PRIMARY SOURCE READINGS

PROGRAM OF LIBERAL STUDIES ALUMNI SEMINAR 2017
"Creationism and Science:

God Creates Universe by Geometry: 13th C. Manuscript French Bible

Notre Dame Program of Liberal Studies
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TABLE OF CONTENTS AND TEXTS TO BE CONSIDERED

.

INTRODUCTORY DISCUSSION

The large topic under discussion in this series of classes is intended to assist us in reformulating the dialogue between science and theology, and especially that between Catholic theology and modern science related to the issue of "creation." This issue has been badly misunderstood in a long history of discussion, described in the Hanby book, that has lead to the conflict of "evolution" and "creation." The need to clarify these issues is critically important. Popular discussions typically repeat familiar positions that have little connection with classical Christian understandings of these issues as developed over a long tradition. As a consequence, scientific and theological discussions of this are placed at the level of competing accounts of the same phenomena: "creation" is posed in terms of some kind of external craftsmanship of the world by a superpower, and is faced off with Darwinian evolutionary theory; "Creation" is understood as an "ordering" of nature, rather than an issue of its fundamental "existence" in *any* order whatever; "chance" is seen as a better explanation of how things are than any purposeful plan.

Our primary goal in these discussions and readings is gain some insight into the way these misunderstandings have arisen in history through the reading of some primary sources. The secondary commentary by Michael Hanby and Stephen Barr, one a theologian, the other a theoretical physicist, give us two different ways of approaching these questions. The purpose is to gain a more adequate understanding of the questions and possible lines of answer in a creative dialogue between science and theology.

There are several ways the issue of "creation" can be approached. Other readings and discussions in this summer workshop will give you some of these other perspectives. Our route will be to emphasize the scientific issues along the lines laid out by Michael Hanby's book in dialogue with the primary sources included here in this selection below. We are not committed to Hanby's analysis, I should comment, but his effort has probed deeply into historical and philosophical, as well as theological, issues, and for this reason aids us in clarifying some important issues. Our final reading from a contemporary theoretical physicist interested in the science-theology dialogue gives us some different ways of discussing these questions from a more contemporary perspective.

We will also restrict our primary focus to issues involving the life sciences. When discussions around science and creation began in earnest in the early modern period, they involved a wider range of issues. These included discussions of cosmology—the origins of the earth, solar system, and cosmos generally—; analyses of the divine or naturalistic foundations of physical laws of nature; they included discussions of the nature and the origins of matter.

They also included discussions of the origins of form and function in living beings. The early-modern debate over the Copernican system raised by the Galileo issues is most familiar from this period.

As the physical sciences have developed in the last four centuries, however, these sciences have seemed more and more accessible to descriptions in terms of natural laws and material processes. These sciences no longer require or suggest, it seems at least, explanations beyond the naturalistic realm, although we will see the complexities of this issue with regard to the physical sciences today through the Barr book. By contrast, the world of living organisms, their design, functions, and interrelations, became by the eighteenth and nineteenth centuries the refuge of "creationism," meaning a certain way of conceiving the relation of the world to the divine order, with the weight of this argument resting on a form of the **argument from design**.

Organisms seemed most dramatically to show properties and features that would seem to imply intelligent construction and purposive fashioning. This was an argument made even in Antiquity. The great Greek physician and anatomist, Claudius Galenus (Galen) (129-ca. 216 AD), developing on insights we will see in their origin in Plato's *Timaeus*, applied this to anatomy and the design of the body in his *On the Usefulness of the Parts*, and the modern version of this argument is often seen to have reached its apex in the nineteenth century in the arguments of the English Anglican clergyman William Paley (1743-1805). His works, *View of the Evidences of Christianity* (1794), and especially his *Natural Theology: or Evidences of the Existence and Attributes of the Deity Collected from the Appearances of Nature* (1802), became highly influential works in the nineteenth century that seemed to provide a decisive argument for the design of nature by an intelligent Deity. Charles Darwin, as a student at Cambridge from 1827-31, like all Cambridge students at that time, was required to pass an examination on Paley's work, and this Paleyean background formed much of the foil against which he later formulated his theory of evolution by natural selection. Paley will be the subject of Hanby's chapter 4 and Barr chapter 9, and debates over his conception of creation in some way continues to be at the center of contemporary discussions of "evolution" and "intelligent design," particularly pursued at present by individuals such as biochemist Michael Behe in his *Darwin's Black Box* (1996), which is a response in many respects to scientist Richard Dawkins *The Blind Watchmaker* (1986). The "intelligent design" heritage has been the source of a continuous debate that has transpired since the nineteenth century with scientific, theological, and even social and political ramifications.

The aim of this mini-course is to develop some new ways of reformulating these questions and developing a new understanding of the issues. Certainly for any theist and Christian believer, the concept of "creation" involves issues

that bear on many questions related to ethics, to the foundations of law, rights, and ultimate human purpose. But addressing these questions in new ways can help us move past some historic controversies between religion and the sciences. This is the basic goal of this series of discussions and readings together.

To help clarify these issues we will approach our topic through a selective historical reading in some primary texts that we will place in dialogue with the discussions of the Hanby book. At the end, we will do some selective readings in the text by theoretical physicist Stephen Barr, who moves us more into the physical sciences and the conceptualization of the question of design in nature from contemporary physical science.

To lay some foundations, we will begin Day One with a discussion of the creation accounts (plural) from three sources. Our first selection will be from the Book of *Genesis* I and the so-named "two" creation accounts of *Genesis* I.i and I.ii (**read any edition**). This will be put in dialogue with a selection from Plato's influential dialogue *Timaeus*. The *Timaeus* was the one major dialogue of Plato that survived in the Latin West before the main recovery of Plato's works in the Italian Renaissance. As such it was commonly placed in dialogue with the *Genesis* texts. The selection from the *Timaeus* is provided below in both English and Greek for those so interested, and is downloaded from the copyright-free version at http://www.ellopos.net/elpenor/physis/plato-timaeus/genesis.asp?pg=4 which gives both the 19th c. translation of Benjamin Jowett and the facing Greek text.

We will then read a selection from the influential text of St. Augustine, his *On the Literal Reading of Genesis: A Commentary in Twelve Books*, a text that was completed in 415, around the same time as the *City of God* and was continuously available in the Middle Ages, and the subject of commentary by Christian thinkers such as Thomas Aquinas. This is a commentary that covers the first three books of *Genesis* with an exhaustive discussion. This was first printed in 1506 with other printed editions in 1528, 1576, and 1680. It has also been influential on the evolutionary theories of Fr. John Zahm of Notre Dame in his important *Evolution and Dogma* of 1896, and even more recently in reflections of late Notre Dame philosopher Fr. Ernan McMullin in the "Introduction" to his *Evolution and Creation* (1985). Both of the latter have seen a way of reconciling evolutionary theory with the doctrine of creation through Augustine's theory and approach.

In this text, Augustine begins a tradition of giving the *Book of Genesis* a non-literal reading, acknowledging the difficulties of reconciling this with the known state of science and astronomy in his day. He presents as a solution an account of "virtual" and "temporal" creation which was to be highly influential on some of the early modern discussions. The first book of this is

available on the secure website ("**CW")**. For reading this text, **first read chp. 19 (pp. 186-187)** to see his basic approach to these issues.

From this point we will jump up to some early modern readings that created the immediately inherited formulation of issues dealt with by Hanby. For this discussion we will look first at the speculations of the French philosopher Réné Descartes, **[these selections are both below and also on the secure website "CW"]** who in his influential synthesis of philosophy, metaphysics, and natural philosophy of 1644, the *Principles of Philosophy*, sketched out a historical account of the formation of the planets and the earth, including its geological history. This is, we should note, posed only as a "contrary to fact" account that is posed as a "way of understanding" rather than as a necessary true account. This left for over a century an uncertainty about the philosophical status and truth claims of the "histories of the earth" that largely derived from Descartes' account. Are these anything more than convenient hypotheses that do not conflict with Scripture? This is the "hypothetical" reading that many gave these speculations, and this was one way of avoiding any kind of conflict with the received religious tradition. Or are these "true" accounts that would seem to conflict with the accepted readings of Scripture and require non-literal readings of scripture. For this reading, one influential way this was resolved was to develop the "allegorical" reading of scripture. This reading enabled natural theology, in the special form of this detailed by Hanby in chp. 4, to become a vehicle for harmonizing scripture and science in ways that set up the eventual evolution and creation problem.

Our next selection jumps up more than a century with some selections from the major synthesis of issues by the French natural philosopher Georges Louis LeClerc, Compte de Buffon (1707-1788). Buffon was in many ways the most important natural historian of the eighteenth century, only equaled in influence by his contemporary and rival, the Swedish naturalist Carolus Linnaeus (1707-1778). Buffon attained this importance as the Director (*Intendant*) of the King's Garden and Natural History gallery in Paris, a position he held from 1739-1788. From this powerful position, supported with the financial aid of Louis XV and XVI, Buffon exercised nearly autocratic authority over French natural history. His monumental *Histoire naturelle générale et paticulière avec la description du cabinet du roi* began in 1749 and continued with supplements issued by his understudies until 1803.

From Buffon's work we will move in Day Three to some readings from the middle of the nineteenth century. Our first selection is taken from an enormously popular work of the early Victorian period that effectively "softened up" the British reading public for the more restrained and limited theories of Charles Darwin. This is the work of Scottish publisher, Robert Chambers (1802-1871), the *Vestiges of the Natural History of Creation.* This work, published anonymously in 1844 and until the 1860s, no one knew the identity of the author, with it being attributed to individuals as various as

Darwin, the geologist Charles Lyell, Harriet Martineau, John Henry Newman, Prince Albert, husband of Queen Victoria, and many others. In terms of numbers of copies sold and editions printed during the nineteenth century, it was more popular than Darwin's *Origin of Species.* It also had a considerable impact on literature, serving in many respects as the framework for Alfred Lord Tennyson's famous poem, *In Memoriam*, published in 1850. This is a long poem describing the overcoming of grief and death by a cosmic march to fulfillment. Much more decisively than Darwin would later argue, this presented a grand picture of a cosmos developing by natural laws from an initial nebulous state up to humanity, displaying a grand teleological ascent over geological ages under divine providence. We will look at some excerpts of this in our class.

