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Contents.

(Illustrated articles are marked with an asterisk.)

THE ORGANIC ORIGIN OF THE EARTH'S CRUST.

A popular theological dogma declares that life is the grand object of creation, that the composition as well as the contour of the earth's surface has special reference to its habitability, and that all things show a ruling design to fit the world to be the home of sentient creatures, more especially of man.

Strictly speaking, Science has nothing to do with such dogmas. It has no means of discovering the ultimate purposes of things, and no time to waste on their discussion. Nevertheless it is difficult sometimes not to take an indirect interest in the claims of those who presume to decide such questions, at least so far as to notice how aptly the facts of Nature contradict their assertions. Thus in the present case, it would be much easier to sustain the contrary thesis, namely, that so far from having been made what it is that it might be inhabited, the earth became what it is through being inhabited; in short, that life has been the means, not the end, of the earth's development.

In the light of recent discoveries, Byron's poetic extravagance: "The dust we tread on was alive!" becomes a simple statement of observed fact. And the earlier and more paradoxical assertion of Linnæus, that not the superficial dust merely but the very framework of the earth is the product of life, would seem to be equally true. "Fossils are not the children but the parents of rocks," he said; and Huxley declares that the whole effect of the discoveries made since his day has been to complete a larger and larger commentary on his words. The deeper we go into the history of the earth's crust, the greater the part we find to have been played by life in determining its composition and character. Even the rocks heretofore accounted azoic, and of an age anterior to the beginning of life, are now shown to be, in all probability, of organic origin; still more remarkable, as in process of formation to-day.

The observations of Dr. Hooker during Sir James Ross's voyage of antarctic exploration, confirmed by those of Dr. Wyville Thompson on the Challenger expedition, leave no doubt that the antarctic sea bottom, from the fiftieth parallel to the eightieth, perhaps to the pole, if the sea extends so far, is being covered with a fine deposit of silicious mud composed of the shells of diatomaceous vegetation, the skeletons of radiolarian animals (all microscopic and inhabiting the surface water) with the spicula of sponges which live on the bottom. In many parts of the arctic sea beds, a similar deposit is known to be in process of formation. Thus, through the agency of minute life, immense beds of silicious rock are forming in the polar regions, similar in character to those of early geological strata. In many cases the soft and friable fine-grained sandstones thus formed in fresh water have been changed by the action of percolating water into a dense, semi-transparent, opaline stone; and there is no reason to doubt that the same metamorphic agencies may convert the polar deposits likewise into a form of quartzite, a kind of rock whose organic origin was formerly unsuspected.

Throughout the broad belt of warmer water between the polar caps of silicious mud, the same accumulations are going on, but they are obscured and overpowered by an immensely greater amount of calcareous sediment, chiefly composed of the skeletons of dead *foraminifera*, also microscopic. This forms the *globigerina* ooze, containing a large percentage of carbonate of lime and a small percentage of silica: a chalky deposit capable of conversion into limestone and even crystalline marble by ordinary metamorphic agencies.

The formation of coral reefs has long been a favorite illustration of the gigantic results effected by minute organisms; but great as these are—and the longest coral reef extends, like a huge wall two thousand feet high, as far as from Boston to Chicago—the work of the little reef builders becomes insignificant in comparison with the *débris* of microscopic life which covers the beds of all the seas to unknown depths; while the coralline limestones of the continents, vast and massive as they are, are immensely overbalanced by the strata which undoubtedly owe their existence to minute plants and animals.

The cretaceous *globigerina* ooze is the most widely spread material of the sea bottom throughout all the great oceans, at depths from a few hundred to over two thousand fathoms. In shallower waters—and they are extensive—the gray ooze is slowly transformed into a green deposit identical in character with the greensands of the geologists: a formation which Ehrenberg found to be mainly made up of casts in a silicate of lime and alumina of the interior cavities of *foraminifera*, after Professor Baily had discovered that such was the origin of the greenish mud from the sea bottom off the Florida coast. "In these casts, the minutest cavities and finest tubes in the *foraminifera* were sometimes reproduced in solid counterparts of the glassy mineral, while the calcareous original had been entirely dissolved away." In other places, in the Gulf of Mexico, in the South Atlantic, and in the Pacific, the same transformation of *globigerina* ooze to greensand is going on.

