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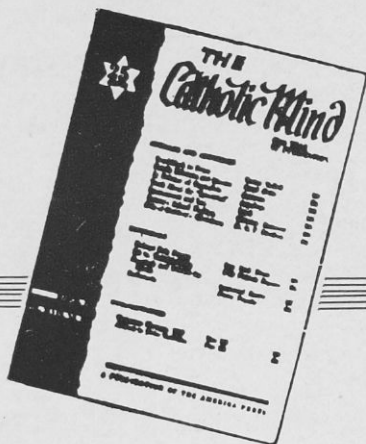
THE CHURCH and Modern Science

The Existence of God

HUMAN EVOLUTION

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1. Evolution of the Human Body

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CONTENTS

1. Evolution of the Human Body

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2. Modern Science and the Existence of God

Pope Pius XII

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Address of the Holy Father to the Pontifical Academy of Science, November 22, 1951, reprinted from THE CATHOLIC MIND, March, 1952.



1. Evolution of the Human Body: Scientific *Status Quo* and Theological Implications

THE HYPOTHESIS of evolution is far more complex and presents much greater difficulties than was suspected half a century ago. As exhibited in schematic outline, the evolutionary process used to be depicted as a tree. Now it is more often likened to an extremely bushy shrub; and the points where the branches divide and subdivide are generally hidden under heavy layers of moss.

FOSSIL MEN

The following summary will be limited to some important items of evidence that bear on the evolution of the human body.¹ The intermediary links leading morphologically from the anthropoids to *Homo sapiens* are conveniently classified according to three stages: first, the group known as Australopithecus; secondly, the "pre-humans," Pithecanthropus and Sinanthropus; thirdly,

¹ Many works were consulted in the preparation of this summary. Some of the more useful among recent studies are: R. W. Murray, *Man's Unknown Ancestors* (Milwaukee: Bruce, 1943); G. Coury, *Origine et évolution de l'homme* (Paris: Picard, 1948); G. L. Jepsen, G. G. Simpson, E. Mayr, *Genetics, Paleontology and Evolution* (Princeton: Princeton Univ. Press, 1949); G. G. Simpson, *The Meaning of Evolution* (New Haven: Yale Univ. Press, 1950); W. K. Gregory, *Evolution Emerging* (New York: Macmillan, 1951); R. Mouterde, "L'évolution chez les primates supérieurs et chez l'homme," *Mélange de science religieuse*, VII (1950), 139-53. The best work to consult for chronology is F. E. Zeuner, *Dating the Past* (London: Methuen, 1950).

Neanderthal man. In addition, account must be taken of a number of other forms that are harder to classify.

The most ancient simian fossil in which a human orientation can be discerned was discovered in South Africa in 1924, when Raymond A. Dart of Witwatersrand University found at Taungs the skull of a young animal with a well-preserved face. Later, in 1936, 1938, and 1947 the same region yielded up other fragments confirming the importance of the first discovery, which had been difficult to interpret because of the creature's tender age at death. Despite their evident relationship, these fossils received various names, *Australopithecus*, *Plesianthropus*, *Paranthropus*; but they belong to the same group of hominoids, and are morphologically closer to man than our present apes. The cranial capacity of about 600 cubic centimeters is superior to that of modern apes of the same size (450 to 500 cc.). The development of the lobes resembles that of the human cranium; the face is less projecting and the prognathism is less pronounced than is the case with modern apes; the dentition presents a curious mixture of simian traits, human traits, and more specialized traits. The supraorbital ridge is less developed than in *Pithecanthropus*; some remnants of long bones seem to indicate an upright stature. The antiquity of the fossils has not been accurately established, but they are situated near the limit of the Tertiary and Quaternary eras, more or less a million years ago.

This is the most advanced branch of great apes known to us. *Australopithecus africanus* exhibits a number of human traits, striking in detail, associated with predominantly simian traits. Although this creature is not man's ancestor, it is structurally a close relation, and is one of the first forms of the branch of anthropoids orientated toward man.

A further effort toward the direction of man is marked by two forms that are often referred to as prehominids;

these are *Pithecanthropus* and *Sinanthropus*.

The first discovery in this group was made in 1891 and the following year by a young Netherlands doctor named Eugene Dubois, who had sailed for Indonesia for the express purpose of finding the intermediary being, the "ape-man," demanded by the evolutionist theory. Soon after his arrival in Java Dr. Dubois unearthed the top part of a skull, a thighbone, and two molars in the prehistoric volcanic stratum of the dried-up bed of the Solo River near the village of Trinil. These fragments, found some yards apart during an interval of several months, enabled the scientist to assemble *Pithecanthropus erectus*. The audacious reconstruction was hotly debated in anthropological circles; the teeth have often been attributed to an ape, and the thighbone to a man. To shed light on the controversy, Dr. G. H. R. von Koenigswald, research associate of the Carnegie Institute, undertook a series of excavations from 1936 to 1941. The volcanic strata of Sangiran, contemporaneous with those of Trinil and some thirty-seven miles distant, gave up half of a lower jaw, then three rather complete skulls, and finally a whole lower jaw. The various pieces belong either to *Pithecanthropus erectus* or to a related, more primitive species, *Pithecanthropus robustus*. Because of its extraordinary size, the lower jaw discovered in 1941 has received the name *Meganthropus*; it seemingly belongs to a type more ancient and primitive than *Pithecanthropus*. These fragments tend to confirm the bold reconstruction made by Dubois, although the brain capacity is less than that of *Pithecanthropus*, which is 900 cc. A mixture of human and simian traits is discernible in the teeth; the upper jaw, with its disposition of teeth, their strength, and the diastema, is very simian, while the dentition of the lower jaw is more human and approaches that of *Sinanthropus*. The fragmentary skull of an infant of several years of age, discovered in Modjokerto in 1936,

has an estimated cranial capacity of 650 cc., which is more than two-thirds the size of that of a modern baby one year old. This fossil is generally associated with the group of Pithecanthropus.

Even if all these fragments do not belong to the same species, a series of primates much closer to man than any living anthropoid lived in Java at the beginning of the Quaternary era. This is clear from the development and convolutions of the brain as well as from the dentition. Whether the Java hominids were endowed with true intelligence is still uncertain.

During the period of hesitation about the nature of Pithecanthropus, a more important discovery was made in China to the west of Peking, in the famous bed of Chou Kou Tien. Excavations were conducted in 1927 and the following years under the direction of Dr. Davidson Black, with the collaboration of Père Teilhard de Chardin. The prehistoric fossils that were found go under the name of *Sinanthropus pekinensis*. Remains of twenty-five adult skeletons and of fifteen infants were unearthed; the teeth are very numerous. Five of the skulls are well preserved. From the discovery of the first cranium in 1929, scientists were struck by its relationship with what was then known of Pithecanthropus. If these two forms do not belong to the same species, they at least belong to the same genus, that of Peking being less remote from modern man than that of Java. The brain capacity is greater in *Sinanthropus*, with a mean of 1,043 cc., and one cranium reaches 1,225 cc. The skulls are low-vaulted, with heavy continuous brow ridges. The cheek bones are prominent. The face projects in a sort of muzzle and the chin recedes. The teeth are strong but the series is unbroken, without diastema; they reveal a mixture of human and simian characteristics in the same jaw, and the first lower molar is quite human. Only a few pieces of long bones were turned up, and they are not so close

to their modern counterparts as the famous thighbone of *Pithecanthropus*; yet agreement that *Sinanthropus* walked erect is unanimous. The many animal fossils found in the neighborhood of the bones of *Sinanthropus* are attributed to the Middle Pleistocene, suggesting an age of more than 400,000 years, although Teilhard de Chardin is content to say "several hundred thousand years."

A last witness of the "prehominids" was discovered in 1935, at Tanganyika, Africa. This creature, called *Africanthropus*, is represented by several incomplete skulls that have a brain capacity of some 1,100 cc. The cranial vault is low, the brow ridges are prominent, and the strong teeth lack a diastema. These traits suggest a close similarity with *Sinanthropus*.

Many authors relate to these fossils the Mauer jaw, discovered in 1907, eighty feet from the surface in an ancient stratum of a sand pit at Mauer, near Heidelberg. The jaw is massive and, like many Neanderthal specimens, lacks a chin; yet the teeth and dental arch are human and do not differ greatly from some primitive types of living races. Whether Heidelberg man goes with the *Pithecanthropus-Sinanthropus* group is extremely doubtful; he is better classified as pre-Neanderthal. The geological age is put at about 450,000 years ago.

In any case, during the ancient Quaternary era, there lived in Asia and Africa, and perhaps in Europe also, a morphological type with traits still partly simian, but clearly on the road to humanity and probably arriving.