We will then read some selections from Darwin's original discussions in his *Origin of Species*. This will allow us to compare selections from Chamber's *Vestiges* and Darwin on the image they present for how natural causes are involved in the development of life and world and the relation of the world to divine causation.

We will then move in our final two classes to consider some more contemporary discussions, developing off the final chapters of the Hanby book, but also involving reading selectively from Stephen Barr's *Modern Physics and Ancient Faith.* Given the range of issues treated in the Barr book, we will concentrate on three issues: First (chps. 1-3) we will see how he deals with the philosophical claims of materialism; second (chps. 9-13), we will examine his analysis of the "design" argument (19).

Our goal in this examination of the question of "creation" from the standpoint of scientific reflections is to gain some greater clarification and insight into where a meaningful discussion can take place with the theological tradition. Our final class will summarize and discuss these issues generally.

Plato *Timaeus* 27c-3

The following selection is taken from the free download version from Elpenor(http://www.ellopos.net/elpenor/physis/plato-timaeus/genesis.asp?pg=4) in the English translation of Benjamin Jowett. The *Timaeus* is a complex dialogue, written around 360 BC and unlike most Platonic dialogues, it is mainly given as a monologue delivered by a stranger, *Timaeus*, supposedly from Locri in Italy, who tells his own story of creation and origin. The dialogue itself begins somewhat where the *Republic* leaves off, but then takes this form of a "likely story" told by Timaeus. Since it is presented as a "likely story," the degree to which this was held to be a true account was debated. The survival of this dialogue through the middle ages meant that this account could be read alongside the *Genesis* story of creation, with syntheses of these an effort of commentators. Our selection drops in where Timaeus begins to recount to Socrates and the other interlocutors his explanation of the origin of things. In this he also presents the real origin of an "intelligent design" account of the origin of the cosmos and all its creatures. Compare this account with that in *Genesis* I-II to see points of similarity and difference.

27C:Timaeus. All men, Socrates, who have any degree of right feeling, at the beginning of every enterprise, whether small or great, always call upon God. And we, too, who are going to discourse of the nature of the universe, how created or how existing without creation, if we be not altogether out of our wits, must invoke the aid of Gods and Goddesses and pray that our words may be acceptable to them and consistent with themselves. Let this, then, be our invocation of the Gods, to which I add an exhortation of myself to speak in such manner as will be most intelligible to you, and will most accord with my own intent.

First then, in my judgment, we must make a distinction and ask, What is that which always is and has no becoming; and what is that which is always **28A**becoming and never is? That which is apprehended by intelligence and reason is always in the same state; butthat which is conceived by opinion with the help of sensation and without reason, is always in a process of becoming and perishing and never really is. Now everything that becomes or is created must of necessity be created by some cause, for without a cause nothing can be created. The work of the creator, whenever he looks to the unchangeable and fashions the form and nature of his work after an unchangeable pattern, must necessarily **28b**be made fair and perfect; but when he looks to the created only, and uses a created pattern, it is not fair or perfect. Was the heaven then or the world, whether called by this or by any other more appropriate name-assuming the name, I am asking a question which has to be asked at the beginning of an enquiry about anything-was the world, I say, always in existence and without beginning? or created, and had it a beginning? Created, I reply, being visible and tangible and having a body, **28C**and therefore sensible; and

all sensible things are apprehended by opinion and sense and are in a process of creation and created. Now that which is created must, as we affirm, of necessity be created by a cause. But the father and maker of all this universe is past finding out; and even if we found him, to tell of him to all men would be impossible.

29a And there is still a question to be asked about him: Which of the patterns had the artificer in view when he made the world-the pattern of the unchangeable, or of that which is created? If the world be indeed fair and the artificer good, it is manifest that he must have looked to that which is eternal; but if what cannot be said without blasphemy is true, then to the created pattern. Every one will see that he must have looked to, the eternal; for the world is the fairest of creations and he is the best of causes. And having been created in this way, the world has been framed in the likeness of that which is apprehended by reason and mind and is unchangeable, and must therefore of necessity, if this is admitted, be a copy of something.

29b Now it is all-important that the beginning of everything should be according to nature. And in speaking of the copy and the original we may assume that words are akin to the matter which they describe; when they relate to the lasting and permanent and intelligible, they ought to be lasting and unalterable, and, as far as their nature allows, irrefutable and immovable- nothing less. **29c** But when they express only the copy or likeness and not the eternal things themselves, they need only be likely and analogous to the real words. As being is to becoming, so is truth to belief. If then, Socrates, amid the many opinions about the gods and the generation of the universe, we are not able to give notions which are altogether and in every respect exact and consistent with one another, do not **29d** be surprised. Enough, if we adduce probabilities as likely as any others; for we must remember that I who am the speaker, and you who are the judges, are only mortal men, and we ought to accept the tale which is probable and enquire no further.

Soc. Excellent, Timaeus; and we will do precisely as you bid us. The prelude is charming, and is already accepted by us-may we beg of you to proceed to the strain?

29e Tim. Let me tell you then why the creator made this world of generation. He was good, and the good can never have any jealousy of anything. And being free from jealousy, he desired that all things should be as like himself **30a** as they could be. This is in the truest sense the origin of creation and of the world, as we shall do well in believing on the testimony of wise men: God desired that all things should be good and nothing bad, so far as this was attainable. Wherefore also finding the whole visible sphere not at rest, but moving in an irregular and disorderly fashion, out of disorder he brought order, considering that this was in every way better than the other. Now the deeds of the best could never be or **30b** have been other than the fairest; and the creator, reflecting on the things which are by nature visible, found that no unintelligent creature taken as a whole was fairer than the intelligent taken

as a whole; and that intelligence could not be present in anything which was devoid of soul. For which reason, when he was framing the universe, he put intelligence in soul, and soul in body, that he might be the creator of a work which was by nature fairest and best. Wherefore, using the language of probability, we may say that the world became a living creature truly endowed with soul and intelligence by the providence of God.

30c This being supposed, let us proceed to the next stage: In the likeness of what animal did the Creator make the world? It would be an unworthy thing to liken it to any nature which exists as a part only; for nothing can be beautiful which is like any imperfect thing; but let us suppose the world to be the very image of that whole of which all other animals both individually and in their tribes are portions. For the original of the universe contains in itself all **30d** intelligible beings, just as this world comprehends us and all other visible creatures. For the Deity, intending to make this world like the fairest and most perfect of intelligible **31a** beings, framed one visible animal comprehending within itself all other animals of a kindred nature. Are we right in saying that there is one world, or that they are many and infinite? There must be one only, if the created copy is to accord with the original. For that which includes all other intelligible creatures cannot have a second or companion; in that case there would be need of another living being which would include both, and of which they would be parts, and the likeness would be more truly said to resemble not them, but that other which included **31b** them. In order then that the world might be solitary, like the perfect animal, the creator made not two worlds or an infinite number of them; but there is and ever will be one only-begotten and created heaven. Now that which is created is of necessity corporeal, and also visible and tangible. And nothing is visible where there is no fire, or tangible which has no solidity, and nothing is solid without earth. Wherefore also God in the beginning of creation made the body of the universe to consist of fire **31c** and earth. But two things cannot be rightly put together without a third; there must be some bond of union between them. And the fairest bond is that which makes the most complete fusion of itself and the things which it combines; and proportion is best adapted to effect such a union. For whenever in any three numbers, whether cube or square, there is a **32a**mean, which is to the last term what the first term is to it; and again, when the mean is to the first term as the last term is to the mean-then the mean becoming first and last, and the first and last both becoming means, they will all of them of necessity come to be the same, and having become the same with one another will be all one. If the universal frame had been created a surface only and having no depth, asingle mean would have sufficed to bind together itself and the other terms; but now, as the world must be solid, and solid bodies are always compacted not by one mean but by two, God placed water and air in the mean **32b**between fire and earth, and made them to have the same proportion so far as was possible (as fire is to air so is air to water, and as air is to water so is water to earth); and thus he bound and put together a visible and tangible heaven. And for these reasons, and out of such elements which are in number **32c**four, the body of the world was created, and it was harmonised by proportion,

and therefore has the spirit of friendship; and having been reconciled to itself, it was indissoluble by the hand of any other than the framer.

Now the creation took up the whole of each of the four elements; for the Creator compounded the world out of all the fire and all the water and all the air and all the earth, leaving no part of any of them nor any power of them outside. His intention was, in the first place, that the animal should be as far **32d**as possible a perfect whole and of perfect parts: secondly, that it should be one, leaving no remnants out of which another such world might be created: and also that it should be free from old age and unaffected by disease.

Considering that if heat and cold and other powerful forces which unite **33a**bodies surround and attack them from without when they are unprepared, they decompose them, and by bringing diseases and old age upon them, make them waste away-for this cause and on these grounds he made the world one whole, having every part entire, and being therefore perfect and not liable to old age and disease. And he gave to the world the figure which **33b**was suitable and also natural. Now to the animal which was to comprehend all animals, that figure was suitable which comprehends within itself all other figures. Wherefore he made the world in the form of a globe, round as from a lathe, having its extremes in every direction equidistant from the centre, the most perfect and the most like itself of all figures; for he **33c**considered that the like is infinitely fairer than the unlike. This he finished off, making the surface smooth all around for many reasons; in the first place, because the living being had no need of eyes when there was nothing remaining outside him to be seen; nor of ears when there was nothing to be heard; and there was no surrounding atmosphere to be breathed; nor would there have been any use of organs by the help of which he might receive his food or get rid of what he had already digested, since there was nothing which went from him or came into him: for **33d** there was nothing beside him. Of design he was created thus, his own waste providing his own food, and all that he did or suffered taking place in and by himself. For the Creator conceived that a being which was self- sufficient would be far more excellent than one which lacked anything; and, as he had no need to take anything or defend himself against any one, the Creator did not think it necessary to bestow upon him hands: nor had he any need of feet, nor of the whole apparatus **34a**of walking; but the movement suited to his spherical form was assigned to him, being of all the seven that which is most appropriate to mind and intelligence; and he was made to move in the same manner and on the same spot, within his own limits revolving in a circle. All the other six motions were taken away from him, and he was made not to partake of their deviations. And as this circular movement required no feet, the universe was created without legs and without feet.

