a whole, are no more than half paid for their labor, in a vocation so deleterious to health). It would require more time and labor, and just as many hands be employed, and the trade would then be worth learning.

However, one is not to blame, if he has made any discovery which has cost him time and money, should he wish to keep it a secret, or patent it, until he can make his money out of it; yet in all minor matters, it is not only neighborly to instruct one another, but is really an honor to the craft.

The art of painting, in all its various branches, is, perhaps, under present regulations, quite as injurious to health as almost any other branch of mechanical business, especially house and general shop-painting.

It is supposed that painters, in the aggregate, pay an interest on their life of about twenty-four per cent.; that is, they shorten their lives about two months every year for the privilege of following the noxious business, and getting a taste of the colic every other moon. In fact, it is statistically true that the average lives of painters do not come up to the average standard of longevity.

It is well known that painting is an unhealthy business; and to such an extent is this prejudice abroad, that it is with difficulty, in some places, that master workmen can procure an apprentice.

The house-painter is much more exposed, and liable to the poisonous effects of colors, than those who follow other branches, on account of the large quantities of vapor exhaled from lead and the arsenious greens, especially that most brilliant but deadly color, emerald green. This poisonous color, as all arsenious preparations will, gives out exceedingly large quantities of vapor, the inhalation of which very suddenly show itself, and is quite often mistaken for some other disease, and frequently, by physicians, so treated. It causes inflammation of the throat and lungs, and produces, in different parts of the body, small watery pustules, which are exceedingly troublesome. We have known painters to be so afflicted with this affection upon their breast, groins, and armpits, that they were unable, for several days together, to move a limb without great inconvenience and pain.

In England, where much of this green is used, it has been ascertained from actual observation, and the experience of physicians and other scientific men, that a series of diseases the most complicated have resulted from having the walls of houses washed, painted, or papered with arsenious greens. Cases have been known where whole families have been poisoned by living within the walls of such houses.

Copper, arsenic, and lead are exceedingly volatile, and those persons immured within the walls covered with them are so perfectly enveloped with the vapor arising therefrom that they are continually inhaling it, greatly to their detriment.

A very singular case (and a remarkable and unmistakable evidence of the noxious effects of arsenious vapor) occurred in England a few years ago. A family, a short time after moving into a certain house, were taken suddenly and violently sick. A physician was sent for, who pronounced it a case of poisoning from arsenic. The patients were relieved, but lingered on for some time, and finding they did not recover their health, left the building. Another family moved into the tenement, and were attacked in like manner; still other persons occupied the rooms, and the same results followed, until, at last, it was alleged that the house was haunted, and Madame Rumor set about making up the legends. But science eventually got hold of the matter, when, by investigation, the premises were known to have formerly been occupied by painters, who were accordingly called upon, when it was ascertained that previous to leaving the house they had buried a large quantity of refuse arsenic three feet deep, in the bottom of the cellar. The deadly drug was removed, and people were no longer haunted with this arsenious ghost.

Almost every painter is familiar with the noxious effects of lead, especially when cooped up in a close room, with *drawn flatting*, and perhaps the keyholes stopped up. Few there are who can work three hours thus, who will not, on coming to the fresh air, almost immediately fall, or stagger as though they had imbibed something of a different nature from turpentine. This part of the business will soon produce the painter's colic, and eventually paralyze, unless much care be taken to guard against it.

In England, benefit has been experienced in cases of painter's or lead colic, both by those who manufacture and those who use white lead, in the use of sulphuric acid in very small quantities. One way of using it is to put one dram of acid into ten pints of table or spruce beer, or mild ale; to shake it up well, and allow it to stand a few hours. A tumbler-full twice or three times a day is used. Another way, not so convenient, is to make the beer as follows: Take of molasses, 14 pounds; bruised ginger, ½ pound; coriander seed, ½ ounce; capsicum and cloves, ¼ ounce each; water, 12½ gallons; yeast, 1 pint. Put the yeast in last, and let it ferment. When the fermentation has nearly ceased, add 1½ ounces of oil of vitriol mixed with 12 ounces of water, and 1½ ounces bicarbonate of soda dissolved in water. Fit to drink in three or four days.

