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January and February, 1889.

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ELEMENTARY LECTURE ON GEOLOGY.

BY R. W. ELLS, LL.D., F.G.S.A.

Delivered on Monday Afternoon, January 21, 1889.

In attempting to prepare a paper for this Society on the subject of Geology, I must confess I have found myself at a considerable loss to know how best to discuss it—for such is its greatness and so limited the time at my disposal that the utmost economy of material must be exercised in order to touch even upon the leading points. I have thought however that possibly a brief sketch of the views held from time time as to the origin and early history of our earth might be of interest first of all, and then we might present a brief outline of the several systems into which the science is generally divided.

Strictly speaking, Geology is the science which tells us about the earth. It investigates the many changes which have taken place on its surface, both in relation to organic and inorganic matter as well as the causes which have produced these changes and the influence which they have exercised. It may for the sake of convenience be considered under three heads, structural, dynamical and historical, though some authors make a much more elaborate division of the subject. Of these the first, *Structural* geology, deals with the general form and structure of the earth, the kinds of rock, whether *sedimentary* or *stratified* or igneous and unstratified with their mode of occurrence, either *plutonic* or deepseated, not reaching the surface, or *eruptive*, volcanic and reaching the surface. It takes cognizance also of the metamorphic rocks and the manner in which the metamorphism has been effected, as well as the general condition of the earth's crust, as affected by faults, joints, veins, etc. It also considers the origin and structure of mountains and many similar subjects connected with the earth's architecture.

The second, *Dynamical* geology, treats of the forces or agencies by which the several changes have been effected, whether aqueous, igneous or organic. Among the first of these, the *aqueous*, may be classed rivers, seas, glaciers, &c. The 2nd, or *igneous*, refers to the agency of the internal heat of the earth, as volcanoes and their resulting effects, geysers, etc.; whilst the 3rd, or *organic*, includes, 1st, vegetable accumulation as peat-bogs, etc., and, 2nd, animal agencies, such as coral reefs and other subjects of that nature.

The third division, *Historical* geology, or as some call it "*Statigraphical* geology, treats of the rocks in the order of their formation with the contemporaneous events in their geological history, and includes both stratigraphical and paleontological geology, the latter being regarded by some, however, as a distinct branch, with a review of the laws or systems of progress in the globe and in its kingdoms of life. While in this place we can only consider the science of geology properly so called, we may say that its relation to many other physical sciences is exceedingly intimate. Among these may be specially mentioned astronomy, chemistry, mineralogy, zoology and botany, with all of which, and with others, the elucidation of the many geological problems which constantly arise requires an acquaintance more or less profound. In the present stage of the science each of these subjects is frequently assigned to a specialist in that particular branch, in so far at least as it applies to the science of geology. Thus the chemist and lithologist study the composition and peculiarities of the several kinds of rock structure. The paleontologist studies the remains of organic life, in which now paleontological botany forms a special branch. The mineralogist works out the peculiar properties of the several varieties of minerals which are encountered, and this division of study is carried on almost indefinitely in certain lines; thus one person devotes his time to studying the peculiarities of special forms of life, as, for instance, the graptolites, the trilobites, the extinct mammalia, and so on.

With the early history of our planet, or that part of its history which precedes the appearance of solid land, known in geological language as the Laurentian time, geology proper is supposed to have nothing to do, its strict province being confined to the study of the rocks of the earth's crust itself. So intimately, however, are the rocks of the Laurentian time connected with the original crust of the earth that the consideration of the agencies which led to the deposition or formation of that crust is by many regarded as strictly within the province of geological investigation, and in most works on the science we find a chapter devoted to the early history of the earth, viz.: that portion of it preceding the commencement of the geological record as we consider it. This portion of the earth's history is generally known under the term cosmogony, and under this head we consider the many changes which have transpired previous to the formation of the first solid crust. While of necessity this portion of the earth's history must be treated almost entirely from a theoretical standpoint, it has always been endowed with peculiar interest and the theories connected therewith can be traced back for many hundreds and even thousands of years. Anyone who has ever read that great work "Lyell's Principles" must have been astonished and interested in the many curious and diverse views as to the early stages of the earth's history there presented. To enumerate these would form material for many hours talk alone. Thus we learn that the earliest Indian and Egyptian schools of philosophy ascribed the first creation of the world to an omnipotent and infinite Being who had existed from all eternity and by whom the earth and its inhabitants had been repeatedly destroyed and reproduced. The frequent submergence of land beneath the waters of the universal ocean was also held by them, and the act of creation of life was ascribed to that person of the Hindoo Trinity called Bramah, thus: "In the beginning of things the first sole cause created with a thought the waters, and then moved upon their surface in the form of Bramah the creator, by whose agency the dry land was produced and the earth peopled with plants, animals, celestial beings and men." The Egyptian philosophy also held the theory of recurrent creations; the returns of the great catastrophes by which the surface of the earth was destroyed were determined by the period of the Annus Magnus or Great Year, a cycle composed of the revolutions of the sun, moon and planets, and terminating when these returned to the same sign from which they set out at some remote epoch, the duration of which cycle was estimated at from 120,000 to 350,000 years.

While it would be of great interest to examine the many theories propounded for the creation of the world by such men as Pythagoras. Strabo, Aristotle and other early philosophers, lack of time prevents, The idea of repeated inundations of the globe appears to have been held by most of them, the different relative levels of land and sea, had been, even so early as that time, observed. The theories for the repeopling of the earth after the destruction of organic life also varied; thus the Gerbonites, a sect of philosophers who lived some centuries B.C., held that after every period of 36,400 years there were produced a pair of every species of animal, both male and female, from whom other animals might be propagated and inhabit this lower world, but when a circulation of the heavenly orbs was completed, which was supposed to be finished in that time, other genera and species were propagated, as also plants and other things, the first order was destroyed, and so on forever.

The theory of Strabo to account for the phenomena of submergence and upheaval is worthy of much attention, and shows that even many hundreds of years ago considerable thought had been bestowed upon some of the most puzzling problems of science. "Thus," he says, "it is not because the lands covered by the seas were originally at different altitudes that the waters have risen or subsided or receded from some parts and inundated others, but that the same land is some. times raised up and sometimes depressed, and that the sea is simultaneously raised and depressed, so that it either overflows or returns into its own place again. We must therefore ascribe the cause to the ground, either to that which is beneath the sea or to that which becomes flooded by it, but rather to that which is beneath the sea for this is more movable, and on account of its humidity can be altered with greater celerity. It is proper, he observes, to derive our explanations from things which are obvious and in some measure of daily occurrence, such as deluges, earthquakes and volcanic eruptions and sudden swellings of the land beneath the sea, for the last raise up the sea also, and when the same lands subside again they occasion the sea to be let down, and these affect not merely the small but the large islands and even the continents, which can be lifted up together with the seas."

The cosmogony stated in the Koran is brief but of interest. Thus: "The Prophet declares that the earth was created in two days, and the mountains were then placed upon it, and during these and two additional days the inhabitants of the earth were formed, and in two more the Seven Heavens. Concerning the deluge the waters were supposed to be poured out of an oven, and all men were drowned save Noah and his family; then God said, "O earth! swallow up thy waters, and thou, O heavens! withhold thy rain, and immediately the waters abated."