But the most remarkable change goes on in the extreme depths of the sea, especially below 3,000 fathoms. Professor Thompson reports that, in crossing from the shallower regions occupied by the ooze into the deeper surroundings, the calcareous formation is found universally to pass gradually into an extremely fine, pure clay, which occupies, speaking generally, all depths below 2,500 fathoms, and consists almost entirely of a silicate of a red oxide of iron and alumina. "The transition is very slow, and extends over several hundred fathoms of increasing depth; the shells gradually lose their sharpness of outline, and assume a kind of 'rotten' look and a brownish color, and become more and more mixed with an amorphous red-brown powder, which increases steadily in proportion until the lime has almost entirely disappeared." The geological importance of this red clay formation is shown by the fact that, in sounding between Teneriffe and Sombrero, a distance of about 2,700 miles, two areas of red clay (aggregating 1,900 miles across) were discovered.

From his studies of the character and distribution of the red clay, Professor Thompson concludes that it is not a substance introduced from without, but that it is produced by the removal, by some means unknown, of the carbonate of lime which forms something like 98 per cent of the material of *globigerina* ooze; that it is, in fact, the ash or insoluble residue of calcareous organisms: a supposition sustained by the reddish mud, consisting of silica, alumina, and red oxide of iron, that remains after treating the ooze with a dilute acid. But one test remains to be tried to give, if successful, the highest probability to Professor Thompson's conclusion; and that is the chemical examination of *globigerina*, diatoms, and the rest, taken in the open sea for the constituents of the red clay. This done, we might rest satisfied that the clay is, as Professor Thompson believes, an essential element of the organic part of the ooze, and therefore to be classed, with chalk, as an organic product, not, as heretofore supposed, as in all cases the result of the disintegration of older rocks. The significance of this admission of clay to the list of organic products can scarcely be over-estimated, for it compels us to push back the probable antiquity of life to periods so remote that the Lower Silurian epoch becomes relatively modern. It is, as Professor Thompson observes, impossible to avoid associating the red clays of existing deep seas with the fine, smooth, homogeneous clays and schists of the remotest geological periods, formations which, more or less metamorphosed, obtain such a vast thickness in the so-called azoic strata.

Reviewing the results of the Challenger expedition in this field of research, Professor Huxley, assuming the correctness of Professor Thompson's hypothesis, shows how, by the agency of the microscopic plants and animals which are filling existing seas with silicious, cretaceous, and clayey sediments, the entire crust of the earth might have been developed. "Just as a silicious deposit may be metamorphosed into opal or quartzite," he says in conclusion, "and chalk into marble, so known metamorphic agencies may metamorphose clay into schist, clay slate, slate, gneiss, or even granite. And thus by the agency of the lowest and simplest of organisms, our imaginary globe might be covered with strata of all the chief kinds of rocks of which the known crust of the earth is composed, of indefinite thickness and extent."

The agency of organic acids in precipitating from chalybeate and other mineral waters our beds of iron ore, our veins of copper and other metals, according to Professor T. Sterry Hunt, falls in here as another indication of the vast, almost omnipotent, influence of life in determining the earth's mineral character, and consequently its geology, geography, flora, fauna, and the rest.

PROGRESS OF RAPID TRANSIT IN NEW YORK CITY.

The State Legislature has granted authority to the Elevated Railway Company, to extend its line northerly to the Harlem river, and it is said that the new work will soon be commenced. At present there is a single track supported on single iron posts over the sidewalk, commencing at the southerly end of Greenwich street, near the North river, and extending north as far as 30th street on Ninth avenue, a distance of 3½ miles. It is well patronized, but its capacity is limited. Under the new powers given to the corporation, the work is to be enlarged. The company has lately repaired the present track, put on wooden crossties, changed the gage, etc. A small space is left between each crosstie, and the bed of the road is not, therefore, quite a complete deck. The *Railroad Gazette* questions the propriety of using these crossties, believing them to be unnecessary in respect to strength, and likely to result in annoyance to pedestrians, owing to the drip caused by rain and snow.