The last of the intermediary stages is occupied by the Neanderthal man, who flourished during the Middle Paleolithic period, some 75,000 to 125,000 years ago, but lived on until long after that. About a hundred skeletons of this type are known, and many of them are complete. Neanderthal man was a short, stocky individual with a large head having a mean brain capacity of 1,400 cc., the maximum exceeding 1,600 cc. The forehead recedes

somewhat, the skull is low but higher than that of *Sinanthropus*, the brow ridges are thick, the face projects slightly, and the lower jaw is heavy with undeveloped chin. The teeth are very strong, yet clearly human. Neanderthal man used well-made flint tools and had definite religious convictions; he carefully interred his dead with attention to precise rites, such as East-West position of the corpse, protection for the head, and provisions for the next life.

This type is widely spread throughout Europe, North Africa, Asia, China, and Java, where the *Homo soloensis* seems to be a Neanderthal man not far removed from *Pithecanthropus*. The most interesting cases are those in which an attenuation or even effacement of certain typical traits occurs. The fossils discovered in Palestine since 1925, especially those of Nazareth and Mount Carmel, exhibit a mixture of Neanderthal and *Homo sapiens* characteristics. Many of them combine heavy brow ridges with a high skull and a well-marked chin. The tendency today is to consider such specimens as an intermediary group representing Neanderthal men on the road toward the heights of *Homo sapiens*, or else to regard them as genetic crosses between these two forms. The latter hypothesis receives confirmation from the fact that certain fossils of the Cro-Magnon group of *Homo sapiens*, for example those found in Moravia, have certain Neanderthal traits, such as brow ridges. This indicates that the Neanderthal type had relations with *Homo sapiens* and is not isolated.

Beginning with the Upper Paleolithic period, some eighteen or nineteen thousand years ago, *Homo sapiens* is well known; he is represented by tall men having high foreheads, no brow ridges, and well-marked chins. But men of the modern type are far older than that; their history may even go back to the Lower Paleolithic, that is, to a period when the Neanderthal man did not yet exist

or at least had not taken on his characteristic features.

In 1912, strata probably pertaining to early glaciation times yielded up important fragments of a skull and half a jaw that permit a tentative reconstruction of the Pilt-down man. The cranium of this famous "dawn man" is remarkably like that of modern man, and has a brain capacity of 1,350 cc., although doubt still persists whether the ape-like jaw belongs to the skull. Swanscombe man, pertaining to the Middle Pleistocene, in his preserved remains resembles modern man. In the opinion of F. E. Zeuner, this fossil man alone is sufficient to settle the issue that *Homo sapiens* existed some 250,000 years ago; accordingly he would be more ancient than the entire datable Neanderthal group, with the possible exception of the Heidelberg jaw.

L. S. B. Leakey holds that both the Kanam jaw and the fragments of the Kanjera skull found in East Africa are of Lower Pleistocene age; others regard their antiquity as uncertain. Fresh evidence will very likely come from this important area. If Leakey is correct, the Kanam man goes back to 500,000 or more years ago. In any case, a being with the cranium of *Homo sapiens* lived in ancient Paleolithic times. Further confirmation is afforded by Mlle. Germaine Henri-Martin's discovery, in 1947 and 1948, of two skulls of modern type in a grotto of Char-ente at Fontéchevade in France. The fossils are dated at about 180,000 years ago, although the age of the stratum has not been established on strictly geological grounds. Of great interest was the announcement in *The New York Times*, April 28, 1951, of three "Hotu man" skeletons, found by Prof. Carleton S. Coon in northern Iran. The skulls, including the chins, are of the same form as those of modern man, although the cranial capacity is smaller, about 1,150 cc. Preliminary study of the geological evidence indicates that Hotu man lived about 75,000 years ago.

One of the most striking facts to be noted in the fossils known to us is the increase of the brain capacity, which is 450 to 600 cc. for anthropoid apes, 600 cc. for Australopithecus, 800 to 900 cc. for Pithecanthropus, 1,043 with a maximum of 1,250 cc. for Sinanthropus, 1,450 cc. for Neanderthal man, and 1,550 as the mean for the modern European or American male. The complications of the brain convolutions also increase. This rather regular progression seems to indicate a steady march toward a greater brain.

If the shapes of skulls and faces, especially of jaws and teeth, are studied, the problem becomes more complicated. Strange combinations turn up. A bestial jaw can carry a very human dentition, as in the Mauer jaw and Sinanthropus; of two related forms, Pithecanthropus and Sinanthropus, the former has a diastema, the latter lacks it; in Pithecanthropus a lower jaw with quite human teeth seems to be associated with an upper jaw that is very simian; in the Piltdown man a modern-type skull may be associated with a simian jaw. In the present state of our knowledge, the indications are that the human branch did not pass through the stages of Australopithecus, Pithecanthropus, Sinanthropus, and Neanderthal man before arriving at the *Homo sapiens* level. For, as our summary of fossil evidence has brought out, some stages are more specialized in certain details than the stages that follow, or a so-called "progressive" stage appears before the advent of a more "primitive" one. In particular, some items of evidence suggest that men of the modern type may be the most ancient of all.

THE WITNESS OF SACRED SCRIPTURE

The Book of Genesis proposes two accounts of man's origin. These fundamental texts do not require a slavishly literal exegesis; they can bear an evolutionist interpretation. Yet neither of them favors evolution; on the con-

trary, they stress a special intervention of God in the production of the human body. According to the first account, "God created man to His own image; to the image of God He created him; male and female He created them" (Gen. i. 27). Three times the author uses the verb *bara*, which is employed exclusively of God's activity; and the divine causality extends to the production of the body, since a distinction between the sexes is brought about by it. Nothing in the text suggests the idea of the origin of the human body from pre-existing, living beings. Indeed, if this were the only text we had, we should be inclined to suppose that God directly created the first pair, body and soul.

The other narrative is anthropomorphic in expression: "And the Lord God formed man of the slime of the earth, and breathed into his face the breath of life; and man became a living soul" (Gen. ii. 7). God is represented as fashioning the first man from the clay of the earth in the way a potter makes a vase. God then ascertained that it was not good for man to be alone, and decided to give to His creature a companion similar to him. To this end He created all the animals and led them in parade before the man. The latter did not find in the animal world the desired associate, so God again set to work and derived the woman from the man himself, to be his mate and partner. The popular character of this narrative is obvious; yet it clearly does not describe the origin of the first human couple as a climax in the evolution of living species.

MIND OF THE MAGISTERIUM

Nevertheless evolution of man's body from some sub-human species is not excluded; this is plain from the carefully chosen words of the reigning Holy Father in his 1941 allocution to the Pontifical Academy of Sciences:

Only from a man could there proceed another man who would call him father and progenitor; and the help-

mate given by God to the first man also comes from him and is flesh of his flesh, formed to be his companion, who receives her name from the man, because she was derived from him. Man, endowed with a spiritual soul, was placed by God at the summit of the ladder of living beings, to be the head and lord of the animal kingdom. The many researches conducted in the field of paleontology or of biology and morphology have not yet furnished any positively clear and certain evidence bearing on other problems respecting man's origins. Therefore we can only leave to the future the answer to the question whether science, illuminated and guided by revelation, may some day be able to present secure and definite results with regard to so important a subject.²

In this passage the Holy Father asserts, first, that man is not the son of a brute animal; secondly, that the first woman was made from the body of the first man; thirdly, that man is endowed with a rational, spiritual soul. With regard to other problems, including the manner in which the first man's body was formed, acknowledgment is made that the natural sciences may some day come forward with certain evidence, although as yet such is not the case. A point to be noted in the Pope's address is the statement that a brute animal cannot be regarded as the father of the first man. The human father and mother are true parents of their children, for, although they do not produce the soul, they induce by their generative causality a disposition in their offspring's body that calls for the creation and infusion of the soul by God. Since such an effect transcends the causality exercised by sub-human animals in their mating, a special intervention on the part of God would be required, in the evolutionist hypothesis, to make the organism produced by them fit for the reception of the human soul.

Another document of great interest in this discussion is the letter written January 16, 1948, by J. M. Vosté, O.P., secretary of the Pontifical Commission for Biblical

² *Acta Apostolicae Sedis*, XXXIII (1941), 506.