But it is impossible here to follow the many curious theories of creation and the early views as to the early condition of the earth down to the present. For many centuries, in fact the time has in some places scarcely yet expired, a conflict between the theologians and the men of science concerning these points and the causes of the various geological phenomena was waged with considerable bitterness, in which it did not always happen that the views of the former were consistent either with reason, truth or common sense. The chronology of the Bible evolved by Archbishop Usher and first published in 1701 limited the age of all things to 4004 years B.C., so that the theories necessary to compress the history of the earth as evidenced by the succession of strata everywhere apparent, and of which many contained the remains of extinct animals and plants, into this limited period, were often exceedingly curious. While the rival doctrines of the *Neptunists*, who held that the present physical condition of the earth was due almost entirely to aqueous agencies, and the *Vulcanists*, who maintained that the active agent was principally fire, caused a wordy warfare almost if not quite as violent as the other. As late as 1809 De Luc propounded the hypothesis that the form and composition of the continents and their existence above the seas must be ascribed to causes no longer in operation. These continents, he held, emerged at no very remote period upon the sudden retreat of the ocean, the waters of which made their way into subterranean caverns. The formation of the rocks of the earth's crust, he held, began with the precipitation of granite from a primordial liquid, after which other strata containing the remains of organized bodies were deposited, till at last the present sea remained as the residuum of the primordial liquid and no longer continued to produce mineral strata; while Werner, who is generally considered the leader of the Neptunists' philosophy, held the theory of universal formations, which had been simultaneously precipitated over the whole earth from a common menstruum or chaotic fluid, and regarded basalts and other rocks, which we now know to be of igneous origin, as precipitates by chemical action from water.

The controversy of these two factions at last reached such a pitch that a new school gradually arose, which professed the utmost indifference to the views of both parties and determined to devote its labors to observation, ignoring theories entirely unless supported most strongly by facts obtained in the field, and to this end the researches of the members of the Geological Society of London, established in 1807, were largely devoted, and at length became instrumental in rescuing the science from the dangerous position into which it had been brought, largely by visionary enthusiasts, both in science and theology. Since the formation of this society, which forms one of the most important epochs in connection with the progress of the science, the study of geology has proceeded without due regard to the dictates of reason. The assistance of kindred sciences has been evoked, and while of necessity many changes have occurred in the interpretation of the several problems, these changes have been made after careful consideration of all the facts relating thereto, till now geology stands on the proud pedestal as one of the most useful and important of the sciences.

The generally accepted theory as to the earliest stages of the earth's history is that now known as the "Nebular Hypothesis." By this it is assumed that not only the earth but all the planets, together with the sun, and in fact all the celestial bodies, first existed as a gaseous mass. This in its revolution around a central axis from time to time threw off huge rings which, partaking of the motion of the original mass, gradually formed by condensation the planetary and stellar bodies, the remaining nucleus of our system still remaining as its sun and centre. The process of condensation and cooling proceeded gradually till in time the first crust of the earth was formed, and became covered with water, gradually also the first land rose from beneath the wave and from this point the beginning of the Geological record must be assumed. While therefore the discussion of this theory would be of great interest as well as of the views regarding the condition of the earth's interior we must be content with this brief notice and consider the divisions of geology proper and more particularly in reference to that branch of it known as historical or stratigraphical geology.

For purposes of convenience it has been found desirable to divide the portion of geological time which elapsed since the formation of the first rocky crust into several parts. These may be generally known as the Azoic Paleozoic, Mesozoic and Cenozoic. By the first, the *Azoic*, is known that portion as yet held to be devoid of organic remains. This has, however, by some been subdivided into two, the *Azoic* and *Eozoic*, from the discovery of certain structures which have been regarded by some authorities as of organic origin in certain portions of these earliest rocks, more especially of that peculiar so-called organism known as the Dawn Animal, or *Eozoon Canadense*, which has the honor of being regarded as our first known form of life. It is but fair, however, to state that the organic nature of this substance has been strongly combated by many scientific men, the great defender of its organic nature at present being Sir William Dawson, through whose efforts and researches it was first most prominently brought into notice, and who has devoted more time and close study to its history than probably any other person. Some, however, hold that in this Azoic time, or the Eozoic part of it, evidences of organic life are manifest in the presence of the beds of graphite or carbon, which are claimed to represent the early presence of vegetable matter in some form. The beds of iron ore are also regarded by some as indicating the presence of organic agencies as well as our deposits of Apatite. These, however, are all as yet subjects of controversy and will probably remain so for many years. The Azoic may be said to embrace two periods, the *Laurentian* and *Huronian*, and is followed by the *Paleozoic*, a time when organic life flourished everywhere over the world's surface, and so generally were the species distributed that precisely the same forms are found at points the most widely removed. The *Primary* or Paleozoic time embraces several periods, or systems so-called, including the Cambrian of our nomenclature, or the Lower Silurian of earlier times, the Cambro-silurian or middle Silurian, the upper Silurian or Silurian proper, the Devonian, Carboniferous and Permian ; and forms the longest and probably the most important portion, in many ways, of the earth's history. The succeeding time, the secondary or Mesozoic, embraces the Triassic, Jurassic and the Cretaceous, while the Tertiary or Cenozoic includes the Eocene, Miocene and Pliocene. The closing period, the Post-tertiary, includes the Pleistocene, recent and prehistoric.

The earliest or Laurentian rocks form what we may call the backbone of our continent. They are all crystalline, and consist for the most part of gneisses, granites, limestones, schists, labradorites, quartzites and in some places altered slates. They contain, prominently among minerals, apatite, graphite and mica with great beds of iron ore and many others of great interest to the mineralogist. These rocks are well developed in the Chelsea hills and the country to the north. Geographically and roughly speaking, they may be said to extend from Labrabor along the north side of the St. Lawrence to Lake Superior and Lake of the Woods, whence they trend away north-westerly and reach almost the Arctic Ocean. Various theories as to the origin of these different kinds of rocks have been put forth. For many years they were regarded by most geologists as altered sediments entirely, which had been recomposed from the debris resulting from the disintegration of the first existing crust of the earth, through the agency of water or the atmosphere, as well as by the action of the ocean, by which the sands, etc., were redistributed and formed sedimentary layers, which subsequently became metamorphosed into the gneisses, limestones, etc. By others it is held that a great part of these rocks was formed by deposition from a semi-fluid magma, and that they represent the true crust of the earth without the agency of water, while other portions are true altered sediments. Still others again hold that all *Archean* rocks, by which term is meant generally, though the phrase is somewhat ambiguous, all rocks devoid of organisms, thus including Huronian as well as Laurentian, were formed of sedimentation, and that they are originally crystalline rocks, in part at least due to chemical agencies, their crystalline character not being a superinduced but an original property. In such a variety of opinions it seems hard to decide which should have the preference, and while it is scarcely possible that the old wars of the Neptunists and Vulcanists will ever revive in all the intensity of early days, there is yet to be found in the statements of the advocates of either theory plenty of food for discussion. In solving such problems the microscopist plays an important part by the examination of thinly-sliced rock sections, from which their characters are in many cases readily deciphered and their igneous or aqueous origin easily determined. It is probable that both agencies have been largely exerted. Certainly if the organic nature of the *Eozoon Canadense* can be considered as established, there can be no doubt of the sedimentary character of much of the strata of the system. So also the beds of quartzite and slate, in which the graphite sometimes occur, would in any other system be classified as of aqueous origin. In certain cases of apparent sedimentation, such as the banding of gneisses, this is not so clear since this structure might be induced by other causes, such as pressure, shearing, etc., and we frequently find gneissic structure in true granitic rocks, In fact, no hard and fast theory can be drawn in geological discussion any more than in many other sciences. So much difficulty has been found in drawing the line of division between the two groups of Archean rocks. the Laurentian and Huronian, that very often the two are comprised under one head, the pre-Cambrian, in which the Cambrian is held to constitute the lowest fossiliferous series,the underlying pre-Cambrian being, in so far as yet known, with the possible exception mentioned above, non-fossiliferous.

