

scientists and theologians now recognize to be of inestimable value. As we shall have occasion, in the sequel, to examine at length the teachings of the Angelic Doctor on this topic, it will suffice for the present simply to advert to them, and to signalize in advance their transcendent importance.

CHAPTER III.

FOSSILS AND GIANTS.

Early Notions Regarding Fossils.

IN the beginning of the sixteenth century geological phenomena began to attract more attention than they had hitherto received. Special interest was centered in fossils, which were so universally distributed over the earth's surface, and their study contributed materially towards placing the theory of Evolution on a firmer basis than it ever before possessed. Aristotle and other Greek writers had, indeed, made mention of them, but did not, as it appears, devote to them any particular study.

Theophrastus, a pupil of Aristotle, supposed them to be due to "a certain plastic virtue" of the earth, which possessed the power of fashioning inorganic matter into organic forms.

The distinguished painter, Leonardo da Vinci, one of the most gifted men that ever lived, was among the first to dispute the absurd theories which were currently accepted regarding the nature and origin of fossils. "They tell us," he says, "that these shells were formed in the hills by the influence of the stars; but I ask, where in the hills are the stars now forming shells of distinct ages and species? And how can the stars explain the origin of gravel,

occurring at different heights and composed of pebbles rounded as by the motion of running water; or in what manner can such a cause account for the petrification in the same places of various leaves, sea-weeds and marine crabs?"

Fracostoro, a contemporary of Da Vinci, followed in the footsteps of the illustrious artist, and taught that fossils were the exuviæ of animals that formerly lived where their remains are now found. He showed the futility of the opinion then prevalent which attributed fossils to the action of the Noachian Deluge, which, according to the ideas then entertained, not only strewed the earth's surface with the remains of the animals which were destroyed, but also buried them at great depths on the highest mountains.

Clear and cogent arguments like those adduced by Da Vinci and Fracostoro should have sufficed to end all controversy regarding the true nature of fossils, but unfortunately for the cause of science the dispute was destined to last nearly three centuries longer. All sorts of imaginary causes were feigned to account for the petrified organic forms everywhere abundant, and no theory was too fantastical to attract supporters, provided only it was not antagonistic to the notions of geogony and cosmogony then popularly received.

Thus, according to Agricola, fossils were the product of a certain *materia pinguis*, or fatty matter, set in fermentation by heat; porous bodies, like bones and shells, according to Mattioli, were petrified by what he designated a "lapidifying juice,"

while according to Fallopio, of Padua, petrified shells were produced by the "tumultuous movements of the terrestrial exhalations." Olivi, of Cremona, considered fossils as mere *lusus naturæ*, or "sports of nature," while others regarded them as mere stones which "had assumed their peculiar configuration by the action of some occult 'internal principle' from the influence of the heavenly bodies;" and others still maintained that they were bodies formed by nature "for no other end than to play the mimic in the mineral kingdom."

That such fanciful notions regarding the nature of fossils could ever have been seriously entertained by men of sound judgment now seems almost inexplicable. But if we reflect a moment we shall see that almost equally ridiculous views of nature are held by even eminent men of science at the present day. As for the students of nature who lived some centuries ago, it may be pleaded in extenuation of the errors into which they lapsed, that some of the theories which they deemed to be beyond question appeared to give color to their beliefs.

Among these was the theory of spontaneous generation, or the theory that certain living plants and animals are produced spontaneously from inorganic matter, or spring from organic matter in a state of decomposition. And then, too, they were confirmed in their views by observing the peculiar forms assumed by stalactites and stalagmites which grew under their very eyes; by the strange figures found in agates, notably the moss agate, and the still

stranger figures which often characterize what is known as landscape marble, in which trees, castles, mountains and other objects are frequently depicted with striking fidelity.

But in spite of the yoke of authority, especially of Aristotle, which bore heavily upon the students of science, and notwithstanding the generally received teaching, often based on the Bible, to oppose which required considerable courage, new views were slowly but surely supplanting the old. And strange as it may seem, it was not some philosopher who was the first to proclaim the truth, but the celebrated potter, Bernard Palissy. "He was the first," says Fontenelle, "who dared assert in Paris that fossil remains of testacea and fish had belonged to marine animals."

Italian Geologists on Fossils.