DESCARTES, *PRINCIPLES OF PHILOSOPHY* (1644)
SOURCE: PROJECT GUTENBERG FREE TEXTS,
http://www.gutenberg.org/cache/epub/4391/pg4391.txt
Translated by: Steve Harris, Charles Franks
and the Online Distributed Proofreading Team.

Comments:

Although many of you know of Descartes primarily from the *Discourse on Method* and *Meditations on First Philosophy*, he considered these books in many ways preliminary to his main work the *Principles of Philosophy*, published in 1644. In this work he pulled together his metaphysics, theology, and philosophical principles in a grand synthesis that is the most important work on natural philosophy of the seventeenth century before that of Newton. Newton's magisterial work of 1687 is in many ways written against Descartes' as revealed by Newton's title itself: *MATHEMATICAL Principles of NATURAL Philosophy*. As Descartes described his larger project in the second (1647) edition of his *Principles*, these all fit together as a kind of tree with roots in metaphysics, a trunk in physics and natural philosophy, and the fruits as the practical results of ethics, medicine, and applied mechanics:

> ...[one] should begin seriously to apply himself to the true philosophy, the first part of which is metaphysics, which contains the principles of knowledge, amongst which is the explanation of the principal attributes of God, of the immateriality of our souls, and of all the clear and simple notions which are in us. The second is physics in which, after having found the true principles of material things, we examine generally how the whole universe is composed, and then in particular what is the nature of this earth and of all the bodies which are most commonly found in connection with it, like air, water and fire, the loadstone and other minerals. It is thereafter necessary to inquire individually into the nature of plants, animals, and above all of man, so that we may afterwards be able to discover the other sciences which are useful to man. Thus philosophy as a whole is like a tree whose roots are metaphysics, whose trunk is physics, and whose branches, which issue from this trunk, are all the other sciences. These reduce themselves to three principal ones, viz. medicine, mechanics and morals—I mean the highest and most perfect moral science which, presupposing a complete knowledge of the other sciences, is the last degree of wisdom. (Trans. Haldane and Ross, *The Philosophical Works of Descartes*, p. 211)

In our selection for the readings of Day Two, we will read from his account of the creation of the world by natural causes and mechanical actions. It is important to see in the opening of this book how he regards his account. This will be presented as a "contrary to fact" story that is for the ease of human understanding rather than a true account. As a result, he could claim to be in no way contradicting the Biblical account. This approach will establish a "counterfactual" tradition in speculations on the "Theory of the Earth" as these works are termed, that will finally be challenged in a new way in the text of Buffon discussed on Day 3. We will first read from the opening discussion of Part III of the *Principles* where Descartes makes his methodological point, and then jump to his later account of the earth and its formation in Part IV.

Also of interest is to note in the Part IV selection from the Miller and Miller edition is the way he simply steps over the origin of living creatures and human beings jumping from his history of the earth to a discussion of sensation and the will. The integration of living beings into this cosmological and geological story will again be particularly novel in the *Epochs* of Buffon.

PART III. OF THE VISIBLE WORLD.

I. That we cannot think too highly of the works of God. Having now ascertained certain principles of material things, which were sought, not by the prejudices of the senses, but by the light of reason, and which thus possess so great evidence that we cannot doubt of their truth, it remains for us to consider whether from these alone we can deduce the explication of all the phenomena of nature. We will commence with those phenomena that are of the greatest generality, and upon which the others depend, as, for example, with the general structure of this whole visible world. But in order to our philosophizing aright regarding this, two things are first of all to be observed. The first is, that we should ever bear in mind the infinity of the power and goodness of God, that we may not fear falling into error by imagining his works to be too great, beautiful, and perfect, but that we may, on the contrary, take care lest, by supposing limits to them of which we have no certain knowledge, we appear to think less highly than we ought of the power of God.
II. That we ought to beware lest, in our presumption, we imagine that the ends which God proposed to himself in the creation of the world are understood by us. The second is, that we should beware of presuming too highly of ourselves, as it seems we should do if we supposed certain limits to the world, without being assured of their existence either by natural reasons or by divine revelation, as if the power of our thought extended beyond what God has in reality made; but likewise still more if we persuaded ourselves that all things were created by God for us only, or if we merely supposed that we could comprehend by the power of our intellect the ends which God proposed to

himself in creating the universe. III. In what sense it may be said that all things were created for the sake of man. For although, as far as regards morals, it may be a pious thought to believe that God made all things for us, seeing we may thus be incited to greater gratitude and love toward him; and although it is even in some sense true, because there is no created thing of which we cannot make some use, if it be only that of exercising our mind in considering it, and honouring God on account of it, it is yet by no means probable that all things were created for us in this way that God had no other end in their creation; and this supposition would be plainly ridiculous and inept in physical reasoning, for we do not doubt but that many things exist, or formerly existed and have now ceased to be, which were never seen or known by man, and were never of use to him.

Note: The intermediary section of Part III is not translated here and is in the PDF version from the Harris and Harris edition. This is on the secure website ("CW"). Read these selections. Then read below from the final conclusion of the treatise *after* the Harris and Harris selections where he seems to take back the "hypothetical" reading of what has gone before, further complicating the interpretation of the Cartesian tradition.

The Concluding Statements of PART IV: OF THE EARTH

CCIV. That, touching the things which our senses do not perceive, it is sufficient to explain how they can be, [and that this is all that Aristotle has essayed]. But here some one will perhaps reply, that although I have supposed causes which could produce all natural objects, we ought not on this account to conclude that they were produced by these causes; for, just as the same artisan can make two clocks, which, though they both equally well indicate the time, and are not different in outward appearance, have nevertheless nothing resembling in the composition of their wheels; so doubtless the Supreme Maker of things has an infinity of diverse means at his disposal, by each of which he could have made all the things of this world to appear as we see them, without it being possible for the human mind to know which of all these means he chose to employ. I most freely concede this; and I believe that I have done all that was required, if the causes I have assigned are such that their effects accurately correspond to all the phenomena of nature, without determining whether it is by these or by others that they are actually produced. And it will be sufficient for the use of life to know the causes thus imagined, for medicine, mechanics, and in general all the arts to which the knowledge of physics is of service, have for their end only those effects that are sensible, and that are accordingly to be reckoned among the phenomena of nature. [Footnote: "have for their end only to apply certain sensible bodies to each other in such a way that, in the course of natural causes, certain sensible effects may be produced; and we will be able to accomplish this quite as well by

considering the series of certain causes thus imagined, although false, as if they were the true, since this series is supposed similar as far as regards sensible effects."-French.] And lest it should be supposed that Aristotle did, or professed to do, anything more than this, it ought to be remembered that he himself expressly says, at the commencement of the seventh chapter of the first book of the Meteorologies, that, with regard to things which are not manifest to the senses, he thinks to adduce sufficient reasons and demonstrations of them, if he only shows that they may be such as he explains them. [Footnote: words in Greek]

CCV. That nevertheless there is a moral certainty that all the things of this world are such as has been here shown they may be. But nevertheless, that I may not wrong the truth by supposing it less certain than it is, I will here distinguish two kinds of certitude. The first is called moral, that is, a certainty sufficient for the conduct of life, though, if we look to the absolute power of God, what is morally certain may be false. [Thus, those who never visited Rome do not doubt that it is a city of Italy, though it might be that all from whom they got their information were deceived]. Again, if any one, wishing to decipher a letter written in Latin characters that are not placed in regular order, bethinks himself of reading a B wherever an A is found, and a C wherever there is a B, and thus of substituting in place of each letter the one which follows it in the order of the alphabet, and if by this means he finds that there are certain Latin words composed of these, he will not doubt that the true meaning of the writing is contained in these words, although he may discover this only by conjecture, and although it is possible that the writer of it did not arrange the letters on this principle of alphabetical order, but on some other, and thus concealed another meaning in it: for this is so improbable [especially when the cipher contains a number of words] as to seem incredible. But they who observe how many things regarding the magnet, fire, and the fabric of the whole world, are here deduced from a very small number of principles, though they deemed that I had taken them up at random and without grounds, will yet perhaps acknowledge that it could hardly happen that so many things should cohere if these principles were false.

CCVI. That we possess even more than a moral certainty of it. Besides, there are some, even among natural, things which we judge to be absolutely certain. [Absolute certainty arises when we judge that it is impossible a thing can be otherwise than as we think it]. This certainty is founded on the metaphysical ground, that, as God is supremely good and the source of all truth, the faculty of distinguishing truth from error which he gave us, cannot be fallacious so long as we use it aright, and distinctly perceive anything by it. Of this character are the demonstrations of mathematics, the knowledge that material things exist, and the clear reasonings that are formed regarding them. The results I have given in this treatise will perhaps be admitted to a place in the class of truths that are absolutely certain, if it be considered that they are deduced in a continuous series from the first and most elementary principles of human knowledge; especially if it be sufficiently understood that we can perceive no

external objects unless some local motion be caused by them in our nerves, and that such motion cannot be caused by the fixed stars, owing to their great distance from us, unless a motion be also produced in them and in the whole heavens lying between them and us: for these points being admitted, all the others, at least the more general doctrines which I have advanced regarding the world or earth [e. g., the fluidity of the heavens, Part III., Section XLVI.], will appear to be almost the only possible explanations of the phenomena they present.

