but, so careless had Europe been in the study of its annals, that not until A. D. 527 had it a proper chronology of its own. A Roman abbot, Dionysius Exiguus, or Dennis the Less, then fixed the vulgar era, and gave Europe its present Christian chronology.

The method followed in obtaining the earliest chronological dates was by computations, mainly founded on the lives of the patriarchs. Much difficulty was encountered in reconciling numerical discrepancies. Even if, as was taken for granted in those uncritical ages, Moses was the author of the books imputed to him, due weight was not given to the fact that he related events, many of which took place more than two thousand years before he was born. It scarcely seemed necessary to regard the Pentateuch as of plenary inspiration, since no means had been provided to perpetuate its correctness. The different copies which had escaped the chances of time varied very much; thus the Samaritan made thirteen hundred and seven years from the Creation to the Deluge, the Hebrew sixteen hundred and fifty-six, the Septuagint twenty-two hundred and sixty-three. The Septuagint counted fifteen hundred years more from the Creation to Abraham than the Hebrew. In general, however, there was an inclination to the supposition that the Deluge took place about two thousand years after the Creation, and, after another interval of two thousand years, Christ was born. Persons who had given much attention to the subject affirmed that there were not less than one hundred and thirty-two different opinions as to the year in which the Messiah appeared, and hence they declared that it was inexpedient to press for acceptance the Scriptural numbers too closely, since it was plain, from the great differences in different copies, that there had been no providential

intervention to perpetuate a correct reading, nor was there any mark by which men could be guided to the only authentic version. Even those held in the highest esteem contained undeniable errors. Thus the Septuagint made Methuselah live until after the Deluge.

It was thought that, in the antediluvian world, the year consisted of three hundred and sixty days. Some even affirmed that this was the origin of the division of the circle into three hundred and sixty degrees. At the time of the Deluge, so many theologians declared, the motion of the sun was altered, and the year became five days and six hours longer. There was a prevalent opinion that that stupendous event occurred on November 2d, in the year of the world 1656. Dr. Whiston, however, disposed to greater precision, inclined to postpone it to November 28th. Some thought that the rainbow was not seen until after the flood; others, apparently with better reason, inferred that it was then first established as a sign. On coming forth from the ark, men received permission to use flesh as food, the antediluvians having been herbivorous! It would seem that the Deluge had not occasioned any great geographical changes, for Noah, relying on his antediluvian knowledge, proceeded to divide the earth among his three sons, giving to Japhet Europe, to Shem Asia, to Ham Africa. No provision was made for America, as he did not know of its existence. These patriarchs, undeterred by the terrible solitudes to which they were going, by the undrained swamps and untracked forests, journeyed to their allotted possessions, and commenced the settlement of the continents.

In seventy years the Asiatic family had increased to several hundred. They had found their way to the plains of Mesopotamia, and there, for some motive that

we cannot divine, began building a tower "whose top might reach to heaven." Eusebius informs us that the work continued for forty years. They did not abandon it until a miraculous confusion of their language took place and dispersed them all over the earth. St. Ambrose shows that this confusion could not have been brought about by men. Origen believes that not even the angels accomplished it.

The confusion of tongues has given rise to many curious speculations among divines as to the primitive speech of man. Some have thought that the language of Adam consisted altogether of nouns, that they were monosyllables, and that the confusion was occasioned by the introduction of polysyllables. But these learned men must surely have overlooked the numerous conversations reported in Genesis, such as those between the Almighty and Adam, the serpent and Eve, etc. In these all the various parts of speech occur. There was, however, a coincidence of opinion that the primitive language was Hebrew. On the general principles of patristicism, it was fitting that this should be the case.

The Greek Fathers computed that, at the time of the dispersion, seventy-two nations were formed, and in this conclusion St. Augustine coincides. But difficulties seem to have been recognized in these computations; thus the learned Dr. Shuckford, who has treated very elaborately on all the foregoing points in his excellent work "On the Sacred and Profane History of the World connected," demonstrates that there could not have been more than twenty-one or twenty-two men, women, and children, in each of those kingdoms.