A century after Palissy's time, in 1669, Nicholas Steno, a Danish Catholic priest, showed the identity of the teeth and bones of sharks then living in the Mediterranean with those of fossil remains found in Tuscany. "He also compared the shells discovered in the Italian strata with living species; pointed out their resemblance and traced the various gradations from shells which had only lost their animal gluten, to those petrifications in which there was a perfect substitution of stony matter."

And yet, notwithstanding the observations of such men as Steno, Palissy, and others, the old notions, according to which fossils were the products of a certain plastic virtue latent in nature, or were

deposited *in situ* by Noah's flood, still found favor with the majority of geologists. This was especially the case with the physico-theological writers of England, who, in spite of the discoveries of the Italian geologists, still persisted in accommodating all geological phenomena to their fanciful interpretations of the Scriptural accounts of the Creation and the Deluge. Thus Woodward taught that "the whole terrestrial globe was taken to pieces and dissolved by the Flood," and that subsequently the strata "settled down from this promiscuous mass as any earthy sediment from a flood."

Such views were in marked contrast with those held by the learned Carmelite friar, Generelli, who strongly argued against the unreasonableness of calling "the Deity capriciously upon the stage, to make Him work miracles for the sake of confirming our preconceived hypotheses." He insisted on it that natural causes were competent to explain geological phenomena, and to account for the occurrence of fossil remains on hills and mountains. In referring to the formation of mountains and their denudation by the action of the elements, he forestalls the teachings of modern geologists when he declares "that the same cause which, in the beginning of time, raised mountains from the abyss, has down to the present day continued to produce others, in order to restore from time to time the losses of all such as sink down in different places, or are rent asunder, or in other ways suffer disintegration."¹

¹ See Lyell's "Principles of Geology," vol. I, p. 54.

Legends About Giants.

As illustrating the difficulties which students of science had to contend with, I may here refer to another curious but deeply-rooted notion that long prevailed regarding certain fossils. Accepting as certain the ordinary interpretation of the Hebrew word *nephilim*, נְפִילִים, in Genesis, vi, 4, as meaning giants, or persons of extraordinary stature, and taking as literal the mythical or exaggerated accounts of giants who were reputed to have lived in the early ages of the world, the discoverers of large fossil bones had no hesitation in pronouncing them the remains of some one or other great giant of legendary lore.

Greek and Roman authors, no less than German, French and English writers at a much later period, give us very detailed descriptions of the remains of giants discovered in various quarters of the earth. The bones found in one place, were, it was asserted, those of Antæus or Orestes, those in another, of the giant Og, King of Bashan, while those of still another locality were identified as the skeleton of the famous Teutobocchus, king of the Teutons and Cimbri, who was defeated by the Roman general, Marius. According to the accounts which have come down to us, the teeth of these giants each weighed several pounds and were in some instances as much as a foot long, while the estimated stature of others of the giants whose remains are described was no less than sixty cubits. Later investigators, however, had no difficulty in showing that the supposed teeth of giants were nothing other than the

molars of some extinct elephant or mammoth; that what were regarded as the vertebræ and femurs of Titans and giants belonged in reality to certain monstrous pachyderms long since extinct, and that what was exhibited as the hand of one of the huge representatives of the human family proved, on examination, to be the bones of the fore-fin of a whale. And, as science advanced, it was finally discovered that there had never been any material difference in the stature of men, that the races of antiquity were no taller than those now existing, and that there is no evidence whatever that there were ever, at any period of the world's history, men of greater stature than those occasionally seen in our own day.¹

But notwithstanding the progress of discovery, people were loath to give up their belief in giants, as they were unwilling to change their opinions respecting the plastic power of the earth and the universally exterminating effects of the Flood. Men who believed in the existence of griffons and flying dragons, and who regarded the horns of fossil rhinoceroses, so numerous in parts of Europe and Asia, as the claws of griffons and as certain proofs of the existence of these fabled creatures, could not be blamed if they gave more or less credence to the countless traditional tales respecting Titans and giants.

True Significance of Fossils.

