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The scientific work of this Society in the year which closes to-night, is not so remarkable for its variety as for the interest and importance of the subjects to which it relates. A list of the papers read is appended to this address; but I shall confine myself principally to two subjects embraced in their scope. One is the bearing of the dredging operations of our colleague, Mr. Whiteaves, on the Post-pliocene Geology of Canada, in connection with other oceanic and geological researches. The second is the growth of our information as to the geological structure of those great plains of the West, whose profitable occupancy is now so important a problem for our statesmen.

Mr. Whiteaves in the past summer was chiefly occupied with the exploration of the great southern Bay of the Gulf of St. Lawrence, a basin of shallow water nearly semicircular in form, and in which is set the beautiful Island of Prince Edward. It is protected to some extent by the encompassing land, by its limited depth, and by the islands and shoals stretching across its mouth, from the influence of those cold northern currents which pervade all the middle and northern parts of the Gulf, and give to its fauna an almost Arctic character: it thus forms a peculiar and exceptional zoological province. The marine animals of Northumberland Strait were those with which I was myself most familiar in early youth, and I still possess many drawings of the more minute forms, made under the microscope for my amusement, before I had received any scientific training in natural history. In my cabinet there has been for the last thirty years a nearly complete representation of its mollusks, and I was even then aware from the observations of Gould and others in New England, of the specially southern character of this group of animals, though at that time I had no means of publishing my observations, and the importance of these peculiarities of distribution had scarcely dawned upon the minds of

geologists. In later years, however, Mr. Whiteaves and Prof. Verrill have, in connection with the dredging operations carried on in the interest of our fisheries, more fully worked up the relations of these faunæ, and we are now in a position to speak with some certainty of the facts, and to appreciate their significance.

If we draw a straight line from the northern end of Cape Breton through the Magdalen Islands to the mouth of the Bay des Chaleurs, we have to the southward an extensive semicircular Bay, 200 miles in diameter, which we may call the great *Acadian Bay*, and on the north the larger and deeper triangular area of the Gulf of St. Lawrence. This Acadian Bay is a sort of gigantic warm-water aquarium, sheltered, except in a few isolated banks which have been pointed out by Mr. Whiteaves, from the cold waters of the Gulf, and which the bather feels quite warm in comparison with the frigid and often not very limped liquid with which we are fain to be content in the Lower St. Lawrence. It also affords to the more delicate marine animals a more congenial habitat than they can find in the Bay of Fundy or even on the coast of Maine, unless in a few sheltered spots, some of which have been explored by Prof. Verrill. It is true that in winter the whole Acadian Bay is encumbered with floating ice, partly produced on its own shores and partly drifted from the north; but in summer the action of the sun upon its surface, the warm air flowing over it from the neighbouring land, and the ocean water brought in by the Strait of Cansean, rapidly raise its temperature, and it retains this elevated temperature till late in autumn. Hence the character of its fauna, which is indicated by the fact that many species of mollusks whose headquarters are south of Cape Cod, flourish and abound in its waters. Among these are the common oyster, which is especially abundant on the coasts of Prince Edward Island and northern New Brunswick, the Quahog or Wampum shell, the *Petricola pholadiformis*, which along with *Zirfea crispata*, burrows everywhere in the soft sandstones and shales; the beautiful *Modiola plicatula* forming dense mussel-banks in the sheltered coves and estuaries; *Cytherea* (*Callista*) *convexa*; *Cochlodesma leana* and *Cummingia tellinoides*; *Crepidula fornicata*, the slipper-limpet, and its variety *unguiformis*, swarming especially in the oyster beds; *Nassa obsoleta* and *Buccinum cinereum*, with many others of similar southern distribution.

Nor is the fauna so very meagre as might be supposed. My own collections from Northumberland Strait include about 50 species of mollusks, and some not possessed by me have been found by Mr. Whiteaves. Some of these, it is true, are northern forms, but the majority are of New England species.