CCVII. That, however, I submit all my opinions to the authority of the church. Nevertheless, lest I should presume too far, I affirm nothing, but submit all these my opinions to the authority of the church and the judgment of the more sage; and I desire no one to believe anything I may have said, unless he is constrained to admit it by the force and evidence of reason.

BUFFON, *SOME EPOCHS OF NATURE* (1779)
SOURCE: *THE EPOCHS OF NATURE,*
Translated by Jan Zalasiewicz, Anne-Sophie Milon and Mateusz Salasiewicz
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Comments:
Our next selection jumps up more than a century after Descartes with the opening *Preliminary Discourse* from the major Enlightenment synthesis of issues by the French natural philosopher Georges Louis LeClerc, Compte de Buffon (1707-1788). Buffon was in many ways the most important natural historian of the eighteenth century, only equaled in influence by his contemporary and rival, the Swedish naturalist Carolus Linnaeus (1707-1778). Buffon attained this importance as the Director (*Intendant*) of the King's Garden and Natural History gallery in Paris, a position he held from 1739-1788. From this powerful position, supported with the financial aid of Louis XV and XVI, Buffon exercised nearly autocratic authority over French natural history. His monumental *Histoire naturelle générale et paticulière avec la description du cabinet du roi* began in 1749 and continued with supplements issued by his understudies until 1803.

Buffon consciously wished to develop a "history of nature" rather than a classification of species—the Linnean project—, and his works were characterized by their exploration of topics in historical cosmology and geology, biogeography, anthropology, comparative anatomy and speculations about the degeneration of species and the historical origins of life. His work formed, along with the rival writings of Linnaeus, one of the two most influential series of works on natural history to emerge from the eighteenth century, and the impact of his work on Lamarck, Cuvier, Etienne Geoffroy St. Hilaire, Daubenton, Herder, Goethe, Kant and even Thomas Jefferson is significant. His *Natural History* ran through several editions in most European languages, including three editions in English, and was one of the most widely read works of the eighteenth century. Darwin would read important portions of work with some care in the late 1830s, although this text, *Epochs of Nature*, was never translated into English prior to this translation and it is not evident that Darwin ever read this specific work.

No feature of Buffon's *Natural History* created such an immediate reaction, nor had a more lasting impact, than his novel geological and cosmological speculations, first put forth in the long treatises of the first volume of the *Histoire naturelle* in 1749. In many respects his work revived a "realistic" interpretation of the "History of Nature" that we have seen as an issue since Descartes. This described the origin of the solar system through a comet strike on the sun which cast off large pieces of molten matter that gradually consolidated to become the planets circling the sun.

Of immediate importance was the absence of appeals in Buffon's work to creationism or to miraculous intervention in the origins of the natural order or any attempts to reconcile this with the Book of *Genesis.* This led to the condemnation of several of his

statements by the Theology Faculty of the Sorbonne in 1751 concerning his first published reflections in 1749. and Buffon issued a public retraction in 1753 of main claims.

This was altered in the selection we are reading from his last major synthesis of issues, the *Epochs de la Nature* (1778-9). In this influential work he updated his speculations of 1749 and for the first time developed an explicit analogy with the days of creation outlined in *Genesis*. The "days of creation" are now interpreted as long "epochs" of several thousand years' duration. This is the first explicit attempt to do this in a scientific treatise. He also makes an implicit appeal to the arguments a century before of Galileo concerning the interpretation of Scripture: The *Bible* is not a work of science, and its account of creation needs to be interpreted allegorically. The general outline of the seven epochs is summarized in the accompanying table.

BUFFON'S EPOCHS OF NATURE

Epoch	***Events***	***Duration*** (**Manuscript** Chronology)	***Duration*** (**Published** Chronology
Epoch 1: When the eartl and the planets have tak their form	Comet collides with sun, causes masses of gase be thrown off. Earth and other planets form by gradual cooling and assume spherical shape . Satellites formed. Earth assu of an oblate spheroid by Newtonian principles.	0-117,440 years	0-2,936 years
Epoch 2: When the consolidation of the material of the earth has formed the interior rock the globe as well a vitreous masses at its su	Period of gradual cooling of the earth. Forn minerals and metals, formed first at surface, interior. Major mountain ranges formed. sufficient to support life.	117,440-700,0(years	2,936-35,000 years
Epoch 3: When the Waters have covered the Continents	Water vapor condenses on the earth's surface universl sea covering all by highest mountains. rocks formed. Fishes and bivalves, large in size than now found (ammonites, Belemnites, foss shell-bearing creatures appear by spontaneou Plants appear on land.	700,000- 2,000	35,000-50,000 years
Epoch 4: When the waters have retreate volcanoes have commen	Period of intense volcanic activity, caused by subterranean activity; Earth is altered by ex flows, causin retreat of the waters over long an of time; Continents take shape. Tides cut the v of continents, and build up the eastern.	2,000,000-2,99	50,000-60,000 years

Epoch 5: When the Elephants and the other animals from the equato have inhabited the lands the north	Vulcanism ceases. Earth largely in its presen animals originate as earth cools in the north (elephants, rhinoceros) and move toward t regions; land bridges and connections of continents permits migration to New World; H arise, presumably by divine creation	within the prev	60,000-65,000
Epoch 6: When the separation of the Continents Occurs	Earth takes its present form; Land-bridges elimi populated and cool enough for passage of huma animals to Southern Hemisphere; Islands (En Sicily Greenland etc.) separate from the mai varieties of human species arise	within previous	65,000-70,000
Epoch 7: When the Pow of man has supplemente that of Nature	Human society is developed; migrations from remote islands (Tahiti); technology and scienc in Northern Europe; In Northern Europe alm domination of nature achieved; Domestication animals for human needs	2,993,280 (The Present)	70,000-75,000 (The Present)
The end of Living Natur	Earth continues to cool to point that it no longer	7,000,000	168,000

(SOURCE: Translated by P.R. Sloan from *Des Epoques de la Nature* from table in the edition, ed. J. Roger [Paris: Muséum national d'histoire naturelle, 1988])

Buffon's basic arguments effectively set up the issues explored in more detail in the life and earth sciences of the early nineteenth century. This involved the claim that geology and cosmology required a long, even millions of years "history of nature," that required a time-scale considerably greater than the times assumed by the Biblical tradition. Furthermore, Buffon now integrated into this a sequential "natural history" of living beings that accompanied this history of the earth; there are major changes in animal forms in relation to the changes in the earth's history. This is not an "evolutionary" view in that it does not mean species derive sequentially from one another. We see from the table that instead different forms of life arise by the forces of matter alone. But Buffon's model provided a framework on which his successors, particularly his understudy Jean Baptiste Lamarck (1744-1829), would develop the first genuine pre-Darwinian evolutionary theory in his *Zoological Philosophy* of 1809.

THE EPOCHS OF NATURE

Georges-Louis Leclerc, le Comte de Buffon

Translated, edited and compiled by Jan Zalasiewicz, Anne-Sophie Milon and Mateusz Zalasiewicz
With an Introduction by Jan Zalasiewicz, Sverker Sorlin, Libby Robin and Jacques Grinevald
Illustrations by Anne-Sophie Milon
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First discourse

In civil History, one consults documents, studies old medals, deciphers antique inscriptions, to determine the epochs of human revolution and to establish the dates of moral events. Likewise, in Natural History, one must rummage through the Earth's archives, pull ancient monuments from the entrails of the Earth, reassemble their remains, and put together in a body of evidence all of the indications of physical change which can allow us to reach back into the different ages of Nature. This is the only way to fix some points in the immensity of space, to place some milestones along the eternal passage of time. Time is like distance: our view-would diminish in it, and also even got lost in it, if our History and Chronology [p. 2] did not provide lanterns and torches in the darkest places. But, despite the light shed by the written tradition, if one only goes back a few centuries, then what uncertainties in the facts! – what errors are made regarding the causes of events! - and what profound obscurity surrounds yet older times! Moreover, the written word only conveys to us the actions of a few Nations – that is, the actions of a tiny part of the human race. All of the other peoples have left nothing for us, nothing for posterity. They only emerged from nothingness to pass like shadows, leaving no trace - and praise the heavens that the names of all the supposed Heroes, whose crimes and bloody exploits were once celebrated, have passed into oblivion!

Thus~~,~~ civil History, limited on one side by the shadows of a time that is quite close enough to ours, only extends on the other to small parts of the world, successively inhabitated by peoples mindful of their collective memory. Natural History, by contrast, encompasses equally all of space, all of time, and has no limits other than those of the Universe.

Nature, being contemporary with matter, space and time, its history is that of all substances, of all places, of all ages. It may seem at first sight that its great works neither alter nor change, and that, in its productions – even the most fragile and fleeting [p. 3] – it shows itself as forever the same, since at every moment its first models reappear to our eyes in new representations. However, looking more closely, one can see that its course is not completely uniform: one can see that Nature admits distinct variation, shows successive changes, and is even given to forming new combinations and mutations in composition and in form. Thus, as much as it can seem constant overall, it shows variation in all of its parts. And, if we try to encompass its entire span, we cannot doubt that is very different today than it was at its beginnings, and to what it will become as time passes. These are the various

changes that we can call its epochs. Nature is found in different states: the surface of the Earth has taken successively different forms: even the heavens have varied, and all things in the physical Universe, like those of the moral world, are in a continual movement of successive changes. For example, the state in which we today see Nature is as much our work as its own: we have learnt to temper it, modify it, bend it to our needs and desires. We have penetrated deep into, cultivated and made fertile the Earth: the face it now shows is therefore quite different to that of times before the invention of arts. The golden age of morality – or rather that of fable – was only the iron age of physics and of truth. The people [p. 4] of those days were still half-savage, dispersed, few in number, and did not sense their power or know their real worth; the treasure of their lights was still hidden. He was unaware of the power of a united will and did not suspect that, through society and through sustained, concerted work, he would come to imprint his ideas on the entire face of the Universe.