The true significance of fossils, however, was not understood until the time of Cuvier, the illustrious

¹ See Howorth's "Mammoth and the Flood," chaps. I and II, and Wood's "Giants and Dwarfs."

founder of paleontology. Many had asserted, as we have seen, that fossil remains were the exuvia of what were once living animals, but no one before Cuvier had a true conception of their relation to the existing fauna of the globe. At the close of the last century this profound naturalist commenced an exhaustive study of the rich fossiliferous rocks of the Paris basin, and was soon able to announce to an astonished world that the fossils there discovered were not only the remains of animals long since extinct, but that they belonged to species and genera entirely different from any now existing. To the amazement of men of science he proved the existence of a tropical fauna in the latitude of Paris, and exhibited animal forms totally unlike anything now living. His discoveries carried men's minds back to times far anterior to the Deluge of Noah; back to epochs whose remoteness from our own is to be estimated by hundreds of thousands and millions of years. The theory that the fossiliferous strata of the earth were deposited by Noah's Flood was proven to be untenable and absurd, and it was therefore relegated definitively to the limbo of fanciful speculations and exploded hypotheses. Thinking men were compelled to recognize the fact that the world is much older than had been imagined; that far from having been created only a few thousand years ago, it had been in existence for many millions of years; and that many strange forms of life had inhabited the earth long before the advent of man on our planet. Further investigations carried on by Brongniart, Cuvier's collaborator, by D'Or-

bigny, Sedgwick, Murchison, Smith, Lyell and others, showed that there was a gradual development from the forms of life which characterize the earlier geological ages to those which appeared at later epochs. From the simple, primitive forms of the lower Silurian Age there was a steady progression towards the higher and more specialized types of the Quaternary.

Did this succession betoken genetic connection? Were the higher and later forms genealogically descended from the simpler antecedent types? Was there here, in a word, evidence of organic Evolution?

Controversy in the French Academy.

Such questions had been suggested before but they were now asked in all seriousness, and by those most competent to interpret the facts of paleontology. A storm was brewing in the scientific world, and when, in 1830, it burst in the French Academy, in the celebrated contest between Cuvier and Étienne Geoffroy Saint-Hilaire, it created an unprecedented sensation in the whole of Europe, notwithstanding the great political excitement of the time.

An anecdote, told of Goethe, shows in what light the great poet-philosopher viewed the dispute which was to have such an important bearing on the question of the origin of species. The news of the outbreak of the French Revolution of July had just reached Weimar, and the whole town was in a state of excitement. "In the course of the afternoon," says Soret, "I went around to Goethe's. 'Now,' exclaimed he to me, as I entered, 'what do you

think of this great event? The volcano has come to an eruption; everything is in flames, and we have no longer a transaction with closed doors!' 'Terrible affairs,' said I, 'but what could be expected under such outrageous circumstances, and with such a ministry, otherwise than that the whole would end with the expulsion of the royal family?' 'My good friend,' gravely returned Goethe, 'we seem not to understand each other. I am not speaking of those creatures there, but of something quite different. I am speaking of the contest, so important for science, between Cuvier and Geoffroy Saint-Hilaire, which has just come to an open rupture in the French Academy!'" This individual contest between two giants was the signal for a general outbreak. The first gun was fired and a war ensued, which has continued with almost unabated vigor until the present time. The scientific world was divided into two camps, those who sympathized with the views of Geoffroy regarding Evolution, and those who sided with Cuvier, the advocate of the traditional doctrine of special creations.

Much, however, remained to be accomplished before the views of Saint-Hilaire could be considered as anything more than a provisional hypothesis. The evidence of all the sciences had to be weighed, a thorough survey of the vast field of animate nature had to be made, before the new school could reasonably expect its views to meet with general acceptance. Special and systematic investigations were accordingly inaugurated, in all parts of the world, in which representatives of every department of science took an active and interested part.

CHAPTER IV.

SPONTANEOUS GENERATION AND SCIENTIFIC DISCOVERY.

Early Views Regarding Abiogenesis.

BEFORE recounting the results of these investigations, it may not, perhaps, be out of place, briefly to summarize a chapter in the history of biology which has always had a peculiar interest for students of nature, and which, even to-day, notwithstanding many long and animated controversies on the subject, has probably a greater interest for a certain school of evolutionists than almost any other one topic. I refer to the subject of spontaneous generation, or abiogenesis,¹ to which reference has already been made *en passant*.

The discussion of this question has played such an important part in the history of science, that any treatment of the theory of Evolution which should contain no reference to the subject of spontaneous generation, would ignore one of the most essential factors in a great and long-continued controversy. In good sooth, some knowledge of the more salient facts of abiogenesis are absolutely indispensable to a proper appreciation of certain of the most interesting problems connected with the theory of Evolution

¹Generatio æquivoca, heterogenesis, and autogenesis, are sometimes employed as synonyms of spontaneous generation.