The causes of this exceptional condition of things in the Acadian Bay carry us far back in geological time. The area now constituting the Gulf of St. Lawrence seems to have been exempt from the great movements of plication and elevation which produced the hilly and metamorphic ridges of the east coast of America. These all die out and disappear as they approach its southern shore. The tranquil and gradual passage from the Lower to the Upper Silurian ascertained by Billings in the rocks of Anticosti, and unique in North America, furnishes an excellent illustration of this. In the Carboniferous period the Gulf of St. Lawrence was a sea area as now, but with wider limits, and at that time its southern part was much filled up with sandy and muddy detritus, and its margins were invaded by beds and dykes of trappean rocks. In the Triassic age the red sandstones of that period were extensively deposited in the Acadian Bay, and in part have been raised out of the water in Prince Edward Island, while the whole Bay was shallowed and in part cut off from the remainder of the Gulf by the elevation of ridges of Lower Carboniferous rocks across its mouth. In the Post-pliocene period, that which immediately precedes our own modern age, as I have elsewhere shown,* there was great subsidence of this region, accompanied by a cold climate, and boulders of Laurentian rocks were drifted from Labrador and deposited on Prince Edward Island and Nova Scotia, while the southern currents flowing up what is now the Bay of Fundy, drifted stones from the hills of New Brunswick to Prince Edward Island. At this time the Acadian Bay enjoyed no exemption from the general cold, for at Campbelltown, in Prince Edward Island, and at Bathurst in New Brunswick, we find in the clays and gravels the northern shells generally characteristic of the Post-pliocene; though perhaps the lists given by Mr. Matthew for St. John and by Mr. Paisley for the vicinity of Bathurst, may be held to shew some slight mitigation of the Arctic conditions as compared with the typical deposits in the St. Lawrence valley. Since

* Notes on Post-pliocene of Canada, *Canadian Naturalist*, 1872.

that time the land has gradually been raised out of the waters, and with this elevation the southern or Acadian fauna has crept northward and established itself around Prince Edward Island, as the Acadian Bay attained its present form and conditions. But how is it that this fauna is now isolated, and that intervening colder waters separate it from that of southern New England. Verrill regards this colony of the Acadian Bay as indicating a warmer climate intervening between the cold Post-pliocene period and the present, and he seems to think that this may either have been coincident with a lower level of the land sufficient to establish a shallow water channel, connecting the Bay of Fundy with the Gulf, or with a higher level raising many of the banks on the coast of Nova Scotia out of water. Geological facts, which I have illustrated in my Acadian Geology, indicate the latter as the probable cause. We know that the eastern coast of America has in modern times been gradually subsiding. Further, the remarkable submarine forests in the Bay of Fundy show that within a time not sufficient to produce the decay of pine wood, this depression has taken place to the extent of at least 40 feet, and probably to 60 feet or more.* We have thus direct geological evidence of a former higher condition of the land, which may when at its maximum have greatly exceeded that above indicated, since we cannot trace the submarine forests as far below the sea level as they actually extend. The effect of such an elevation of the land would be not only a general shallowing of the water in the Bay of Fundy and the Acadian Bay, and an elevation of its temperature both by this and by the greater amount of neighbouring land, but as Prof. Verrill well states, it would also raise the banks off the Nova Scotia coast, and extending south from Newfoundland, so as to throw the Arctic current further from the shore and warm the water along the coasts of Nova Scotia and Northern New England. In these circumstances the marine animals of Southern New England might readily extend themselves all around the coasts of Nova Scotia and Cape Breton, and occupy the Acadian Bay. The modern subsidence of the land would produce a relapse toward the glacial age, the Arctic currents would be allowed to cleave more closely to the coast, and the inhabitants of the Acadian Bay would gradually become isolated, while the northern animals of Labrador would work their way southward.

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* Acadian Geology, p. 29.

Various modern indications point to the same conclusions. Verrill has described little colonies of southern species still surviving on the coast of Maine. There are also dead shells of these species in mud banks, in places where they are now extinct. He also states that the remains in shell-heaps left by the Indians indicate that even within the period of their occupancy some of these species existed in places where they are not now found. Willis has catalogued some of these species from the deep bays and inlets on the Atlantic coast of Nova Scotia, and has shown that some of them still exist on the Sable Island banks.*

Whiteaves finds in the Bradelle and Orphan bank littoral species remote from the present shores, and indicating a time when these banks were islands, which have been submerged by subsidence, aided no doubt by the action of the waves.