The painter is often asked what the painter's colic feels like. He could not, probably, describe it better than to say to those who do not wish to try the experiment, that if the strands of a rope, while being twisted together, should be passed through the bowels horizontally, and the whole abdominal viscera be twisted with it, a faint idea might be formed of the lead colic.—*Haney's Painters' Manual.*

Another Solar Engine.

The London *Scientific Review* announces that similar researches to those made by Capt. Ericsson, announced some weeks since in the SCIENTIFIC AMERICAN, have been made by Prof. Mouchot, at Tours in France. It further states that Prof. Mouchot took out a patent in March 1861, for an apparatus of this description which he allowed to lapse. However, in 1864, he constructed a solar boiler on the same principle which worked at Mendon with satisfactory results. On the 2nd September, 1866, he brought a machine of this description to the palace of St. Cloud that it might be seen at work by the Emperor. It was a small steam engine worked by a solar boiler, but the bad state of the weather interrupted the experiment. A little later, however, the Emperor having gone to Biarritz the machine was taken thither and the experiment succeeded. Since that time M. Mouchot has contrived various kinds of apparatus on the same principle for cooking meat and vegetables, distilling spirits, baking and latterly steam and hot air engines. Prof. Mouchot also announces a work upon the subject in preparation and soon to be in press.

THE PRIMEVAL FLORA---LECTURE BEFORE THE AMERICAN INSTITUTE, BY PROFESSOR DAWSON.

Reported for the Scientific American.

The above topic formed the subject of a very interesting lecture by President Dawson, of McGill College, Montreal, at Steinway Hall, in this city, on the evening of the 23d December. Notwithstanding the lecture embraced altogether too wide a field for anything like thorough treatment, the happy style and popular method adopted by the lecturer, made it very acceptable. After the usual introduction of the lecturer to the audience, President Dawson said: An eminent authority has defined geologists to be a class of amiable and harmless enthusiasts, who are happy and grateful if you will only consent to give them an unlimited quantity of that which, to them, has, perhaps, the most value of all things, namely, past time. I confess to this definition of geologists, so far as my subject this evening is concerned, for I shall have to make a large demand upon your faith as to the extent of the past time, and shall have to ask you to give me all of it which you reasonably and conscientiously may. Geology, indeed, works strange revelations in our view of things, new and old. The primitive forests, and even the gray rocks and hills themselves are things not primitive and unchanging, not things, comparatively, of yesterday, the successions of olden forests and olden rocks that in dim and ghost-like procession recede from our view into the past of an antiquity, compared with which all human antiquities are things of yesterday. The murmuring pines, and the hemlock, bearded with moss and in garments green, indistinct in the twilight, may stand like Druids of old with voices sad and prophetic; but they belong not to the forest primeval of the earth's younger days, though they may point backward to perished predecessors of truly old date, truly primitive and geological antiquity. It is to them that I must try to carry you back in imagination this evening, to awaken those slumbering ages and make them green again in your eyes and vocal in your ears. Transferring our thoughts to these old forests, and imagining their strange fantastic forms, and the singular creatures that lived beneath their shade, we shall find ourselves in a new world different from that which we inhabit, and differently peopled. Could we marshal in one view four or five planets, each clothed with the peculiar flora, and inhabited by the peculiar fauna of a distinct geological period, we should truly have before us so many distinct worlds with nothing to connect them with each other save only certain similarities of plan and conception. But when we view these several worlds as successive, and destined the one to prepare the way for the other, we can perceive relations of the most remarkable and unexpected character, and have presented to us a long protracted scheme of creation too vast to be contained on the surface of our planet at any one period, and representing with our present flora all the possibilities of vegetable existence, and all the uses, present and past, which plants can serve. I have selected as the subject of this lecture one small department of the vast field of fossil plants, a department of peculiar interest as relating to the oldest known plants, and which, as a special and favorite study of my own I must endeavor to make attractive to you. But I must not rest contented with this, but in justice to the subject must try also to present it in an orderly and systematic manner. I must endeavor to give you something like a connected sketch of that primeval flora which is the subject of this lecture; and in order to do this, I must first say a few words on the relations of their primeval flora to existing plants; 2d, I shall say something of their relations to the geologic time; 3d, I shall enter upon the subject proper by describing to you some of the more remarkable plants that flourished in that primeval age; and, 4th, I shall conclude with noticing some of the uses of this primeval flora to us, the practical use it serves to our present race; and I shall endeavor to give you, if possible, some idea of the light which geology gives us as to the first appearance of plants on our planet, and how far back they can be traced in geologic time. First, then, I shall speak for the benefit of those who may not have pursued the study of botany, of the relations of existing planets, and the relation of the fossil flora to them. Taking the whole of the plants known to us, we shall find upon examination that they may all be divided into two great series; first, that series of plants in which we observe distinct flowers, and fruit containing seeds. These constitute the phenogamous plants of the botanist. Then we have a great class of plants of a lower and humbler organization, which are destitute of true flowers, and which instead of producing seeds, produce granules, performing the functions of seeds, called spores. These are the cryptogamous plants of the botanist. The whole vegetable kingdom is divided into these two great classes. Now, taking first the phenogams, we shall find three classes of them. We have, first, that group of plants to which all our trees and shrubs and the greater part of our cultivated plants and weeds belong—the exogens, which have a distinct pith, and wood, and bark Then we have a class in which these features are more or less mixed through the entire structure, and in which there is little distinction of wood and bark, and of which the palms of the tropics and the grasses of our own latitude are examples. These are called endogens. A third class are the gymnosperms, which have naked seeds, specimens of which are the well known pines and the sago of the tropics. Thus, to recapitulate, we have three groups of the phenogams, of which the oak or maple, the palm, and the pine tree, are respectively representatives.

