25. *Equisetum limosum* (?), L. Green's creek nodules (Stewart).
26. *Equisetum scirpoides*, Michx. Green's creek, Ottawa (J. W. Dawson).
27. *Fontinalis* (?), sp. Green's creek, Ottawa (J. W. Dawson).
28. *Fucus*, sp. Green's creek, Ottawa (J. W. Dawson).
29. *Navicula lata*. Rolling river, Manitoba.
30. *Encyonema prostratum*. Rolling river, Manitoba.
31. *Denticula lauta*. Rolling river, Manitoba.
32. *Licmophora* (?). Rolling river, Manitoba.
33. *Cocconeis*. Rolling river, Manitoba.

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ON THE PLEISTOCENE FLORA OF CANADA

BY

SIR WILLIAM DAWSON, F. G. S.,

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PROFESSOR D. P. PENHALLOW, F. R. S. C.

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(*Read by abstract before the Society December* 28, 1889.)

CONTENTS.

I. GEOLOGY OF THE DEPOSITS. BY SIR WM. DAWSON.

GENERAL GEOLOGY OF THE PLEISTOCENE.

The Pleistocene deposits of Canada may be defined as consisting of three principal members, which may be characterized as follows, in ascending order:

1. The Till, or lower bowlder clay, a tough or sometimes sandy clay, containing local and traveled stones and bowlders, often glaciated. It usually rests on glaciated surfaces, but is sometimes underlain by stratified gravels or by old soil surfaces or peaty beds. These are, however, rare and local.* In the more maritime regions—*e. g.*, in the lower St. Lawrence—it contains marine shells of arctic species. Farther inland—*e. g.*, in western Ontario and in the plains west of Red river—it is not known to hold marine remains.

2. Stratified clays and sandy clays. In the more maritime regions these are the lower and upper *Leda* clays, holding many marine shells of boreal rather than arctic types, especially in the upper part. They also contain locally, drift plants, insects, and land or fresh-water shells, indicating the

*Acadian Geology, 1878, p. 63.

proximity of land clothed with vegetation. In the interior they are, so far as known, destitute of marine remains, but hold remains of land plants and even beds of peat with a few fresh-water shells. These beds are those known in the interior region as "interglacial." They seem to vary much locally in composition and thickness, and are sometimes absent. Where they are absent or replaced by bowlder clay, the latter occasionally contains drift trunks and branches of trees.

3. Sands, coarse clays, and gravels, often stratified, sometimes containing traveled bowlders throughout. In other cases there are bowlders at the base of the deposit and also at its surface, the intervening beds being destitute of bowlders. In the maritime regions these beds often contain marine shells and are the *Saxicava* sands and gravels. Inland they are unfossiliferous or have a few drift plants, sometimes of sufficient importance to be reckoned as a second or upper interglacial bed. These beds constitute the upper or newer bowlder formation. Their traveled bowlders are often of great size, and have been as a whole carried farther and deposited at higher levels than those of the older bowlder formation.

Above the third member are alluvial deposits, lake terraces, gravel ridges and eskers, prairie silt, peat beds, etc., which may be regarded as early modern or post-Glacial.

More detailed descriptions of the Pleistocene deposits of Canada will be found in the author's "Notes on the Post-Pliocene of Canada;"* also in his "Acadian Geology" and "Handbook of Canadian Geology."†

Fossil plants appear in these deposits in various places, from the Atlantic coast to the base of the Rocky Mountains and even in Queen Charlotte's islands; but the species are not numerous, and for the most part those now indigenous to the boreal regions of America, while their state of preservation is usually very imperfect.

As might be expected, vegetable remains in the Pleistocene are not confined to Canada, but occur very extensively in the United States. Whittlesey, Worthen, Andrews, Orton, Newberry, and others have referred to deposits of this kind in Illinois, Indiana, Ohio, and Minnesota; and in the "Proceedings of the American Association" for 1875 Professor N. H. Winchell has summed up what was known up to that date, and has noticed more than fifty localities of the "forest beds," as these accumulations are called. Professor Worthen has recognized two distinct forest beds in Illinois, one immediately below the loess, the other under till or true bowlder clay. The latter he says extends over nearly the whole of central and southern Illinois. Though I have had specimens kindly sent to me by Professor Worthen, Dr. Andrews, and others, I do not propose to enter into any details on these deposits in the United States, but merely to refer to their extension from Canada to the southward as important in a geological sense.

*Canadian Naturalist, new ser., vol. VI, 1871, p. 11, et seq. †Montreal, 1889.

Special Localities of Fossil Plants.

The plants referred to in Professor Penhallow's paper are derived in part from deposits belonging to each of the columns in the above table.

(1.) At Green's creek, on the Ottawa river, the *Leda* clay, there containing marine shells (*Leda arctica*, etc.) and bones of *Capelin* in nodules in the clay, has in its lower part nodules with leaves, seeds, and fragments of wood. These have been collected by the late Mr. Billings, Dr. R. Bell, the late Sheriff Dickson, of Kingston, the late Mr. J. G. Miller, and the writer, and were noticed in a paper by the writer on the "Evidence of fossil plants as to the climate of the Post-Pliocene in Canada," published in the Canadian Naturalist in 1866. These constitute a considerable part of the specimens described below. A few specimens of wood have also been found and noticed by the writer in the *Leda* clay of Montreal, and the available collections have been augmented since 1866 by additional specimens from Green's creek acquired by the Peter Redpath Museum of McGill University.