Studies, to Cardinal Suhard, then Archbishop of Paris. The author observes that the official responses of the Biblical Commission, including the very important ones of June 30, 1909, on the historical character of the first three chapters of Genesis, "by no means block the way to a further, truly scientific investigation of these problems, in accord with the findings of the past forty years." However, the contention that the first eleven chapters of Genesis do not contain history in the modern sense of the word might give the false impression that they do not convey history in any sense at all, "whereas they recount, in simple and figurative language, adapted to the minds of less cultured men, the basic truths that are presupposed by the economy of salvation, along with a popular description of the origins of the human race and of the chosen people."³

The encyclical *Humani generis* refers to the question of the origin of the human body from organic matter, and expressly teaches that the direct creation of the human soul by God pertains to Catholic faith. The Supreme Pontiff repeats what he had said in 1941, that the derivation of man's body from organic matter has not yet been proved. Discussion of the problem may continue, but with certain restrictions that ought not to be overlooked; this freedom is meant for professionals in theology and the sciences, and is not left indiscriminately to preachers, lecturers, and popular writers. Further, the investigation should be conducted seriously and the results presented without exaggeration; and all who take part in such debates must be ready to submit to the judgment of the Church, if that should be forthcoming in the future. No one should speak as though the animal origin of the human body were a demonstrated fact, and no one should proceed as though the sources of revelation contained

³ *Acta Apostolicae Sedis*, XL (1948), 46 f.

nothing that cautions to prudence and moderation.⁴ Consequently the derivation of the human body from a living organism cannot be designated as a freely disputed theological question, if by that is meant a view which no longer interests the teaching authority of the Church.⁵

CAUSALITY AND HUMAN EVOLUTION

A cause is a sufficient principle of its effect, for what is greater cannot arise from what is less. And the cause not only produces its effect but in some way assimilates the effect to itself. The likeness may fall short of the specific perfection proper to the cause, or it may attain to specific identity with the cause. But the effect can never excel its adequate cause in metaphysical richness; if the proximate cause is not sufficient to account for the perfection found in the effect, the reason is that it served merely as an instrument employed by some higher cause.

In the generation of living beings the specific nature of the parents is communicated to their offspring. The latter cannot surpass its parents in the perfection of its specific nature. Nevertheless, the specific nature surpasses any of its particular realizations; since matter is the principle of individuation and limitation, the species always contains more perfections and capacities for development than can be possessed by individuals or definite groups. That is at least a partial reason why living beings may, in the course of many successive generations, progress or regress within the same specific nature, or even, on the empirical level, may pass from one biological species to another.

The case of man presents incomparably greater difficulties. Human generation requires the creative activity of the first Cause; the spiritual soul can come into existence only by direct creation. God's intervention in the

⁴ *Acta Apostolicae Sedis*, XLII (1950), 562, 575 f.

⁵ A. Bea, S.J., "Die Enzyklika 'Humani generis,'" *Scholastik*, XXVI (1951), 52.

creation of the soul is an activity of His ordinary providence and is called for by the disposition engendered in matter by the parents. And the latter are truly parents; even though their causality does not extend to the production of the substantial form of their child, except by the requirement of the disposition they introduce into matter, their generative act terminates in an individual who subsists in the same nature as their own.

On the other hand, the generative causality of animal parents cannot endow living matter with the power to form a human body, that is, an organism whose act is the spiritual soul. The disposition for the human soul is essentially superior to anything that such a cause can produce, and, in the absence of a proportionate generative cause, would require the intervention of God Himself as the immediate cause. But there is no reason why the animal act, exercised under the action of the first Cause, should not be elevated so as to contribute instrumentally to such a disposition; God can at will utilize secondary causes for a transition to higher forms. The instrumental causality envisaged bears only on the disposition for the soul, which remains a pure effect of creation to the exclusion of all instrumentality. The soul itself could be infused into an embryo organism or even into a fully developed adult body. Since the spiritual soul does not coexist with lower forms, it would be the only substantial form present; but the previous preparation would not on that account be superfluous. St. Thomas perceived no difficulty in admitting a succession of forms in the development of the human embryo; he favored the doctrine that animation by the human soul was not immediate precisely because he thought that some preparation was needed, in the ordinary course of divine providence, for so great an effect as the infusion of the spiritual soul. If the hypothesis of evolution were to be confirmed, this idea could readily be transferred to the history of life, and in

the progressive advance of animal organisms to higher morphological perfection we could discern a gradual preparation for the reception of the human soul.⁶

THE FIRST MAN AS DEPICTED IN THEOLOGY

In common with his contemporaries, St. Thomas had a sublime notion of man's original state, the state of innocence. Man, as he came forth from the hands of God, is pictured as a splendid creature enjoying God's intimate friendship from the first moment of his life and as endowed with the aggregate of gifts constituting original justice. This state is repeatedly described by St. Thomas as a perfect harmony, an integrity of internal concord comprising mainly three levels of submission. The first and most important was the submission of the soul and especially of the will to God; on this depended all the rest; this was the principle, the "root" or original justice.⁷ The second, flowing from the first, was the submission of the lower powers, particularly of sensibility, to reason. The third was the complete submission of the body to the soul as principle of life, and this assured immortality. The beautiful harmony was crowned by the submission of all external nature to man. Such was the gratuitous gift of God which, in Adam, was conferred on human nature.⁸

Adam possessed more than the supernatural and preternatural gifts he was to transmit to his descendants. He was the first man: not only the first in time but the first in eminence, the father in whom had to be found, as in their cause, all the perfections of human nature. The idea of progressive evolution has penetrated so deeply into the modern mind that this view is quite strange to us, if not bizarre. St. Thomas, indeed, also teaches that,

⁶ Cf. M. Labourdette, O P., "Le péché originel et les origines de l'homme," *Revue Thomiste*, L (1950), 502 ff.

⁷ *Compendium of Theology*, c. 192.

⁸ *Ibid.*, c. 187.

in the order of generation, the perfect comes at the term, not at the beginning. But that is not the way he represents history. Although Adam stands at the source of human history, he is not the germ of perfections to come but their active cause, already enjoying them to a degree never to be reached by his posterity. Our original ancestor is not only the first in a long series, but is the most perfect member of the human family; he is excelled by the second Adam alone. In particular, the first man is endowed with infused knowledge that puts him in possession of all truth which the human mind can naturally know and which his children could ever learn.⁹

Such, in brief, is the description of the first man commonly proposed by theology. Is the description valid? Can we still retain it, in view of the problems raised in modern times by the sciences of nature and prehistory? Fossil men did not reveal Adonis in beauty and, to judge from the dimension and convolutions of their brains, did not possess the intellectual genius of Aristotle. We cannot recognize in them the perfections ascribed to the first men by theology.

SOME THEORIES

Theology cannot be expected to provide an immediate and triumphant response to all the challenges offered by the evolutionist hypothesis. In the present state of our knowledge such a demand would impose an impossible task. The sciences of prehistory are very young; in spite of notable achievements, they have as yet brought forward skimpy evidence about human origins. A more fundamental difficulty, which may never be overcome, is the fact that the data unearthed do not take us back to the cradle of the race either in space or in time.

Where did man first appear? Certainly not in America or Europe. Africa has a number of partisans. Many con-

⁹ *Summa*, Ia, q. 94, a. 3 et ad 1.

jecture that Asia is the birthplace of mankind. Some favor southern Asia, India, or the islands of Indonesia. Others believe that the great central plateau may be the starting point for the dispersal of the human family. The regions that might furnish precious relics, possibly enabling us to push farther toward the origins, have not yet been systematically explored, and will very likely guard their secret for centuries.

We have no means of ascertaining when man began to inhabit the earth. The fossils we possess are few and may be tremendously remote from the original father. Vast stretches of time were required to enable bold adventurers of ancient eras to occupy the various continents. Behind any prehistoric man whose bones have been brought to light, long series of unknown ancestors lived and died and have left no trace. The existence of Tertiary man has been much discussed, although the proofs alleged have slight value. Yet man may have lived during the latter part of the Tertiary era; the hypothesis is not entirely lacking in probability. No fossil remains have been discovered; but that may be owing, among other causes, to the fact that the cradle of the race has never been the object of methodical research; indeed, it could not be, because we do not even know where it is.

Since the problems raised by the existence of prehistoric men cannot now be solved with any assurance of certitude, we can do no better than propose various theories designed to reconcile faith or theology with the probable conclusions of the sciences of prehistory. These theories are interesting and merit attention; but none of them can be imposed.¹⁰ Nothing obliges us to take a

¹⁰ For a fuller discussion of some aspects of the theories briefly presented below, see: P. M. Perrier, *Le transformisme* (Paris: Beauchesne, 1938), 305-21; R. W. Murray, *Man's Unknown Ancestors* (Milwaukee: Bruce, 1943), 335-56; E. Amann, "Transformisme," *Dictionnaire de théologie catholique*, XV, (1946), 1388-94; C. Journet, *Introduction a la théologie* (Paris: Desclée de Brouwer, 1947), 213-26.

definite stand; indeed, the future may well reserve embarrassing surprises for those who hastily commit themselves to this or that hypothesis on the basis of our present flimsy evidence. Moreover, precipitate speculation encounters the risk of rashness by anticipating the judgment of the Church, which alone is competent to settle controversies having theological implications.