In the cryptogams we may also make a three-fold division respectively represented by the ferns and club mosses, the common mosses, and lichens, fungi and seaweeds.

Next let us see what relation these primeval flora bears to that of modern times. Two relations are possible: First, that the primeval flora may belong to a different classification altogether; and second, which is the true supposition, that the whole flora of the earth, from the earliest geologic times, comes under one classification. This shows that, from the beginning of geologic time, one plan has been followed out in the construction of the vegetable kingdom, and that the whole vegetable kingdom consists not of the plants now living upon the earth, but includes all the plants that have ever lived upon it. Again, there is another possibility, that the primitive flora may include representatives of all our modern classes of plants, or only some of them. The fact is, that it includes mainly representatives of some of them, and those of a medium grade, neither the lowest nor the highest, so far as the land flora is concerned. The fossil plants are not chiefly exogens or endogens, but gymnosperms. On the other hand the acrogens, or the highest group of the cryptogamous plants in our day were then the most abundant. The primeval flora, therefore, embraced the higher cryptogams and the lower phenogams. If we had known nothing of vegetation but that manifested by the primeval flora we should not have known the possibilities of the vegetable kingdom, either in its highest ranks or its lowest ranks, but only in the middle of the scale. Next let us glance at the relations of the primeval flora to geologic time. The oldest rocks we know, the eozoic, have afforded no plants, so far as we know, at all. The next stratum, the paleozoic, includes the oldest land plants we know. But in the mesozoic period we arrive at a different flora, and in the cainozoic, or modern period, we have two other floras. It is the paleozoic flora only of which I shall speak to-night. During the whole of the paleozoic period, the seaweeds have existed. In the earlier periods the classes of acrogens and gymnosperms far exceeded the exogens and endogens, while the reverse is the fact at the present day. The warm and moist climate of portions of the southern hemisphere at the present day, now have a flora more nearly resembling the early epochs than any other portions of the earth. The uniformity of the flora of that early period indicates a temperature nearly uniform throughout the earth. At present we have in our atmosphere but a small quantity of carbonic acid gas. If we had more, it would tend to make the climate more uniform, by preventing the radiation of heat from the earth. The carbon locked up in our coal mines, and then existing in the atmosphere, may therefore have been at least one reason for the uniformity of climate on the earth in the paleozoic period, the flora of that day indicating a warm and moist climate. Next, looking to the flora of the plants, we will turn to the carboniferous period, when there was a vast amount of vegetation, afterward made fossil and becoming coal. In that moist, warm, but unwholesome atmosphere, we find the sigillaria, or seal-tree, one of those most abundant in the swamps of the carboniferous period. Here we have a large tall stalk, without branches, covered with large leaves; or perhaps divided into a few branches. We have remains showing the ribbed structure of the stalk, and the scars of the leaves. There are no trees in our latitude resembling it in structure. We know of the fruit of the sigillaria only by the abundance of a certain nut that is found around them. Trees of two and three feet in diameter were not uncommon. The root of this tree is more remarkable even than its stem, having attracted the attention of geologists before the stem, and obtained the name of stigmaria. These roots are bifurcated and spread out in a remarkably regular way, all the little rootlets spreading as regularly as leaves. These roots occur very often in the coal formation without the stems; and at first it was supposed that they were the whole of the plant. The first process in the formation of a bed of coal was usually the growth of a forest of sigillaria.

