THE ORIGIN OF MAN

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BY

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1921

Printed in the United States of America

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As to the origin of man we do not know and probably never will know, but such a thought cannot prevent us from theorizing on the subject. There are today two theories as to the origin of man which have been universally accepted, namely, the scientific and the theological, but these theories are so vague in some instances and there are many points which remain unexplained. After a prolonged study I have come to a conclusion which differs from these two theories, and in the following treatise I shall endeavor to present my theory in as clear and concise a way as possible. I shall first give an account of the origin and evolution of animal life which I shall not make lengthy, for to those who already have that knowledge, the reading would only be burdensome, and to those who have no knowledge on this subject whatsoever, except that gleaned from the Bible, would probably find the account uninteresting and tiresome, and if such be the case the theory would not appeal to them. Furthermore a careful perusal of the following account is vitally important for a clear understanding of the theory. In addition to this account I have added a brief explanation as to the origin of the earth and solar system and also a brief explanation of the theory of light, for I deem these additions of the utmost importance. I thereby conclude my brief introduction with the final remark that, although my theory is new, it is by no means incredible and preposterous.

In the beginning God created the heaven and the earth. And the earth was without form, and void; and darkness was upon the face of the deep. And the Spirit of God moved upon the face of the waters. And God said, let there be light, and there was light. And God saw the light, that it was good: and God divided the light from the darkness. And God called the light Day, and the darkness he called Night. And the evening and the morning were the first day. And God said, let there be a firmament in the midst of the waters, and let it divide the waters from the waters. And God made the firmament and divided the waters which were under the firmament from the waters which were above the firmament: and it was so. And God called the firmament Heaven. And the evening and the morning were the second day. And God said, Let the waters under the heaven be gathered together unto one place, and let the dry land appear: and it was so. And God called the dry land Earth; and the gathering together of the waters called he Seas; and God saw that it was good.

The above, as you will perceive, is an extract from the first part of the Book of Genesis. Let us see just what is meant by the above. To be brief let us say that in the first day God made the waters and light. And in the second day He made the firmament which He called Heaven.

The above is very true according to the theological point of view, but let us create this universe as science has created it. As the theological and scientific theories, as to creation of the universe differ greatly, and as it is not my object in the present treatise to present both sides of the question, let us take the scientific point of view as it serves my purpose better.

All matter in this universe is composed or made up of small particles called atoms (from the Greek words meaning not cut or divided). A piece of wood, a piece of coal or a piece of iron is composed of small particles held together by mutual attraction. The atoms of wood, coal and iron are not all the same, but the atoms of wood are all alike, the atoms of coal are all alike, and the atoms of iron are all alike.

The earth is composed of a large number of elements, these elements being all composed of atoms. Some of the elements which are constituents of the earth are oxygen, silicon, aluminium and iron. Now oxygen is made up of oxygen atoms, silicon of silicon atoms, etc. Also our planetary system which consists of the sun, moon, stars, etc., is likewise composed of elements.

Now that we know of what the earth and planets are composed let us use our imagination. Before we begin I wish to say that I will present two theories (one of which is incorrect) so that you will form a clear conception of the scientific theory of the formation of the universe. Let us imagine that there was once nothing but space and through this space let us distribute billions and billions of atoms. In the eighteenth century the nebular hypothesis was formed. It was founded essentially upon the conception of the condensation of matter or of these atoms, originally existing in a diffuse state, through gravitation attraction. Or in other words these atoms united and formed different masses. Another essential part of this hypothesis was the conception of a nebula as a unit body, distended by heat, and revolving as a single mass. In this nebular hypothesis we have been dealing with only one force, namely attraction. In the nineteenth century evidences of another force in our stellar universe became prominent, that force being repulsion.