1. *First hypothesis: the regression theory.* According to this theory, certain human races whose fossil remains have been discovered by paleontologists are not primitive but degenerate. The sin of the first man entailed the privation of the supernatural and preternatural gifts that had perfected him. With the loss of immortality, the soul ceased to dominate the body and man's earthly life closed with death. With the loss of integrity, reason could no longer fully control the passions, and disorders arose in sense life. Moreover, the earth which had been presented to man as a paradise ceased to be subservient to him, with the result that conflicts between him and outer nature inevitably ensued.

The men reconstructed by the sciences of prehistory as bearing pithecoïd traits in their anatomy, yet as capable of shaping tools, using fire, and even of burying their dead, are regarded as descendants of the first biblical couple. Endowed with the prerogatives of original justice, the first man had possessed a refined bodily structure and a high level of culture.¹¹ After the Fall, Adam and Eve retained their physical and cultural perfections, and to some extent transmitted them to their children by generation and education. In the endless ages that followed, repeated migrations carried great masses of human beings into a progressive degradation and engaged them in a process of bestialization capable of modifying their skulls, brow ridges, and other skeletal details. Under the crushing weight of a hostile universe, man descended down to

¹¹ Cf. St. Thomas, *Summa*, Ia, q. 94, a. 3.

the limits separating humankind from animality. In his organism that was still plastic he underwent anatomical alterations that made him morphologically akin to the great anthropoids and, thus degraded, entered into the long night of prehistory.

The theory here outlined does not imply polygenism. The ancestors of all men who have lived on the earth are the single couple who, adorned by God with marvelous gifts, did not guard their treasure but, on the contrary, by their sin released evil upon the world. Certain of the descendants of this one pair, such as Sinanthropus, Heidelberg man, and Neanderthal man, are considered to be degenerate races.

The moral fault committed by the first father is evidently not the direct cause but only the occasion of the physical decadence. Whatever regression occurred was owing to the influence of environment and all the new conditions in which the despoiled descendants of the original couple found themselves during their protracted wanderings. So little is known about evolution that such regression cannot be declared impossible. "Whatever criterion you choose to adopt, you are sure to find that by it the history of life provides examples not only of progress but also of retrogression or degeneration. . . . The expansion of life has not been constant and there have even been points where it has lost ground temporarily, at least."¹² Evolution implies the existence of some ascensional principle within the living being; this principle tends to modify anatomy in a definite direction, although no satisfactory explanation of the process is available. Alongside this principle, another and contrary principle seems to lie dormant; when circumstances stimulate its operation, the antagonistic principle, instead of pushing the organism farther ahead, tends to let it degenerate.

¹² G. G. Simpson, *The Meaning of Evolution* (New Haven: Yale University Press, 1950), 243.

Thus the history of the origins of life brings to light three phenomena: a slow, ascending evolution, sudden emergence, and regression followed by extinction; and none of them may be ignored. Examples of recession are numerous. The Shetland pony, for instance, is the product of close inbreeding under controlled conditions within a restricted area. Another instance is provided by the dwarfed horses of American Indians in post-Spanish times, discovered at the bottom of the Grand Canyon. Among men, an indication that retrogression has occurred is the fact that Neanderthal skulls exhibiting the most accentuated pithecoïd traits are chronologically among the most recent. Even in historical times, unfavorable diet and climate have often brought about physical degeneration on a limited scale. Such degeneration may proceed so far as to have repercussions not only on man's physiology, but even on his anatomy. Vast stretches of time would be required for such changes; but the human race is extremely ancient. Although a definite number of millennia cannot be assigned, the various peoples discovered by paleontology had all the time that might be necessary to achieve differentiation and to disperse over the earth.

The theory encounters no obstacle on the part of theology. The degeneration of mankind was the fatal consequence of original sin. Bereft of the preternatural gifts that were designed to perfect him, man fell under the unfavorable influence of a harsh environment. Rebel against his Creator, he was challenged by the rebellion of nature of which he ought to have been lord and master. The moral fall was followed by repercussions affecting the organism itself, sensitive as it was to the action of external causes. As the conditions of life varied enormously in the different areas reached by the migrating peoples, multiple races were gradually formed.

2. *Second hypothesis: the "homo faber" theory.* The

fossils which prehistorians regard as the remains of primitive human races perhaps belong to beings morphologically close to man, although they do not pertain to the human species. Such animals would not be true men but only pre-men, rough sketches of human beings. Lacking spiritual souls, they would also lack reason and free will. They would occupy a place intermediate between true men and the highest anthropoids.

We can easily imagine such creatures. God can, at His good pleasure, draw the gradations of the scale of being closer and closer. Theoretically, nothing is opposed to the existence of higher animals endowed with an organism almost as perfect as that of man and reaching, by the power of their senses, memory, and imagination the extreme limits that mark an essential separation between highly refined sense cognition and intellectual knowledge. Their psychological faculties would far surpass those of the great apes; their abilities and resources, no longer met with even among domesticated animals, would explain the whole of Lower Paleolithic industry. The first man in the philosophical sense, endowed with a spiritual, immortal soul, pertaining morphologically to the race of *Homo sapiens* and raised by God to the supernatural state, would appear on earth subsequent to them.

In the realm of the imagination anything that is not at odds with a sane philosophy is possible. But can we actually maintain that the primitive races not classed as *Homo sapiens* were only hominids without reason and free will? The prehistorians, A. and J. Bouyssonie, seriously entertain the hypothesis. "Does the industry of Sinanthropus prove reason and freedom, that is, a properly human nature? Some hasten to reply in the affirmative. It is more prudent to ask whether the association of images, which is a purely empirical and animal operation, without being necessarily rational, cannot explain the usage of fire or the shaping of stone and wood. . . .

Homo faber is not necessarily *Homo sapiens*. We daily see animals performing complicated actions without being tempted to attribute to them the notion of cause and the acceptance of the principle of causality, which would point to reason properly so called."¹³

However attractive this suggestion about beings possessing a human skeleton but lacking a human nature may seem to be at first sight, it has won few adherents. The general verdict of prehistorians is that the existence of clearly marked fireplaces and the discovery of tools suffice to indicate the presence of man. No one has ever seen an animal make a fire or even try to keep a flame going by adding fuel. The most marvelous accomplishments of animals are directed to the conservation of the individual or of the species and are governed by an instinct that is quite different from reflective consciousness. Bees and beavers perform minute and delicate tasks with their own bodily members, instruments supplied by nature; they have no use for artificial tools. Birds build their nests in such a way that they almost seem to exercise a judicious choice in the materials they employ. But for such actions no reasoned knowledge of an end is needed; all that is required is an image: "an end present to the imagination, not an end proposed by reason."¹⁴ The manufacture of artificial tools, on the contrary, implies true intelligence; the intelligibility of the means is grasped in the end, the reason for tools is perceived in their destined use. Burial of the dead, such as practiced by Neanderthal man, clearly rules out instinct; if the dead are the object of special care, the only reason is that survivors are persuaded that earthly existence is prolonged in a future world where consciousness of personality is retained.

¹³ "Polygenisme," *Dictionnaire de théologie catholique*, XII (1935), col. 2533.

¹⁴ St. Thomas, *Summa*, Ia IIae, q. 1, a. 1 ad 3.

The *Homo faber* theory seems to bog down under the weight of the growing awareness of Neanderthal man's intellectual ability and the realization that even the very primitive *Sinanthropus* had a culture and industry far surpassing any phenomena observed on the level of sub-human life.