(2.) The interesting deposits at Scarboro' heights and elsewhere on Lake Ontario were described by Dr. J. G. Hinde in the Canadian Journal in 1877, and he notices the following plants as found by him:

Wood of pine and cedar.
Portions of leaves of rushes, etc.
Seeds of various plants.
Hypnum commutatum.
H. revolvens.
Fontinalis.
Bryum.
Chara, sp.

More recently Mr. J. Townsend, of Toronto, was so fortunate as to find leaves and fragments of wood with shells of *Melania* and *Cyclas*, in beds apparently of the same age, in excavations in progress on the River Don, at Toronto. These collections have been acquired for the Peter Redpath Museum. The section observed at this place is given as follows by Mr. Townsend:

The locality of the principal vegetable specimens was 150 feet from the bank of the Don, and in a cutting 70 feet deep. The section showed 26 feet of fine light-colored sand with layers of clay at bottom. Below this were 24 feet of tough stratified blue clay, the "Erie clay" of the region. At the base of this clay is a seam of reddish ferruginous sand about three feet thick, and with argillaceous nodules in which was the maple leaf described by Professor Penhallow. Below this sand were sixteen feet of alternating sand and dark-colored clay, with fresh-water shells and wood. Below this was the blue till resting on the surface of the Hudson river beds. In this section

the upper bowlder clay of Hinde's section is not represented, but only the groups III and IV as given in the table. The upper bowlder clay is, however, seen on higher ground in the vicinity.

Dr. J. W. Spencer, who has studied this locality, as well as the whole north shore of Lake Ontario, writes to me that he regards the earthy sand holding wood and fresh-water shells as equivalent to Hinde's "interglacial" beds at Scarboro' heights, and the overlying clay as the so-called "Erie clay," over which, as above stated, is the upper bowlder deposit which in the vicinity of Toronto has many Laurentian bowlders.

(3.) Many observations have been made on the interglacial beds by Dr. G. M. Dawson, and are recorded with sections in his reports on the 49th Parallel and on the geology of the Bow and Belly rivers, and in a paper on borings made in Manitoba and the North West Territories in Vol. IV of the Transactions of the Royal Society of Canada; and he has placed in our hands specimens of peat and wood from those regions. In one locality on the Belly river he finds a bed of interglacial peat hardened by pressure in such a manner as to assume the appearance of a lignite.

(4.) In addition to the vegetable remains found as above stated in the "forest beds" or "interglacial" deposits, trunks of trees and vegetable fragments occur in the bowlder clays themselves, indicating either the partial destruction of the older interglacial bed and the mixture of its débris with glacial deposits, or the enclosure of drift-wood in the latter in the manner now so common in the arctic regions and described by so many arctic explorers.* This raises very interesting questions respecting the origin of the bowlder clay, to be noticed in the sequel.

One of the most marked illustrations is that of the boring at Solsgirth, in Manitoba, on the Manitoba and Northwestern railway, and at an elevation of 1,757 feet above the sea.† At this place the section is as follows:

	Feet.
1. Loam	2
2. Hard blue clay and gravel	42
3. Hard blue clay and stones	10
4. Hard yellow "hard pan"	12
5. Softer bluish clay	16
6. " " "	74
7. Sand with water	--
8. Blue clay with stones	136
9. Gray clay or shale (Cretaceous?)	68
	360

Fragments of wood, more or less decayed and compressed, were obtained from depths of 96, 107, 120, and 135 feet from the surface. They were thus distributed through a considerable thickness of the clay rather than in a

* See Manual of the Natural History, Geology, and Physics of Greenland, by Professor T. R. Jones, issued by the Royal Society of London, 1875, index—"Driftwood."

† Dr. G. M. Dawson, Trans. Royal Society Canada, vol. IV, 1887, sec. IV, p. 91, et seq.

distinct interglacial deposit. It is to be observed, however, they were included within the central part characterized as a softer blue clay, between two beds apparently harder and more stony.

Additional specimens from this place have recently been obtained by Mr. J. B. Tyrrell, of the Geological Survey of Canada, and have been kindly communicated to us. Mr. Tyrrell has also found vegetable remains in a bed under the bowlder clay at Rolling river, Manitoba, which are noticed in Professor Penhallow's paper. They were accompanied with fresh-water shells of the following species, determined by Mr. Whiteaves, F. G. S., Palæontologist to the Geological Survey of Canada:

Lymnea catascopium ?, variety with very short spire.
Valvata tricarinata, and a keelless variety.
Amnicola porata ?
Planorbis parvus?
P. bicarinatus.
Pisidium abditum.
Sphærium striatinum.

With these was the centrum of a vertebra of a small fish.

(5.) The most western locality of bowlder clay with plants is that described by Dr. G. M. Dawson in the vicinity of Skidegate, Queen Charlotte's islands. At this place hard bowlder clay is overlain by stratified sand and gravel, ten to fifteen feet in thickness. The bowlder clay in places shows bedding and holds a few marine shells (*Leda fossa*, etc.). In tracing the bed along the coast the shells disappear and the clay is found to contain fragments of decayed and partially lignitized wood. Specimens of this were collected, but appear to have been mislaid and could not be found in time for this paper.*

(6.) The most eastern locality from which I have collected Pleistocene plant remains is that on the northwest arm of the River Inhabitants in Cape Breton, described in "Acadian Geology," p. 63. This is a hardened peaty bed resting on a gray clay and overlain by twenty feet of till or bowlder clay, apparently the lower bowlder clay. It is quite hard and burns with flame in the manner of a lignite, and contains twigs and branches of coniferous trees and a great variety of fibrous and epidermal tissues apparently of swamp vegetation, which have been examined by Professor Penhallow. This locality is of special interest as showing a bed of vegetables evidently not drifted and under the till or bowlder clay. It shows that this was deposited on what had been a land surface and under circumstances which did not disturb a bed of soft vegetable matter. It indicates also a mild climate preceding the deposit of the bowlder clay rather than an interglacial period. There was no evidence in this case of any land-slip or other accidental disturbance, but rather of successive depositions.