Let us then conceive that these atoms which we have distributed through space to have become united into one mass. Then let us suppose that matter was thrown out from this mass or sun, and assuming the form of a spiral nebula, not as under the nebular hypothesis, as being the residue left behind from the primal condensation of matter into a sun. The form of the nebula was maintained, let us suppose, through the motion of its particles moving in orbits, and not by the resistance of heated matter to condensation. Then the scattered nebulous matter became drawn into nuclei. The nebula consisting of planetesimals which by the way are particles of nebulous matter, thus passed into the planetary system. Therefore our earth was made by the condensation of atoms thrown out from a sun or mass. This belief is known as the planetesimal hypothesis and is the scientific theory of the formation of our universe.

As the earth gradually became larger and its attraction stronger so as to hold the gases emitted from the volcanos, it gradually came to have an atmosphere. When the earth reached its present size, the atmosphere gave rise to the processes of solution, to weathering of rocks, and to the washing together of sediments formed on the earth's face, and the resulting finer materials gravitated to the lower places and eventually into the oceanic basins. This then explains the formation of our atmosphere and oceans.

And God said, Let there be light: and there was light. And God saw the light, that it was good: and God divided the light from the darkness. And God called the light Day, and the darkness he called Night. And the evening and the morning were the first day.

Before we proceed we will devote a few moments of our time to the theories of light, as light is essential to man, and to be better able to understand the evolution of man, it will be necessary to know what light really is. The source of most of our light is, as we all know, the sun. Sir Isaac Newton believed that light is due to the emission of luminous particles from the source. This hypothesis is known as the emission theory and he appears to have adopted this hypothesis chiefly because it explained the rectilinear propagation of light. However, the wave theory which is the more acceptable, supposes that space is filled with a rare medium, the ether, through which waves are propagated from luminous bodies. We can then say that from luminous bodies, such as the sun, waves are propagated and which, when they reach our eye, produce the sensation we know as light. I have thus pointed out the scientific theories as to the origin of our universe. We shall now turn our attention to the origin of life on our planet, but before we proceed let us see what life is. To know what life is, it will be therefore necessary to take up the subject of matter and organisms.

Matter is that which is perceptible to the senses. The earth is composed of matter which science recognizes as inorganic and organic. The former is lifeless matter much of which is in the crystal form and hence it is sometimes referred to as the Crystal Kingdom. Organic matter when alive manifests vitality, either in the form of single cells or in aggregates of cells, and is thus classified on the basis of its cell structure and mode of nourishment into the Plant Kingdom or Animal Kingdom. The entities occurring in the inorganic world are in the crystalline form, or in the fragmental or altered condition; while the bodies of living matter have their substance organized into a mechanism capable of response to external and internal agencies, and are hence called organisms.

A living organism exhibits five inherent activities—contractility, the power of movement, which is better developed in animals, than in plants; irritability, the power of responding to stimulus in the wide sense, also more marked in animals; nutrition or the utilization of food; respiration; and excretion, which is again greatest in animals—besides the periodic activities of growth and reproduction.

These manifestations of living matter are seen even in the simplest of plants and animals, where the individuals are microscopic in size and the unit is contained in a single cell. However, living matter is more commonly seen and comprehended when many cells live together and form the unit or individual that is in the plants and animals as usually understood. All these forms are said to have a body consisting of unit masses or cells, which in the higher forms of plants run into countless numbers. It is impossible for these cells to remain the same, for as they increase in number they become diversely related to the outer world, to food, to one another, and so on. Division of labor, consequent on diversity of conditions, is thus established in the organism. In some cells one kind of activity predominates, in others a second, in still others a third, and this division of labor is associated with that complication of structure which is called differentiation.

The functions, cellular structure, and development in plants and animals are essentially alike, and there is no absolute distinction between them. But as these two groups are organisms differing in their totality of organization and in the detail of their functions, they have developed along two independent trunk lines since early in the earth's history.

Besides the more or less constantly recurrent activities or functions, there are the processes of growth and reproduction. When income exceeds expenditure in a young animal, growth goes on, and the inherited qualities of the organism are more and more perfectly developed. At the limit of growth, when the animal has reached maturity, it normally reproduces, that is to say, liberates either parts of itself or special germ cells which give rise to new individuals.