3. *Third hypothesis: the theory of pre-Adamites in a state of pure nature.* This proposal implies the existence of true men not elevated to the supernatural state and living prior to the first pair, Adam and Eve, who were chosen to receive the matchless gifts of original justice. The wonderful benefit of divine adoption with its call to eternal beatitude was preceded by a long preparation. The appearance on earth of the privileged couple who possessed an anatomical and psychical perfection suited to their higher vocation was foreshadowed during untold thousands of years by precursors who were less perfect and were closer to anthropoid forms. Into their bodies, which from the evolutionist point of view were incompletely disengaged from animality, God had infused spiritual souls. Whether the soul was imprisoned for many generations in an organism incapable of giving it access to the outside world, as in the case of an infant or a mentally undeveloped man, or whether it enabled pre-Adamite man to exercise fully human functions from the first generation, is a subject for speculation. At any rate these primitive human beings, who were vastly inferior to Adam and Eve in their psychological faculties as well as in their anatomy, were capable of progressive evolution, as may be attested by the fossil forms preceding the races of the New Stone Age and by Lower Paleolithic cultures. Yet they were destined to die out completely before the advent of the first couple mentioned in the Bible; for the coexistence of descendants of these primitive races and descendants of Adam and Eve is incompatible with the fundamental dogma of original sin. Thus they are

not our brethren; they were not responsible for the Fall and they did not receive the promise of a Redeemer. The part they played in the general economy of the world is highly mysterious; perhaps their supreme role, in the infinite variety of God's designs, was to mark the place of pure nature in the world to come.

Needless to say, such pre-Adamites are an entirely hypothetical people; no reference to them occurs in the Bible. The hypothesis seemed to have some plausibility as long as prehistorical evidence indicated a sharp break between Paleolithic and Neolithic cultures. But the discovery of a transitional Mesolithic culture closing the gap between the Old and New Stone Ages, as well as the extreme antiquity of some *Homo sapiens* fossils, have tended to discredit the theory.

4. *Fourth hypothesis: reconsideration of original man's natural perfection.* This theory supposes that the gifts of original justice eminently supplied for the natural qualities of bodily perfection and cultural refinement which theologians have traditionally attributed to Adam and Eve. When grace deserted the first man at the moment of the Fall, it did not leave him either bodily and culturally developed or anatomically and psychologically degraded. The privation of original justice merely laid bare the initial poverty of a human nature remaining uncultured but endowed with great plasticity and with unactuated potentialities that would awaken on contact with the world and with the first warming rays of Christ's redemptive grace. When this nature began to evolve in the course of the following ages, it did not proceed in a single direction; for, as is scientifically established, the vital tendency underlying evolution develops in the form of a branching bush. Thus the hypothesis does not envisage a purely regressive evolution, although the traces of bestialization noted in some ancient branches of the human family would appear as recessive characteristics.

The state of innocence does not seem to be incompatible with a process of human development, whether bodily, intellectual, or moral. "These gifts [integrity, impassibility, immortality, and infused knowledge] did not in any way transport mankind to a region of fairy tales. Humanity thus described was real and concrete, and was not necessarily at variance with the human origins which paleontology and prehistory are able dimly to discern."¹⁵ The first man's body, free from the scars of degeneracy disfiguring some fossil races, may well have been closer to the primitive types described by prehistorians than to the beautiful models fashioned by Greek sculptors. His intellect, though functioning in a condition of notional simplicity and inexperience, was strong in its original energy, and its efficient operation was facilitated by the harmonious subordination of the lower powers. God's inspiration, descending without hindrance from reason to the nethermost fringes of sensibility, could at each moment guide the activity of the natural faculties and could further raise the unspoiled mind to the highest reaches of contemplation. Man's will was untrammelled in its free exercise by disorderly concupiscence, and was naturally as well as supernaturally turned toward God. Cultural simplicity did not impede moral advertence or responsibility in a man whose easy mastery over his acts was guaranteed by the preternatural gift of integrity. Besides, the power of free will is not gauged by the richness of conceptual experience. The three children of Fatima, to select one of countless instances, stood undaunted in their purpose in spite of threats of torture and death which, though deceptive, were frighteningly graphic to them; yet they were quite artless and unacquainted with formal schooling.

We know almost nothing about the physical appearance of our original human father. The first chapter of Gene-

¹⁵ E. Mersch, *The Theology of the Mystical Body* (St. Louis: Herder, 1951), 143.

sis informs us that he was made according to the image and likeness of God; but this refers to his spiritual soul, not to his body, for Scripture attributes no bodily qualities to the Creator. Whether the first men were white, yellow, brown, or black is not narrated in the Bible and escapes the probings of paleontology. So far as revelation and science are concerned, the colored peoples are no less ancient or Godlike than the Caucasian race; indeed, some prehistorians believe that the Negro is more ancient than the other branches of mankind. Not only the color of Adam's skin, but his build and the shape of his head are left undescribed in Genesis, and, for all that we know, may have resembled the bodily characteristics of primitive fossil men.

The earliest known eoliths or "dawn stones," that is, pieces of chipped gravel which some archaeologists regarded as the first human tools, suggest that man made his appearance on earth, in Asia or Africa, toward the end of the Tertiary era. Through force of economic necessity or the attractions of opportunity, augmented perhaps by tribal quarrels, their descendants gradually drew apart and set out on their wanderings. During the ebb and flow of the ice ages of the Quaternary era the migrants, continually increasing in numbers, scattered over the various continents. Under the influence of radical changes in geographical environment, climate, food, and occupation, along with natural selection and gene mutations brought about by factors not yet fully understood, physical characteristics became altered and new races were developed. Owing to such causes and others that can only be conjectured, the "different fossil men of Quaternary Europe, such as the Piltdown, Swanscombe, Neanderthal, and Cro-Magnon types, appear to be the chief known representatives of Adam's early descendants who wandered westward, while the Java and Peking fos-

sils seem to be the earliest known relics of those who wandered eastward."¹⁶

This theory stresses the truth that man's real greatness is found in his soul, which was furthermore enriched with all the prerogatives of original justice. Whatever may have been the first man's antecedents, whether he was fashioned by God from inanimate matter or from a living organism, the dogma of original justice is not endangered. Man started to be man when he received a spiritual soul. Since God gave this soul, why could He not have created it in the state of original justice? Such privileges may surprise us more in human beings capable of evolving into more perfect types than they would in a couple who emerged from God's hands in the fullness of physical beauty and intellectual culture; but such an impression is purely subjective,¹⁷ and may eventually have to yield to objective evidence.

A POSSIBLE CLUE TO SOLUTION

In his stimulating book, *Introduction a la théologie*, Charles Journet has a section on "Themes" which requires further investigation by scholars working in the area of historical theology. One of these themes deals with "The Condition of Man at His Entrance Into Historical Time."¹⁸ The author closes his discussion of this topic with the following suggestion:

From the point of view that is ours, the main thing is to recall the key which in this matter opens all locks and without which, however competent and learned he may be, the Christian will forever labor in vain. The key is this: when there is question of the appearance of the *world* or of the appearance of *life* or of the appearance of the *human soul* or of the appearance of the *sanctifying grace of the first Adam*, we have to consider prior to all else the movement of descent by which the divinity, break-

¹⁶ R. W. Murray, *Man's Unknown Ancestors*, p. 357.

¹⁷ Cardinal Achille Liénart, "Le chrétien devant les progrès de la science," *Etudes*, CCLV (1947), 289 f.

¹⁸ Pp. 213-26.

ing with all that went before, inaugurates a new, higher order that is discontinuous; there then follows, but only as a consequence, the movement of ascent by which a pre-existing being sets out in a continuous march toward its proportionate ends, or prepares, under the influence of an elevating motion, an order that surpasses it. Such is the principle which, considered by St. Thomas in its supreme application, permits him to explain, under its various aspects, the very mystery of the appearance of the "second Adam." It was of a sudden, he writes, and not progressively, that the body of Christ was assumed by the Word (*Summa*, IIIa, q. 33, a. 3 ad 3); it was also of a sudden, not progressively, that Christ possessed sanctifying grace (*ibid.*, q. 34, a. 1 ad 1).

That is the extent of the suggestion; but the inference may be drawn out. The sudden assumption of the incarnate Word's body, along with the God-man's perfect possession of sanctifying grace from the outset, is followed by the gradual assumption of Christ's members into His body to form the Whole Christ. That process, the fashioning of the Whole Christ, is the most exalted "evolution" occurring in the world of men; it is still going on and it will continue until the end of time. Likewise, the sudden appearance of the primeval chaotic mass was followed by the slow evolution of the constellations with their countless stars and solar systems; the sudden appearance of life was followed, if the transformist hypothesis is correct, by the evolution of plant and animal species; the sudden appearance of grace in the first man was to be followed by an ascent to the heights of sanctity. Continuation of the parallel indicates that the sudden appearance of the human soul in the body of the first man was followed by an evolution of the original stock into many diversified races: those that are familiar to us among the men of historical times as well as their prehistoric ancestors, some of whose remains have been unearthed and tentatively classified.