It would thus appear that the colonisation of the Acadian Bay with southern forms belongs to the modern period, but that it has already passed its culmination, and the recent subsidence of the coast has no doubt limited the range of these animals, and is probably still favouring the gradual inroads of the Arctic fauna from the north, which, should this subsidence go on, will creep slowly back to reoccupy the ground which it once held in the Post-pliocene time.

Such peculiarities of distribution serve to show the effects of even comparatively small changes of level upon climate, and upon the distribution of life, and to confirm the same lesson of caution in our interpretation of local diversities of fossils, which geologists have been lately learning from the distribution of cold and warm currents in the Atlantic. Another lesson which they teach is the wonderful fixity of species. Continents rise and sink, climates change, islands are devoured by the sea or restored again from its depths; marine animals are locally exterminated and are enabled in the course of long ages to regain their lost abodes; yet they remain ever the same, and even in their varietal forms perfectly resemble those remote ancestors which are separated from them by a vast lapse of ages and by many physical revolutions. This truth which I have already deduced from the Post-pliocene fauna of the St. Lawrence Valley, is equally taught by the molluscs of the Acadian Bay, and by their Arctic relatives returning after long absence to claim their old homes.

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* Acadian Geology, p. 37.

Still another lesson may be learned here. It appears that our present climate is separated from that of the glacial age by one somewhat warmer, which was coincident with an elevated condition of the land. Applied to Europe, as it might easily be, this fact shows the futility of attempting to establish a later glacial period between the Post-pliocone and the present, in the manner attempted, as I must think on the slenderest possible grounds, by Prof. Geikie in his late work "The Great Ice Age."

The grandeur of those physical changes which have occurred since the present marine animals came into being, is well illustrated by some other facts to which our attention has been directed. Recent excavations in the Montreal mountain have enabled Mr. Kennedy to observe deposits of Post-pliocene marine shells at a still higher level than that of the old beach above Cote des Neiges, which was so long ago described by Sir Wm. Logan and Sir Charles Lyell. The new positions are stated to be 534 feet above the sea. Let us place this fact along with that recorded by Prof. Bell in the Report of the Geological Survey for 1870-71, of the occurrence of these same shells on the high lands north of Lake Superior, at a height which, taking the average of his measurements, is 547 feet above the sea level. Let us further note the fact, that in the hills behind Murray Bay and at Les Eboulements I have recorded the occurrence of these remains at the height of at least 600 feet. We have then before us the evidence of the submergence of a portion of the North American continent at least 1000 miles in length and 400 miles in breadth to a depth of more than a hundred fathoms, and its re-elevation, without any appreciable change in molluscan life.

Another important and impressive fact in this connection has recently been brought out by Dr. Hunt in a paper on the Geology of the South-eastern Appalachians.* He there shows that in these mountains, which lie to the south of the region of the great Post-pliocene submergence, the gneissose rocks have been decomposed in place to enormous depths, without any of the material being removed—a most striking contrast to the generally bare and scraped condition of similar rocks in the north. I was struck very much with this fact several years ago, when, under the guidance of my friend Dr. Tyson, I had an opportu-

* Proceedings American Association, 1873.

nity of examining the crystalline rocks near Baltimore, and I have also in my notes on the Post-pliocene of Canada, pointed out that in some places, as at Les Eboulements and on the southern side of our own mountain, where the rocks have been sheltered from the northern currents, extensive evidence of old sub-aerial disintegration may be seen.