* Report Geol. Survey of Canada, 1878–'9, p. 91B.

Geographical and Climatal Conditions.

With reference to these I shall first refer to the district from the Atlantic to the head of Lake Ontario.

In this district and the eastern part of North America generally, it is, I think, universally admitted that the later Pliocene period was one of continental elevation, and probably of temperate climate. The evidence of this is too well known to require re-statement here. It is also evident, from the raised beaches holding marine shells, extending to elevations of 600 feet, and from bowlder drift reaching to a far greater height, that extensive submergence occurred in the middle and later Pleistocene. This was the age of the marine *Leda* clays and *Saxicava* sands found at heights of 600 feet above the sea in the St. Lawrence valley nearly as far west as Lake Ontario.

It is reasonable to conclude that the till or bowlder clay under the *Leda* clay belongs to the intervening period of probably gradual subsidence, accompanied with a severe climate and with snow and glaciers on all the higher grounds, sending glaciated stones into the sea. This deduction agrees with the marine shells, bryozoa, and cirripedes found in the bowlder deposits on the lower St. Lawrence, with the unoxidized character of the mass, which proves subaquatic deposition, with the fact that it contains soft bowlders, which would have crumbled if exposed to the air, with its limitation to the lower levels and absence on the hill-sides, and with the prevalent direction of striation and bowlder drift from the northeast.*

All these indications coincide with the conditions of the modern bowlder drift on the lower St. Lawrence and in the arctic regions, where the great belts and ridges of bowlders accumulated by the coast ice would, if the coast were sinking, climb upward and be filled in with mud, forming a continuous sheet of bowlder deposit similar to that which has accumulated and is accumulating on the shores of Smith's sound and elsewhere in the arctic, and which, like the older bowlder clay, is known to contain both marine shells and drift-wood.†

The conditions of the deposit of till diminished in intensity as the subsidence continued. The gathering ground of local glaciers was lessened, the ice was no longer limited to narrow sounds, but had a wider scope as well as a freer drift to the southward, and the climate seems to have been improved. The clays deposited had few bowlders and many marine shells, and to the west and north there were deposits of land plants, and on land elevated above the water peaty deposits accumulated.

The shells of the *Leda* clay indicate depths of less than 100 fathoms. The numerous foraminifera, so far as have been observed, belong to this range,

*Notes on the Post-Pliocene: Canadian Naturalist, op. cit.; also paper by the author on Bowlder Drift at Metis, Canadian Record of Science, Vol. II, 1886, p. 36, et seq.

†For references, see Royal Society's Arctic Manual, London, 1875, op. cit.

and I have never seen in the *Leda* clay the assemblage of foraminiferal forms now dredged from 200 to 300 fathoms in the Gulf of St. Lawrence.

I infer that the subsidence of the *Leda* clay period and of the interglacial beds of Ontario belongs to the time of the sea beaches from 450 to 600 feet in height, which are so marked and extensive as to indicate a period of repose. In this period there were marine conditions in the lower and middle St. Lawrence and in the Ottawa valley, and swamps and lakes on the upper Ottawa and the western end of Lake Ontario; and it was at this time that the plants described in this paper occupied the country. It is quite probable, nay certain, that during this interglacial period re-elevation had set in, since the upper *Leda* clay and the *Saxicava* sand indicate shallowing water, and during this re-elevation the plant-covered surface would extend to lower levels.

This, however, must have been followed by a second subsidence, since the water-worn gravels and loose, far-traveled bowlders of the later drift rose to heights never reached by the till or the *Leda* clay, and attained to the tops of the highest hills of the St. Lawrence valley, 1,200 feet in height, and elsewhere to still greater elevations. This second bowlder drift must have been wholly marine, and probably not of long duration. It shows no evidence of colder climate than that now prevalent, nor of extensive glaciers on the mountains; and it was followed by a paroxysmal elevation in successive stages till the land attained even more that its present height, as subsidence is known to have been proceeding in modern times.

The above sequence applies to the districts of Ontario, Quebec, the arctic coast, and the maritime provinces, and might be illustrated by a great accumulation of facts; but these may be found in papers published in the Canadian Naturalist and the Canadian Record of Science and in the reports of the Geological Survey, more especially those by Dr. G. M. Dawson, Mr. Chalmers, and the writer.

For the region between the great lakes and the Rocky Mountains and for the Pacific coast the sequence is similar, but either the interior region has experienced a greater elevation or the times must have been somewhat different. In the mountainous regions of the west, also, more especially in the interior of British Columbia, the evidence of great local glaciers is much more pronounced than on our lower mountains of the east.*

I am quite aware that the above sequence and the causes assumed are somewhat different from those held by many geologists with reference to regions south of Canada, but must hold that they are the only rational conclusions which can be propounded with reference to the facts observed from the parallel of 45° to the Arctic ocean.