But the final word has not been said and cannot now be said. The problem of human origins is still unsolved,

and perhaps never will be wholly solved. Yet we do know this: an evolution that is purely materialist is unscientific from beginning to end. Furthermore, a theistic, finalistic evolution that recognizes nothing beyond a special divine causality in the creation of the soul, while excluding such causality from the formation of the first man's body, is philosophically and theologically unacceptable. But an evolution which admits that God, in infusing a soul into an animal organism, likewise effected all the modifications necessary to fit that organism for union with a human soul, seems to run afoul of no exegetical or theological objection. Catholics do not have to spurn such an explanation; no conflict with their religion can arise from the facts brought forward by anthropology and paleontology. Nevertheless we should be wasting our time if we desired at present to settle all difficulties and to establish perfect agreement between the faith and the sciences of prehistory that are far from being in agreement about the import of their own discoveries.

2. Modern Science and the Existence of God

POPE PIUS XII

*Address of the Holy Father to the Pontifical
Academy of Science, November 22, 1951*

THIS meeting of the Pontifical Academy of Science brings Us an hour of serene happiness, for which We are grateful to the Almighty. At the same time it affords Us the welcome opportunity to spend some time in the company of a select group of eminent Cardinals, illustrious diplomats, outstanding personages and of yourselves, the members of the Pontifical Academy, who are indeed worthy of the solemnity of this gathering. For, by your research, your unveiling of the secrets of nature and your teaching of men to direct the forces of nature towards their own welfare, you preach at the same time, in the language of figures, formulæ and discoveries, the unspeakable harmony of the work of an all-wise God.

In fact, according to the measure of its progress, and contrary to affirmations advanced in the past, true science discovers God in an ever-increasing degree—as though God were waiting behind every door opened by science. We would even say that from this progressive discovery of God, which is realized in the increase of knowledge, there flow benefits not only for the scientist himself when he reflects as a philosopher—and how can he escape such

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reflection?—but also for those who share in these new discoveries or make them the object of their own considerations.

Genuine philosophers profit from these discoveries in a very special way, because when they take these scientific conquests as the basis for their rational speculations, their conclusions thereby acquire greater certainty, while they are provided with clearer illustrations in the midst of possible shadows, and more convincing assistance in establishing an ever more satisfying response to difficulties and objections.

PROOFS FOR THE EXISTENCE OF GOD

Thus stimulated and guided, the human intellect approaches that demonstration of the existence of God which Christian wisdom recognizes in those philosophical arguments which have been carefully examined throughout the centuries by giants in the world of knowledge, and which are already well known to you in the presentation of the "five ways" which the Angelic Doctor, St. Thomas, offers as a speedy and safe road to lead the mind to God. We have called these arguments "philosophical." This does not mean that they are a prioristic, as they are accused of being by a narrow-minded and incoherent Positivism. Even though they draw their demonstrative force from the power of human reason, they are nevertheless based on concrete realities established by the senses and by science.

In this way both philosophy and the sciences, by means of activities and methods which are analogous and mutually compatible, carry on their work. Though in different measures, they all make use of both empirical and rational elements and cooperate in harmonious unity for the discovery of truth.

But if the primitive experience of the ancients could provide human reason with sufficient arguments to dem-

onstrate the existence of God, then with the expanding and deepening of the field of human experiments, the vestiges of the Eternal One are discernible in the visible world in ever more striking and clearer light. Hence it seems helpful to re-examine on the basis of new scientific discoveries the classical proofs of the Angelic Doctor, especially those based on motion and the order of the universe (S.Th., 1 p., q. 2, art. 3), that is to say, to inquire if, and in what degree, a very profound knowledge of the structure of the macrocosm and the microcosm contributes towards strengthening these philosophical arguments.

It is also helpful to consider, on the other hand, if and to what degree these proofs have been weakened, as is not infrequently affirmed, by the fact that modern physics has formulated new basic principles, ruled out or modified certain ancient ideas, whose content was perhaps judged in the past to be fixed and definitive, such as time, space, motion, causality, substance—all of which concepts are supremely important for the question which now occupies us.

The question, then, is not one of revising the philosophical proofs, but rather of inquiring into the physical foundations from which they flow—although limitations of time will oblige Us to restrict Our attention to only some few of these foundations. There is no reason to be fearful of surprises. Not even science itself aims to go outside that world which today, as yesterday, presents itself through these “five modes of being,” whence the philosophical demonstration of the existence of God proceeds and draws its force.

TWO ESSENTIAL CHARACTERISTICS OF THE COSMOS

From these “modes of being” of the world around us which, in greater or less degrees of comprehension, are noted with equal evidence by both the philosopher and

the human mind in general, there are two which modern science has, in a marvelous degree, fathomed, verified and deepened beyond all expectations: 1) *the mutability of things, including their origin and their end*; and 2) *the teleological order which stands out in every corner of the cosmos*. The contribution thus made by science to the two philosophical arguments which hinge on these facts, and which constitute the first and the fifth ways of St. Thomas, is most notable.

To the first way physics, especially has provided an inexhaustible mine of experiments, revealing the fact of mutability in the deepest recesses of nature, where previously no human mind could ever even suspect its existence and vastness. Thus physics has provided a multiplicity of empirical facts which are of tremendous assistance to philosophical reasoning. We say "assistance," because the very direction of these same transformations, precisely in view of the certainty afforded by physics, seems to Us to surpass the value of a mere confirmation and acquires almost the structure and dignity of a physical argument which is in great part new and more acceptable, persuasive and welcome to many minds.

With similar richness other sciences, especially the astronomical and the biological sciences, have in our own day contributed to the argument from order such a vast array of knowledge and, so to speak, so stupefying a vision of the conceptual unity animating the cosmos, and of the teleology directing its movements, as to anticipate for modern man the joy which the Poet (Dante) imagined in the empyrean heaven when he beheld in God

"Into one volume bound by love, the same that
the universe holds scattered through its maze"
(Par. 33, 85-87).

Nevertheless, Providence has disposed that just as the notion of God, which is so essential to the life of each

individual, can be gathered easily from a simple look at the world—in such a way that not to understand the voice of creation is foolishness (Wis., 13, 1-2)—so also this same idea of God finds confirmation in every new development and progress of scientific knowledge.

Wishing to give here only a rapid summary of the priceless services rendered by modern science to the demonstration of the existence of God, We shall limit Ourselves, first of all, to the fact of changes, pointing out principally their amplitude and vastness and, so to speak, their totality which modern physics meets in the inanimate cosmos. We shall then dwell on the significance of their direction, which is likewise verified by science. Thus, in Our treatment of these points, We shall, so to speak, be lending an ear to a miniature concert of the immense universe, which nevertheless has a voice strong enough to sing “the glory of Him who moveth all that is” (Par., 1, 1).

A. THE MUTABILITY OF THE COSMOS: THE FACT OF MUTABILITY

a) *in the macrocosm:*

At first sight it is rightly a source of wonderment to recognize how the knowledge of the fact of mutability has gained ever greater ground, both in the macrocosm and in the microcosm, according as science has made new progress, as though confirming with new proofs the theory of Heraclitus: “Everything is in flux”: *panta rhei*. As is known, our own everyday experience brings to light an immense number of transformations in the world around us, both near and far away, particularly the local movements of bodies. But, over and above all these local movements strictly so-called, the manifold chemico-physical changes which take place in the world are equally noticeable, as, for example, the change in the physical state of water in its three phases of steam, liquid and ice. We are

aware also of the far-reaching chemical effects produced by the use of fire, the knowledge of which goes back to pre-historic times, and of the weathering of rocks and the corruption of vegetable and animal life.

This common experience is corroborated by the natural sciences, which have taught people to understand these and other similar changes as processes of destruction and construction of corporeal substances in their chemical elements, that is to say, in their tiniest parts, the chemical atoms. Going still farther, natural science made known that this chemico-physical mutability is not, as the ancients thought, restricted to terrestrial bodies, but even extends to all the bodies of our solar system and of the great universe, which the telescope, and still more the spectroscope, have demonstrated to be composed of the same kind of atoms.

b) *in the microcosm:*

Nevertheless, in the face of the undeniable mutability of even inanimate nature, there still rises the enigma of the unexplored microcosm. It seemed, in fact, that, unlike the organic world, inorganic matter was in a certain sense immutable. Its tiniest parts, the chemical atoms, were indeed capable of combining in most diversified manners, but they appeared to be endowed with a privilege of eternal stability and indestructibility, since they emerged unchanged from every chemical synthesis and analysis. A hundred years ago, the elementary particles were still regarded as simple, indivisible and indestructible.

The same idea prevailed regarding the material energy and forces of the cosmos, especially on the basis of the fundamental laws of the conservation of mass and energy. Some natural scientists went so far as to consider themselves authorized to formulate in the name of their science a fantastic monistic philosophy whose sorry memory is linked up, among others, with the name of Ernst Haeckel.