Protoplasm is the genuinely living matter, or as Huxley expressed it in 1870, "it is the physical basis of life." Thomson states: "Protoplasm is a marvelous form of matter in motion, or a subtle kind of motion of which we can form only a vague conception."

All complex organisms are made up of organs and these are composed of tissues that are contractile, nervous, glandular, etc. In turn the tissues are made up of cells, so that all organisms have a cellular structure and a cellular origin. The simplest organisms are unicellular and the entire life process goes on in such single cells, each a unit mass of living matter; as such all plants and animals begin. In the great majority of organsims, however, the body is made up of hundreds upon hundreds of cells combined into tissues and organs. A cell, therefore is a unit mass of living matter, usually with a nucleus.

In a general way it may be said that the cells of plants have firm, more or less thick walls enclosing protoplasm, with granules of green coloring matter. This stiffness of wall structure isolates the living substance, and consequently independence of action, that is, movement, in plants, as compared with that in animals, is diminished.

By means of the green coloring matter, plants have the power of producing their own nutritive substances from certain constituents of the air and water and from the salts contained in the soil, and are thus able to exist independently, while animals are dependent for their nourishment, and so for their very existence on plants. Plants are therefore the primary magazines of food.

Now that we know to a certain extent what life is: namely the formation, growth and reproduction of cells, let us trace the progress of evolution of animal life from the very beginning to the age where man first came into existence.

By means of the science of Paleontology, which deals with the life of past ages, as shown by the remains or natural molds and imprints of plants and animals, called fossils, which have been preserved, enclosed in rocks, scientists have been able to trace the evolution of life from the very beginning. The evolution of animal life is divided into three eras: the first being the Paleozoic or Ancient Life; the second the Mesozoic or Medieval Life; the third the Cenozoic or Modern Life. And the Psychozoic or the Age of Man.

When the earth grew to about half of its present size or about 4200 miles in diameter, the inorganic matter deposited on the shores and bottoms of bodies of water, gradually came to life. This animal life which consists entirely of invertebrates, contains representatives of all the more fundamental types, ranging from simple sponges to complex forms of the Crustacea. The common animals are almost wholly trilobites and brachiopods. It is thought that life first came into being during the Archeozoic and early Proterozoic eras, but as fossils of those eras are unknown, it is safe to say that life came into existence in the Cambrian period of the early Paleozoic eras in the form of marine faunas. Then came the dominancy of the trilobites, which was followed by the rise of shelled animals, and which concludes the Cambrian period.

The word trilobites means three-lobe-like, and has reference to the three longitudinal lobes seen on the dorsal or upper side of most trilobites.

They were sexed animals, and their bodies were made up of segments, many of which articulated upon one another. These segments were divided into three divisions. The under, or ventral, side with the limbs had a very thin outer shell, while the carapace or upper shell was thin, and made up of chitin, a nitrogenous substance which greatly resists chemical alteration and for this reason trilobites are so often preserved as fossils. Trilobites inhabited only marine and mainly in shallow waters. Most of them were good swimmers, some crawled over the bottom, while others lived partly buried in the muds. Many or most of the trilobites could roll up their bodies for the protection of the softer and more delicate parts of the ventral side, thus presenting to the enemy the hard thick carapace.

Shelled animals as a rule are generally divided into two classes, the Brachiopoda and the Mollusca.

The word Brachiopoda means arm-footed and was given to the group because of a false physiological interpretation of the brachia or arms, for the animals do not crawl on their arms as was formerly supposed. The two more or less looped or spirally rolled, fleshy, fringed arms, on the contrary, serve two functions: first, through movements of the cirri and their cilia they attract currents of water into the shell, where the microscopic food is extracted from it and fed into the mouth; second, they serve for respiratory purposes, that is, for the absorption of oxygen. All Brachiopods are sexed, gregarious, marine animals, living from the strand-line down to the great oceanic abyss, but their greatest abundance is, however, in the shallow waters.