With a view to strengthen the track, the Company has also lately added four braces or struts to each column, extending from the upper part of the column to the under sides of the track girders, with a longitudinal reach of about three feet. The *Gazette* says: "Whatever may be the object of these struts, their actual effect is the transmission of unbalanced longitudinal side thrusts to the columns, which bend, quite perceptibly, from the direction of approaching trains. These columns are ill suited to withstand side thrusts, and the frequent application of such can hardly fail to prove injurious. As every train bends all the columns over which it passes, more or less, it may be found a wise economy, in prolonging the life of the structure, to entirely remove these struts, which have just been attached at no small expense."

We are sorry that our cotemporary is not better satisfied with the improvements that have been made. Its fears as to the effects of the struts on the stability of the columns are in our view unnecessary. The Company appears to have done the best it knew how under the circumstances, and all the patrons of the road are pleased with the improvements.

A portion of the new Underground Railway, on Fourth avenue, has just been opened for traffic, namely, from the Grand Central Depot at 42nd street, northerly to 98th street, over two miles. All the trains of the Harlem, Hudson River, and New Haven Companies now run underground, and their withdrawal from the surface of Fourth avenue gives great satisfaction to the inhabitants residing on the line. The vibration produced by the passage of trains is scarcely noticeable in the adjoining houses. The avenue surface above the railway tunnels is now being repaved, and will soon present a most beautiful, attractive appearance. A stranger in passing through this portion of the avenue would be surprised if told that, directly under his feet, the trains of three great railways were flying along at lightning speed. The forty-ton locomotives are no longer seen or heard.

The underground tunnels are three in number, built side by side, consisting of a central single arch tunnel of 26 feet 8 inches width in the clear, for two tracks, and two single-track tunnels, 16 feet wide, one on each side of the central. The central tunnel is spacious, well aired, and tolerably well lighted, by frequent central openings through the roof. It is a complete success, being much more pleasing to the traveler, and far better ventilated, than any of the tunnels of the London Underground railways. The single track tunnels, however, are defective in respect to ventilation; but they could be easily rendered satisfactory by the use of mechanical means for introducing additional air.

The value of property along this portion of the line has augmented since the tunnels were authorized. The same may be said of property at the northerly or Harlem portion of the avenue, where the tracks, although not arched, are placed below the street surface, and bridged at the street crossings. But the contrary is the case along that portion occupied by the viaduct, from 98th to 116th street. The solid granite walls of this structure occupy the central portion of the avenue, for a width of 50 feet, and rise from 10 to 30 feet above the street surface. The prospect of a blank stone wall directly in front of one's window is not considered very inviting by householders, and the price of property here is comparatively low.

The State Legislature has also passed a general law, under which commissioners may be appointed in any city in the State, with power to locate a steam railway, and convey a franchise for construction, to stock subscribers.

GREAT GUNS.

It was thought by our government, not long ago, that a 15 inch cast iron gun, able to throw a 500 lbs. ball a distance of three miles, was about as big a thing in the way of armament as would ever be wanted. And so the forts in New York harbor and other places were supplied with them at great expense. The visitor at Forts Hamilton and Tompkins, down the bay, will see long rows of these grim monsters, arranged in battle line, vainly waiting for employment against floating enemies. Compared with more recent guns they are now mere pigmies, of no sort of consequence, and the quicker they are broken up and removed the better.

Mr. Menelaus, new President of the Iron and Steel Institute, England, says: "Mr. Longsden informs me that they are making at Essen, at the present time, 14 inch guns of steel, which weigh, when finished, 57½ tuns, carrying a shot of 9 cwt. 9½ English miles, using a charge of 210 lbs. of gunpowder. They are about to make steel guns of the following capacities and weights: 15¾ inch bore, 30 feet long, weighing 82 tuns, using 300 lbs. of powder, with a shell of 1,500 lbs. weight; guns of 18 inches bore, 32 feet 6 inches long, weighing 125 tuns, using 440 lbs. of powder, with a shell of 2,270 lbs. weight. Mr. Longsden demurely adds: 'It is calculated, for the present, that these guns will be heavy enough to destroy any armor a ship can carry.' In gloating over the destructive properties of these weapons, he is leaving out of his calculation, perhaps, the flash of lightning ships which Mr. Reed is about to build, and which may, under smart management, be able to get out of the way of such a conspicuous object as a shell weighing over a tun, even when fired with about a quarter of a tun of gunpowder."

THE DISTRIBUTION OF WEALTH.