A very vital point in this system of chronological computation, based upon the ages of the patriarchs, was the great length of life to which those worthies attained.

It was generally supposed that before the Flood "there was a perpetual equinox," and no vicissitudes in Nature. After that event the standard of life diminished one-half, and in the time of the Psalmist it had sunk to seventy years, at which it still remains. Austerities of climate were affirmed to have arisen through the shifting of the earth's axis at the Flood, and to this ill effect were added the noxious influences of that universal catastrophe, which, "converting the surface of the earth into a vast swamp, gave rise to fermentations of the blood and a weakening of the fibres."

With a view of avoiding difficulties arising from the extraordinary length of the patriarchal lives, certain divines suggested that the years spoken of by the sacred penman were not ordinary but lunar years. This, though it might bring the age of those venerable men within the recent term of life, introduced, however, another insuperable difficulty, since it made them have children when only five or six years old.

Sacred science, as interpreted by the Fathers of the Church, demonstrated these facts: 1. That the date of Creation was comparatively recent, not more than four or five thousand years before Christ; 2. That the act of Creation occupied the space of six ordinary days; 3. That the Deluge was universal, and that the animals which survived it were preserved in an ark; 4. That Adam was created perfect in morality and intelligence, that he fell, and that his descendants have shared in his sin and his fall.

Of these points and others that might be mentioned there were two on which ecclesiastical authority felt that it must insist. These were: 1. The recent date of Creation; for, the remoter that event, the more urgent the necessity of vindicating the justice of God, who ap

parently had left the majority of our race to its fate, and had reserved salvation for the few who were living in the closing ages of the world; 2. The perfect condition of Adam at his creation, since this was necessary to the theory of the fall, and the plan of salvation.

Theological authorities were therefore constrained to look with disfavor on any attempt to carry back the origin of the earth to an epoch indefinitely remote, and on the Mohammedan theory of the evolution of man from lower forms, or his gradual development to his present condition in the long lapse of time.

From the puerilities, absurdities, and contradictions of the foregoing statement, we may gather how very unsatisfactory this so-called sacred science was. And perhaps we may be brought to the conclusion to which Dr. Shuckford, above quoted, was constrained to come, after his wearisome and unavailing attempt to coördinate its various parts: "As to the Fathers of the first ages of the Church, they were good men, but not men of universal learning."

Sacred cosmogony regards the formation and modeling of the earth as the direct act of God; it rejects the intervention of secondary causes in those events.

Scientific cosmogony dates from the telescopic discovery made by Cassini—an Italian astronomer, under whose care Louis XIV. placed the Observatory of Paris—that the planet Jupiter is not a sphere, but an oblate spheroid, flattened at the poles. Mechanical philosophy demonstrated that such a figure is the necessary result of the rotation of a yielding mass, and that the more rapid the rotation the greater the flattening, or, what comes to the same thing, the greater the equatorial bulging must be.

From considerations—purely of a mechanical kind—Newton had foreseen that such likewise, though to a less striking extent, must be the figure of the earth. To the protuberant mass is due the precession of the equinoxes, which requires twenty-five thousand eight hundred and sixty-eight years for its completion, and also the nutation of the earth's axis, discovered by Bradley. We have already had occasion to remark that the earth's equatorial diameter exceeds the polar by about twenty-six miles.

Two facts are revealed by the oblateness of the earth: 1. That she has formerly been in a yielding or plastic condition; 2. That she has been modeled by a mechanical and therefore a secondary cause.

But this influence of mechanical causes is manifested not only in the exterior configuration of the globe of the earth as a spheroid of revolution, it also plainly appears on an examination of the arrangement of her substance.

If we consider the aqueous rocks, their aggregate is many miles in thickness; yet they undeniably have been of slow deposit. The material of which they consist has been obtained by the disintegration of ancient lands; it has found its way into the water-courses, and by them been distributed anew. Effects of this kind, taking place before our eyes, require a very considerable lapse of time to produce a well-marked result—a water deposit may in this manner measure in thickness a few inches in a century—what, then, shall we say as to the time consumed in the formation of deposits of many thousand yards?