It is most instructive to compare in connection with this point the condition of the Silurian rocks on the north-east and south sides of the Montreal mountain. On the former they show no signs of sub-aerial waste, but are polished and striated in the most perfect manner. The striae are N.E. and S.W., or in the direction of the river valley, and that the force producing them acted from the N.E. is shewn by the manner in which projecting trap dykes are ground on the N. E. side and left rough on the opposite one. The striae vary in direction, having evidently been produced by many successive impacts of heavy bodies moving from the north-east but not always in precisely the same lines. It seems absolutely impossible that anything except floating ice running from the N. E. or against the present drainage of the country could have produced these striations.* On the limestone slopes which front the mountain, all is different. In the vicinity of the reservoirs, for example, the coarse earthy limestone, where it has been protected by hard trap dykes, is in many places decomposed to a great depth, and shows no signs of glacial action.

What does this teach us? The same truth which we learn from the wholesale transference of boulders, sand and clay to the south-west over our country, namely, that *the great agent in denuding it of all its decomposed and broken rock has been the Arctic current passing over it when submerged.* The boulders which have been swept away from our Laurentian hills are merely the harder and less decomposed parts of rocks which had been disintegrated long before the glacial period, but became the prey of water and ice when the land was submerged. Geologists will not learn to understand fully the Post-pliocene period,

* I saw last autumn on St. Helen's Island a very instructive instance of striation on Utica shale produced by the ice-shove of the previous spring. This was in the direction of the river valley, but the evidence of the force acting from the south-west was plain, while a miniature moraine of rock fragments in advance of the markings shewed the agent by which they had been effected.

until they are prepared to admit that the power of the heavy Arctic currents passing over the submerged land and carrying with them their burden of ice, is vastly greater as an agent of denudation than either the rivers or glaciers. Nor must we confine this to the Post-pliocene period. Prof. Hall has shewn that the whole of the vast thickness of the Palæozoic rocks of the Appalachians may be attributed to the carrying power of the same currents which are now piling up banks of Arctic sand and stones along the American coast. Nay more, the history of the land of the Northern Hemisphere throughout geological time has been that of a series of elevations and depressions or gigantic pulsations of the earth's crust, so regular that we cannot hesitate in referring them to some constantly operating law. Every elevation exposed the land to sub-aerial disintegration. Every subsidence scraped and peeled it by the action of the Arctic currents, and thus the carriage of material and the growth of the continents have ever been to the south-west. I cannot leave this subject without according to Dr. Carpenter much credit for contending as he has done for the reality, power, and true causes of these great sub-oceanic rivers, which have played and are playing so important parts as geological agents, that without them it is impossible to account either for the Palæozoic deposits or the Post-pliocene deposits of our North American continent.

But it is time to turn to the second topic which I have marked out for myself in this discourse. In the past summer three lines of geological reconnaissance have been pushed out from the Laurentian and Huronian country of Lake Superior over the plains of Manitoba. One of these, under Mr. Selwyn, followed the line of the North Saskatchewan. The second was that of Prof. Bell on the south branch of the same river and its tributaries. The third was that of Mr. G. M. Dawson on the 49th parallel. All of these have been brought under the notice of this Society in the course of the winter. This great western plain presents first a wide expanse of Cretaceous rocks, apparently not highly fossiliferous and not well exposed, but containing some limestone layers rich in Foraminifera and Coccoliths precisely similar to those of the English chalk. Some of these have been described by Mr. Dawson in our Journal. This is succeeded by vast estuarine and lacustrine deposits of clay and sand, holding brackish-water and fresh-water shells, and beds of lignite with abundant plant remains. The general geological

history of these great prairie lands is thus as plain and simple as their own superficial features. First, we have a great Cretaceous Mediterranean, extending from the Gulf of Mexico perhaps to the Arctic sea. Then we have this dried up into estuaries, lakes and marshes, and becoming clothed with a rich vegetation similar in general character to that of the west coast at present, and indicating a mild and genial climate. Then we have the great Post-pliocene subsidence, with its trains of gravel and ice-borne boulders; and lastly the re-elevation into the prairie lands of to-day, with perhaps an intervening age of modern forests. The final results are a vast expanse of fertile soil, and great stores of mineral fuel, which may one day make these now lone lands the seats of extensive manufacturing industries. Detailed reports of the explorations of the past year are in progress, and will greatly increase our precise and definite knowledge of regions which have hitherto been known to us principally through the vague impressions of unscientific travellers.