The next class are the calamites. The lecturer here related an anecdote of an unlearned individual who having been shown some specimens of ferns and calamites, the former being called filices, reported to his friends that he had seen the savant's "felicities" and "calamities." In one sense the calamites may be justly styled calamities, for they had been the subject of more dispute on the part of geologists perhaps than any other fossil plant. They seem to have grown on muddy flats along the margin of the sigillarian woods, resembling equiseta or mare's tails; and they are still preserved in coal formations in large numbers. The calamites seem to have preserved the sigillarian forests from the effects of inundation, by causing the mud to settle before the waters passed into the forests. The calamites thus contributed very much to the purity of our coal beds. The next plant is the lepidodendron, or scale-tree, of a size equal to the sigillaria, resembling our ground pines or club-mosses. This tree was more plentiful in the earlier coal formations than in later periods. Many other diagrams and petrifactions of fossil plants were here exhibited. The plants of the carboniferous period would have presented to our eyes a very monotonous appearance; for it was characteristic of the flora of that period that there was a large number of species, but few genera. There were also some plants more familiar to our eyes. The ferns are to be found in the coal beds preserved as beautifully as they could have been preserved in an herbarium. They resembled more closely the ferns of New Zealand or the Hebrides than the ferns with which we are familiar. Some of these ferns grew to the dignity and beauty of the palm-tree itself. One species was peculiar, having only two leaves at a time. We find sometimes in the coal-beds things looking like enormous brooms, which are tree ferns, with roots sent out to straighten the stems. We also find in the coal formation varieties of pine, the wood of which much resembled our modern pines. It is remarkable that the pine is widely diffused at the present day; and it is not wonderful, therefore, that they should have existed in the carboniferous period. Those pines have features more nearly resembling those of Australia and New Zealand than those of our climate. When wood is buried in the earth and its cells filled with water holding silica or lime in solution, they become filled with stone, and the wood becomes coal; and this is the form in which we find these fossil remains. By removing the mineral we can observe the vegetable structure of the plants, and determine their character. Next to the soil on which we tread, the most valuable substance we have is mineral coal, which is derived from the plants of the carboniferous period. A bed of coal is usually composed of the remains of the trunks and bark of sigillaria trees. Examining coal with a microscope, after proper preparation, we can see the structure of the wood from which the coal was derived. Of eighty-one distinct seams of coal in Nova Scotia, every one but two or three had sigillaria, either in the coal or immediately above or beneath it. The top of a coal seam is merely the debris of the last forest that grew on this swamp where the coal was produced. Great Britain annually consumes 100,000,000 tuns of coal, and we know of nothing that will supply its place. The consumption of coal in America is already equal to the labor of 150,000,000 horses, and our coal beds are as yet hardly opened. All this power is extracted from the sunbeams of the paleozoic period. (Applause.) What did these magnificent forests grow for? There seem to have been no higher animals to enjoy them. We know of no birds that lived among their branches. We know of a few insignificant reptiles that crawled beneath them, but we know of nothing higher in that age. What were they created for? For two great purposes. First, to purify the atmosphere so that it might be made suitable for the higher animals that were to live in a future geologic period; and that very process of purifying the atmosphere was made the means of laying up those enormous stores of fossil fuel upon which so much of our modern civilization is based. See how grand are the economies of nature, preparing far back in geologic periods before man existed, for the existence of the present state of the arts in the world. Next to coal in its value comes iron; and although we are not so dependent upon the coal formation for iron as we are for coal, still we get an immense quantity of iron from the carboniferous rocks, accumulated by the agency of these very plants; for as they went to decay, and were converted into coal, they helped to gather together the particles of iron out of the clays and sands, and to store them up for us in iron ore. Therefore we owe to the growth of those old forests not only our coal but a large portion of our iron. And whether we look to the value of the coal in boiling the tea-kettle, of which Prof. Silliman spoke to you in the last lecture, or to the use of the iron which makes our iron horse, and the steam engine of our factories, we owe it all to the primeval plants, or rather the Maker and Creator of these old plants. Now let me trace these plants a little further back than the period of the coal formation. If we go back from the carboniferous rocks to the Devonian, we shall find a different flora, which no doubt helped to purify the air, and prepare the world for the carboniferous flora. We have in Canada a bed of coal two or three inches thick, belonging to that epoch, and it is the only one I know in America. In this drawing, some of the plants of that period are represented; and here you find the sigillaria, the lepidodendron, the calamites, the pines, etc., as in the later period; so that you see that the Devonian flora was really not very different from that of the carboniferous period. The species are mostly different but the generic forms are the same. As a whole the Devonian flora may be characterized as less massive and magnificent, more delicate and slender in its proportions; not less beautiful but less useful perhaps in the accumulation for us of vast stores of fuel. If we go down below the Devonian rocks into the Silurian, we find a few plants; but in the lower Silurian formation we hardly find any traces of plants. Nearly all the rocks known to us of that age were marine rocks. Prof. D. was not hopeless of the eozoic period even. We have as yet found no plants there; but we have found carbon. We have found plumbago; and even in later formations the remains of plants have sometimes been converted into black-lead in the eozoic strata, occurring in beds, so as much to resemble the remains of plants. They have been sea plants. If they were land plants we may guess what they were—anophytes and thallophytes, gigantic mosses and gigantic lichens. If we were to walk among those ancient forests of mosses, if they really did exist, we should be in a world something like what this would appear to an insect creeping upon the mosses of our woods. I have given you but a faint outline of a great subject, on which treatises might be and have been written, which would afford the material for a course of lectures more interesting than a single one can possibly be. The chief interest of the subject, no doubt, is to the botanist and geologist. The vegetable kingdom now is most beautiful and most varied, especially when we look at it as presenting forms of plants adapted to every climate and every situation upon earth, all of them finding their proper place and their own due season. But the subject before us carries us back into geologic times, and shows us a plan too large to be realized on one earth.