* G. M. Dawson, Superficial Geology of British Columbia: Quart. Jour. Geol. Soc., vol. 34, 1878, p. 89, et seq.; ibid, vol. 37, 1881, p. 272, et seq.

One other point remains to be illustrated with reference to the local origin of the vegetable remains. Where these consist of trunks and branches and are contained in the bowlder-bearing beds, they may, like those found under similar conditions in the arctic, be drift-wood, derived from great distances and in a condition of partial submergence of the continent. The facility for such distribution must, in the Pleistocene age, have been greater than it now is in the arctic, where there is, according to the testimony of voyagers, not only a great quantity of such material on the shore, but mixed with clay and bowlders at some distance inland. There is reason to believe that throughout Canada such drift-wood may be found here and there in both the upper and lower bowlder deposits.

Where, however, we have leaves and other perishable parts, and especially where there are peat beds and peaty soils, or where the vegetable remains are associated with fresh-water shells, the case is different. We have in these circumstances evidence of the local flora, and cannot doubt that the climate must have been sufficiently mild to permit the growth *in situ* of the plants whose remains are found. So far as we know at present, evidence of this kind applies, *first*, to the land surfaces anterior to the earlier bowlder deposit; *secondly*, to the swamps and uplands of the *Leda* clay and "interglacial" period; and, *thirdly*, to the early modern time succeeding the upper bowlder drift. The plants specially referred to in the following notes are, so far as known, those of the second of the above periods.

In conclusion, it is deserving of notice that the plants indicated in Professor Penhallow's lists are not an arctic assemblage, but rather a part of the cold temperate flora. They scarcely indicate so much refrigeration as that evidenced by the plants from British interglacial beds as described by Carruthers.* Further, as the species referred to are either local or drifted by streams from the north, it follows that the arctic flora must have existed to the north of the Canadian localities referred to. This accords with the fact proved by arctic explorers and the officers of the Geological Survey of Canada,† that in the glacial period striation and driftage of bowlders point to drift toward the arctic basin as well as toward the south. Thus, when these plants flourished in Canada, there must have been open water and a land flora in the arctic basin—conditions, of course, altogether incompatible with the existence of a polar ice-cap, though not inconsistent with the occurrence of glaciers in the more elevated districts or those cooled by the cold arctic currents. That the climate was colder, locally at least, in the period of the bowlder clay need not be doubted, but there is reason to believe that the general difference of temperature in the so-called interglacial period as compared with that of the bowlder clay has been greatly exaggerated.

* British Association Report, 1886, pp. 683; Dawson, "Geological History of Plants," 1888, pp. 225.
† G. M. Dawson, Geology of Northern Part of Canada, Report Geological Survey of Canada, 1887, p. 51, et seq.

II. *NOTES ON THE PLEISTOCENE PLANTS. BY D. P. PENHALLOW.*

The Pleistocene plants submitted to the author by Sir William Dawson and described in this paper, are chiefly from collections made by Dr. G. M. Dawson and Mr. J. B. Tyrrell, of the Geological Survey of Canada, and by Mr. J. Townsend, with specimens from different localities in the collections of Sir William Dawson, now in the Peter Redpath Museum of McGill University. A few are donations from Messrs. Worthen and Andrews from localities in the United States. These latter will be but briefly referred to, as the precise formation in which they occurred is not wholly free from doubt. Some of the material is of recent collection and until now undescribed. Other specimens were collected at least twenty years ago, and have already been more or less fully described* by Sir William Dawson. These I have submitted to examination for the purpose of verification, and now present in the following statement.

Annotated List of Canadian Plants.

TAXUS BACCATA, L.

The material representing this species was embraced in several slides, which I have designated by the numbers 1, 2, and 3, and by specimens of wood, which have also been numbered as follows:

No. 1. A section taken from a specimen from the Don river, Toronto. The structure is fairly well preserved, and shows the characteristic structure of *Taxus*.

No. 2. A longitudinal section of a specimen from Solsgirth, Manitoba, taken from the bowlder clay of a well at a depth of 135 feet.† The structure is well preserved, and the taxine characters of the wood are more clearly recognizable than in the preceding.

No. 3. Transverse section of a specimen also from Solsgirth, Manitoba. The section is cut diagonally, but as the structure is well preserved the characters are recognizable.

No. 4. A fragment of wood about one and one-half inches square, much compressed, and evidently the nodal portion of a small stem or branch. It was collected in 1887 by Mr. Tyrrell from the till formation of the Solsgirth well. It is readily softened in hot potash, but the whole structure is badly decayed and much distorted by compression. It everywhere shows coniferous markings, and where more fully preserved the structure of *Taxus* is plainly seen.

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*Can. Nat., Vol. II, 1857, p. 522; ibid., New Ser., Vol. III, 1870, p. 69; ibid., Vol. VI, 1871, p. 403.
†Trans. Roy. Soc. Can., Vol. IV, Pt. IV, 1886, p. 92.

No. 5. A specimen from the same locality by the same collector as above. It represents the broken end of a branch or small trunk about two inches in diameter. The form has suffered little change, and to the surface there still adhere small pieces of bark. The preservation of this specimen is so distinct from that of the others as to lead to the supposition, upon external examination, that it is a distinct kind of wood. It shows everywhere the effects of advanced decay, and it is also impregnated to some extent with silica. This condition of preservation rendered it extremely difficult to obtain longitudinal sections and impossible to get transverse sections. The former, which were secured in small fragments, were sufficient to place the coniferous character of the wood beyond dispute, and in places the spiral structure of *Taxus* was evident.