The Mollusca or Shell-Fish comprises such animals as clams, oysters, snails and the pearly nautilus. They are soft-bodied animals, often inhabiting shells to protect themselves. Most of them are very sluggish and have unsegmented bodies, and as they are devoid of limbs for crawling or swimming, they move about by means of the so-called foot, a creeping sole situated underneath the belly. Within the mantle, which is a thin membrane that secretes the shell when such is present, is the mantle cavity in which are the gills, organs setting up currents of water out of which is extracted not only the oxygen for respiration but also food for sustenance. The mouth of molluscs is furnished with a flexible chitinous ribbon known as the radula, a sort of tongue, usually provided with numerous minute, sharp hard teeth and moved by special muscles for breaking up the food. Most of the Mollusca inhabit the shallow parts of seas and oceans but some are found in the fresh waters of the land. A word about the shells may be interesting. The shells usually consist of three layers: an outer, a very thin, brown, horny layer; a thick, middle, limy layer referred to as the porcelanous layer and an inner, generally thick prismatic layer. Of the molluscs are the Lemellibranchia, the term coming from lamella, meaning leaf, and branchia meaning gills and was chosen because in these molluscs the gills are leaf-like. This group consists of all the headless and degenerate Mollusca, such as mussels, clams, oysters, cockles and scallops. The body is compressed from side to side and always covered with two shells or valves, one on the right side, the other on the left side. Their habitat is mostly marine, living in the shallow waters near the shore where the food is most abundant. Then the Gastropoda which means stomach-footed and has reference to the fact that the animals creep about by the contraction of the sole of the foot which lies on the ventral side. This class includes such shelled forms as the limpets, drills, periwinkles, whelks, conchs and snails. They are most abundant in the shallow seas where they crawl over the bottom; they are far less varied in fresh waters and are represented on land by the vegetarian, air-breathing or pulmonate snails. They are in habit, as a rule herbivorous, sometimes carnivorous and scavengers. The carnivorous forms known as drills bore holes into their shelled victims, with the radula and the aid of a weak secretion of sulphuric acid. The head of most gastropods is usually distinctly marked off from the rest of the body, and has a pair of eyes and one or two pairs of sensory organs or tentacles. Cephalopoda means head-footed and is the most highly organized class of the molluscs and includes such animals as the nautilus, ammonites, octopus, cuttlefish and squid. They all are exclusively marine.

Having concluded the first period of the Early Paleozoic era, we shall then pass into the second or Ordovician period which comprises the rise of nautilids, armored fishes, land plants and corals.

In the Lower Ordovician the first true graptolites existed, also many gastropods, some of which were large and thick-shelled. There was also a variety of straight, bent and coiled nautilus, and many trilobites. During the middle Ordovician the waters swarmed with a vast variety of invertebrate animals, chiefly of bryozoans, which were exceedingly small animals resembling corals, brachiopods, gastropods, cephalopods and trilobites. It is thought that armored fishes came into being during this period as an abundance of fragmentary vertebrate remains has been found which are somewhat similar to the type seen often in the late Silurian and Devonian times. The faunas of the upper Ordovician were at first similar to those of the Middle. But the Arctic invasion introduced new types of animals. These differences are seen more especially among the bryozoans, brachiopods and corals. Before we proceed with the Silurian period let us discuss the animals with radial symmetry as among the lowly organized invertebrates, which were the first forms of life, there is a vast variety in which the outer form and the arrangement of the organs are not bilaterally planned as in other animals. The study of these animals will therefore help us to understand more thoroughly the evolution of animal life.

Animals with radial symmetry are classified into two divisions, the first being the more simply formed or primitive one and which is the stock (phylum) Cnidaria, or Coelenterata, the latter implying that the animals have but one internal cavity which serves both as a body cavity (coelome) and as a digestive cavity or sac (enteron). All higher animals have two cavities, a true body, one which may contain the internal organs, such as the heart and lungs, and within this another independent digestive cavity, such as the stomach or intestine. These higher animals are known as coelomates. The coelenterates are very simple animals in which appear the beginnings of definite organs and as many of them are flower-like they have been called zöophites or plant animals.