With the primary or paleozoic rocks our acquaintance with the organic life of the globe may be said to begin, though from the advanced types of life first found it is held by many that lower and earlier forms must have existed in earlier times, the remains of which have completely disappeared from the record because of the great metamorphism to which the rocks of the preceding age have been subjected. Thus in the lower Cambrian are found the remains of huge trilobites with a length of 17 or 18 inches, in fact of a size unknown or unsurpassed in subsequent periods. As we advance in Paleozoic time, however, the various species increase with great rapidity, and in some places, judging from their remains, the shores and shallow waters must have absolutely swarmed with life. That these shores were exposed to the action of sun and wind, tidal currents, etc., is evidenced by the presence of sun cracks, ripple marks and false bedding even in the oldest Cambrian strata, while the presence of beds of conglomerates with sandy layers indicates that the character of the sea beaches of those early days was in many respects very similar to those observed along the coasts at the present time. In fact, in the interpretation of geological problems in the stratified rocks, sufficient attention is rarely paid to the present shore phenomena, varieties of texture in rock, passage from conglomerates to sandstone, limestone and shale being sometimes supposed to form a basis sufficient to draw well defined lines between rocks of different systems. If, however, we traverse any of our coasts of the present day we find in very limited space the greatest variety of beach. Here we have a stretch of fine sand, passing speedily into grit and soon becoming a rough shore covered with loose stones of various sizes, while a little further on, this may possibly, especially near the mouth of some small stream, give place to beds of soft clayey mud. In one place we have a considerable accumulation of sea shells which may, however, be only local, and we may traverse long stretches of shore without observing any trace of organic life. Now precisely similar conditions must have, to a great extent, prevailed in early times, and the variously composed beaches of that period have now become the hard stratified rocks which are distinguished by the terms Cambrian, Silurian, Devonian or what not, as the case may be, the fine clay mud becoming shale, which by alteration passes into a hard clay slate, the fine sandy stretch will form a bed of hard sandstone or possibly a glassy quartzite, while the pebbly beach will pass into a conglomerate which may be interstratified, and often is, with beds of shale and limestone, and yet all these various kinds of rock are of precisely the same age, notwithstanding their great diversity of character.

Although we may undoubtedly assume from the advanced type of many of the Cambrian fossils that a long ancestry of earlier forms must have existed, of which the traces have been removed, the fact is patent that the increase in species is wonderfully greater as we advance to more recent periods. From the fossils collected also from all available points on the world's surface we find that a wonderful uniformity in order of life existed, so that from the strata of New Zealand or Australia precisely the same forms are obtained as are found in the rocks of Great Britain, Norway and Canada to the Rocky Mountains.

While, however, the forms of marine life speedily increased, we do not find indications of land plants till we reach the later portion of the Silurian period. Of sea weeds, however, there was a great abundance even in the earlier eras. But in the Devonian period plant life assumed great proportions. The hillsides and marshes were beautiful with the green of that earliest land vegetation. Further we know that n those early forest glades insect life abounded, whose cheery um broke the monotony of the long silence, while the rich tints displayed by the flashing of their wings enlivened the sombre gloom. Many of these insects were of the order Neuroptera, and in size equalled, if even they did not far surpass, those of the present time, having a spread of wing of eight or ten inches, and in some recently found specimens of nearly two feet. The earliest remains of these insects have been found in our own country, or more properly speaking in the provinces by the sea, the fern ledges near St. John, N.B., having yielded a rich harvest to the labors of the local geologists, and so wonderfully preserved were they that the delicate veinings of the wings are yet perfectly distinct. Large fishes also occupied the waters in the Devonian time, and the visitor to the geological museum will find there a fine collection of the same forms as those described years ago by Hugh Miller from the Old Red Sandstone of Scotland. These also are found in New Brunswick and along the adjacent shore of the Gaspe Peninsula, where the strata are sometimes thickly strewed with their well-preserved forms. So great in fact was the number of species in that period that the Devonian has been styled the age of fishes. The distribution of these fish remai. s is worthy of notice, for while the Devonian rocks are well and widely known throughout Canada, the fish localities are very few, being mostly, in so far as yet known, confined to two areas, one at Campbellton, N.B., and the other on the north side of the mouth of the Restigouche, opposite Dalhousie, where they occupy a portion of the shore about five miles in length. In these cases also the most delicate markings of the scale are as perfect as in the living fish to-day.

I have passed over the periods of the Cambro-Silurian and Silurian of our scale with scarcely a reference. These systems are largely represented in Canada and everywhere abound in organic remains, but are for the most part not conspicuous for economic minerals. Each of the systems is divided into several formations, each of which in turn is characterized by its own peculiar forms, but as these pertain more particularly to the province of the Paleontologist we will not pause longer on this portion of the subject, but pass to the consideration of the closing portion of the paleozoic, viz.: the Carboniferous.

The rocks of this period, though unknown to old Canada, have a large development in the Lower Provinces, and are of special interest from an economic standpoint as the source of our coal supply. For while from time to time we may read startling reports of the discovery of valuable seams of coal in the provinces of Quebec and Ontario, these famous discoveries on investigation have invariably resulted in disappointment to the discoverers. Coal is for the most part confined to the Carboniferous formation. In New Brunswick, however, a small seam of anthracite is found in the Devonian rocks west of St. John, though of no economic value, and in the extremity of the Gaspé Peninsula a small seam from two to three inches thick is seen in the Devonian cliffs which front the Gulf of St. Lawrence. In the Territories and British Columbia, however, bituminous coal, lignite and anthracite, occur in great quantities, but for the most part in rocks much newer or later in age than the Carboniferous, viz.: the Cretaceous. As none of these rocks are found in Ontario or Quebec, the reason for the absence of coal in these localities is easily explained. The Devonian of Western Ontario is, however, regarded by many as the source of the oil commonly but erroneously known as coal oil, a name given to it at first from its supposed relation to the coal fields of Michigan and the Middle States, a supposition afterward found to have no foundation in fact, though the name has adhered to the material.

The Carboniferous time was especially distinguished by the presence of vast swampy forests of tropical aspect, the decay of which afforded the material from which the immense coal beds were derived. The extent of these swamps and the lapse of time necessary for their growth may to some extent be inferred from the presence of seams of coal from 20 to 40 feet thick, the supposition advanced by good authority being that for the production of one foot of coal about eight feet of peat swamp was requisite. In these ancient groves also we find the remains of our first lizards, some of which, from their footprints, must have been of large size. The earliest traces yet known of these are found in the Lower Carboniferous of New Brunswick and in the millstone grit of Nova Scotia.

The close of the Carboniferous, or rather of its later portion, the Permian, marks an important geological boundary, viz., the close of the paleozoic age, and in the ensuing period, the Triassic, we take up the third great division of geologic time, the Mesozoic.

The development of the Triassic rocks in Eastern Canada is very limited, certain small areas in Nova Scotia, New Brunswick and Prince Edward Island, in all of only a few square miles in extent, comprising all that is present known of the formation between the Atlantic and the prairie section. Small areas have been recognized in the Rocky Mountain district, and on the Pacific coast, in Queen Charlotte Islands and in Vancouver, beds supposed to be of this age have been found underlying the Cretaceous and containing characteristic fossils.