In a recent communication, Mr. Tyrrell stated that specimen No. 4 was obtained from a depth of 360 feet, and that No. 5 was exceedingly soft when found; but the precise depth at which it occurred is not known, though probably one of those depths at which wood occurred as mentioned in the report of Dr. G. M. Dawson.*

No. 6. Embraces two small fragments of wood about one-half inch square and strongly compressed; also three slides of the same. This material was collected by Mr. J. B. Tyrrell, in 1887, from the drift of Rolling river, two miles above Heart hill, Manitoba.

Fresh sections were cut, but the material was in such an advanced state of decay that the treatment with potash had to be applied cautiously, and microscopical examination showed that it had also resulted in the removal of a large part of the structure of the cell walls, of which, in most cases, only the primary cell wall remained. The characteristic markings of coniferous wood were thus in many cases wholly removed, but in places, where the action of decay was more limited, the markings peculiar to *Taxus* were observed.

7. Another specimen of *Taxus* from peat below bowlder clay on the River Inhabitants, Cape Breton, obtained by Sir William Dawson, and now in the collection of the Peter Redpath Museum, has been examined. It is a fragment of a branch about three-fourths of an inch in diameter and six inches long, much flattened by pressure. The structure shows it to be a *Taxus*, but presenting some aspects different from those of our modern species. These may have resulted from local conditions, since the wood rings show it to have grown very slowly, as if in a situation unfavorable to it. A more critical examination will be made later; for the present I refer it to *T. baccata* provisionally.

The modern Canadian species of *Taxus* are *T. brevifolia*, Nutt., and *T. baccata*, L., var. *Canadensis*, Gray. To the first, none of the specimens described

*Ibid.

can be referred, as they differ from it in a somewhat marked manner; but they do approach the latter species, to which I shall therefore refer them. *Taxus baccata* is now found extending from Newfoundland, Anticosti, and Nova Scotia, where it is abundant, through New Brunswick, Quebec, and Ontario. On the shore of Lake Huron it often forms impenetrable thickets. Passing to the west it still continues abundant north of Lake Superior, and at least to Lake Winnipeg, according to Macoun.*

ASIMINA TRILOBA, DUNAL.

The specimen of this fossil is from the Pleistocene of the Don river, Toronto, having been collected in 1887, by Mr. J. Townsend, from a cut at Jail hill, at a depth of sixty-six feet below the surface, and from below the Erie clay of that locality. It is about six inches long by two wide, and evidently was derived from a tree of small diameter, as indicated by the curvature of the growth rings. In its general aspect it bears a very strong resemblance to the wood of our modern *Asimina triloba*, with which it is also closely comparable in its minute structure. It presents certain differences in detail—*e. g.*, the development of the thyloses is much more strongly marked, the wood cells are of smaller diameter, and there are also certain differences in the markings of the vessels. Alteration under the conditions established by its long burial may account for some of these, and perhaps none of them are sufficient to mark a distinct species. I would therefore assign it for the present to our modern species of *A. triloba*.

The material was well preserved, and all the details of structure could be distinguished without difficulty. By boiling in potash, sections were as readily cut as if taken from fresh material.

At present *Asimina triloba*, the only species found within Canadian limits, occurs in Ontario, at Queenstown heights. It is very abundant at Point Pelée and in the townships bordering on Lake Erie between that point and Amherstburg. Doubtless it is not rare along Lake Erie, though not yet reported (Macoun).

ULMUS RACEMOSA, THOMAS.

This fossil is represented by two specimens, numbered 2 and 3.

No. 2 is twelve by six inches, and evidently derived from a somewhat large tree. It was obtained in 1887 from a cutting on the Don river, from beneath the Erie clay, at a depth of sixty-six feet from the surface, and associated with the previously described species.

The material is fairly well preserved, though showing the effects of decay in the exfoliation of the growth layers; while under the microscope the dis-

*The occurrence of *Taxus baccata* in the Pleistocene deposits of Manitoba has been noticed by Dr. G. M. Dawson in the Transactions of the Royal Society of Canada, vol. IV, part IV, 1886, p. 92.

torted structure shows the effect of compression, which has turned all the medullary rays off obliquely. This, together with compression of the vessels and wood parenchyma, has resulted in the groups of wood cells being distributed in the form of diamond-shaped masses, which are at first very misleading as to the true character of the wood. In consequence of these alterations it was impossible to cut truly radial or tangential sections. The material submits readily to the action of potash, whereby sections are easily cut.

No. 3 was obtained from the same locality as the preceding, and about two feet below a band of sand containing leaves. It appears to be one side of the stump of a small tree, as it shows the spreading base usually found at the point where the roots separate. It is four inches long by three and one-half wide at the widest part. Portions boiled in caustic potash gave very fine sections, and showed the structure to be not only well preserved, but also largely free from the effects of compression, so that the distribution of the tissues could be readily determined. The compactness of the structure, as well as the very small, thick-walled cells, shows it to have been a very hard wood. Both of these specimens (2 and 3) are identical. They present the unmistakable structure of the genus *Ulmus*, of which *U. fulva*, Michx., *U. americana*, L., and *U. racemosa* are at present found in Canada.

A close comparison with these different species shows that the fossils so nearly approach *U. racemosa* as to admit of referring them to that species.