The second division is the phylum Echinodermata which includes animals that have marked superficial radial symmetry, but as they have the true body cavity they are therefore coelomates. Echinodermata are exclusively marine and are of great diversity of external form.

The phylum Cnidaria includes two widely different kinds of individuals: the attached polyps and the free individuals or medusae, which are mostly known as swimming-bells or jellyfish. By the way, Cnidaria comes from the Greek for nettle, because the majority of these animals have the power of stinging. This stinging is done by a multitude of very minute threads, each one of which is shot out of a cell buried in the skin and enters any soft body that comes in contact with the animals. The body of these animals is a sac with the closed end attached and the other free, the widely distensible opening being the mouth. Into it is passed the food, which is digested in a more or less simply constructed cavity of the sac, and through the same opening any indigestible remainder is ejected. They feed on the smaller animals, but when the individuals or polyps are minute, their food consists of microscopic animals or plants. Around the mouth is situated radially a number of hollow, finger-like tentacles and much of this tentacular end, or even the entire outer surface, is covered with innumerable stinging cells.

The medusae or jellyfish are very soft, disc or bell-shaped animals with the mouth and stomach hanging from the under side of the bell, while around its edges are the stinging cells.

The hydrozoa or hydroids (named after the nine-headed dragon of Greek mythology because of the many polyps) usually have chitinous external skeletons and a digestive cavity which is undivided and relatively simple in that the walls of the sac are not folded or ridged, while the mouth is rounded.

The graptolites were linearly arranged colonial hydroids with thin chitinous tubular buds, one end of which was fastened to a rod-like axis. The polyps were arranged in a single linear series (mongraptids) or there were two series back to back against the axis or even four series with the rod in the center. A variable number of such colonies were fastened by rods to a float or swimming-bell from which they hung and in this way they were freely suspended in water and drifted along with sea currents. There was also another group of these animals known as dendroids or net-like graptolites and these were of a very different habit, being attached either to seaweed or to the sea bottom. These polyps did not have the axial rod but were arranged on flexible, more or less irregular branches united to one another by cross-bars.

The Anthozoa or flower animals include the sea anemones and corals. They are attached polyps whose internal cavity has hanging down in it a rudimentary, tubular, digestive gullet, opening upward into an elongated mouth and below into the true digestive cavity.

There are many more species of corals but these illustrations I think will be sufficient. Before we proceed with the second division let us make a brief résumé of corals. In the first place they are all exclusively marine, that is living on the shores, in shallow waters and in many instances in deep waters. They feed on animals but in cases where they are very minute they feed on microscopic animals or plants. They multiply either by sexual reproduction or by budding. Sexual reproduction as a rule involves two parents and the production of two kinds of germ cells, the eggs and sperms. It is usually brought about by the union of a sperm cell with an egg, or less commonly by the development of the egg without union with a sperm. Another method of reproduction is by budding. The bud starts as a protrusion of protoplasm in a small area of the surface of a protozoan cell or as a localized proliferation of cells. The protuberance grows until it assumes the form and perhaps the size of the parent. It usually develops organs similar to those of the parent and either becomes independent of, or remains attached to the parent as the case may be.

The second division of phylum Echinodermata includes spiny-skinned animals, a name given because the outer surface of these animals is usually more or less studded with spines and plates. The parts of the body are usually arranged on the plan of five divisions, five radii and the same number of spaces between them. Along each radius are usually two or more rows of soft, tube-like processes terminating in sucking disks; these are the tube-feet which are the chief means of locomotion. However in forms that do not crawl about these organs may be modified into feelers and respiratory organs. The tube-feet are connected with the water-vascular or ambulacral system, a system of tubes consisting of a circular canal extending around the inner side of the centrally situated mouth, from which branch five canals that run along the center of the arms or radii, these five giving off, in turn, numerous lateral branches which connect with the tube-feet. The sea water has access to this system of canals on the dorsal or upper side of the animal through a large porous, sieve-like plate and the animals can force the water into the tube-feet and so elongate them into action. The Echinodermata are divided into two main classes on the basis of their leading a free or sedentary life.