But in the very life-time of the latter, towards the end of the last century, even this over-simplified conception of the chemical atom was shattered by modern science. The growing knowledge of the periodic system of chemical elements, the discovery of the corpuscular radiations of radioactive elements, along with many other similar facts, have demonstrated that the microcosm of the chemical atom, with dimensions as small as ten-millionths of a millimeter, is a theater of continuous mutations, no less than the macrocosm known to all.

It was in the sphere of electronics that the character of mutability was first established. From the electronic structure of the atom there emanate radiations of light and heat, which are absorbed by outside bodies, corresponding to the energy level of the electronic orbits. In the exterior parts of this sphere there take place the ionization of the atom and the transformation of energy in the synthesis and analysis of chemical combinations. At that time, however, it was possible to suppose that these chemico-physical transformations provided one last refuge for stability, since they did not reach the very nucleus of the atom, which is the seat of its mass and of the positive electric charge which determine the place of the chemical atom in the natural system of the elements, and where it seemed science had found, so to speak, an example of an absolutely stable and invariable being.

But already at the dawn of the new century, the observation of radio-active processes, which, in their last analysis, were connected with a spontaneous breaking down of the nucleus, began to exclude any such example. Hence, once science had established the fact of instability reaching down into the deepest depths of known nature, there still remained one further perplexing fact, since the atom was apparently unattackable, at least by human forces, because in the beginning all efforts to hasten or to retard its natural radioactive disintegration, or even to break

down inactive nuclei, had failed. The first very modest attempt to break down the nucleus (of nitrogen) goes back to hardly more than three decades ago, and it is only in recent years that it has been possible, by bringing into play tremendous forces, to produce very numerous processes involving the formation and the breaking down of nuclei.

Although this result—which, insofar as it contributes to the cause of peace, is certainly to be inscribed among the glories of our century—represents in the field of practical nuclear physics no more than a preliminary step, nevertheless, it provides for our consideration an important conclusion, namely, that atomic nuclei are indeed, by many orders of magnitude, more firm and stable than ordinary chemical compositions, but this notwithstanding, they are also, in principle, subject to similar laws of transformation, and hence are mutable.

At the same time it was possible to establish that such processes have the greatest importance in the economy of energy of the fixed stars. In the center of our sun, for example, according to Bothe, and in the midst of a temperature which goes as high as some twenty million degrees, there takes place a chain-reaction returning upon itself, in which four hydrogen nuclei combine with one nucleus of helium. The energy thus liberated comes to compensate the loss involved in the radiation of the sun itself. Also in modern physical laboratories, through bombardment with particles endowed with tremendous energy or with neutrons, successful efforts are being made to effect transformations of nuclei, as can be seen in the example of the atom of uranium. In this connection mention must also be made of the effects of cosmic radiation, which can break down even the heaviest atoms, thus not infrequently liberating entire swarms of sub-atomic particles.

We have desired to cite only some few examples, but

such as could establish beyond all possible doubt the explicit mutability of the inorganic world, large and small: the countless transformations of the forms of energy, especially in the chemical decompositions and combinations taking place in the macrocosm and, in no smaller degree, the mutability of chemical atoms, even down to the sub-atomic particles of their nuclei.

Therefore, the scientist of today, directing his gaze more deeply into the heart of nature than his predecessor of a hundred years ago, knows well that inorganic matter is, so to speak, in its innermost being, countersigned with the stamp of mutability, and that, consequently, its existence and its subsistence demand a reality entirely different and one which is by its very nature invariable.

Just as in a picture done in chiaroscuro, the figures stand out on a background of darkness, and only in this way achieve the full effect of form and life, so also the image of the eternally immutable Being emerges clear and resplendent from the torrent which snatches up and carries off with itself all the material things of the macrocosm and the microcosm in an intrinsic mutability which knows no pause. The scientist who stops on the bank of this immense torrent finds rest in that cry of truth with which God defined Himself: "I am who am" (Exod., 3, 14), the God to whom the Apostle gives praise as to "the Father of lights, with whom there is no change or shadow of alteration" (James, 1, 17).

B. THE DIRECTION OF TRANSFORMATIONS

a) *in the macrocosm: the law of entropy*

Modern science has not only widened and deepened our knowledge of reality and the vastness of the mutability of the cosmos; it likewise provides us with valuable indications on the direction taken by the processes of nature. As late as a hundred years ago, especially after

the discovery of the law of the conservation of energy, it was thought that natural processes were reversible. Consequently, in conformity with the principles of the strict causality, or rather the determination, of nature, an ever-recurring renovation and rejuvenation of the cosmos was regarded as possible. Through the law of entropy, however, discovered by Rudolph Clausius, it was recognized that the spontaneous processes of nature are always accompanied by a diminution of free and utilizable energy. In a closed material system, this conclusion must lead eventually to the cessation of processes on a macroscopic scale. This unavoidable fate, from which only hypotheses—sometimes unduly gratuitous, such as that of continued supplementary creation—have endeavored to save the universe, but which instead stands out clearly from positive scientific experience, postulates eloquently the existence of a Necessary Being.

b) *in the microcosm:*

In the microcosm, this law, which is basically statistical, is not applicable. Besides, at the time it was formulated, practically nothing was known regarding the structure and the behavior of the atom. However, recent atomic research, as well as the unexpected progress of astrophysics, have made it possible to achieve surprising discoveries in this field. Here we can only allude briefly to the results of these discoveries, but they can be summed up by saying that both atomic and intro-atomic development are clearly marked with a sense of direction.

To illustrate this fact, it will be sufficient to cite the example, already mentioned of the behavior of solar energy. The electronic structure of the chemical atoms in the sun's photosphere releases at every moment into the surrounding space a gigantic quantity of radiant energy which does not return. This loss is compensated from within the sun through the formation of helium from

hydrogen. The energy thus released comes from the mass of the hydrogen nuclei which, in the course of this process and in a small degree (7 per cent), is converted into equivalent energy. Therefore, the process of compensation takes place at the expense of the energy which, originally, in the hydrogen nuclei, exists as a mass. Thus, in the course of billions of years, through a progress which is slow yet irreversible, this energy is transformed into radiations. A similar process is found in all radioactive processes, whether they be natural or artificial.

Thus here also, in the microcosm strictly and properly so-called, we find a law indicating the direction of evolution, a law which is analogous to the law of entropy for the macrocosm. The direction of spontaneous evolution is determined through the diminution of utilizable energy in the structure and the nucleus of the atom and, up to the present time, science knows of no processes capable of compensating or annulling this exploitation through the spontaneous formation of nuclei having high energy value.

C. THE UNIVERSE AND ITS DEVELOPMENTS

If the scientist turns his attention from the present state of the universe to the future, even the very remote future, he finds himself constrained to recognize, both in the macrocosm and in the microcosm, that the world is growing old. In the course of billions of years, even the apparently inexhaustible quantities of atomic nuclei lost utilizable energy and, so to speak, matter becomes like an extinct and scoriform volcano. And the thought comes spontaneously that if this present cosmos, today so pulsating with rhythm and life, is, as we have seen, insufficient to explain itself, with still less reason will any such explanation be forthcoming from the cosmos over which, in its own way, the shadow of death will have passed.

Let us now turn our attention to the past. The farther

back we go, the more matter presents itself as always more enriched with free energy, and as a theater of vast cosmic disturbances. Thus everything seems to indicate that the material universe had in finite times a mighty beginning, provided as it was with an indescribably vast abundance of energy reserves, in virtue of which, at first rapidly and then with increasing slowness, it evolved into its present state.

This naturally brings to mind two questions:

Is science in a position to state when this mighty beginning of the cosmos took place? And, secondly, what was the initial or primitive state of the universe?

The most competent experts in atomic physics, in collaboration with astronomers and astrophysicists, have attempted to shed light on these two difficult but extremely interesting problems.

D. THE BEGINNING IN TIME

First of all, to quote some figures—which aim at nothing else than to give an order of magnitude fixing the dawn of our universe, that is to say, to its beginning in time—science has at its disposal various means, each of which is more or less independent from the other, although all converge. We point them out briefly:

1. *Recession of the spiral nebulae or galaxies*

The examination of various spiral nebulae, especially as carried out by Edwin W. Hubble at the Mount Wilson Observatory, has led to the significant conclusion, presented with all due reservations, that these distant systems of galaxies tend to move away from one another with such velocity that, in the space of 1,300 million years, the distance between such spiral nebulae is doubled. If we look back into the past at the time required for this process of the "Expanding Universe," it follows that, from one to ten billion years ago, the matter of the spiral nebu-

lae was compressed into a relatively restricted space, at the time the cosmic processes had their beginning.