We cannot hope to give, in the brief space here at our disposal, more than a passing notice to a few of the more salient thoughts in the admirable address recently delivered by Mr. David A. Wells, before the American Social Science Association, at Detroit. The subject, "The Accumulation and Distribution of Wealth," is one which relates to the much discussed relation of capital and labor, regarding which no one topic exists more encumbered with sophisms and popular fallacies. In these times, when the latter underlie a constant succession of agitations, ranging from the French commune to a local trade uprising, such views as those of Mr. Wells, boldly spoken and widely published, are doubly welcome. We commend them to those who would limit the distribution of wealth, who believe in the subversion of the relations of employee and employed, who denounce the substitution of machines for hands, and indeed all who, while ostensibly laboring for the imaginary rights of a semi-deified ideal dubbed the working man, are themselves the main obstacles to the advancement and to the amelioration of the real grievances of the laboring poor.

Mr. Wells points out that never before has man been able to produce so much with a given amount of personal effort. The productive power of this country since 1860 has increased 20 per cent, and there is no more curious incident of this continuing progress than the fact that, in staple manufactures, the abandonment of large quantities of costly machinery, and its replacement by new, is periodically rendered a matter of absolute economical necessity to produce more perfectly and cheaply, and at the same time to avoid the destruction of a much greater amount of capital by industrial rivalry. On the other hand, a highly increased consuming power on the part of the masses is evident, showing a corresponding rise in the standard of comfort. Despite this, however, the difficulties of earning a living are not lessened, the cry of the poor is as loud, and the discontent with the irregularities of social condition even more strikingly manifested. The relative position of poor and rich, in other words, remains practically unchanged, although every one knows that the benefits conferred by Science and invention have fallen on all equally. The humblest laborer of the present day possesses luxuries which kings not many years ago could not obtain; but still, if a disparity exists between him and other men, due no matter to what cause, he becomes the propounder of that interminable social problem which, stripped of all disguises, amounts to the reduction of all men to the level of the weakest in mind or body, and the prevention of any future inequality by the abolition of every species of reward for superior effort, skill, or attainment.

There is no doubt but that, as Mr. Wells in another portion of his address remarks, the doctrine of every man for himself is a pernicious one from a social point of view. Society must protect itself; it must labor for its own benefit as if it were a body physical, and each member is thus compelled to work for the welfare of his fellows in order to serve his own material interests. The conditions precedent, however, to the future progress and well being of society are not merely that shall be increasing abundance, but that it shall be distributed among the masses to the greatest extent consistent with the retention and exercise of individual freedom. To gain this last end, demands have been made extending to the cutting down of the working time to six hours per day, and the actual *per capita* division of all the wealth of the country or of the world.

Mr. Wells shows very clearly the fruitlessness of these propositions, by pointing out that. even with the bettermode of living wrought by the introduction of improved machinery, people must labor as much as they do now, in order to maintain themselves in their present condition. There is not enough capital in existence to allow of reduced laboring hours. The maximum value of the annual product of this country is $7,000,000,000; and of this nine tenths must be immediately consumed in order that we may live, and to make good the loss and waste of capital. The result has been that, after 250 years toiling as a nation, we have only managed to get three and a half years ahead in the way of subsistence If now, as a whole people, we should stop working, four years would be more than sufficient to starve three fourths of us out of existence, and reduce the remaining one fourth to barbarism. If the annual profits of the country could be divided among the inhabitants, it would give each an income of but $175 a year. The average annual earnings of common unskilled laborers is about $400; or allowing each man to support three other people, this would average $100 to each individual. The wealth of the country, according to Mr. Wells' estimate, is $25,000,000,000, which, if divided among the inhabitants, would be $6,000 each. The division, however, would be of short duration, as the money would inevitably find its way back into the hands of the most prudent. cunning, and skillful.

In conclusion, Mr. Wells said that "it is entirely within the power of society to effect a remedy, by adopting agencies whose simplicity and effectiveness long experience has proven beyond all controversy. But herein lies the difficulty. Like Naaman, we are anxious to be cleansed, but, like him, expect to be called upon to do some great thing, and are apt to be disappointed when we are told that the simplest measures will prove the most effectual. In point of natural resources, we have all we can desire. To make these productive of boundless abundance, there must be industry and economy on the part of the individual; and on that of society, a guarantee that every man shall have an opportunity to exert his industry and exchange its products with the utmost freedom and the greatest intelligence. When society has done this, we shall have solved the problem involved in the relations of capital and labor so far as the solution is within the control of coöperative human agency; for in giving to each man opportunity, conjoined with freedom and intelligence, we invest him as it were with crown and miter, and make him sovereign over himself."