Therefore, one has to go to seek, and look upon, Nature in newly discovered lands, in countries that have remained uninhabited, to gain an idea of its ancient state. And, that ancient state is still modern in comparison to that state where terrestrial continents were covered by the waters, where fish once lived above our plains, where our mountains formed the reefs of the seas. How many changes and different states must have succeeded each other since those antique times (which were not, though, the first times of all) up until the ages of History! How many things lie buried; how many events have been entirely forgotten; and how many revolutions have taken place beyond the reach of human memory! It took a very long succession of observations, over thirty centuries of the culture of the human mind, just to sketch out the present order of things. The Earth has not yet been entirely explored. It is only recently that its true shape has been determined, and it is only in our days that one has been able to form a theory of its internal structure, to demonstrate the order and arrangement of the materials of which it is composed. Hence [p.5] it is only now that one can begin to compare Nature with itself, and reach back from its known, present-day state into epochs of a more ancient state.

But it is a case here of penetrating the darkness of time: of surveying, by observation of present-day objects, the former existence of things now destroyed, and to get back, through the sole force of substantive facts, to the historical truth of buried things. It is a matter, in a word, of judging, not just the modern past, but also the much more ancient past, only from what is in the present. For us to reach this viewpoint, we need to combine all our powers, and to make use of three main pathways: (1) those facts which allow us to get near the origin of Nature; (2) the monuments that one can regard as witness to its first ages; (3) the traditions that can give us some idea of subsequent ages. After this, we must try to tie together the whole through use of analogies and to form a chain that, from the summit of the ladder of time, can descend as far as to us.

FIRST FACT

The Earth is raised at its equator and depressed at its poles, in the proportions demanded by the laws of gravity and of centrifugal force.

SECOND FACT

The terrestrial globe has its own internal heat, which is independent of that conveyed to it by the rays of the sun [p. 6].

THIRD FACT

The heat which the Sun sends to the Earth is relatively small by comparison with the heat within the terrestrial globe; and that the heat from the sun would not be sufficient by itself to sustain living Nature.

FOURTH FACT

The materials that make up the globe of the Earth are in general of the nature of glass, and can be all reduced to glass.

FIFTH FACT

One finds on all of the Earth's surface, and even on mountains up to 1500 to 2000 toises in height, an immense quantity of shells and other debris of the sea's production.

Let us look first if, in these facts that I wish to use, there is anything that one can reasonably dispute. Let us see if they can all be proved – or at least if they are capable of being so. After that we will pass on to the deductions that we can draw from them.

The first fact, of the bulging out of the Earth at the equator and its flattening at the poles, is mathematically demonstrated and physically proven by the theory of gravitation and by experiments with a pendulum. The terrestrial globe has precisely the shape that a fluid globe would take, that rotates with the speed that we know that the Earth's globe possesses [p. 7]. Therefore the first consequence arising from this incontestable fact is that the matter of which our Earth is made was in a fluid state at the moment when it took its form, and that that was also the moment when it first began to rotate. If the Earth had not been fluid, and had it the same consistency which we see in it today, it is clear that the consistent and solid matter would not have obeyed the law of centrifugal force, and therefore, despite the speed of its rotation, the Earth, rather than being a spheroid bulging out at its Equator and being flattened at the poles, would be a perfect sphere and it could not have taken any shape but that of a perfect sphere, by virtue of the mutual attraction of all of the particles of matter of which it is composed.

And, as in general all fluidity has heat as its cause, since water itself without heat would form only a solid substance, we have two different manners of appreciating the possibility of this primitive state of fluidity of the terrestrial globe, because it seems initially that Nature has two means of effecting this. The first is of dissolution or even the suspension of terrestrial materials in water, and the second is liquefaction by fire. But we know that the great majority of the solid materials that make up the terrestrial globe are not soluble in water – and at the same time we can see that the amount of water is so small in comparison [p. 8] to dry matter, that it is not possible that one could ever have been suspended in the other. Thus the fluidity, which once was possessed by the entire mass of

the Earth, could not have been caused either by dissolution or by suspension in water. That fluidity must have been a liquefaction caused by fire.

This just consequence, already reasonable in itself, gains a new degree of probability through the second fact, and it becomes a certainty from the third fact. The internal heat of the Earth, that is still present and that is much greater than that which comes to us from the Sun, shows us that this ancient fire, which the Earth experienced, has not yet dissipated entirely. The surface of the Earth is colder than the interior. Certain and repeated observations assure us that the entire mass of the Earth has its own heat that is quite independent of that from the sun. This heat is manifest to us by comparison of our winters and our summers, and one senses it, in a manner that is yet more palpable, once one penetrates below the surface. It is constant in all places for each depth, and seems to increase the farther one descends. But what are such observations in comparison to those that would be needed to trace [p. 9] the successive degrees of internal heat in the depths of the Earth? We have excavated into the mountains to depths of a few hundred toises to extract metals. On the plains, we have dug wells to a few hundred feet. These are our greatest excavations, or rather our deepest trenches. They barely scratch the surface of the outer rind of the Earth, and nevertheless the internal heat there is already more noticeable than that at the surface. One therefore presumes that if one penetrates farther, the heat would become greater, and that those regions close to the centre of the Earth are hotter than those more distant from it – just as one sees a fire-heated cannonball maintain its incandescence internally long after its surface has lost its incandescent state and red glow. The fire – or rather the internal heat – of the Earth is also indicated by the effects of electricity, which converts this invisible heat into luminous thunderbolts. It is shown to us by the temperature of the water in the sea, which at the same depths is about equal to that of the interior of the Earth. Besides, it is easy to show that the liquid state of the water in the oceans in general cannot be attributed to the power of the Sun's rays, because it can be shown by experiment that sunlight does not penetrate more than 600 feet even through the most limpid of waters, and therefore [p. 10] its heat does not reach even a quarter of this depth, that is to say, to one hundred and fifty feet. Thus, all of the waters that lie below this depth would be frozen, without the internal heat of the Earth that can maintain its liquid state. Similarly, it can be proven by experiment that the heat of the sun's rays do not penetrate more than 15 or 20 feet into the Earth, because ice can be kept at such depths even during the hottest summers. Thus it is evident that beneath the ocean basins, just as in the primary layers of the Earth, there is a continual emanation of heat that keeps water liquid and gives rise to the temperature of the Earth. Thus there is a heat in its interior that inherently belongs to it, and is quite independent of that which the Sun can provide.

We can confirm this general fact by a great number of specific facts. Everyone has noticed that, in the times of frost, snow melts in all of those places where vapours from the interior of the earth have free passage, as above wells, covered aqueducts, vaults, cisterns and so on, while, over the rest of the area where the ground is gripped by ice and intercepts these vapours, snow remains, and freezes instead of melting. That in itself suffices to show that the emanations from the Earth's interior [p. 11] possess a quantity of heat that is very real and detectable. But it is useless here to wish to gather new proofs of a fact that is clear from experiment and observation. It is sufficient that one cannot henceforth place this into

doubt, and that one recognizes the internal heat of the Earth as a real and genuine fact, from which, as from other general facts of Nature, one must deduce particular consequences.

There is from this a fourth fact: one cannot doubt, following demonstrable proofs that we have given in several sections of our *Theory of the Earth*, that the materials of which the Earth is made are not of the nature of glass. The basis of minerals, of plants and animals, is rather made of vitrescible matter, because all of their residues, all of their subsequent waste, can be reduced to glass. The materials that the chemists call *refractory* and those that they regard as infusible, because they resist the fires of their furnaces, can nevertheless be so reduced by the action of a more intense fire. In this way, all of the materials which compose the globe of the Earth – at least all that are known to us – have glass as the basis of their substance, and we can, on submitting them to the powerful action of fire, subsequently reduce them all to their primary state. [p. 12]

The primitive liquefaction of the entire mass of the Earth by fire is therefore proved with all the rigour demanded by the strictest logic. First, *a priori*, by the first fact of the Earth's own elevation at its equator, and its depression at the poles. Second, *ab actu*, by the second and third facts concerning the Earth's still-persistent internal heat. Third, a *posteriori*, by the fourth fact, which shows us the product of this action of fire, that is to say, glass, in all terrestrial substances.

But although the materials that make up the globe of the Earth were primordially of the nature of glass, and one can reduce them to this subsequently, one must nevertheless distinguish and separate them, relative to the different states in which they are found before they return to their primary state, that is to say, before they revert to glass through the action of fire. This consideration is all the more necessary here, because only that can show us how the formation of these materials differs. One thus first has to divide them into vitrescible materials and calcinable materials. The first of these do not show any effect from fire unless they are subjected to a sufficient degree of its force to convert them into glass. The others, by contrast, undergo, at much lesser levels, a process that converts them into lime. The quantity of calcareous substances, although considerable on Earth, is nevertheless very small by comparison with the quantity of the vitrescible materials.

The fifth fact we have put forward proves that their formation [p. 13] also came at a different time and from a different element. And one sees clearly that all materials that were not formed directly by the action of primitive fire, were formed via the intermediary of water – because all are made of shells and other debris which are the products of the sea. We place in the class of vitrescible materials quartz and quartz-rock, sands, sandstones and granites; also slates, shales, clays, metals and metallic minerals. These materials taken together form the true foundations of the globe, and make up the principal and by far the greater part of it.

All were originally produced by primitive fire. Sand is only powdered glass, and clays are sands that have decayed in water. Slates and shales are dried and hardened clays. Quartz-rock, sandstones and granite are only vitreous masses or vitrescible sands in concrete form; pebbles, crystals, metals and most other minerals are only distillates, exudations or sublimates of primary materials, which all reveal to us their primitive origin and common nature, by their aptitude to be reduced directly into glass.