Simple though the structure of these Western regions is, it has already given rise to controversies, more especially with reference to the age of the plants and animals whose remains have been found in these formations south of the United States boundary. In looking over these controversies, I am inclined in the first place to believe that we have in the West a gradual passage from the Cretaceous to the Tertiary beds, and that these last may scarcely admit of a definite division into Eocene and Miocene. We may thus have in these regions the means of bridging over what has been one of the widest gaps in the earth's history and of repairing one of the greatest imperfections in the geological record.

Physically the change from the Cretaceous to the Tertiary was one of continental elevation—drying up the oceanic waters in which the marine animals of the Cretaceous lived, and affording constantly increasing scope for land animals and plants. Thus it must have happened that the marine Cretaceous animals disappeared first from the high lands and lingered longest in the valleys, while the life of the Tertiary came on first in the hills and was more tardily introduced on the plains. Hence it has arisen that many beds which Meek and Cope regard as Cretaceous on the evidence of animal fossils, Newberry and Lesquereux regard as Tertiary on the evidence of fossil plants. This depends

on the general law that in times of continental elevation newer productions of the land are mixed with more antique inhabitants of the sea; while on the contrary in times of subsidence older land creatures are liable to be mixed with newer products of the sea. Thus in Vancouver's Island plants which Heer at first regarded as Miocene have been washed down into waters in which Cretaceous shell-fishes still swarmed. Thus Cope maintains that the lignite-bearing or Fort Union group contains remains of cretaceous reptiles, while to the fossil botanist its plants appear to be unquestionably Tertiary. Hence also we are told that the skeleton of a Cretaceous Dinosaur has been found stuffed with leaves which Lesquereux regards as Eocene. At first these apparent anachronisms seem puzzling, and they interfere much with arbitrary classifications. Still they are perfectly natural, and to be expected where a true geological transition occurs. They afford, moreover, an opportunity of settling the question whether the introduction of living things is a slow and gradual evolution of new types by descent with modification, or whether, according to the law so ably illustrated by Barrande in the case of the Cephalopods and Trilobites, new forms are introduced abundantly and in perfection at once. The physical change was apparently of the most gradual character. Was it so with the organic change, That it was not is apparent from the fact that both Dr. Asa Gray and Mr. Cope, who try to press this transition into the service of evolution, are obliged in the last resort to admit that the new flora and fauna must have migrated into the region from some other place. Gray seems to think that the plants came from the north, Cope supposes the mammals came from the south; but whether they were landed from one of Sir William Thomson's meteors, or produced in some as yet unknown region of the earth, they cannot inform us. Neither seems to consider that if giant Sequoias and Dicotyledonous trees and large herbaceous mammalia arose in the Cretaceous or early Tertiary, and have continued substantially unimproved ever since, they must have existed somewhere for periods far greater than that which intervenes between the Cretaceous and the present time, in order to give them time to be evolved from inferior types; aud that we thus only push back the difficulty of their origin, with the additional disadvantage of having to admit a most portentous and fatal imperfection in our geological record.

The actual facts are these. The flora of modern type comes into being in the Cretaceous of the West without any known ancestors, and it extends with so little change to our time that some of the Cretaceous species are probably only varietally distinct from those now living. On the other hand the previous Jurassic flora had died out apparently without successors. In like manner the Cretaceous Dinosaurs and Cephalopods disappear without progeny, though one knows no reason why they might not still live on the Pacific Coast. The Eocene mammals make their appearance in a like mysterious way. This is precisely what we should expect if groups of species are introduced at once by some creative process. It can be explained on the theory of evolution, only by taking for granted all that ought to be proved, and imagining series of causes and effects of which no trace remains in the record.