Within Canadian limits, *U. racemosa* is rather rare in the eastern townships, Quebec, extending thence westward throughout Ontario, in the limestone areas. It seems to be confined to dry, gravelly soils, and is usually associated with sugar maple in such localities. It was formerly very common, according to Macoun.

GEN. AND SP. UND.

Three sections of wood—one transverse and two radial—from the interglacial at Solsgirth, Manitoba, collected by Dr. G. M. Dawson. The plant was evidently exogenous. It was either very soft in its original state, or, as seems more probable, the sections present the remnants of decayed tissue. At all events, the state of preservation was such as to prevent correct determination.

THUYA OCCIDENTALIS, L.

A small fragment of wood, about one-fourth of an inch in diameter and an inch and one-quarter long, from the *Leda* clays, Montreal (collection of Sir William Dawson). This species extends from New England, throughout Quebec and Ontario, northward to within twenty miles of Lake Mistassini, to James's bay and in the neighborhood of Moose factory. The northern

limit crosses the Albany at some distance from the sea, extending westward to a point about seventy-five miles southwest of Trout lake, thence southward to Lake Winnipeg and the United States boundary. It is one of the trees most likely to be found in this formation. This species has been recognized by Sir William Dawson in the drift of the Roseau river, Manitoba, and of Montreal (*Leda* clay) and the Ottawa river.*

ELODEA CANADENSIS (?), MICHX.

A specimen of soft stone bearing the impress of a small branching plant and the carbonized remains of another of the same kind. This was from the collection of Mr. Tyrrell, made in 1887, and obtained from Rolling river, Manitoba, two miles above Heart hill. A slide of the same plant and from the same locality, from Dr. G. M. Dawson, shows the plant to have been herbaceous, but with a distinctly vascular axis, the wood cells of which are thin walled and with rather blunt terminations. This vascular structure is surrounded on all sides by a distinctly parenchymatous structure. Associated with this plant are many diatomaceous remains belonging to fresh-water species, among which I have recognized *Navicula lata*, *N. legumen*, *Encyonema prostratum*, *Denticula lauta*, and various species of *Licmophora* (?) and *Cocconeis*. It is therefore clear that the plant is not a seaweed. The distinctly branching habit and the structure suggest *Elodea*, although the state of preservation is not such as to render exact comparison possible. I therefore refer it provisionally to our common Canadian species, *E. canadensis*, which is everywhere found in fresh water.

VALLISNERIA (?).

Several fragments of the same earthy material as above, bearing each a small fragment of a leaf. This is in each case linear, with a well-rounded apex, and usually about 2.5 mm. wide. The epidermis is apparent under a pocket lens. In fact the remains appear to consist wholly of the two epidermal layers, which may be separated readily. Under the microscope the epidermal cells are found to be well preserved. No stomata have been found, and this, together with the presence of fresh-water diatoms, would indicate that it must have been a submerged, aquatic plant. The structure strongly reminds one of *Vallisneria*, to which I shall provisionally refer it. This plant is everywhere common in fresh water, and is very likely to have occurred in such a locality as that from which the fossil was obtained.

CAREX MAGELLANICA, LAMARCK.

The Green's creek nodules contain an abundance of leaves, evidently of grasses and sedges. In one nodule from the Miller collection and in two

*Can. Nat., New Ser., Vol. III, 1868, p. 72; Report on 49th Parallel, 1875, p. 214; Notes on Post-Pliocene, op. cit., 1871, p. 404.

belonging to the collection of Mr. John Stewart, of Ottawa, there were found portions of old spikes devoid of seeds, but with the persistent glumes widely spread, evidently the remains of a *Carex*. In other nodules belonging to the Miller collection in the Peter Redpath Museum, there were found complete spikes containing the seeds, apparently the same as the preceding. In both cases the resemblance to *Carex magellanica* is so marked that I have ventured to refer them to it.

At present this species is found in peat bogs from Newfoundland to Vancouver.

BRASENIA PELTATA, PURSH.

This is evidently an undeveloped leaf, of which only one-half, embracing the stump of the petiole, is represented. The form and, to some extent, the venation show its probable relation to the species above named.

Brasenia peltata occurs at Rocky lake, Nova Scotia; Grand lake, New Brunswick; Point St. Charles, Montreal; River Range; and is abundant throughout the northern counties of Ontario, and about Rainy lake and Lake of the Woods, according to Macoun.

LARIX AMERICANA, MICHX.

Several small branches about three inches or less in length and from one-third to three-fourths of an inch in diameter, from the Geological Survey of Canada, through Sir William Dawson. They were collected by Mr. J. C. Weston from the *Leda* clays in Peel's clay pit, Montreal. The structure is fairly well preserved and recognisable without difficulty.

In its present distribution, *Larix americana* is common in all swampy ground from Newfoundland and Labrador, through the eastern provinces, to the foot of the Rocky Mountains; northward to latitude 65°.

POPULUS GRANDIDENTATA, MICHX.

Base of a small stem or branch about two and one-half inches long. The structure is quite well preserved and readily comparable with the above species. It was obtained from the *Leda* clays of Montreal by Mr. J. C. Weston, and transmitted to me from the Geological Survey of Canada by Sir William Dawson. Also in nodules from Green's creek, Ottawa, now in the collection of Mr. J. Stewart, small branches of this same species were found.

Populus grandidentata is common in Nova Scotia and New Brunswick, as also throughout Quebec and Ontario.

POTAMOGETON RUTILANS (?), WOLFGANG.

A single specimen in a Green's creek nodule from the collection of Mr. J. Stewart. It embraces the stem and several leaves.