The plan of the Creator was so vast that the whole surface of the earth was not big enough to hold it. It required a series of earths, one after the other, to develop it, just as it has required a series of ages to develop the history of the human race. We have in these old plants something that adds enormously to the variety of the vegetable kingdom; something that shows us how small is our own knowledge, and how great and capable of extension is the plan of the vegetable kingdom. And when we consider further that we know of these fossil plants only what their remnants have taught us, it affords a widening field of wonder and of thought. As it is more interesting to the botanist to go out and collect plants for himself than to study them in the class books, so this subject is of the deepest interest to those who will examine the primeval flora and the coal formations; who will split open the rocks and see the forms that no one ever saw before, and perhaps make discoveries of facts which the world never knew before concerning that remote period of time. I must plead guilty as a fossil botanist—I mean a botanist studying fossils [laughter]—to having the deepest interest in this subject. And it arises in part from the very fact that different names are sometimes given to the same plant—as the tree is called sigillaria, the root stigmaria, and the nut still another name; and it requires much observation and study to discover and to show that these different names all belong to what was really one and the same plant. As our knowledge increases we may be able to dispense with many of these old names, which is more than can be said for modern botany. What would we have been without these old plants, without this great provision made for us in primitive times before man existed upon the earth? These plants form a part of the same plan to which we belong, and undoubtedly that plan existed at the time these old paleozoic plants grew. And now, I may say, even in this Christmas time, as we gather around the hearth, although our coal fire does not burn, and cackle and blaze like the old yew log of our ancestors, yet the trunks of our old sigillaria, burning upon our hearths to-night, send forth a quiet, kindly look, befitting their great age and long burial in the earth. And the happy hearts that gather around the Christmas fireside may thank God that we have had these great stores prepared for us in the times of old, and that we have hearts and minds fitted to enter somewhat into that great plan which stored them up, and for the enjoyment in a measure, even of the beauty of the plants that lived so long ago.