But the calcareous sands and gravels, chalks, freestones, rubble stones, marbles, alabasters, calcite spar, both opaque and transparent – all the materials that, in a word, transform into lime, do not at first show their primary nature. Although originally glassy like all the others, these calcareous materials have passed along pathways [p. 14] which have denatured them. They have been formed in water: all are entirely composed of shells and of the detritus of those aquatic animals which alone know how to convert liquid into solid and transform seawater into stone. Common marbles and other calcareous rocks are composed of entire shells and fragments of shells, of corals, of starfish and others of which the parts are still evident or easily recognizable. Calcareous gravels are only the debris of marbles and limestones that the action of air and freezing has detached from rocky crags, and one can make lime out of such gravels, out of marble or out of rock; one can do the same with the shells themselves, and with chalk and with tufas which are yet only debris or rather decayed remains of the same substances. Alabasters and comparable marbles that contain alabaster can be recognized as large stalactites, which form at the expense of other marbles and out of common rocks; the calcite spars form similarly by exudation or distillation in [p. 15] calcareous materials, just as rock crystal forms in vitrescible materials. All this can be proved by inspection of these materials and by close examination of the monuments of Nature.

FIRST MONUMENTS

One finds shells and other marine products on the surface and in the interior of the Earth; all of the materials that one can call limestone are made out of their remains.

SECOND MONUMENTS

On examining the shells and other marine products that one can extract from the ground, in France, Germany and the rest of Europe, one sees that a large proportion of the animal species to which these remains belonged are not found in the adjacent seas, and these species either no longer survive, or are found only in more southerly seas. Similarly, one finds in slates and in other such materials, at great depths, impressions of fish and plants, none of which can be found in our climes, and these either exist no longer, or are found in southern climes.

THIRD MONUMENTS

One finds in Siberia and in other northern countries [p. 16] of Europe and Asia, skeletons, tusks and bones of elephants, hippopotami and rhinoceri, in large enough quantities to be assured that species of these animals, which today can only propagate in the lands of the south, existed and propagated previously in the northern lands. One can see that these remains of elephants and other terrestrial animals occur at shallow depths, while shells and other debris of marine production are found buried at greater depths in the interior of the Earth.

FOURTH MONUMENTS

One finds elephant tusks and bones and also the hippopotamus teeth, not only in the northern lands of our continent, but also in those of north America, while species of elephant and hippopotamus do not now exist at all in the continent of the New World.

FIFTH MONUMENTS

One finds in the interiors of continents, in regions that are the farthest removed from the sea, an infinite number of shells, of which most belong to animals currently living in southern seas, and of which a number of others have no living analogue, and so these species seem to be lost and destroyed, through causes that are at present unknown [p. 17].

In comparing these monuments with the facts, one sees first that the time of formation of vitrescible minerals is considerably more distant than that of calcareous substances. And, it seems that we can already distinguish four and even five epochs in the greatest depths of time. The first: when the matter of the globe was in a state of fusion through fire, and the Earth took its shape and was elevated at the equator and depressed at the poles by its movement of rotation. The second: when the matter of the Earth, being solidified, formed great masses of vitrescible material. The third, when the sea, covering a land presently inhabited, nourished shell-making animals of which the remains formed calcareous substances. And the fourth: when the retreat took place of the seas that had covered the continents. A fifth epoch, as clearly marked as the first four, is that of the times when the elephants, hippopotamuses and other animals of the south lived in the northern regions. This epoch is evidently later than the fourth, because the remains of these terrestrial animals are found almost at the ground surface, while those of the marine animals are, in the same regions, mostly found at great depths.

What? - one might say. Did the elephants and other animals of the south formerly inhabit the lands of the north? This singular fact, as extraordinary as it may seem, is no less certain for that. People have found [p.18] and find still, all the time, in Siberia, in Russia, and in other northern countries of Europe and Asia, ivory in great quantities. These elephant tusks may be extracted from a few feet below the ground, or are disinterred by running water as it undercuts the ground at river banks. One finds these bones and tusks of elephants in so many different places and in such abundance that one can no longer say that they are the remains of a few elephants transported by humans into cold regions. One is now forced to say by these repeated proofs that these animals naturally inhabited the countries of the north, just as they live today in southern lands. And, what seems to render this fact yet more marvelous – that is to say, more difficult to explain – is that one finds these southern animal remains on our own continent, not only in our northern regions, but also in the lands of Canada and other parts of north America. We have in the *Cabinet du Roi* several tusks and a great number of bones of elephants that were found in Siberia; we have other tusks and other elephant bones which have been found in France, and finally we have the elephant tusks and hippopotamus teeth found in America in the land bordering the River Oyo. It is thus unavoidable that these animals which can – and do – only exist today in hot countries, formerly lived in [p. 19] northern climes and so, by consequence, this cold zone must have been as hot then as is our torrid zone today. For, it is not possible that the

constitutive form, or, if one wishes, the true constitution [N.B. USE 'HABITUS' OR NOT HERE? OR FOOTNOTE ON THIS? – IT IS NOT A TERM I HAVE COME ACROSS BEFORE] of animal bodies, which is one of the most fixed things in nature, can change to the point of giving the temperament of the reindeer to the elephant, nor to suppose that the animals of the south, which need great warmth to survive, could live and multiply in the northern regions, if the climate had been as cold then as it is today. M. Gmelin, who has traversed Siberia and himself collected a number of elephant bones in these northern regions, seeks to explain this by proposing that the great inundations that affected southern regions drove the elephants to the northern countries, where they all perished at once because of the harshness of the climate. But this proposed cause is not proportional to the effect. There has perhaps already been more ivory found in the north than all of the elephants of India living today could provide. One will find much more ivory over time, when the vast deserted regions of the north, which are barely explored, will be inhabited, and when these regions will be shaped and dug over by the hand of man. Besides, it seems decidedly strange that that these animals took the route which conformed least to their nature, because if one supposes that they were pushed out of the south by the floods, there would have been two natural escape routes – to the east and to the west [p. 20]. And why flee as far as 60 degrees north while they could stop en route and go off to the side towards happier regions? And how can we conceive that, due to a flood from southern seas, they could have been chased a thousand leagues into our continent and more than 3000 leagues into the other? It is impossible that a marine inundation in the Far East would have sent elephants to Canada or even Siberia, and it is equally impossible that they would arrive in numbers as large as indicated by their remains.

Being little satisfied by such an explanation, I have thought that one could give another explanation that is more plausible and that accords perfectly with my theory of the Earth. But before presenting this, I will observe, to forestall any difficulties: 1. That the ivory that one finds in Siberia and in Canada is certainly elephant ivory, and not the ivory of a walrus or sea cow, as some travellers have suggested: one also finds fossil walrus ivory in southern countries, but it is different from that of an elephant, and it is easy to distinguish them by comparing their internal texture. The tusks, the molar teeth, the shoulder blades, the femurs and other bones found in the northern regions are certainly elephant bones. We have compared them to the various respective parts of an entire elephant skeleton, and one cannot doubt their identity as species. The large square teeth found in the same northern lands, of which the biting surface is clover-shaped, has all the characters of the molar teeth of a hippopotamus, and the other enormous teeth, of which the biting surface is made up of large rounded points, belonged to a species now obliterated on the Earth, like the large spirals termed the horns of Ammon is now obliterated in the sea [p. 21].

2: The bones and tusks of these ancient elephants were at least as large and as thick as those of today's elephants that we have made comparison with. This proves that these animals were not forced to live in these regions, but lived there in a state of nature and in complete liberty, because they attained there their largest dimensions and fullest growth. Thus one could not presume that they were transported there by humans. Just in itself, the state of captivity, quite apart from the rigours of the climate, would have reduced them to a quarter or a third of the size that is revealed by their remains.

3: That this great quantity of remains has already been found by chance in near-deserted regions, where no-one looks for them, suffices to show that this is not by one or a few accidents, nor on a single occasion, when a few individuals of that species happened to be found in the northern lands, but it is an absolute necessity that these very species [p. 22] lived, fed and multiplied there, just as they live, feed and multiply today in the countries of the south.

Put like this, it seems to me that the question comes down to knowing, or rather consists of looking if there is or was, a mechanism that could change the temperature in different parts of the globe, to the point at which the lands of the north, today very cold, could have previously been as warm as the southern lands. Some physicists are given to think that this effect can be produced by a change in the obliquity of the ecliptic: because, at first sight, this change seems to show that the inclination of the axis of the globe not being constant, the Earth could have previously turned around an axis quite distant to that around which it turns today, so that Siberia could have found itself beneath the equator. The astronomers have observed that the change in the obliquity of the ecliptic is of the order of 45 seconds every century. Thus, supposing that the increase is progressive and constant, it needs only sixty centuries to produce a difference of 45 minutes, and three thousand and six hundred centuries to give one of 45 degrees – that which would bring the 60th degree of latitude to the 15th, that is to say, the Siberian regions, where elephants once lived, to the region of India where they live today. So it is only a matter, one says, of stating that there was such a long period of time in the past, to explain the presence of elephants in Siberia: three hundred and sixty thousand years ago, the Earth turned [p. 23] on an axis aligned 45 degrees away from that around which it turns today; the 15th degree of latitude is now the 60th, and so forth.

To this, I reply that this idea and means of explanation cannot be upheld, once one comes to examine them. The change in the obliquity of the ecliptic is not a decrease or increase that is progressive and constant. To the contrary, it is a limited variation, at times in one direction and at times in the other, and so consequently could never produce in any fashion or for any climate a difference of 45 degrees in inclination: because, the variation in the obliquity of the axis of the Earth is produced by the planets which displace the ecliptic without moving the equator. Taking the most powerful of these attractions, that of Venus, it would take twelve hundred and sixty thousand years to change by 180 degrees the situation of the ecliptic on the orbit of Venus – and by consequence produce a change of six degrees and 47 minutes in the real obliquity of the axis of the Earth, since 6 degrees and 47 minutes is twice the inclination of the orbit of Venus. Similarly, the action of Jupiter could only, in nine hundred and thirty-six thousand years, change the obliquity of the ecliptic by two degrees and thirty-eight minutes, and then this effect is in part compensated by the preceding effect. And thus, it is not possible that change in the obliquity of the Earth's axis could ever reach six degrees, unless one supposes that all [p. 24] the orbits of the planets will themselves change – a supposition which we cannot, or should not, admit because there is no mechanism that could produce this effect. And as we can only determine the past by observation of the present and by our view of the future, it is not possible, however far one wishes to push back the limits of time, to suppose that the variation in the ecliptic could ever have produced a difference of more than six degrees in the climates of the Earth – and

so this mechanism is quite insufficient, and the explanation that one would wish to draw from it has to be rejected.

