

years. The falls are now seven miles back from Lake Ontario from the point where the river first overflowed into its waters, and if the retrogression has followed the same rate throughout, the wearing away of this rock over this distance must have covered a period of at least 147,840 years and even granted that the rock was in places soft and friable, the lowest computation would give at least 50,000 years as a minimum period within which the operation had been carried on. We are thus brought face to face with the operations of nature during great periods of time, and to the value of such knowledge in determining the periods during which the successive ages of the world's history have developed themselves. Now let us consider what geology reveals to us from the rock book of Nature's history. What does it reveal to us of its beginning and subsequent advancement, what was the order of creation, and how does the information thus derived by science correspond with the description given to us by one to whom the science of geology was unknown? "Beginning"—this word carries us back to a period when there was a commencement, and what was that commencement?

It is valuable to note how almost every age and civilization had its idea of what this "commencement" was. The Egyptian had his idea of the beginning: a chaos, an intermingled condition of elements constituting heaven and earth. The Phœnician had his void—the deep—to potential power imparting form and law. The Babylonians believed in a chaos, and the Nineveh Tablets are very precise in regard to the same. Hesiod the poet, says, "In the beginning was chaos," and Ovid describes our earth at its beginning as a rude and unformed bulk. Science of the present day takes up these traditions, and, in the words of Prof. Taylor Lewis, says of the world's commencement, "It was without form and void. Without form referring to utter irregularity of dimensions and outward extent; and void, as to deficiency of gravity, denoting not so much an absolute but a relative want of weight, and adds, this language would describe a fluid or rarified condition, with an absence of all solidity or cohesion, or it may be a huge nebulousity that has been floating through space for millions of years." And this theory is now the one generally accepted, that, at this introductory part of its history, our universe was nebulous matter with little or no cohesion, without shape and diffused through immense space out of which has been constructed our globe and the other planetary worlds with suns and satellites that now form part of our solar system.

But you may ask. What is a *Nebula*? In a few words, as I have just indicated, a mass of vapour, a faint misty appearance like a fog as seen even yet in our stellar system, existing in a state of darkness: and so it lay diffused throughout space, a huge vaporous mass, with no light shining upon it, but the blackness of darkness itself—and yet out of this was to be evolved the *clear blue expanse of the heavens*, the brilliant sun—the earth with its variegated landscapes and the rivers and lakes in all their beauties. Now science informs us that our world at an early date was subject to an intense heat, that the shape of our world with its flattened poles and bulged out equator is similar to what would be the shape assumed by a drop of liquid matter rapidly whirling on its axis, and that, it would appear that the world was once in a state of vapour, became condensed into a molten state and subsequently became solidified and in time assumed its present shape. Now let us take two substances, a piece of steel, say a watch spring, and water, one a solid and the other a liquid. If we take the former in its solid state and heat it, it becomes a molten or liquid mass, if we heat it still further with a heat more intense it burns away or becomes vaporized, or changed into an invisible vapor. So with water; if we freeze it, it becomes a solid; if we apply an intense heat we vaporize it, and get an invisible vapor which we call steam. Now what we may do here with the above two substances could be done with the whole Universe, and the whole material mass could be changed into vapor by imparting a sufficient degree of heat, and so the converse of the rule must hold good, that if all matter were once in a state of vapour a process of slow cooling would in the most natural order of things account for the condition of our Globe as we now find it. Now to shew that there is a great deal of truth in this theory, we have only to consider our stellar system. By aid of the wonderful little instrument, the Spectroscope, we find that the sun has in its glowing atmosphere all the bodies which we find in a solid state on our earth, in a state of vapour. Our moon, small among the worlds, has cooled rapidly and is a waterless, lifeless thing. The world we inhabit has cooled slower, and is habitable; while Jupiter and Saturn, being very much larger, cool slower still, and are very much in the condition of steel while red-hot. Thus we get the Nebular Hypothesis, now generally accepted by all Scientific men, and in which we can see in our system the whole process still going on and forward. The 'coal sacks' in the milky way showing as the original nebulous matter without form and void, and dark. The Nebulae which have become luminous, the melted burning systems, and the gradually cooling planets. And now let us picture to ourselves the changes which at this period of its history the world went through. We see our world a revolving mass of gaseous matter, gradually condensing itself around a central nucleus. This vaporous mass (containing all the elements that now exist in the world; not only the solid rocks, but also those of the seas and atmosphere) whirls round about the centre of the still vaporous system, the atoms kept apart by the influence of heat, preventing not only mechanical but chemical combination. Now, as this journey is made, we know, from our distance from the sun, (some 95,000,000 miles) that in the course of its annual revolution around the centre—our sun—a distance is covered of some 570,000,000 of miles, and this long journey is through cold space. We may get some faint idea of the intensity of this cold by reading the accounts of those who have ascended great heights on the earth's mountain ranges, or have soared aloft into the blue vault of heaven in balloons, and we know that even in the Torrid Zone, at the highest altitudes the thermometer stands at zero. Could we ascend fifty miles above the surface of the earth, we would experience a cold so intense that we can have no conception of it, and it is estimated that the temperature of space is about 250 degrees below zero, and Rev. Dr. Barr in his "Ecce cœlum" estimates it 50,000 degrees below zero. You can now imagine what effect this intense cold would have upon this heated vaporous body, the heat is rapidly radiated into space, while the atoms gravitate towards a centre and soon form a liquid nucleus. As this process continues the globe becomes a fluid mass surrounded by a vast cloudy pall in which condensing vapours gather in huge masses, and amid terrible electric explosions, these vapours falling in acid corrosive rains upon the seething molten mass, are shot up again into space in the shape of vapours. Thus darkness dense and gross would settle upon the vaporous deep only lit up as some of the more incandescent matter would burst through the slag, rapidly forming, or the electrical explosions would dart athwart the sky. By degrees the surface slag sets permanently and the covering remains in huge wrinkles—giving here an incipient mountain chain, and there a sea basin too shallow at first but rapidly deepening and now for unnumbered years the rain pours down. It was the storm epoch—and the epoch of pulverizing the surface of the rock. Things grew quiet, water remains in the hollows and pours down the mountain side, and one great ocean covers the world from pole to pole. The fire is got under, the hatches are battened down, and water is triumphant. We have