The Cretaceous or third division of the Mesozoic is, however, largely developed in that portion of the Dominion lying to the east of the Rocky Mountains as well as in British Columbia. It both places it is remarkable for the presence of immense beds of coal which at times almost rival in thickness the greatest beds of Nova Scotia. The great abundance and variety of fossils in these localities clearly indicate the horizon of these beds, while the presence of such great seams of coal on either side of the Rockies renders this formation of the greatest economic importance. The newer Tertiary formations are sparingly developed in Canada, a few localities in the North-West Territories closely associated with the Cretaceous and for some years almost inseparable, having of late been judged to belong to this period of time. But the great thickness of formations which are found in England and France, and which there complete the geological record, are, in so far as yet known, almost absent from this portion of the American continent.

Throughout the long interval of the many millions of years which elapsed between the beginning of the fossiliferous rocks and the close of the Tertiary many eras of subsidence and elevation of the earth's crust must have taken place, and are evidenced very plainly by the varying character of the sediments. Thus conglomerates and coarse grits are supposed to represent shallow water and beach deposits, while fine slates represent deposition of sediment under deeper and quieter conditions. From the observation of these peculiarities some authors have developed the theory of geological cycles, by which is meant a regular periodical recurrence of the physical conditions of the earth's crust, as regards elevation and submergence, throughout each one of the great systems into which the geological scale has been divided.

We have now reached in our hasty sketch that portion of the earth's history which is most closely related to our own time, viz., the *Post-tertiary*, the phenomena of which are generally discussed under the head of superficial geology. At the close of the Pliocene or last of the divisions of the Cenozoic or Tertiary a great change of conditions as regards the surface of much of the globe evidently took place, introducing what is known as the *glacial epoch*, a time of intense cold, when large areas of the northern hemisphere, at least, became covered with ice, which extended probably over the whole or greater part of Canada. Whether similar glacial conditions occurred at earlier stages of the earth's history is a subject which has evoked considerable discussion, some eminent authorities maintaining that the evidence of such ice action, as seen in the presence of glaciated or striated stones in conglomerates, are clearly visible even as far back as the Paleozoic time. It would be out of place here, even did time permit, to discuss the causes that led to the changes in the climate of this period, such considerations more properly belonging to the domain of the astronomer and physicist.

The last of the geological periods, that now under consideration, is also styled the Quaternary or Post-pliocene. It is generally divided into two parts, the first known as pleistocene or *diluvial*, in which many of the mammals are of species now extinct, and the *alluvial* or recent, in which all or nearly all the mammals are of still living species. The indications of a change of climate at the close of the Tertiary are seen in the character of the organic life of that time, and it affected the higher latitudes both of the old and new worlds. The cold gradually increased until the conditions now prevailing in Greenland reached a latitude of about 39° in Eastern America. Over a great part of the hemisphere north ot this parallel it is held by many that a great ice cap, many hundreds and even thousands of feet in thickness, covered the surface, which, following the law of glaciers, moved steadily but slowly forward. The effect of the movement of so vast a body of ice was of necessity to remove the soil and superficial deposits and to smooth and in places polish the underlying rocks. After the culmination of this period of cold, which was probably to some extent due to elevation of the continent, there succeeded an era of milder climate, with partial submergence, followed again by a period of re-elevation and increased cold, with a partial recurrence of the former glacial conditions, after which gradually the ice retreated northward and the present condition of surface began to be assumed. Traces of the ice age yet exist in the elevated areas of the highest mountain ranges even in comparatively low latitudes, and glaciers of considerable size are found in the Rocky Mountains of British Columbia at the present day.

The presence of the ice sheet is recognized by its markings upon the exposed rock surface. Instances of this are common on the ledges about Ottawa and even in the heart of the city itself, the grooving and striation of the surface due to the planing of the ice being well seen in the quarry at the corner of Sussex and Rideau streets. In many cases also the action of ice is recognized by the presence of smoothly-rounded hill slopes. The direction in which the ice passed if the exposed striated surfaces are well seen, can generally be told from the shape or contour of the elevations. Thus the rock surfaces away from the direction of ice-flow, called the "lee side," are usually rough and weather-worn, while those which face the direction of the flow are all ice worn; hence the term *stoss seite*, or struck side, is applied to the latter.

In opposition to the theory of a great universal ice cap of immense thickness just stated is the view now entertained by many that the most of the glacial phenomena were caused rather by a number of small or local glaciers which had their source about the summits presumably of every mountain range, and in their course followed the prevailing configuration of the surface. This view is well supported by the direction of the rock striations in the provinces of Quebec, New Brunswick and Nova Scotia, where the evidences in favor of a great south-easterly moving ice sheet are very few, and where the indications evidently point in the other direction or in favor of local glaciers.

Among the supposed indications of the presence of a great ice sheet, besides the striation of the rock, is the presence of scattered boulders of various kinds, at points far removed from their native place, and such boulders often furnish conclusive proof of the direction in which the glacier moved. Thus if the glacier or boulders from a certain range of hills are found to the north of that range, the inference is that the ice moved northward. Such evidence is not always, however, strictly conclusive as to the agency of a glacier, for though ice in some form must have been largely instrumental in the moving of boulders, in very many cases the active agent has been in the form of floe or floating ice, either in bergs or huge pans, such as now float up and down the St. Lawrence, and which have carried huge masses of Laurentian rock from their original place on the north shore of the river to the south side, where they can now be seen for hundreds of miles along the beaches of the Gaspè coast.

Subsequent to the ice age we find a period of depression and submergence, during which the present surface was hundreds of feet under water, and the arctic currents from the north carried huge trains of bergs, with their loads of dirt, stone and gravel, just as at the present day are seen off the coast of Newfoundland, which by their stranding and subsequent melting deposited their debris at points now many hundreds of feet above present sea level. The proofs of submergence are well seen in the presence of beds of clay, containing often great quantities of marine shells of forms similar to those now found in northern waters. These can be picked up at many points about Ottawa and Montreal as well as elsewhere, while bones of seals have been found in the brickyards in this vicinity. With the nodules of Green's Creek you are also, most of you at least, familiar.

The amount of submergence has also been a fruitful source of controversy, some holding to the view that this must be determined by the present elevation of known shell beds above the sea level, ignoring the evidence of drift boulders, and thus limiting it to some 500 feet. Others, again, maintain that as much of the glacial phenomena is due to the action of ice bergs and floating ice, the submergence should be measured by thousands instead of hundreds of feet, and in certain places there is unmistakable evidence of the presence of old sea beaches several thousands of feet above the present level. The various claims of the rival schools can be found in most text books on geology, but it is certain that both agencies were largely employed in sculpturing the rock surface and fashioning the features of our landscape as we now see them.

In addition to the more active agents of disturbance just described, others which perform their work quite as effectually probably exist. These are the atmosphere, rains, frosts, winds and the wash and wear of tides and seas. The degrading action of rivers in motion, by which immense quantities of material are removed and carried down and de posited at their mouths, as in the case of the Mississippi, the Nile, and nearer home, the St. Lawrence, is well known, and from these sources an estimate has been made of the rate of degradation of our continents and the number of years which would elapse before these would be reduced to the present sea level should no further period of upheaval occur. Some idea of the immense force of excavation exercised by running waters can be formed by considering the great canons of the Colorado, where huge chasms thousands of feet deep have been cut out by the action of streams, sometimes comparatively small, till now these present some of the most remarkable geological phenomena in the world. It is probable also that the great rock cliffs about this city owe their origin to a great extent to the wearing action ot the rivers in this vicinity.