But I can provide this so-difficult explanation and deduce it from immediate causes. We have seen that the terrestrial globe, as it took its form, was in a fluid state, and it can be shown that water could not have caused the dissolution of terrestrial material, and so this liquid state must have been caused by fire. And, to pass from this primary state of heating and liquefaction, to a gentle and temperate warmth, time was needed. The Earth could not cool suddenly to the state that it is in today. Thus, in the times just after its formation, the Earth's own heat was infinitely greater than that which it received from the Sun, since it still greater today. Thus, this great fire being dissipated little by little, the climate of the poles underwent, as did all the other climates, successive stages of diminishing heat and of cooling. There was hence a time, and [p. 25] even a long period of time when the northern regions, having roasted as did all the other regions, enjoyed the same warmth that is present today in the southern regions. Therefore, these northern lands could be and were inhabited by those animals which now live in the south, and which have need of such warmth. Hence that fact, far from being astonishing, ties in perfectly with the other facts, and is only a simple consequence. Rather than contradicting the theory of the Earth that we have now established, this same fact rather becomes additional proof which can only confirm it where it is most unclear, that is to say, where one begins to fall into such a depth of time that the light of the imagination appears to be extinguished and where, for lack of evidence, it seems to be unable to guide us further.

A sixth epoch, subsequent to the other five, is that of the separation of the two continents. It is certain that they were not separated when the elephants also lived in the northern regions of America, of Europe and of Asia. I say this also because one finds their bones in Siberia, in Russia and in Canada. The separation of the continents thus only happened in the times after those animals lived in the northern lands. But, as one also finds elephant tusks in Poland, in Germany, in France and [p. 26] Italy, one must conclude that as those northern regions cooled, these animals retreated towards the temperate zones where the heat of the Sun and the greater thickness of the globe compensated for the loss of the Earth's internal heat. And, when those zones finally also became too cold over time, they then reached the climates of the torrid zone, which are those where internal heat is conserved the longest by the greater thickness of the spheroid of the Earth, and the only ones where this heat, combined with that of the Sun, is still strong enough today to maintain them, and support their propagation.

Similarly, there are found, in France and all other parts of Europe, shells, skeletons and vertebrae of marine animals that can only live in the most southerly seas. It was therefore the case that the climates of the seas showed the same changes in temperature as did those of the land; and, as this second fact may be explained, like the first one, by the same causes, this seems to confirm the point of this thesis.

As one compares the ancient monuments of the first age of a living Nature with today's forms, one clearly sees that the constitutive form of each animal has been similarly conserved and without [p. 27] alteration of its principal parts. The type of each species has not changed; the inner mould has conserved its form and has not varied. However long one imagines the passage of time might be, and however many generations one admits or supposes, the individuals of each kind today represent the forms of those first centuries,

especially as regards the *espèces majeures*, of which the imprint is most distinct and the nature most fixed. This is because the *espèces inférieures* have, as we have said, visibly undergone all of the effects of different types of degeneration. Only, one can remark as regards the *espèces majeures*, such as elephant and hippopotamus, that in comparing their remains with those of our days, one sees in general that these animals were larger than they are today. Nature was in its first flush of vigour; the internal heat of the Earth gave its predecessors all of the force and the extent of which they were susceptible. There were, in this first age, giants of all kinds: the dwarfs and pygmies arrived later, that is to say, after the cooling and if (as other of the monuments seem to indicate) there were species that were lost – thus, animals which had once existed and which no longer exist, they could only be those whose nature demanded a warmth greater than that of today's torrid zone. Those, enormous molar teeth, almost square and with great rounded points; those great petrified spirals [p. 28], some of which are several feet in diameter; and a number of other fish and fossil shells of which no living analogues can be found anywhere, only existed in those first times when the land and the sea were still hot, had to nourish these animals for which this degree of heat was necessary, and which no longer exist, probably since they perished because of the cooling.

There, thus, is the order of time indicated by the facts and the monuments: there, we have six epochs in the succession of the first ages of Nature; six spans of time of which the limits, although undetermined, are no less real: because these epochs are not like those of civil History, marked by fixed points, or limited by centuries and other segments of time that we can count and measure exactly; nevertheless, we can make comparisons among them, and evaluate their relative duration, and relate other monuments and facts to each of these time intervals, which will reveal their contemporary dates, and maybe also other intermediate and subsequent epochs.

But before going further, we must make haste to anticipate a grave objection, which could even degenerate into an imputation. How could you reconcile, one might say, such a great age that you give to matter, with the sacred traditions, which only provide for the world some six or eight thousand [p. 29] years? However strong might be your proofs, however well-founded might be your reasoning, however evident might be your facts – are not those reported in the Holy Book yet more certain? To contradict them, is that not to lack respect to God, who had the goodness to reveal them to us?

I am grieved each time that one abuses the great, the holy Name of God; I am hurt each time that people profane Him, and prostitute the idea of the first Being, in substituting for it the phantoms of their opinions. The more I have penetrated into the heart of Nature, the more I have admired and profoundly respected its Creator. But, a blind respect would be superstition; true religion entails by contrast an enlightened respect. Let us see then: let us try to hear reasonably the first facts that the divine Interpreter has transmitted to us on the subject of the creation; let us collect with care the rays that have escaped from that first light; far from obscuring the truth, they can only add a new degree of luminosity and of splendour.

IN THE BEGINNING GOD CREATED THE HEAVENS AND THE EARTH

That does not mean to say that at the beginning God created the heavens and the earth *as they are now*, because it is said immediately after, *that the earth was formless*; and that the sun, the moon and the stars were only placed in the heavens on the fourth day of creation. One would make the text contradict itself, if one wished to uphold that *at the beginning God created the earth and the heavens as they are now*. It was at a subsequent time that [p. 30] He made them in effect *as they are*, giving form to matter, and placing the sun, the moon and the stars in the heavens. Thus to here reasonably understand those words, it is necessary to supply a word that reconciles the whole, and read:

At the beginning God created THE MATTER of the heavens and the Earth.

And *this beginning*, the first time, the most ancient of all, during which the matter of the heavens and the Earth existed without a determinate form, seems to have had a long duration; because let us carefully listen to the words of divine Interpretation.

THE EARTH WAS A FORMLESS AND ENTIRELY NAKED AND DARKNESS COVERED THE FACE OF THE DEEP, WHILE A WIND FROM GOD SWEPT OVER THE FACE OF THE WATERS.

The Earth *was*, darkness *covered*, the spirit of God *was*. These expressions, using the past tense of the verb – do they not indicate that it was during a long interval that the Earth was formless and that darkness covered the face of the abyss? If this formless state, this dark face of the abyss, had existed only for a day, or even if this state did not last long, the sacred Writer would either have expressed this differently, or would have made no mention of this moment of darkness. He would have passed from the creation of matter in general to the production of its particular forms, and would not have made a distinct rest, a marked pause between the first and the second instant of the works of God. I therefore clearly [p. 31] see that not only one can, but even that one must, to conform to the sense of the text of the holy Scripture, regard the creation of matter in general as more ancient than the particular and successive productions of its particular forms; and this is further confirmed by the following transition.

THEN GOD SAID

This word *then* suggests things that have been made and things still to make; it is the plan of a new design, it is the indication of a command to change ancient or existing things into a new order.

LET THERE BE LIGHT, AND THERE WAS LIGHT.

Here is the first word of God; it is so sublime and so swift that it shows us well enough that light was produced in an instant, though the light did not appear first nor suddenly as a universal flash, it was for a while combined with darkness, and God himself took the time to consider this, for it is said

AND GOD SAW THAT THE LIGHT WAS GOOD, AND GOD SEPARATED THE LIGHT FROM THE DARKNESS

The act of separation of the light from the darkness is therefore distinct and physically separated by a period of time from the act of its production, and this time, during which it pleased God to consider it to see that *it was good*, that is to say [p. 32] useful for its purpose.

This time, I say, still belongs to and should be joined with that of the chaos which only began to become ordered when light was separated from darkness.

Here there are thus two spans, here there two intervals of duration that the sacred Text forces us to recognize. The first, between the creation of matter in general and the production of light. The second, between the production of light and its separation from darkness. In this way, far from lacking respect to God and in giving matter a greater age than the Earth *as it is*, it by contrast shows as much respect as is within us, in conforming our intelligence to his Word. In effect, does not the light which illuminates our souls come from God? Can the truths that it shows be contradictory to those that He has revealed to us? We must remember that this divine inspiration has been passed through human senses; that His words have been transmitted to us in an impoverished language, bereft of precise expressions for abstract ideas, meaning that the Interpreter of this divine word had been obliged to frequently employ words of which the respect is only determined by circumstances. For example, the word *to create* and the words *to form* or *to make* are used indeterminately to signify the same thing or similar things, while in our language these two words each have a very different and very determinate sense; 'to create' is to draw something out of nothingness, 'to form' or 'to make' is to draw it out of something into a new form [p. 33]; and it seems that the word 'to create' belongs by preference and perhaps uniquely to the first verse of Genesis, of which the precise translation in our language should be *at the beginning God drew out of nothingness the matter of the heavens and of the earth*; and that which proves that the word *to create* or *to draw out of nothingness* can only be applied to these first words, is that all of the matter of the heavens and of the earth being created or drawn out of nothingness from the beginning. By consequence, it is no longer possible or permissible to consider new creations of matter, since then *all matter* would no longer have been created from the beginning. Consequently the work of six days can only be understood as a formation, a production of forms drawn from matter created previously, and not as other creations of matter drawn directly out of nothingness. And, in effect, while it is a question of the light which is the first of these formations or productions drawn out of the heart of matter, it is said only *that the light was made* and not *that the light was created*. All goes together, thus, to prove that matter was created *in principio*, and it was only in subsequent times that it pleased the sovereign Being to give it form, and in the place of creating and forming everything in the same instant, as He could have done, if He had wished to deploy the full extent of his Omnipotence, He wished only, by contrast [p. 34], to act over time, to produce successively and even place periods of repose, considerable intervals, between each of his works. What can we understand by the six days which the sacred Writer shows us so precisely in counting them one after the other, if not six spans of time, six intervals of duration? And these spans of time indicated by the name of *days*, for