THE DURABILITY OF GLASS.

It is well known that many kinds of glass, especially when submitted to the influence of moist air, do, in the course of time, undergo certain changes; the polish is tarnished, the transparency diminished, while the surface becomes covered with thin iridescent layers, small fragments of which peel off, while threads show themselves in the mass. All kinds of glass are not equally subject to these changes; but certain qualities possess the tendency to undergo such modifications in the highest degree. They show, sometimes in the course of a few days or weeks, a very slight efflorescence on their surface, which we should be very much inclined to consider to be dust. But in order not to be deceived, it is well to apply the microscope and chemical analysis; and then, in many instances, the supposed dust is proved to be composed of transformed glass. Some kinds of glass soon become covered with an exceedingly thin layer of moisture, which causes the dust to adhere, and the glass never shows a fresh, clean, or brilliant surface.

These changes may be observed in the highest degree, and studied the most easily, in glass which has been buried a long time. Such glass, when unearthed, is found to be opaque, almost through its whole mass. It has often lost its solidity, and consists of a number of thin and opalescent layers. We have had the good fortune to obtain specimens of glass recently found in an ancient temple on the Island of Cyprus. It had been buried for 3,000 or 4,000 years, and most of it exhibits an opalescence, surpassing in beauty the finest mother of pearl. For these specimens we are indebted to General Di Cesnola, who made the collection of Cyprian antiquities known by his name, now belonging to the Metropolitan Museum of Art, New York city. General Di Cesnola has returned to Cyprus in order to continue his investigations. and, if possible, secure for our country a series of interesting antiquities forming the intermediate link which succeeded Egyptian and preceded Grecian art.

Colladon states that he discovered that, if our modern glass is buried for a long time deep in the earth, it becomes flexible. and may be changed in form without being broken; but that, when again exposed to the air for some time, it becomes hard and brittle as before.

The modifications which glass undergoes in the air are especially due to water and carbonic acid. It is well known that many of the hardest minerals, such as felspar, become disintegrated and change their nature entirely under the influence of these two agents. Their destruction is sure, and is only a question of time. All the particles soluble in water are gradually washed away; while, in regard to the others, when they are not carried off by mechanical action, they remain in the place where the disintegration happened. It is the same with glass. The silicic acid, which, in glass, is combined with an alkaline base, is set free by the carbonic acid of the air, which combines with the said alkali. The alkaline carbonate thus formed is dissolved by the water and washed away; and finally there remains, in the place of the glass, nothing but the almost pure silicic acid. According to Griffith, all very ancient glass proves by analysis to possess this composition. Hausmann has analyzed glass which had been buried for a long time. It possessed an opalescent surface, was opaque, and disintegrated; while only the interior layer was still transparent. He found that the opalescent surface contained almost no alkali, that the lime, as well as the sub-oxide of iron, had been carried off, and that the transformed mass contained nearly 20 lbs. of water. We found that the Cyprian specimens also, alluded to above, contained no trace of alkali, consisting as they did of an al most pure and beautifully opalescent silicic acid.

The first things carried off by the water are the soda and potash. Then follows the lime, which is less soluble. This was especially verified by Bingley, who analyzed specimens of glass which had, for various periods of time, been submerged in a lake. The action of water on glass was first investigated by Scheele, and is very remarkable. According to the old experiments of Bischof and Fuchs, if a good, hard glass is placed in water, after having been finely pulverized, the glass soon shows a blue reaction on red litmus paper, when placed in contact with it, which reaction can only be due to carbonates of the alkalies. Pelouse made recently the same experiment; and not being aware of the older experiments, he announced it as a new discovery.