This species is at present known only near Red Rock, Lake Superior, and on Twin island, James's bay; in marshes on Anticosti; and at the mouth of the Nipigon river (Macoun). It would therefore appear probable that it was more abundant in the past than at present.

EQUISETUM LIMOSUM (?), L.

E. SYLVATICUM (?), L.

Fragments of plants with lateral members in whorls were frequently met with and, although not satisfactorily referable to any modern genus, presented the closest resemblance to the two species of *Equisetum* above named, to which they are provisionally referred.

MENYANTHES TRIFOLIATA, L.

A specimen of the *Leda* clays from Montreal, now in the Peter Redpath Museum, shows the remains of a plant of which only the basal portion is preserved. This consists of a central axis from which rather stout lateral members are developed at right angles, and from which in turn are produced numerous fine roots. The specimens are of small diameter, but from their evidently shrunken character must represent the remains of plants approaching one-quarter of an inch in diameter. Although not clearly referable to any existing species, the resemblance to the stem of *Menyanthes trifoliata* is very striking, and in all probability it represents a similar underground stem with its roots developed at right angles to the axis of growth. The absence of leaves renders a more accurate determination at present impossible.

Description of New Species.

ACER PLEISTOCENICUM, SP. NOV.

This fossil was recently obtained by Mr. Townsend from the Pleistocene of the Don river, Toronto, and was purchased by Sir Willam Dawson with other specimens and presented to the Peter Redpath Museum. Though not perfect as to form, the leaf is beautifully cast in an argillaceous nodule, and shows several details of venation quite perfectly. A drawing, giving a restoration of the leaf, is herewith presented. From this it will be seen that the left half of the blade is nearly intact, while of the right half only about two-thirds remain, the lobes being entirely cut off by fracture of the matrix.

The leaf is evidently that of a maple, although of a type quite distinct from any of our existing forms. As will appear from the figure, the general

form and venation suggest *Platanus*, and a specific name indicating this resemblance would be appropriate, were not some of the existing species already so distinguished. It is to be regretted that this is the only specimen so far found in a fairly complete condition, since it is unsatisfactory to base conclusions upon a single specimen where there is opportunity for variation.

The modern maples with which the fossil is most nearly comparable are *Acer rubrum* and *A. platanoides*. In its general outline, the fossil is broadly

FIGURE 1.—*Acer pleistocenicum.*

ovate and, if we follow the same rule as in other maple leaves in respect to the number of lobes being determined by the palmate distribution of the principal veins, three lobed; but the terminal lobe has two prominent lateral lobes, while the others have each a small basal lobe, all somewhat strongly defined and making the leaf appear seven lobed. The lobes are all very

acute. The margin is entire with the exception of two teeth, one on each side and situated midway between each lateral lobe and its inferior lobe. The sinuses are open, shallow, and well rounded. In many of these respects it approaches *Acer platanoides*, from which it differs in its much broader terminal lobe and in the broader and more shallow sinuses.

The venation is most nearly comparable with that of *Acer rubrum*, where, as in the fossil, only two veins are arranged palmately with the midrib, and from these branch smaller veins which run to the small basal lobes.

The second and third veins, lateral to the midrib, run to the principal sinus of each side, where they terminate near the margin by repeated dichotomous branching. This, however, is common to several of the modern maples. The finer venation is essentially the same as in our modern maples.

It would appear from this that the fossil cannot be properly referred to any of our existing species, and it appears desirable to give it a distinctive name. I therefore propose to call it *Acer pleistocenicum*, as properly descriptive.

Revision of previously recorded Pleistocene Plants.

The following specimens from Green's creek, as referred to by Sir William Dawson in the preceding pages, have already been partially determined by him and published in 1868, with figures of some of the species.* The present revision shows a few changes and includes a few specimens not originally noted, and which have been acquired by the Redpath Museum from the collection of the late Mr. J. G. Miller since the publication of Sir William Dawson's paper.

DROSERA ROTUNDIFOLIA, L.

A nodule containing a single specimen of what appears to be a leaf of this plant, showing marginal projections and surface markings bearing somewhat close resemblance to the glandular hairs. Its association with the fertile spike of an *Equisetum* shows it to have been a habitant of moist places such as are usually favorable to its abundant development. It is a species very commonly distributed throughout Canada.

ACER SACCHARINUM, WANG.

A basal fragment of a leaf in a nodule. This specimen was originally designated † as *A. montanum*, Ait. (*A. spicatum*, Lamx). The only data on which a determination is possible are to be found in the angles at which the veins separate and in the number and distribution of such veins. With reference to the first, it is to be observed that the angles of the veins with

* Can. Nat., New Ser, Vol. III, p. 70 et seq.
† Ibid.

the midrib vary considerably in the same species, so that this cannot be regarded as a character of more than approximate value. The number and distribution of the veins offers a somewhat more reliable guide, since there is a constancy in this respect which is of value. The majority of our maples fall in one of two types. In the first case, four principal veins are arranged palmately with the midrib, and directly extend to as many distinct lobes of the leaf, the first pair usually extending horizontally or obliquely downward to the basal lobes. To this type can be referred such species as *Acer platanoides* and *A. saccharinum*. In the second case, only two principal veins are directly and palmately arranged with the midrib, while from each of them there springs a subordinate vein at a short distance from the base, which then extends to the corresponding basal lobe. Examples of this type are to be seen in *Acer rubrum* and *A. dasycarpum*, as well as in the fossil *A. plestocenicum*.