The problems for solution are, however, much more complicated than the derivationists seem to suppose. Let us illustrate this by the plants. The Cretaceous flora of North America is in its general type similar to that of the Western and Southern part of the continent at present. It is also so like that of the Miocene of Europe that they have been supposed to be identical. In Europe, however, the Cretaceous and Eocene floras, though with some American forms, have a different aspect, more akin to that of floras of the Southern Hemisphere. There have therefore been more fluctuations in Europe than in America, where an identical group of genera seems to have continued from the Cretaceous until now. Nay, there is reason to believe that some of the oldest of these species are not more than varietally distinct from their modern successors. Some that can be traced very far back are absolutely identical with modern forms. For example, I have seen specimens of a fern collected by Dr. Newberry from the Fort-Union group of the Western States, one of those groups disputed as of Cretaceous or Tertiary date, which is absolutely identical with a fern found by Mr. Dawson in the Lignite Tertiary of Manitoba, and also with specimens described by the Duke of Argyle from the Miocene plant beds of Mull. Further it is undoubtedly our common Canadian sensitive fern—*Onoclea sensibilis*. There is every reason to believe that this is merely one example out of many, of plants that were once spread over Europe and America and have come down to us unmodified throughout all the vicissitudes of the Tertiary ages. But while

this is the case, some species have disappeared without known successors, and others have come in without known predecessors. Nay whole floras have come in without known origin. Since the Miocene age the great Arctic flora has spread itself all around the globe, the distinctive flora of North-Eastern America and that of Europe have made their appearance, and the great Miocene flora once almost universal in the Northern Hemisphere has as a whole been restricted to a narrow area in Western and warm temperate North America. Even if with Gray, in his address of two years ago before the American Association, we are to take for granted that the giant Pines (Sequoias) of California are modified descendants of those which flourished all over America and Europe in the Miocene, Eocene and Cretaceous, we have in these merely an exceptional case to set against the broad general facts. Even this exception fails of evolutionary significance, when we consider that the two species of Sequoia, which have been taken as special examples, are at best merely survivors of many or several species known in the Cretaceous and Tertiary. The process of selection here has been merely the dropping out of some out of several species of unknown origin, and the survival in a very limited area of two, which are even now probably verging on extinction: in other words, the two extant species of Sequoia may have continued unchanged except varietally from Mesozoic times, and other species existed then and since which have disappeared; but as to how any of them began to exist we know nothing, except that, for some mysterious reason, there were more numerous and far more widely distributed species in the early days of the group than now. This is precisely Barrande's conclusion as to the Palæozoic Trilobites and Cephalopods, and my own conclusion as to the Devonian and Carboniferous plants. It is rapid culmination and then not evolution but elimination by the struggle for existence.

The argument deduced from these successive floras reminds one of certain attempts which have been made in England to invalidate Barrande's law in his own special field. With a notice of one of these, which emanates from a successful collector of Primordial fossils, I shall close. He says, after referring to the different species of Paradoxides and allied genera in the Cambrian:—

"Other species show various gradations in the eyes and in the pygidium until we attain to *P. Davidis*, which has small eyes, a small

pygidium, and the greatest number of thoracic segments. Indeed there are forms to represent almost every stage, and there can I think be no doubt that in the fauna of the Tremadoc group, which is separated from the earlier Cambrian by several thousand feet of deposits indicating a period of very shallow water in which large brachiopods and phyllopod crustaceans were the prevailing forms of life, we witness a return to very much the same conditions as existed in the earlier Cambrian periods, and with these conditions a fauna retaining a marked likeness to the earlier one, and in which the earlier types are almost reproduced, though of course greatly changed during their previous migrations. The *Niobe(?)* recently found in the Tremadoc rocks is truly a degraded *Paradoxides*, retaining the glabella and head spines, but with the rings of the thorax, excepting eight, consolidated together to form an enormous tail. Instead therefore of having here, as stated by M. Barrande, "a very important discord between Darwinism and facts," we find in these early faunas facts strongly favouring such a theory, and in support of evolution.

This is an exquisite piece of evolutionist reasoning, worthy of some of the greater masters of this peculiar logic. It is assumed that specific differences are "gradations" and the word "almost" covers the gaps between these. It is taken for granted that Paradoxides, which disappears with the Menevian age, has only gone upon its travels to parts unknown, and after the deposition of several thousand feet of beds, returns disguised as the Niobe of the Tremadoc,—and not only changed but "degraded",—a sorry result certainly of the struggle for existence in the interval, and holding out small prospect that the creature can be promoted in any subsequent age into a fish or even into a Decapod. If Barrande's reasoning can be met only in this way, he need not fear for the result. Seriously, one scarcely knows whether to be amused or grieved at the phases which the doctrine of derivation assumes in the writings of some modern naturalists. It is at least devoutly to be hoped, in order that science may not fall under the contempt of all thinking men, that the advocates of this hypothesis may become more careful in their treatment of facts, and more modest in their demands on our faith.