With the modified conditions of climate which succeeded the glacial period, the conditions of life as we now find it began or were resumed. Evidences of the presence of the human race are visible at the close of that period and even in the interglacial time, while some observers contend that human remains have been obtained as far back as the Miocene Tertiary. But with this phase of the subject we have not time sufficient to deal. Gradually the slowly moving fingers of time have fashioned and rounded our hill tops, have carved out the water courses and hewn the basins of our lakes. The action of sun, frost and rain have softened the hard sterile rock and produced the soil necessary for the cultivation of those things required for man's existence. Many if not all of the geological agencies which have been so potent in past ages are in active operation today, though possibly their action is not so marked as under the peculiar conditions of earlier geological times, but they are going forward all the same. The gradual processes of submergence and elevation are still visible at many places and even in well recorded time portions of our continent are known to be rising from the sea while others are gradually sinking. The latter is well observed in some portions of the coast of Nova Scotia and New Brunswick, where the remains of forests which grew above the sea are now found some 30 to 40 feet below high water mark. Volcanic agencies are still at work forming or removing mountains. The fearful destruction and disturbances of several years ago in one of the islands of the Java archipelago are still fresh in our memories, when a whole mountain was blown into the sea with such force as to send an ocean wave completely round the globe; while during the past summer the frightful eruption in Japan buried many square miles of country under liquid mud, with the destruction of hundreds of lives. Such instances enable us to realize in some slight degree the enormous forces with which nature does her work.

I have in this sketch omitted any marked reference to the geology of the surrounding district. This field has been ably worked by Mr. Ami, who I am sure will at the next meeting entertain you thoroughly with an account of the various geological features in this immediate vicinity.

ENTOMOLOGICAL SOCIETY OF ONTARIO.

As announced in our September number, the annual meeting of the Entomological Society of Ontario was held in Ottawa upon the 5th and 6th October. The meetings were well attended, and several useful and interesting papers were read. The President's annual address was delivered in the City Hall by Mr. James Fletcher, of this Club, on the evening of Friday, 5th, before a large audience, including Hon. Chas. Drury, Minister of Agriculture for Ontario; Mr. John Lowe, Deputy Minister of Agriculture for the Dominion; Prof. Saunders, and many others. It treated of the practical application of the science of Entomology for keeping in check the attacks on cultivated crops by injurious insects. A *résumé* of the insect injuries of the year was also given, and attention was drawn to new works which had been published. Some simple apparatus used for caging and breeding insects was exhibited and explained.

Hon. Chas. Drury spoke in high terms of the work being carried on by the Society, an appreciation which he had shown by coming all the way from Toronto to attend the meeting.

Sir J. A. Grant proposed a vote of thanks in his usual happy and eloquent manner, and surprised many of the audience by his knowledge of entomology. Some years ago Sir James possessed a very nice collection of insects; but being much engaged with his professional duties he decided that his cases would be of more use if placed where they could be examined more freely than in his own house, and generously presented them to the museum of the Ottawa Literary and Scientific Society.

Prof. Saunders, in seconding the vote of thanks, spoke of the progress of the Society, from the time it was first organized, by a few earnest workers, down to its present influential and stable condition.

Dr. Bethune urged upon the audience the pleasures and beneficial results obtainable from the study of insects, and particularly drew attention to the remarkable work accomplished by Miss Eleanor A. Ormerod, the Entomologist of the Royal Agricultural Society of England. He pointed out that ladies were in many ways better suited for carrying out some of the delicate and tedious observations than men were, and hoped that more would join in carrying on the work of the Society.

The election of officers took place upon the morning of the 6th, and resulted as follows:

President—James Fletcher, Ottawa.

Vice-President—E. Baynes Reed, London.

Secretary-Treasurer—W. E. Saunders, London.

Librarian—E. Baynes Reed, London.

Curator—Henry S. Saunders, London.

Council—J. M. Denton, London; J. Alston Moffatt, Hamilton; Gamble Geddes, Toronto; W. H. Harrington, Ottawa; Rev. T. W. Fyles, South Quebec; (and all former Presidents, who are ex-officio members of the Council).

Editor of the Entomologist—Rev. C. J. S. Bethune, Port Hope.

Delegate to the Royal Society of Canada—H. H. Lyman, Montreal.

CONTRIBUTION TO THE GEOLOGY AND PALÆONTOLOGY OF THE TOWNSHIPS OF RUSSELL AND CAMBRIDGE, IN RUSSELL, ONT.

I.—PHYSIOGRAPHY AND GENERAL GEOLOGY.

BY W. CRAIG, (DUNCANVILLE)

The Townships of Russell and Cambridge are almost perfectly level. The Township of Russell is bordered on the south, west and north by a rim of slightly higher land. The main portion and all the centre of the township is quite level and continues so into and through the Township of Cambridge. The soil, or drift of the level land, is composed of very fine blue and red clay, covered in some places by two to three feet of brown loam. The blue clay is of considerable thickness, from twenty-five to one hundred feet, and there are no shells in it. It has probably been deposited in deep water and came from the north. At a depth of thirty to forty feet under the clay there is generally found water-worn gravel or hard pan. In one locality the hard pan is composed of small water-worn pebbles and blue clay ground down to a smooth surface and as hard as rock, When this is drilled through water is always found and rushes up in such quantity that wells cannot be walled up with stone. In other places the gravel is loose and filled with small shells. In one place, when digging a well at about eighteen feet from the surface, in the clay, a bone of some animal was found, supposed to have been a rib. It was about eighteen to twenty inches in length, about one inch in diameter and almost round, and in the same excavation at a depth of thirty-one feet a cedar limb about three inches in diameter was found lying on two or three inches of small white shells covering the gravel. The red clay has been deposited after the blue as it is nearer the surface. They are both very fine and where exposed in cuttings are found to be stratified in layers of three or four inches. They are splendid brick clays and should be first class for the manufacture of terra cotta. In the township of Cambridge the clay covers the whole township and is covered by loam the same as in Russell; and on the north side of the township there is an extensive deposit of yellow sand

(Saxicava) overlying the clay. This sand has come from the north and along the northern boundary of the township is almost continous, and extends into the township in ridges or bands for three or four miles. These ridges and low spaces between follow each other in regular succession like waves on the ocean. This was at one time a winter paradise for the red deer, which had shelter and food in abundance and wintered here in thousands. In one place there are several remarkable sand hills, rising almost round from the level swamp or at the end ot a ridge, about fifty feet at the base and twenty to thirty feet in height; they seem to have been formed in eddies of water. Travelling through the woods here some years ago I came to one of those hills and climbed to the top and was surprised to find in the snow on the flat top, the beds of several deer. *In the* south-east corner of Cambridge *there is an extensive bay;* the sand has not come so far south and the depression was not filled up. The Nation river drains the two townships into the Ottawa, and althou . . the table land is level, it is scarred, seamed and cut up in all directions by streams and gullies, the soil being so very fine it washes out very easily and cuts into gullies, some times to a great depth. The Castor river and its branches drain the township of Russell into the Nation above Casselman. The river follows the strike of the underlying rocks. The Nation at Casselman flows across a ledge of Trenton rock northerly, then turning westerly follows the strike of the rock for three miles and then turning suddenly eastward forms the Ox Bow, below Casselman. The banks are very high, and every little stream running into the river has cut down a channel to its present level. During spring freshets the river rises between Casselman and the Ox Bow, from twenty-five to fifty feet over summer level, and the water piles into the gorge faster than it can get around the bow. The rock exposure at Casselman dips to the north and the strike is east and west, *the edge of the rock is up stream and the river flows over the back of* the ledge making a considerable fall, but ot perpendicular. The rock is covered by drift to the boundary of Russell, about six miles from Casselman, the rock here is the same as at Casselman, solid beds of Trenton limestone, dip north and strike west. It here enters the township of Russell and is next exposed in the bed of a small creek near the