lack of other expressions, cannot have any correspondence with our current days, because three of these passed before the sun had been placed in the sky. It is thus not possible that these days were like ours, and the Interpreter of God seems to show this well enough by always counting from the evening until the morning, rather than as solar days that should be counted from morning to evening. These six days were therefore not solar days like ours, nor even days of light, because they start in the evening and finish in the morning. These days were not even equal, because they were not proportional to the work done. They were thus only six spans of time. The sacred Historian did not establish the duration of each, but the sense of the narration seems to make them reasonably long, so that we can extend them to the duration demanded by the *physical* truths (*verités physiques*) that we have to show. Why then protest so loudly on this use of time that we can only make as much of as we are forced to by our demonstrable knowledge of the phenomena of Nature? Why wish us to refuse this time span, since God gives it to us by His own words [p. 35] and that it would be contradictory or unintelligible, if we did not admit the existence of this first time before the formation of the Earth *such as it is*?

It is fine that one can say, that one can uphold, even rigorously, that since the latest phase, since the end of the works of God, that is to say since the creation of man, there has been no more than six or eight thousand years, because the different genealogies of the human kind since Adam do not indicate more. We own this belief, this mark of submission and of respect to the most ancient, the most sacred of all traditions; we owe it yet more, that it can never allow us to deviate from the letter of the sacred tradition except when *the letter kills*, that is to say, when it seems directly opposed to healthy reason and to the truth of the facts of Nature. Because all reason, all truth, comes equally from God, there is no difference between the truth that He has revealed and the truth that we are allowed to discover, by our observations and our researches. There is, I say, no other difference than that between a first favour made freely and a second that He has wished to separate and make us deserve through our work. And, it is for this reason that His interpreter only talked to the first men, who were still very ignorant, in a common sense. It was not raised above their understanding which, far from reaching towards the true system of the earth, did not even go beyond commonly held notions, found on what their senses told them [p. 36]. Because, in effect, it was to people that is was necessary to speak, and this speech would have been in vain and unintelligible, if it had been in a form that one could state today, since even today there are only a small number of men to whom the astronomical and physical truths are known well enough to not allow them to be doubted, and who are able to hear their language.

Let us see thus what Physics was in these first ages of the world, and what it would still be if man had never studied Nature. One sees the heavens as a blue arch in which the sun and the moon seem to be the greatest stars, of which the first always produces the light of day and the second often makes that of the night; one sees them appear or rise on our side and disappear or set on the other, after having run their course and given their light during a certain interval of time. One sees that the sea is of the same colour as that blue arch, and that it seems to touch the heavens, when one sees it from afar. All of the ideas of people on the system of the world only carry towards those three or four notions; and however false these may be, it is necessary to conform to them in order to make ourselves understood.

Because the sea seems in the distance to unite with the heavens, it was natural to imagine that there exist higher and lower waters, of which one fills the heavens and the other fills the sea, and that to hold up the waters above them there is need of a firmament, [p. 37] that is to say, a support, a solid and transparent arch, through which one can see the blue of the waters overhead; thus it is said: *That the firmament be made in the middle of the waters and that it separates the waters from the waters; and God made the firmament, and separated off the waters which were above the firmament from those which were below the firmament, and God gave to the firmament, the name of the heavens… and to those waters gathered under the firmament, the name of the sea.* It is to these same ideas that are ascribed the cataracts of the heavens, that is to say, the doors or the windows of the heavens which open, when it is necessary to allow the waters from above to drown the earth. It is also from these same ideas, that it is said that the fish and the birds have a common origin. The fish would have been produced by the lower waters, and the birds by the waters above, because they approached in their flight the blue dome, that the common people did not imagine to be much higher than the clouds. Likewise the people have always thought that the stars are attached like nails to this solid dome, that they are smaller than the moon and infinitely smaller than the sun; they did not even distinguish the planets from the fixed stars; and it is for this reason that no mention is made of the planets in all of the story of creation; it is for this reason that the moon is regarded in it as the second star, although it is in effect only the smallest of all the celestial bodies – and so on, and so on.[p. 38]

Everything in the story of Moses is placed within the limits of intelligence of the people. Everything there is represented relative to the common man, to whom it would not do to demonstrate the true system of the earth, but it was sufficient to instruct about that which he owed to the Creator, in showing him the effects of his omnipotence as so many good deeds. The truths of Nature were only to appear after time, and the sovereign Being kept them to Himself as the surest means of recalling man to him, as his faith, declining over centuries, would become unsteady; far from his origins, man could forget Him. Finally, too accustomed to the spectacle of Nature, man was no longer moved by it and came to disregard its Author. It was therefore necessary to reaffirm from time to time, and even to enlarge, the idea of God in the spirit and in the heart of man. And each discovery produced this great effect: each new step we make into Nature brings us closer to the Creator. A newly seen truth is a kind of miracle: the effect is the same, and it only differs from a true miracle in that is a sudden bolt through which God strikes immediately and rarely. Instead He serves man to discover and demonstrate the marvels with which He has filled the heart of Nature. As these marvels operate at each instant, and as they are exposed always and for everybody for their contemplation, God calls it constantly to man's mind, not only by the spectacle itself [p. 39] but also by the successive development of these works. For the rest, I only permit myself this interpretation of the first verses of Genesis with the view of bringing about a great good: this would be a reconciliation forever between the science of Nature and that of theology. They can only, according to me, be in apparent contradiction; and my explanation seems to demonstrate this. But if this explanation, however simple and very clear, seems insufficient and even out of the question to certain minds who are too strictly attached to the letter, I ask them to judge me by my intention, and to consider that my system of the Epochs of Nature, being purely hypothetical, cannot hence harm the revealed

truth, which are so many immutable axioms, independent of all hypothesis, to which I have submitted and submit my thoughts.

ROBERT CHAMBERS, *VESTIGES OF THE NATURAL HISTORY OF CREATION*
(1844)

SOURCE: *VESTIGES OF THE NATURAL HISTORY OF CREATION*, ED. HENRY MORLEY (LONDON: ROUTLEDGE AND SONS, 1887)

Comment: As described in the Introductory Discussion, this work was an immensely popular work with the Victorian reading public that in many ways introduced the grand topic of evolutionary history and its relation to divine creation to a wide reading public both in England, America and the Continent. It was read by an audience as diverse as Queen Victoria, Alfred Lord Tennyson, and Abraham Lincoln, and it set the context for how many then read the *Origin of Species* published in 1859 by Darwin. In fact it appeared just at the point that Darwin was drawing up his long 220 page draft of his theory, and its hostile reception by the scientific community may have been one of the primary reasons Darwin did not decide to publish in the 1840s, waiting another fifteen years before issuing his book. The mysterious authorship of the work served to make it broadly attractive to a reading audience, but also reinforced a very hostile and critical scientific audience who almost universally criticized the work. This may be one of the reasons for Darwin's "long delay" and also for the more restrained and limited scope of Darwin's work when compared to that of Chambers.

In our reading selection available on the department web ("DW") we will read simply the table of contents and the conclusion where he gives some of his views on the relation of nature to creation. Read this carefully in comparison to the opening material and final chapter of Darwin's *Origin of Species* also on the Department Web.

CHARLES DARWIN, *ON THE ORIGIN OF SPECIES BY MEANS OF NATURAL SELECTION*
(1859)
SOURCE: *ORIGIN OF SPECIES* , 2ND ED. LONDON: MURRAY, 1860

Comment:
In the selection from Darwin's famous work **(on Department Web**), which we place in dialogue with the earlier work of Robert Chambers, we can see both themes of continuity and also difference. Some of this can be seen by comparing the Tables of Contents of the two works and noticing the difference in scope and ambition of the two authors. However, because of the unusual circumstances under which the *Origin* was actually produced—a rapid condensation between the summer of 1858 and the early fall of 1859 of his massive "Big Species Book" summarizing his researches since the summer of 1837— Darwin's work was not really as he intended to publish it, filled with data and tables that would have differentiated it from the work of Chambers, especially for a scientific audience. Instead it fell into a reading public that often could not see a difference in kind between Darwin's book and the *Vestiges*. The *Origin* is in fact an abstract of a book that was *never actually published*, unless we regard all the rest of Darwin's works after 1859 as a continuation of this book. The text of the *Origin* as a consequence has no tables or footnotes or careful references to contemporary literature. This made it unlike a typical scientific book of its time. This, coupled with its relatively easy and uncomplicated style, made it accessible to anyone who might have also been a reader of Chamber's *Vestiges* and it could and was picked up by a wider reading public that may have had no particular scientific training. And as the title page, with its facing frontispiece giving quotations from the "natural theological" literature familiar to a wide audience, it could be, and often was, read as a complicated treatise within the "natural theology" tradition of Paley. Only subsequently was it taken as making a polemic against the tradition of Paley, thus setting up the "evolution-creation" debates we still have with us.

For our limited look at Darwin, we will read the Table of Contents, Introduction, and the final conclusion of chp. 14. Of interest to note is that Darwin inserted the phrase "by the Creator" into the sentence 5 lines from the end in this *second* and all subsequent editions.

For our purposes we want to see some of the similarities and differences between the work of Chambers and Darwin in these two works, and how both are conceiving the issue of "creation" in relation to natural laws and the history of the world. These discussions can be read against Hanby's comments on "Darwin as Theologian" (chp. 5).