In the meantime the record of the rocks is decidedly against them in the particular point to which I have above adverted, namely, the abrupt appearance of new forms under several specific types and without apparent predecessors. They should direct their attention in this connection to the appearance of Foraminifera in the Laurentian, of Sponges, Brachiopods, Trilobites,

Phyllopods, Crinoids, and Cephalopods in the older Palæozoic; of Land Snails, Millipedes, Insects, Fishes, Labyrinthodonts, Acrogens and Gymnosperms in the middle and later Palæozoic: of Belemnites, Dinosaurs, Ornithosaurs and other Reptiles, and of Marsupial Mammals and Dicotyledonons trees in the Mesozoic; of Placental Mammals and Man in the Tertiary and modern. When they shall have shewn the gradations by which these, out of the many cases which may be cited, have been introduced, and this without assuming an imperfection in the record incredible in itself and destructive of its value as a history of the earth, they may be in a position to rebuke us for our unbelief.

But it may be asked:—Have we no positive doctrine as to the introduction of species? In answer I would say that it is conceivable that the origin of species may be one of those ultimate facts beyond which science by its own legitimate methods cannot pass, and that all we can hope for is to know something of the modes of action of the creative force and of the modifications of which species when introduced are susceptible. In any case it is by searching for these latter truths that we may hope successfully to approach the great mystery of the the origin of life. It is with reference to these truths also that the discussion of modern theories of derivation has been chiefly valuable, and in so far as established they will remain as substantial results after these theories have been exploded. Among such truths I may mention the following: We have learned that in geological time species tend to arise in groups of like forms, perhaps in many parts of the world at once; so that genera and families culminate rapidly, then become stationary or slowly descend, and become restricted in number of species and in range. We have learned that in like manner each specific type has capacities for the production of varietal and race forms which are usually exercised to the utmost in the early stages of its existence, and then remain fixed or disappear and re-appear as circumstances may arise, and finally the races fall off one by one as it approaches extinction. Many of these races and varieties constitute conventional species as distinguished from natural species, and in so far as they are concerned, descent with modification occurs, though under very complex laws, and admitting of retrogression just as much as of advance. We have also learned that in the progress of the earth's history embryonic, generalised and composite types take precedence in

time of more specialized types, and thus that higher forms of low types, precede higher types and are often replaced by them. We are further, as the relation of varieties and species is investigated and their extension in time traced, becoming more and more convinced of the marvellous permanence of specific types, and of their powers of almost indefinite propagation in time. Lastly, vast stores of facts are being accumulated as to the migration of species from one area to another and as to the connection of the great secular elevations and subsidences of continents with their introduction and extinction. All these are substantial gains to science, and the time is at hand when they will lead to more stable theories of the earth than those now current. If I am not greatly mistaken, these considerations or some of them will be found to cover the case recently so much insisted on of the Tertiary predecessors of the modern Horse; a case which includes a great number of complicated and curious successions and relations, which we may hope to consider at a future time, when the American facts relating to them have been more fully elaborated.

I have however digressed from my special subject, and in returning to it, and in closing this address, would express my thankfulness that here in America we have a field for work on so broad a scale that there is little temptation to abandon the ever fresh and exciting exploration of new regions and the discovery of new facts, and the working out of legitimate conclusions, for that process of evolving worlds out of our own consciousness which seems to be the resource of those who have access only to the often ransacked treasuries of nature in smaller and older countries. Placed on a continent which in its geological development is the grandest and noblest of all, and which may be made a type for all the rest, let us push forward the conquests of legitimate science, and bear in mind that our present aim should be above all things the diminution of that imperfection of the geological record of which so much complaint is made.