In the fossil under consideration there are four distinct veins palmately arranged with the midrib, two of which are large, and the other two running to the basal lobes. It will thus be seen that comparison with *Acer montanum* cannot be considered. A close comparison with the leaves of the first group shows that it approaches most nearly to *Acer saccharinum* in all those characters represented.

The present distribution of *A. saccharinum* covers a wide range throughout Canada, from Newfoundland and Nova Scotia to the western extremity of Lake Superior, and northward to Lake St. John and to the Long portage on the Michipicoten river.

POTENTILLA ANSERINA, L.

Two specimens and their reverses in nodules previously determined* as *Potentilla canadensis* and *P. norvegica*, and also a specimen and its reverse in Mr. Miller's collection in the Peter Redpath Museum. The leaves only are represented, but the venation is so distinctly preserved, as well as the general form and margin, as to leave little doubt as to their true character, although in one case they are so grouped by crushing as to bear a certain resemblance to the leaf of *P. canadensis*. In this species the veins run directly from the midrib of the leaflet to both teeth and sinuses. In *P. norvegica* the veins run to the teeth, taking a direction which tends to become parallel with the margin, and while the vein itself extends into a tooth it gives off a lateral which penetrates the tooth below, so that there are in reality twice as many teeth as veins. The fossils, which in this respect as in others are all similar, show the veins running directly to every tooth, veins and teeth being equal in number.

In this respect, as well as in the form of the leaflet, the shape and apices

* Can. Nat., New Ser., Vol. III, 1868, p. 70.

of the teeth and their inclination to the midrib, the fossil corresponds most closely with *P. anserina*, to which I therefore refer them. At present this species is very abundant along the eastern coast and on the margins of rivers and lakes throughout the interior and as far north as the Arctic sea.

GAYLUSSACIA RESINOSA, TORR. AND GRAY.

A well-preserved leaf in a nodule. This shows the form of the leaf, and the resinous dots are so perfectly seen as to render it readily determinable. This species is now found in rocky or sandy woodlands and in bogs, from Newfoundland and Nova Scotia to the Saskatchewan.

POPULUS BALSAMIFERA, L.

The material representing this species is embraced in leaves and fragments of branches contained in nodules. The former are in most cases well preserved and admit of easy identification. As noted in the original description, however, the leaves are all small, and assuming them to be mature this would indicate a cold climate or very exposed situations. At present *P. balsamifera* is of very wide distribution throughout Canada, extending northward to the mouth of the Mackenzie river, where it attains large size, and is an important source of fuel (Macoun).

POTAMOGETON PERFOLIATUS, L.

Portions of leaves and seeds in nodules. The venation is beautifully distinct, and it is without much doubt referable to the species named. This is one of our most common water weeds, being found everywhere in the streams of the northern United States and Canada.

POTAMOGETON PUSILLUS, L.

This is one of the most abundant plants contained in the nodules from Green's creek. The specimens all show a branching plant with narrow leaves. This species is now common in slow streams and ditches almost everywhere.

EQUISETUM SCIRPOIDES, MICHX.

Common in the nodules from Green's creek, and associated with *Potentilla anserina*. This is a widely distributed species, and would naturally occur among such plants as are found at the above locality.

There is also another nodule containing a portion of a stem cut longitudinally. It has the appearance of an *Equisetum*, and may possibly be referred to one of the larger species, such as *E. palustre* or *E. limosum*.

ORYZOPSIS ASPERIFOLIA, MICHX.

A fragment of a leaf and stem in a nodule, showing features which make them correspond closely with *Oryzopsis asperifolia*, and to which I therefore

refer them. This species is a widely extended one, being found from Newfoundland to the Rocky Mountains.

FUCUS.

A specimen of a seaweed in a nodule, evidently a *Fucus*. It is not strictly comparable with any of our modern species, and until more material is obtained it seems best not to assign any specific name to it, although *digitatus* would appear to be appropriate.

FONTINALIS.

Fragments of mosses are common in the nodules from Green's creek. These appear to be chiefly of the genus *Fontinalis*, or one nearly related to it.

In addition to the above there were also found in the Green's creek nodules various seeds. These require some further examination.

BROMUS CILIATUS, L.

A fragment of a leaf which shows a venation closely corresponding to *Bromus ciliatus*, to which I would for the present refer it. This is a very common species in thickets and damp places throughout Canada. The specimen was collected by Mr. J. G. Miller from Green's creek.

GEN. AND SP. UND.

Among the specimens sent us by Dr. G. M. Dawson was a seed collected by Mr. J. B. Tyrrell, in 1887, from the Rolling river, Manitoba, two miles above Heart hill. The form and size seem to indicate that it is the seed of a Conifer.

Lignites.

A sample of lignite or indurated peat, collected by Dr. G. M. Dawson from the interglacial deposits of Belly river, was presented in the form of balsam mounts and loose material, all of which had been treated with potash, nitric acid, sulphuric acid, or chromic acid. In all cases the material was found to be very finely divided, none of the fragments being of sufficient size to make reference to particular orders or genera possible. It was, however, quite possible to recognize fragments of sclerenchyma tissue, fragments of wood cells, spores of ferns, and what appeared to be the extine of pollen grains. These latter, together with the few spores, constituted the bulk of the recognizable material. There were also to be observed fragments of epidermis, apparently of three different kinds, and in one instance two stomata were found, though imperfectly preserved. The impression gained from a careful examination of a large amount of material is that the