The position of the coast-line of Egypt has been known for much more than two thousand years. In that time it has made, by reason of the detritus brought

down by the Nile, a distinctly-marked encroachment on the Mediterranean. But all Lower Egypt has had a similar origin. The coast-line near the mouth of the Mississippi has been well known for three hundred years, and during that time has scarcely made a perceptible advance on the Gulf of Mexico; but there was a time when the delta of that river was at St. Louis, more than seven hundred miles from its present position. In Egypt and in America—in fact, in all countries—the rivers have been inch by inch prolonging the land into the sea; the slowness of their work and the vastness of its extent satisfy us that we must concede for the operation enormous periods of time.

To the same conclusion we are brought if we consider the filling of lakes, the deposit of travertines, the denudation of hills, the cutting action of the sea on its shores, the undermining of cliffs, the weathering of rocks by atmospheric water and carbonic acid.

Sedimentary strata must have been originally deposited in planes nearly horizontal. Vast numbers of them have been forced, either by paroxysms at intervals or by gradual movement, into all manner of angular inclinations. Whatever explanations we may offer of these innumerable and immense tilts and fractures, they would seem to demand for their completion an inconceivable length of time.

The coal-bearing strata in Wales, by their gradual submergence, have attained a thickness of 12,000 feet; in Nova Scotia of 14,570 feet. So slow and so steady was this submergence, that erect trees stand one above another on successive levels; seventeen such repetitions may be counted in a thickness of 4,515 feet. The age of the trees is proved by their size, some being four feet in diameter. Round them, as they gradually went

down with the subsiding soil, calamites grew, at one level after another. In the Sydney coal-field fifty-nine fossil forests occur in superposition.

Marine shells, found on mountain-tops far in the interior of continents, were regarded by theological writers as an indisputable illustration of the Deluge. But when, as geological studies became more exact, it was proved that in the crust of the earth vast fresh-water formations are repeatedly intercalated with vast marine ones, like the leaves of a book, it became evident that no single cataclysm was sufficient to account for such results; that the same region, through gradual variations of its level and changes in its topographical surroundings, had sometimes been dry land, sometimes covered with fresh and sometimes with sea water. It became evident also that, for the completion of these changes, tens of thousands of years were required.

To this evidence of a remote origin of the earth, derived from the vast superficial extent, the enormous thickness, and the varied characters of its strata, was added an imposing body of proof depending on its fossil remains. The relative ages of formations having been ascertained, it was shown that there has been an advancing physiological progression of organic forms, both vegetable and animal, from the oldest to the most recent; that those which inhabit the surface in our times are but an insignificant fraction of the prodigious multitude that have inhabited it heretofore; that for each species now living there are thousands that have become extinct. Though special formations are so strikingly characterized by some predominating type of life as to justify such expressions as the age of mollusks, the age of reptiles, the age of mammals, the introduction of the new-comers did not take place abruptly,

as by sudden creation. They gradually emerged in an antecedent age, reached their culmination in the one which they characterize, and then gradually died out in a succeeding. There is no such thing as a sudden creation, a sudden strange appearance—but there is a slow metamorphosis, a slow development from a preëxisting form. Here again we encounter the necessity of admitting for such results long periods of time. Within the range of history no well-marked instance of such development has been witnessed, and we speak with hesitation of doubtful instances of extinction. Yet in geological times myriads of evolutions and extinctions have occurred.

Since thus, within the experience of man, no case of metamorphosis or development has been observed, some have been disposed to deny its possibility altogether, affirming that all the different species have come into existence by separate creative acts. But surely it is less unphilosophical to suppose that each species has been evolved from a predecessor by a modification of its parts, than that it has suddenly started into existence out of nothing. Nor is there much weight in the remark that no man has ever witnessed such a transformation taking place. Let it be remembered that no man has ever witnessed an act of creation, the sudden appearance of an organic form, without any progenitor.

Abrupt, arbitrary, disconnected creative acts may serve to illustrate the Divine power; but that continuous unbroken chain of organisms which extends from palæozoic formations to the formations of recent times, a chain in which each link hangs on a preceding and sustains a succeeding one, demonstrates to us not only that the production of animated beings is governed by law, but that it is by law that has undergone no change.