the chaos of boiling seas. Thus we have, in the changes I have thus indicated, a chaos of cosmic matter which we call nebula—a chaos of melted rock, and a chaos of corrosive rains, thick vapors, black skies and boiling seas:—

An earth, formless and void;
A vaporous abyss, dark at its very surface—
A universal ocean!

Pardon me, now, if at this stage I ask you to retrace our steps for a moment for the purpose of enquiring how, and in what manner, these changes occurred; what was the principle or force that set into active operation the molecules of nebulous matter, endowing them with the power to produce these results.

This enquiry brings us face to face with one of the great mysteries of the material Universe—namely *motion*. This principle cannot be explained—science can give no explanation—the most natural state of matter is rest, and unless some energy is imparted to it, it will remain forever in this condition, and yet to this dark, nebulous mass, resting in the immensity of space, certain potencies are imparted, certain vital forces by which the great mass is quickened. Whence came gravitation; whence came the impetus that set the original nebulous mass revolving around a centre; whence came those chemical affinities, so apparent to us, now magnetic and electrical action, laws of crystallization &c. We can only explain them by the theory of some outward interposition—some divine power came into play, brooding over this dark mass and imparting to cosmic matter those qualities to which I have just alluded, qualities which it did not formerly possess. As Dr. Carpenter observes, "so was the dead matter impregnated with vital forces, making it productive of higher forces, and so was it uplifted by these repeated impacts of Almighty power till it stands before us to-day the study of our philosophers and the wonder of our minds." Vital principles such as motion and gravitation imparted to the mass, created and developed chemical combination, and electrical action, and light, the first element of order and perfection is introduced. Light heat and electricity, —potent three. At first as the atoms acting under the new law, obeyed the same light as a faint Aurora would run through the nebulous mass, or if I may use a better illustration, light as a mild phosphorence, such as we may see emitted from decaying wood; but gradually it becomes brighter and brighter, until it assumed the light-giving proportions as we at present find it. Thus, in accordance with the Divine fiat, light appeared and the light after that never went out. Once, it was considered a standing argument against the Mosaic record that the author had falsified his record by speaking of the creation of light before the formation or setting apart of the sun, and yet science corroborates the truth of the Mosaic account that light existed, and was naturally created before the sun.

Thus up to this point we have traced the history of the world as embodied in the first record of the first creative day, and by the term day, I do not mean a solar day, "the obvious meaning of the author" as alleged by Prof. Tyndall, but the day which a critical examination of the term as used by Moses, shows to have been something very different namely, that each successive creation was a dawning out of the previous darkness and disorder. Each was a new morning rising upon an unfinished world. As we examine more and more into the domain of science, we are impressed with the fact that these dawns run on after their commencement parallel with one another, one is started and sent off in its plane of creation, then another is started and goes on side by side, the one keeping pace with the other, or as one author very succinctly puts it, the light making begins but is not completed till a firmament also begins, and while the firmament is preparing, the dry land begins to appear and vegetation to spring up. But both the upheaving of the dry land and the up springing of vegetation are in process when the sun first shines on the earth, and the creation of marine life begins almost immediately after vegetation appears, and a long time before all the new orders of vegetation are completed and so, through to the end. The successive creations are successive only as to their mornings, or their beginnings; one stands close behind the other, and they are going on side by side at the same time, so Moses leaves it. He closes no day's work by saying then came evening. He opens the morning and then starts the next day at its side.

Taking it for granted that the Nebular hypothesis is adopted, as I have endeavoured to explain the same, it naturally follows, that motion imparted to the mass, as I have already indicated, would lead in time to the breaking up of the large mass into smaller Nebulae, and these becoming detached, formed our stellar systems. The fragment that forms our solar system filled all the space now occupied and marked by the planets in their journey round the sun. Thus, a process of space making was instituted. As the great disc of nebulous matter whirled more and more rapidly in proportion as it cooled, and shrank it would throw off from its outer rim a ring of vapor.* After a time this ring would break and roll up into a huge vaporous ball, which at last became a solid globe, and so on, by the formation of another inner ring, until all the planets and stars of our system were born, and in the centre blazed the sun. Thus the original nebulous mass has imparted to it motion, and it becomes luminous. Acting under the new principles imparted to it, it separates into great masses, with spaces between. These great irregular masses of vapour take form, huge discs spin around, rings of bright vapor are thrown off, break, form worlds and blazing planets, and with their attendant satellites, pursue their journey round the sun.

TO MAIDIE B. B.

PASSED THE SENIOR MATRICULATION AT TORONTO UNIVERSITY, SEPTEMBER, 1880

Seen in the brilliant sunshine of success,
The summer days and winter nights of toil;
The ghastly hours illumed by midnight oil;
The weary study, dull suspense, the stress
Of thought that soon outwears hopefulness,
Have vanished utterly; and naught remains
But the proud record of the year's sure gains.
Take the glad greeting I can not repress!
Dear one, for thee, in all the woods about,
October flings her scarlet banners out.

Fenwick.

A. E. W.

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