THE EVOLUTION OF THE NORTH AMERICAN CONTINENT---LECTURE BY PROFESSOR HALL.

Reported for the Scientific American.

The above was the subject of a lecture by Professor James Hall, State Geologist of New York State, before the American Institute at Steinway Hall, New York City. The lecturer was introduced by Judge Daly, who referred to the interesting character of the preceding lecture, delivered, as he said by a distinguished Canadian geologist. We shall to-night have the pleasure of listening to a distinguished geologist of our own State, whose reputation, however, is not limited to our own state or the United States. His reputation will be perpetuated by that noble monument, the Natural History of New York, published under his scientific supervision, and of which more than one fourth is the work of the speaker who is about to address us. It is not too much to say that this great work is unequaled by any similar work in existence not comprising a greater area of the earth's surface.

In reply to the complimentary introduction of Judge Daly, Professor Hall said: I am unprepared to say a word in response to the complimentary introduction of your president, but I will say as an adopted citizen of the State of New York, that the natural history of the State is a monument of which, in succeeding generations, every man, woman, and child will have reason to be proud. It has been carried on many years, amid many conflicting circumstances. For the humble part I have had in the work, I have had many pleasures, many griefs and sore trials. But when these are all past, those that follow will reap the benefit of a work that has developed more of natural science than any other American work; which was, in fact the earliest development of natural science upon the American continent

Professor Hall then proceeded to the discussion of the topic of the lecture, the evolution of the North American continent. The lecturer made such frequent references to diagrams upon the blackboard and to charts, that it is impossible to give in a printed report, without diagrams, the arguments by which he sustained his propositions. We shall therefore limit ourselves to an outline of the lecture, giving as far as possible the order in which the continent was evolved as stated by the speaker.

A period existed, ages upon ages ago, when the surface of the earth was entirely covered with water. Under this universal ocean the solid nucleus existed, and by gradual cooling of the earth's crust or by other causes, upheavals took place. These upheavals occurred first at the northern portion of the globe, and extended until a portion of dry land of the so called granitic formation extended down as far as Nova Scotia—at that period an island—and to the great lakes, and westward nearly to the Rocky Mountains. The whole of the continent remaining is formed of sedimentary deposits from the currents which existed in the ocean then as now, layer upon layer of different periods and characters, many of which are from thirty to forty thousand feet in thickness.

Upon every portion of the surface of the earth, we have mountain chains, plains, and valleys; and we have rocks, loose materials, sand, pebbles, gravel, and other materials of that kind, which are distributed over the surface. These are distributed, not regularly, but according to certain laws, which have prevailed in all geologic time. This pebble, for example, which I have before me, has at one time been an angular fragment of rock, broken from a rock which had itself been, at a still earlier time, a loose mass of sand. It has been consolidated. It has become rock. It has again become broken, and these pebbles have been triturated by the motion of the water, the action of the sea, or of rivers and streams, until they have been rounded, the corners worn off, the finer materials being gradually worn away and disappearing, being reduced by the water to an impalpable condition beyond our reach. The harder particles of material like this makes the sand which strews the sea beaches every where. The sand was not from the breaking down of sand stone, but from the breaking down of materials containing sand. While the finer and more impalpable portions have been widely separated, the harder portions, which are a silicious sand, remain to make sea beaches and river beaches. In this respect nature is constantly active. There is no moment of time when this process, this degradation of the surface of the globe is not going on. During every shower, or if you will go back to the first of all this, the evaporation of water by the action of the sun's rays, in the ocean and upon the surface of the earth, lifting it into the atmosphere and precipitating it again upon the surface, transfers the loose materials into the smaller streams, thence into rivers, and thence into the ocean where they are spread out evenly from the facility of their transportation by currents, the coarser materials being first deposited, and then the finer. And the action of the frost annually prepares these materials for the subsequent action of the rain. The water percolating into the crevices of the rocks, freezes, and by its expansion in freezing separates them, until, year by year, more and more of the rocky mass is broken down, and the material prepared to be transported by the rain storms into the ocean.