Castor, where the water has cut a deep channel through the rock. Four or five acres further west the Castor river crosses the ledge. The river flows eastward across the rocks and has cut a channel through them of ten or twelve feet in depth, the lower beds of rock are solid limestone and the upper limestone and shale in alternate layers of five or six inches, which form the top of the Trenton. About a mile to the westward there is another exposure of Trenton rock on the south side of the Castor river. They are tilted up at a very high angle, dipping to the north, the southern edge in some places almost vertical. Still further westward at Louck's mills the rock is exposed in the river, there is a break or fault here and the rock seems to dip under the drift on the south side of the river to the south and on the north side to the north, the rock exposure continues up the stream past Duncanville and is here probably Utica. To the north the Hudson river formation is exposed, presenting first grey sandstone, weathering brown and holding *Ambonychia radiata*, further north black bituminous shale is found overlaid by sandstone and a considerable area of red shales, the red shales weather to red clay and are probably the source of the bands of red clay already mentioned which has been carried to the east and south of the red shale. There are no indications of minerals in the townships, but on the northern border of Russell in sinking a well a vein of iron pyrites was found. There are no mineral springs in the township of Russell, but there is one in the township of Cambridge, on lot 18 in 5th concession, in the bottom of a deep gully. It comes up through the clay, and is slightly salt, but has never been analysed. The spring is in a level dell, and on digging to clear out the outlet it was found to be a mixture of leaves, sticks and clay. The deer had come here for ages to drink and had tramped all together. If the drift was removed from the two townships the general appearance would be a great central depression from east to west, and along the centre of that depression the rocks broken and tilted up as if pushed up from below. How has this depression been formed? If it had been scooped out by glacial action there would be boulders left behind, but we do not find any here. Then after the rocks were broken up the clay was deposited filling up all the inequalities in the rocks, making all level except where some of the *higher* peaks of rock remained over the surface, when the water commenced to dry off the streams cut their way back through the drift, leaving the land in its present condition of elevation and gradual denudation.

II. PALÆONTOLOGY.

BY HENRY M. AMI, M.A., F.G.S.

(1.) At Cook's Rapids, on the Castor River, on the 8th lot of concession IX. in the Township of Russell there is exposed a series of bluish-gray shaly, nodular and at times unevenly-beded limestones which, *from the fauna it holds, is clearly referable to the* middle porton of the Trenton formation (Ordovician), an horizon which is met with at Ottawa. and represented in the beds which crop out in the vicinity of the Waterworks Office and at the foot of Parliament or old Barrack *Hill.* The *association of fossil remains is precisely similar* here as in those localities, and amongst them were recognized the following species :—

1. *Buthotrephis gracilis*, Hall.
2. *Licrophycus succulens*, H. (Sp.)
3. *Pascolus globosus*, Billings.
4. *Brachiospongia digitata*, Owen.
5. *Protarea vetusta*, Hall.
6. *Streptelasma corniculum*, Hall.
7. *Prasopora lycoperdon*, Vanuxem
8. *Strophomena alternata*, Conrad.
9. *Leptæna sericea*, Sowerby.
10. *Orthis testudinaria*, Dalman.
11. " *pectinella*, Conrad.
12. " *occidentalis*, Hall.
13. *Platystrophia lynx*, Eichwald.
14. *Bellerophon bilobatus*, Sowerby.
15. *Bucania bidorsata*, Hall.
16. *Cyrolites compressus*, Conrad.
17. *Murchisonia bellicincta*, Hall.
18. " *Milleri*, Hall.
19. " *gracilis*, Hall.
20. *Trochonema umbilicatum*, Hall.
21. *Asaphus megistos*, Locke. (*Isotelus gigas*, DeKay.)
22. *Encrinurus vigilans*, Hall.
23. *Dalmanites callicephalus*, Green

The above species were collected by Messrs. Craig and Summerby in company with the writer during a sub-excursion of the geological branch in 1884, and, as may readily be inferred from the small list presented, the same could be greatly increased by subsequent research in those measures which are very fossiliferous.

(2.) From a locality not far distant from the last one (1) Mr. W. Craig, ex-M.P.P., has made an interesting little collection, amongst which the following species have been recognized as not occurring in the previous list :—

24. *Lichenocrinus crateriformis*, Hall.
25. *Amplexopora Canadensis*, Foord.
26. *Pachydictya acuta*, Hall.
27. *Fusispira elongata*, Hall.

Of these No. 24 is particularly interesting, and differs in some respects from its congener found near Government House, Rideau, some six years ago. It is parasitic on a specimen of *Orthis testudinaria*, Dalman, and has a portion of the column preserved.

(3.) Another exposure of what appears to be a ridge or escarpment of Trenton limestone was observed running slightly obliquely to the road between lot 10, con. X., Russell, and lot 30, con. V., Cambridge, where the measures have a gentle dip N. 15° E. a few degrees, and indicate the presence of a line of dislocation with the remains of an ancient escarpment. No fossils were found in this exposure, however, and accordingly the precise horizon to which this ridge must be referred remains doubtful, but is most probably Trenton.

(4.) At Casselman, on the Nation River, and below the Canada Atlantic Railway bridge, there is exposed a considerable thickness of Trenton limestone where the Club held one of its most successful excursions in June, 1883, and amongst the species collected on that occasion the following have been recognized :—

1. *Palæophycus obscurus*, Billings.
2. *Pachydictya acuta*, Hall.
3. *Prasopora lycoperdon*, Vanuxem. (P. Selwyni, N.)
4. *Streptelasma corniculum*, Hall.
5. *Strophomena alternata*, Conrad.
6. *Leptæna sericea*, Sowerby.
7. *Orthis testudinaria*, Dalman.
8. *Platystrophia, lynx*, Eichwald.
9. *Rhynconella increbescens*, Hall.
10. *Cyrtodonta*, sp.
11. *Murchisonia bellicincta*, Hall. (large variety.)
12. *Trochonema umbilicatum*, Hall.
13. *Asaphus platycephalus*, Stokes. (*Isotelus gigas*, DeKay.)
14. *Serpulites dissolutus*, Billings.

SOIREES.

Third.—The third meeting was held on 31st January, and was devoted to the discussion of botanical subjects.

Mr. Fletcher read the report of the Botanical Section.

Mr. Ballantyne then gave an interesting account of some observations made on the duration of the leaves on our various species of evergreen trees. With the white pine (*Pinus strobus*) he had found that as a rule the needles remained on the tree about 18 months. Leaves produced in the spring of one year fell in the summer of the following one, so that the life of a pine needle was two summers and one winter.

In the Spruces the leaves remained on the trees for a much longer period, he considered seven years to be about the length of their duration. The Canadian Balsam Fir not quite so long, four or five years; and the Hemlock a still shorter time, probably only three years.