In its operation, through myriads of ages, there has been no variation, no suspension.

The foregoing paragraphs may serve to indicate the character of a portion of the evidence with which we must deal in considering the problem of the age of the earth. Through the unintermitting labors of geologists, so immense a mass has been accumulated, that many volumes would be required to contain the details. It is drawn from the phenomena presented by all kinds of rocks, aqueous, igneous, metamorphic. Of aqueous rocks it investigates the thickness, the inclined positions, and how they rest unconformably on one another; how those that are of fresh-water origin are intercalated with those that are marine; how vast masses of material have been removed by slow-acting causes of denudation, and extensive geographical surfaces have been remodeled; how continents have undergone movements of elevation and depression, their shores sunk under the ocean, or sea-beaches and sea-cliffs carried far into the interior. It considers the zoological and botanical facts, the fauna and flora of the successive ages, and how in an orderly manner the chain of organic forms, plants, and animals, has been extended, from its dim and doubtful beginnings to our own times. From facts presented by the deposits of coal—coal which, in all its varieties, has originated from the decay of plants—it not only demonstrates the changes that have taken place in the earth's atmosphere, but also universal changes of climate. From other facts it proves that there have been oscillations of temperature, periods in which the mean heat has risen, and periods in which the polar ices and snows have covered large portions of the existing continents—glacial periods, as they are termed.

One school of geologists, resting its argument on

very imposing evidence, teaches that the whole mass of the earth, from being in a molten, or perhaps a vaporous condition, has cooled by radiation in the lapse of millions of ages, until it has reached its present equilibrium of temperature. Astronomical observations give great weight to this interpretation, especially so far as the planetary bodies of the solar system are concerned. It is also supported by such facts as the small mean density of the earth, the increasing temperature at increasing depths, the phenomena of volcanoes and injected veins, and those of igneous and metamorphic rocks. To satisfy the physical changes which this school of geologists contemplates, myriads of centuries are required.

But, with the views that the adoption of the Copernican system has given us, it is plain that we cannot consider the origin and biography of the earth in an isolated way; we must include with her all the other members of the system or family to which she belongs. Nay, more, we cannot restrict ourselves to the solar system; we must embrace in our discussions the starry worlds. And, since we have become familiarized with their almost immeasurable distances from one another, we are prepared to accept for their origin an immeasurably remote time. There are stars so far off that their light, fast as it travels, has taken thousands of years to reach us, and hence they must have been in existence many thousands of years ago.

Geologists having unanimously agreed—for perhaps there is not a single dissenting voice—that the chronology of the earth must be greatly extended, attempts have been made to give precision to it. Some of these have been based on astronomical, some on physical principles. Thus calculations founded on the known changes of the

eccentricity of the earth's orbit, with a view of determining the lapse of time since the beginning of the last glacial period, have given two hundred and forty thousand years. Though the general postulate of the immensity of geological times may be conceded, such calculations are on too uncertain a theoretical basis to furnish incontestable results.

But, considering the whole subject from the present scientific stand-point, it is very clear that the views presented by theological writers, as derived from the Mosaic record, cannot be admitted. Attempts have been repeatedly made to reconcile the revealed with the discovered facts, but they have proved to be unsatisfactory. The Mosaic time is too short, the order of creation incorrect, the divine interventions too anthropomorphic; and, though the presentment of the subject is in harmony with the ideas that men have entertained, when first their minds were turned to the acquisition of natural knowledge, it is not in accordance with their present conceptions of the insignificance of the earth and the grandeur of the universe.

Among late geological discoveries is one of special interest; it is the detection of human remains and human works in formations which, though geologically recent, are historically very remote.

The fossil remains of men, with rude implements of rough or chipped flint, of polished stone, of bone, of bronze, are found in Europe in caves, in drifts, in peat-beds. They indicate a savage life, spent in hunting and fishing. Recent researches give reason to believe that, under low and base grades, the existence of man can be traced back into the tertiary times. He was contemporary with the southern elephant, the rhinoceros lepto-