2. *The age of the solid crust of the earth*

To calculate the age of original radioactive substances, very approximate data are taken from the transformation of the isotope of uranium 238 into an isotope of lead (RaG), or of an isotope of uranium 235 into actinium D (AcD), and of the isotope of thorium 232 into thorium D (ThD). The mass of helium thereby formed can serve as a means of control. This leads to the conclusion that the average of the oldest minerals is at the most 5 billion years.

3. *The age of meteorites*

The preceding method adopted to determine the age of meteorites has led to practically the same figure of 5 billion years. This conclusion assumes special importance from the fact that today the inter-stellar origin of meteorites is generally admitted by all.

4. *The stability of the systems of double stars and starry masses*

The oscillations of gravitation between these systems, as also the attrition resulting from tides, again limit their stability within a period of from 5 to 10 billion years.

Although these figures may seem astounding, nevertheless, even to the simplest of the faithful, they bring no new or different concept from the one they learned in the opening words of Genesis: "In the beginning. . .," that is to say, at the beginning of things in time. The figures we have quoted clothe these words in a concrete and almost mathematical expression, while from them there springs forth a new source of consolation for those who share the esteem of the Apostle for that divinely inspired Scripture, which is always useful "for teaching, for reproving, for correcting, for instructing" (2 Tim., 3, 16).

E. THE STATE AND QUALITY OF ORIGINAL MATTER

In addition to the question of the age of the cosmos, scholars have, with similar earnestness and liberty of research and verification, turned their daring genius to the other problem which has already been mentioned and which is certainly more difficult, concerning the state and quality of primitive matter.

According to the theories serving as their basis, the relative calculations differ in no small degree from one another. Nevertheless, scientists agree in holding that not only the mass but also the density, pressure and temperature of matter must have reached absolutely enormous proportions, as can be seen from the recent work of A. Unsold, director of the Observatory of Kiel (*Kernphysik und Kosmologie*, in the *Zeitschrift für Astrophysik*, 24, B, 1948, pag. 278-305). Only under such conditions can we explain the formation of heavy nuclei and their relative frequency in the periodic system of the elements.

Rightly on the other hand, does the mind in its eagerness for truth insist on asking how matter reached this state, which is so unlike anything found in our own everyday experience, and it also wants to know what went before it. In vain would he seek an answer in natural science, which declares honestly that it finds itself face to face with an insoluble enigma. It is true that such a question would demand too much of natural science as such. But it is also certain that the human mind trained in philosophical meditation penetrates more deeply into this problem.

It is undeniable that when a mind enlightened and enriched with modern scientific knowledge weighs this problem calmly, it feels drawn to break through the circle of completely independent or autochthonous matter, whether uncreated or self-created, and to ascend to a creating Spirit. With the same clear and critical look with which

it examines and passes judgment on facts, it perceives and recognizes the work of creative omnipotence, whose power, set in motion by the mighty "Fiat" pronounced billions of years ago by the Creating Spirit, spread out over the universe, calling into existence with a gesture of generous love matter bursting with energy. In fact, it would seem that present-day science, with one sweeping step back across millions of centuries, has succeeded in bearing witness to that primordial "Fiat lux" uttered at the moment when, along with matter, there burst forth from nothing a sea of light and radiation, while the particles of chemical elements split and formed into millions of galaxies.

NO ABSOLUTE PROOF FROM SCIENCE

It is quite true that the facts established up to the present time are not an absolute proof of creation in time, as are the proofs drawn from metaphysics and Revelation in what concerns simple creation, or those found on Revelation if there be question of creation in time. The pertinent facts of the natural sciences, to which We have referred, are awaiting still further research and confirmation, and the theories founded on them are in need of further development and proof, before they can provide a sure foundation for arguments which, of themselves, are outside the proper sphere of the natural sciences.

This notwithstanding, it is worthy of note that modern scholars in the fields regard the idea of the creation of the universe as entirely compatible with their scientific conceptions and that they are even led spontaneously to this conclusion by their scientific research. Just a few decades ago, any such "hypothesis" was rejected as entirely irreconcilable with the present state of science. As late as 1911, the celebrated physicist Svante Arhenius declared that "the opinion that something can come from

nothing is at variance with the present-day state of science, according to which matter is immutable." (*Die Vorstellung vom Weltgebäude in Wandelnden Zeiten*, 1911 pag. 362). In this same vein we find the statement of Plate: "Matter exists. Nothing can come from nothing, hence matter is eternal. We cannot admit the creation of matter." (*Ultramontane Weltanschauung und Moderne Lebenskunde*, 1907, pag. 55).

On the other hand, how different and much more faithful a reflection of limitless visions is the language of an outstanding modern scientist, member of the Pontifical Academy of Science, when he speaks of the above-mentioned inquiries into the age of the world:

These different calculations point to the conclusion that there was a time, some nine or ten billion years ago, prior to which the cosmos, if it existed, existed in a form totally different from anything we know, and this form constitutes the very last limit of science. We refer to it perhaps not improperly as creation. It provides a unifying background, suggested by geological evidence, for that explanation of the world according to which every organism existing on the earth has a beginning in time. Were this conclusion to be confirmed by future research, it might well be considered as the most outstanding discovery of our times, since it represents a fundamental change in the scientific conception of the universe, similar to the one brought about four centuries ago by Copernicus. (*Space and Spirit*, by Sir Edmund Whittaker, 1946, pp. 118-119).

CONCLUSION

What then is the importance of modern science for the argument for the existence of God based on the mutability of the cosmos? By means of exact and detailed research into the macrocosm and the microcosm, it has considerably broadened and deepened the empirical foundation on which this argument rests, and from which it concludes to the existence of an *Ens a se*, immutable by

His very nature. It has, besides, followed the course and the direction of cosmic developments, and, just as it was able to get a glimpse of the term towards which these developments were inexorably leading, so also has it pointed to their beginning in time some five billion years ago. Thus, with that concreteness which is characteristic of physical proofs, it has confirmed the contingency of the universe and also the well-founded deduction as to the epoch when the cosmos came forth from the hands of the Creator.

Hence, creation took place in time. Therefore, there is a Creator. Therefore, God exists! Although it is neither explicit nor complete, this is the reply we were awaiting from science, and which the present human generation is awaiting from it. It is a reply which bursts forth from mature and calm consideration of only one aspect of the universe, namely, its mutability. But this is already enough to make the entire human race, which is the peak and the rational expression of both the macrocosm and the microcosm, become conscious of its exalted Maker, realize that it belongs to Him in space and in time and then, falling on its knees before His sovereign majesty, begin to invoke His name: "*Rerum, Deus, tenax vigor, Immotus in te permanens, Lucis diurnae tempora, Successibus determinans.*"—"O God, creation's secret force, Thyself unmoved, yet motion's source, Who from the morn til evening's ray, through every change dost guide the day." (Hymn for None).

The knowledge of God as sole Creator, now shared by many modern scientists, is indeed the extreme limit to which human reason can attain. Nevertheless, as you are well aware, it does not constitute the last frontier of truth. In harmonious cooperation, because all three are instruments of Truth, like rays of the same sun, science, philosophy and, with still greater reason, Revelation, contemplate the substance of this Creator whom science has

met along its path, unveil His outlines and point out His features. Revelation, above all, makes His presence, so to speak, immediate, vitalizing and loving, like that presence of which either the simple faithful or the scientist is aware in his inner soul when he recites unhesitatingly the concise terms of the ancient Apostles' Creed: "I believe in God, the Father Almighty, Creator of heaven and earth."

Today, after so many centuries, which were centuries of civilization because they were centuries of religion, the need is not so much to reveal God for the first time, as it is rather to recognize Him as a Father, reverence Him as a Lawgiver, and fear Him as a Judge. If they would be saved, the nations must adore the Son, the loving Redeemer of mankind, and bow to the loving inspirations of the Spirit, the fruitful Sanctifier of souls.

This persuasion, taking its remote inspiration from science, is crowned by Faith which, being ever more deeply rooted in the consciousness of the people, will truly be able to assure basic progress for the march of civilization.

This is a vision of the whole, of the present as of the future, of matter as of the spirit, of time as of eternity, which, as it illuminates the mind, will spare to the men of today a long tempestuous night.

It is that Faith which at this moment inspires Us to raise towards Him whom we have just invoked as *Vigor*, *Immotus* and *Pater*, a fervent prayer for all His children entrusted to our care: "*Largire lumen vespere, Quo vita nusquam decadat*,"—"Grant us light in the evening so that life may never fail"—"light for the life of time, light for the life of eternity." (Hymn for None).

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