The cedars were rather more difficult to understand. They seemed to drop their foliage throughout the year and not at any special season. In this case it was not the separate scales which fell but small twigs dropped off. The Tamarac, another conifer, of course, is deciduous, and drops its leaves every autumn.

Mr. Fletcher spoke of the length of life of the needles of *Picea Sitchensis,* the Menzies spruce which he had found on Vancouver Island growing to a height of not less than 40 feet, and still retaining the sharp stiff needles on the stem, so that it was very uncomfortable to climb up it to procure the cones.

In answer to a question he explained that the cause of the falling of the leaves of deciduous trees was due to the gradual deposition of matter in the passages and the lignification of the petioles so that they could no longer perform their functions.

Mr. Ballantyne's address was followed by the exhibition of a collection of Australian ferns belonging to Mr. R. B. Whyte. Mr. Fletcher drew attention to several specimens belonging to genera represented in our Canadian flora and showed the advantages of having specimens from all parts of the world, if we wanted to thoroughly understand any family of plants.

A paper by Mr. H. M. Ami was read upon the variety *obtusilobata of Onoclea sensibilis.* The writer considered it merely an occasional form of the species and unworthy of a varietal name. The antiquity of the species was shown by the discovery by Dr. G. M. Dawson of well preserved specimens in the rocks of the Laramie age in the North-West Territories.

Dr. H. B. Small read an entertaining account of a volume of lectures on botany which he had recently acquired. These lectures were delivered at Harvard University in 1788 by Dr. Benj. Waterhouse and were the first lectures delivered in America upon botany of which we have any record.

Mr. Robert Whyte spoke for some time upon the subject of bog plants, and illustrated his remarks by exhibiting a fine collection of the local species. The various so called insectivorous forms were treated of and the theories as to their powers of digesting food discussed. This address gave rise to much animated and edifying discussion in which many valuable items of information were brought out.

Messrs. Baptie, Harrington, Ballantyne and Fletcher took part in the discussion. The sundews and pitcher plants were discussed and their habits and structure explained.

During the evening the following note by Prof. John Macoun, was read :—

NOTE ON THE POISONOUS PROPERTIES OF THE *AGARICUS RODMANI.*

BY JOHN MACOUN, M.A., F.L.S., F.R.S.C.

During the past autumn many edible mushrooms have been collected in the vicinity of the city, some of which have had doubts thrown upon their value by an unfortunate occurrence which took place early in September.

A lady purchased two lots of mushrooms on the market, one from the stalls and the other from the open market. The latter lot was that from which the lady partook and which resulted in her death.

Late in September Mr. Martin Benson of this city also purchased a lot on the market and when they were being cooked his wife noticed that they had an offensive smell and the family refused to eat them. A few were sent to the writer who advised Mr. Benson not to use them as they were to say the least of it, unpleasant to both taste and smell.

A few were dried and then forwarded to Prof. Charles Peck, New York State Botanist, who is the highest authority on Agarics in America. He reported that the mushroom in question was related to the edible one, that it had been found in New York State and in France. He said that in France it was looked upon with suspicion but for his own part he did not think it was poisonous, though owing to its woody nature and unpleasant smell he did not set much value on it. Its scientific name is *Agaricus Rodmani*, having been named after its discover. It differs from the common mu hroom in having an unpleasat smell while being cooked, in being quite firm and not expanding nearly so much, and in the stem being quite large where it joins the cap and tapering to the point which seems to enter the soil to some depth.

There are fully thirty species of edible mushrooms along the roadsides, in woods, meadows, and pastures around Ottawa, yet those ignorant of this fact, persist in rejecting good Agarics and partaking of deleterious ones simply because they look like the common mushroom.

If the following simple directions were followed no person need be poisoned and much valuable food could be collected every autumn by those desirous of doing so. At present I have fine mushrooms gathered nearly ten years since that are just as well suited for the table now as they were when collected. In other countries this practice of drying mushrooms for future use is extensively practiced and there is no reason why we should not do the same here.

Directions for testing Mushrooms or Agarics of all kinds :

(1.) Reject all that have an unpleasant smell either in a raw state or when cooking.

(2.) If the smell is pleasant chew a small portion of the raw specimen and swallow the juice. If a burning sensation is felt in the mouth or throat the mushroom is more or less poisonous and should be rejected. On the other hand if the taste is pleasant the mushroom is edible. All puff-balls are edible as long as the spores are white, when the inside begins to turn yellow the specimens should be thrown away.

An interesting discussion on the value of mushrooms as food followed the reading of this paper, in which Mr. Whyte, Mr. Ballantyne and Mr. Harrington took place. Mr. Fletcher spoke of some of the common edible fungi found in the neighbourhood of Ottawa, and also referred to the use made of the Fly Agaric (*Agaricus muscarius*) by the peasants of Northern Russia, who steep it in alcohol to produce prolonged intoxication.

Dr. Baptie said that many fungi undoubtedly contained a very powerful poison, and that people who collected or ate mushrooms ought to examine them carefully. He also drew attention to the fact that some species might be quite wholesome when fresh, but might become poisonous as soon as decomposition set in.

Fourth.—The fourth meeting of the winter course was held on the evening of February 14th, and was made very interesting by the leaders of the entomological section. The report on the work of the branch during the season of 1888 was read by Mr. Fletcher. Several new and rare species had been added to the list of species recorded from the locality since the last report, and much useful work in economic entomology had been prosecuted.

Mr. W. H. Harrington delivered an admirable address upon the Capricorn beetles, which commit such serious ravages by boring timber after it is cut in the woods. This address was illustrated by a beautiful collection of these beetles which had been made in the locality by Mr. Harrington.

There was considerable discussion upon the habits of insects, and many enquiries were made as to the best methods of meeting the attacks of injurious species.

THE ANNUAL MEETING.

The annual meeting for the election of officers for the coming year will be held on Tuesday, 19th March, at 4 o'clock in the afternoon in the usual place, the museum of the Ottawa Literary and Scientific Society. All the members are earnestly requested to be present, as matters of great importance to the welfare of the club are to be discussed. Any who have not already paid their subscriptions are requested to do so before the meeting.

habit and appearance. They are either low, much branched and spreading over the ground or erect and simple. The leaves vary from short, and obtuse, to 4 inches in length, with a tapering point as in the var. *hirsuticaulis.* The size of the flowers and the degree of pubescence vary no less than the leaves.

With regard to these closely allied forms of this genus it is imperative that they should be grown from the seed under the same conditions and several specimens studied in a living state.

1044. A. JUNCEUS, Ait.

A. æstivus, Ait.

Peat bogs, in shade. July—2. (B) A slender species with long narrow leaves. Flowers white tinged with pink, and few in number. Our earliest Aster.

1049. A. PUNICEUS, L. (Tall Michaelmas Daisy.)

Low ground. July—3. (B) A tall handsome species with hairy red stems, auricled clasping leaves and bluish-lilac flowers.

——— ——— var. LAEVICAULIS, Gray.

var. *firmus,* T. & G. Macoun's Cat. p 226.

var. *vimineus,* Gray.

Much scarcer than the type, with paler flowers and almost glabrous stems.

2170. A. VIMINEUS, Lam.

A. vimineus, Lam. var. *foliolosus,* Gray. of Macoun's Cat. p. 545.

In damp soil along the Nation River at Casselman. (Prof. Macoun) Aug—3. A tall species akin to, but distinct from *A. paniculatus,* with long narrow leaves and whitish flowers.