A glass containing 77 per cent silicic acid, and thus quite hard, when finely pulverized and treated with water, gives to the latter over 10 per cent of its substance. This consists, however, not entirely of alkaline ingredients, as a small portion of the silicic acid dissolves at the same time. In order to comprehend the latter statement, it must be considered that insolubility is only relative; there is scarcely a substance which is absolutely insoluble. Water drops constantly falling will at last perforate a stone, so that every drop must carry off some of the substance. Water kept in glass bottles will ultimately dissolve traces of the silicic acid of the glass, and many springs of water contain silicic acid, as the chemical analyses of several kinds of spring and well waters have demonstrated.

The influence of carbonic acid on moistened glass gives rise to many interesting experiments. Pulverized glass moistened with water absorbs carbonic acid from the air, and becomes effervescent. If the glass powder be boiled with the water, it will, after cooling, absorb carbonic acid more rapidly. The researches of Louis on pulverized felspar show that this mineral, which resists most chemical agents so successfully, is easily disintegrated by simple boiling in water. Experience shows that the various kinds of glass found in commerce behave in various ways when exposed to moist air. And why should it be otherwise? These various kinds of glass differ in their chemical composition, in the ingredients used, and in their proportions. They differ in molecular structure, in thickness, mass, and solidity, all of which details affect the properties. At the same time, whatever be the physical or chemical condition of the glass, that is, its molecular state or composition, it is certain that the destruction is more rapid in proportion as a greater surface is exposed to the attacking atmospheric agencies. This being the case, it is an interesting problem to find out which kinds of glass are, by their chemical composition, best adapted to resist these atmospheric agencies.

Government Tests for Metals.

Among the recently passed acts of Congress was a provi sion for the appointment of a Board of Experts to test the Strength and Value of Iron, Steel, and other metals. The President has appointed the following persons to constitute the Board, namely: Lieut. Col. T. T. S. Laidley, President; Commander L. A. Beardslee, Lieut. Col. Q. A. Gillmore, Chief Engineer David Smith, W. Looy Smith, A. L. Holley, R. H. Thurston. Secretary.

This Board of seven persons has organized and divided itself up into fifteen separate committees of three individuals each. W. Looy Smith is chairman of four of the committees, R. H. Thurston chairman of three, Lieut. Col. Gilmore chairman of two, A. L. Holley chairman of two, and Chief Engineer Smith chairman of one.

Most of our modern scientific discoveries are the results of investigations made under adverse circumstances, in many cases by obscure persons living in penury; in others, by teachers or college professors of limited means, oppressed by laborious professional duties. Of late the idea has begun to prevail that the true way to promote original investigation is to employ prominent men at the expense of the government, giving them good salaries, comfortable quarters, and first-rate apparatus for experiments. Relieved of all anxiety in respect to making a living by other duties, it is supposed they thus will be able to devote themselves so exclusively to Science that the boundaries of knowledge will be rapidly extended. The present Board has been created on the above idea. All the members are persons of ability, and if we do not now learn a thing or two that is new about metals, their strains and qualities, it will probably be because nothing remains to be discovered. But our expectations of the present Board are very exalted, and, as fruits of their labors, we hope to chronicle many early, interesting, and important discoveries.

SCIENTIFIC AND PRACTICAL INFORMATION.

THE PROPAGATION OF CELERY.

Celery is a native of Norway and Sweden, where it grows near the edges of swamps. This plant is rarely cultivated as it should be, hence the stunted specimens which appear in our markets. A deep trench should first be dug, at the bottom of which a layer of sticks of wood, say six inches thick, should be placed, a drain pipe being placed endwise upon one or both ends of the layer. The sticks should be then covered with about a foot of rich mold, wherein the plants should be set, in a row and about five inches apart. The plants should be kept well watered, the water being supplied through the drain pipes, so that, passing through the layer of sticks, which serves as a conduit, the water is supplied to the roots of the plant. In earthing up, care should be exercised to close the stems of the plant well together with the hand, so that no mold can get between them. The earthing process should be performed sufficiently frequently to keep the mold nearly level with the leaves of the outside stems. If these directions are carefully observed, the plant may be grown at least four feet in length, and this without impairing the flavor, which deterioration is commonly noticed in overgrown vegetables and fruits.

PHOSPHORUS CRYSTALS.

M. Blondlot announces that crystals of phosphorus may be be obtained by heating dry phosphorus in a sealed tube at 112° Fah. The phosphorus volatilizes and forms crystals on the upper portion of the tube.