The continent has been produced step by step during several geological formations; it has never been elevated above the ocean as an entire continent; it has been produced from sediments which have been made by the distribution of materials from pre-existing continents, pre-existing materials lying above the surface of the water. In the northern portion we find the earliest continent, and the breaking down of its materials has given us the silurian, devonian, and carboniferous formations. Constantly have the materials of the land, during all the period subsequent to the carboniferous, been carried westwardly and southwardly, and spread over that portion of our continent. And then, subsequent to this, all this portion of our continent has been elevated. The North American Continent, so far as it is known, although there have been numerous minor oscillations, has had three great phases: First, that in which this portion of the continent alone was above the sea (indicating the northern portion upon the chart); second, that in which the continent extended southward to this second line; and, third, that in which the whole of the western and southern portions have risen above the sea. In each of these epochs there have been distinctly marked the characteristic conditions of ocean and of dry land, indicated by fossils in immense numbers; so that we are able to trace step by step, in each one of these geological formations, each thousands of feet in thickness, not only the characteristic fossils of each successive bed, but we can easily subdivide them. So that in this portion, from the base of the silurian to the devonian, we recognize 20 or 30 different epochs, each marked by its characteristic fossils, with its fauna and its flora as distinct as upon the shores of the country at the present time. Taking the shores of the United States at the present time, and observing the number of animals living along the coast, we have that repeated some 20 or 30 times in this one epoch; each of these having been superseded by and given place to another, and so on in succession, during the silurian period. When we consider that these various animals have lived and died, that each has occupied its place for successive generations, for we do not know how long a time, when we consider that this country has been covered entirely by subsequent deposits, and other creations have taken their place, and so on, while accumulations hundreds of feet thick have been spread over them, when we remember that hundreds, and even thousands of these animals have lived and died, perhaps in each of those 20 or 30 subdivisions of the time, and thus on fauna after fauna, and flora after flora, through all these epochs, you have at last an incomprehensible number of generations of animals, a result which could only have been reached by a process carried on for an infinitely long period of time. One point which I have endeavored to impress upon you is that while this has been going on, there has been, so far as our own continent is concerned, a constant evolution of dry land. If we begin at the latest period, and go backward through these periods, you have in them all the distinction of ocean and dry land, the latest land being formed from the sediment distributed by the ocean, until at last we trace back the continent to the time when it was included within this area (indicating the northern portion). But we have nothing thus far of the original crust of the globe—nothing which geology can tell us of a nucleus which has been of melted matter. Still further north is a portion of the continent we know very little of. It is possible that this may be of older rocks. We know that there are older rocks that are stratified rocks, not only on this continent but on the continent of Europe; but we have no evidence that there were ever any rocks earlier than the sedimentary rocks. The granite of the Rocky Mountains is as much stratified as that of Northern New York; and wherever these strata are found we know that they have been deposited by water. Even in the old Laurentian rocks, those granite rocks of the North, there are same portions of the rocks containing pebbles derived from pre-existing stratified rocks. When we know that in the old sienite of the northern portion of this country we have pebbles which are stratified, like that which I hold in my hand, showing the remains of sediment, particles of sand transported to another place, and there becoming rock previous to the deposit of the materials which have been converted into gneiss, sienite, and granite, we know that there must have been