Prof. Macoun tells me that his Casselman specimens recorded above belong to the species and not to the variety *foliolosus.*

1050. A. NOVÆ-ANGLIÆ, L. (Purple Michaelmas Daisy.)

Rocky banks. Aug—2.

Found only at Casselman so far, in this locality. (Miss Nellie Macoun). Easily recognized by its bright purple flowers and viscid glandular pubescence.

1061. A. ACUMINATUS, Mx. (Pale Aster.)

Sandy and rocky woods, local but abundant where it occurs. Chelsea, Hull, Stewart's bush, Beechwood. A low plant with a rosette of leaves beneath the few-flowered panicle.

ERIGERON, L. Flea-bane.

1087. E. PHILADELPHICUS, L. (Pink Flea-bane.)
Low grassy places. Ju—1. (B.)

1089. E. ANNUUS, Pers.
Fields and roadsides. July—1. (B.)
A tall coarse species with stem-leaves coarsely toothed.

1090. E. STRIGOSUS, Muhl.
Dry fields and open woods. July—1. (B.)
Slenderer than the last with stem-leaves entire. Stems rough.

1094. E. CANADENSE, L. ("Fire weed.")
Fields, open woods and waste places. July—2. (B.)

ANTENNARIA.

1097. A. PLANTAGINIFOLIA, Hook.
Fields and open woods. May—3. (B.)

ANAPHALIS.

1102. A. MARGARITACEA, Benth and Hook. (Pearly Everlasting.)
Dry fields and woods. July—2. (B.)

GNAPHALIUM, L. Cudweed.

1103. G. DECURRENS, Ives. (Sticky Everlasting.)
Dry fields. July 1.
Easily recognized by the decurrent leaves.

1108. G. ULIGINOSUM, L. (Low Cudweed.)
Waysides and in dried up places where water has stood in the spring. July—2. (B.)

1109. G. POLYCEPHALUM, Mx. (Scented Cudweed.)
Dry pastures. Near St. Louis Dam. Beyond Beechwood. Cemetery. Sep—1.
Smaller than No. 1103. Leaves not decurrent: whole plant strongly scented.

INULA, L. Elecampane.

1112. *I. Helenium*, L.
Introduced. Waysides and pastures. July—2.

AMBROSIA, Tourn. Rag weed.

1119. A. TRIFIDA, L.
Not indigenous in this locality. Low ground. Near St. Louis Dam. Major's Hill. Sep—1.

1120. A. ARTEMISIÆFOLIA, L.

Roadsides and fields. Aug—1.

XANTHIUM, Tourn. Cocklebur.

1125. X. CANADENSE, Mill. var. ECHINATUM, Gray.

X. strumarium, L.

Waste places and alluvial flats. July—1.

RUDBECKIA, L. Cone-flower.

1129. R. HIRTA, L. (Yellow Daisy.)

Fields and railway banks. Introduced from the West. Occasional in various localities, but in great abundance in a pasture at Kingsmere, P. Q.

1130. R. LACINIATA, L.

River sides and wet woods. Casselman. Rare. Aug—2.

HELIANTHUS, L. Sun-flower.

1135. H. *annuus*, L. (Garden Sun-flower.)

Frequent on waste heaps. July—1.

It is rather remarkable that we have so far found none of the native Helianthi wild in this locality.

BIDENS, L. Bur-Marigold.

1155. B. FRONDOSA, L.

Ditches and fields. Aug—1. (B.)

Some of the upper leaves trilobed.

1156. B. CONNATA, Muhl.

Margins of rivers and ponds. Aug—1. (B.)

Leaves connate. None divided.

1157. B. CERNUA, L. Smaller Bur Marigold.

Margins of ponds and streams. A low plant creeping over mud and rooting at the joints. Aug—1. (B.)

1158. B. CHRYSANTHEMOIDES, Mx. (Greater Bur Marigold.)

Alluvial flats. At the foot of Parliament Hill are some tall erect plants five feet high, with flowers and leaves like *B. cernua*, which I refer here.

1159. B. BECKII, Torr. (Water Bidens.)

In shallow water. Not uncommon in the Ottawa and Rideau rivers, but seldom flowering. July—4. (B.)

HELENIUM, L. Sneeze-weed.

1168. H. AUTUMNALE, L.

Islands and river margins. Chaudiere Islands. *(H. M. Ami.)* The Chats. *(Mrs. Chamberlin.)*

ACHILLEA, L. Yarrow.

1173. A. MILLEFOLIUM, L. (Milfoil.)

Meadows and fields. Ju--4. (B.)

A variety with pink flowers is sometimes found.

MARUTA.

1179. *M. Cotula*, DC. (May-weed.)

Introduced. Waste places. Ju—2. (B.)

CHRYSANTHEMUM, L.

1180. *C. Leucanthemum*, L. Ox-Eye Daisy.

Introduced. Meadows and cultivated ground. A troublesome weed. Ju—2.

TANACETUM, L.

1189. *T. vulgare*, L. Common Tansy.

Roadsides, an escape from cultivation. Both the type and the var. *crispum*, DC. occur here.

ARTEMISIA, L. Worm-wood.

1203. A. VULGARIS, L. (Mug-wort.)

Rocky banks and sandy fields. Aug—1.

1200. A. BIENNIS, Willd.

Not indigenous in this locality. Low ground. July—2.

1211. A. *Absinthium*, L. (Wormwood.)

Introduced. Waste places. July—2.

PETASITES, Tourn. Sweet-Coltsfoot.

1214. P. PALMATA, Gray.

Nardosmia palmata, Hook.

Low wood. Powell's Grove, Very rare. May—1.

ERECHTITES, Raf. Fire weed.

1227. E. HIERACIFOLIA, Raf.

Moist places, particularly in recently burnt clearings. Ju—2.

SENECIO, L. Groundsel.

1228. *S. vulgaris*, L. Common Groundsel.

Introduced. A rare weed in gardens. July—2.

SUMMARY

— OF —

Canadian Mining Regulations.

NOTICE.

THE following is a summary of the Regulations with respect to the manner of recording claims for *Mineral Lands*, other than Coal Lands, and the conditions governing the purchase of the same.

Any person may explore vacant Dominion Lands not appropriated or reserved by Government for other purposes, and may search therein, either by surface or subterranean prospecting, for mineral deposits, with a view to obtaining a mining location for the same, but no mining location shall be granted until actual discovery has been made of the vein, lode or deposit of mineral or metal within the limits of the location of claim.

A location for mining, except for *Iron* or *Petroleum*, shall not be more than 1500 feet in length, nor more than 600 feet in breadth. A location for mining *Iron* or *Petroleum* shall not exceed 160 acres in area.

On discovering a mineral deposit any person may obtain a mining location, upon marking out his location on the ground, in accordance with the regulations in that behalf, and filing with the Agent of Dominion Lands for the district, within sixty days from discovery, an affidavit in form prescribed by Mining Regulations, and paying at the same time an office fee of five dollars, which will entitle the person so recording his claim to enter into possession of the location applied for.

At any time before the expiration of five years from the date of recording his claim, the claimant may, upon filing proof with the Local Agent that he has expended $500.00 in actual mining operations on the claim, by paying to the Local Agent therefor $5 per acre cash and a further sum of $50 to cover the cost of survey, obtain a patent for said claim as provided in the said Mining Regulations.

Copies of the Regulations may be obtained upon application to the Department of the Interior.

A. M. BURGESS,
Deputy of the Minister of the Interior.

DEPARTMENT OF THE INTERIOR,
Ottawa, Canada, December 19th, 1887.