The great majority of starfishes have a more or less large disk from which radiate at least five arms. They may be long and slender or indistinct because of the enlarged interradial areas. It is thought that starfishes first appeared in the Ordovician but it has been found that there are entire specimens in the fossils of Paleozoic rocks.

Echinids are, as a rule, extremely spiny, many of the spines being movable on ball-and-socket joints. They are generally dome-shaped, the wall of the dome being made up in living forms of twenty columns of closely adjoining plates arranged in pairs. Five pairs of these are the ambulacral columns which are perforated by tube-feet and alternate with five other pairs which are not perforated, the interambulacral columns. The mouth is on the lower or flatter side and is often provided with a powerful jaw of a very complicated structure. At the top of the dome or corona is the anal opening, around which are arranged ten plates in one or two circles. The five large plates of the inner ring are the genitals because each is pierced by an opening, the terminus of the genital organs. The five smaller plates of the outer ring, situated at the termini of the five pairs of ambulacral columns, are known as the oculars because in them are located the so-called eyes.

The crinids are Echinodermata which are usually gregarious in habit and fixed to the sea bottom by a more or less long stalk, but there are, however, many free forms that crawl or swim around. They consist of three main parts: (1) the calyx or body proper, (2) the arms, and (3) the stalk. The calyx may be large or small and is made up of a variable number of closely adjoining plates, which are arranged in a very definite manner in the different forms. From the upper part of the calyx arise the arms or radii which are made up of single or double columns of plates and may have a regular series of small armlets arising from their inner edges and known as pinnulae. The ambulacra are situated along the inner sides of the arms and pinnulae where the microscopic food is captured and conveyed to the mouth at the top of or within the calyx. The anal aperture is also on the upper or ventral surface of the calyx but is always more or less eccentrically situated and often drawn out into a long anal tube. The stalk consists of many superimposed, disc-like, perforated pieces called columnals, and is usually short.

The blastids are small, stalked, extinct Echinodermata that arose early in the Ordovician time. They are similar to crinids in their general construction but they differ in that blastids have no arms, only delicate armlets called brachioles. These are situated at the sides of the five large and conspicuous ambulacral areas on the sides of the calyx and which are never seen in crinids.

During the early Silurian the invertebrates, which were the corals, crinids, bryozoans, brachiopods and trilobites, still dominated the seas for as yet the fishes were not at all prominent. The Middle Silurian was very similar to the Lower. In the Upper, fishes first made an appearance but as they are very much like those of the Devonian, we will discuss them later. The scorpions of the Silurian are the oldest known air-breathing animals and probably had their origin in the eurypterids of the sea. But were these scorpions wholly adapted to dry land, or did they live along the seashore between the tides? Their remains are rarely found in marine deposits, but usually in those of brackish water and as they are associated with the eurypterids it would thus seem to indicate a littorial habitat. As the scorpions are carnivorous animals and as there was, at this time no life except that of the invertebrates, on what did they feed? But as spiders are closely related to scorpions and as species of the former are known to inhabit the sea coasts, it is safe to say that scorpions did likewise, feeding on the small invertebrates, among them trilobites and small crustaceans.

As the fishes, because they were the first vertebrates and therefore the ancestors of the vertebrates of today, require a somewhat lengthy discussion, it will be advisable to make a careful study of them now before we enter the Devonian period, as they first became prominent during the Upper Silurian. Fishes are veterbrates without a movable neck and with a distinct and hinged lower jaw. As they all, with a few exceptions, pass their whole life in water, they all have gills and fins. The gills are on each side of the head and consist of delicate, hollow filaments in which the blood circulates, and which are supported by internal gill arches of either cartilage or bone. Water is taken in through the mouth and passed out over these breathing organs, where the blood in the tubes extracts the free oxygen dissolved in it. The external gill openings may remain open and unprotected or may be covered over by a hinged bony cover, the operculum. The mouth may be on the under side of the head or at its forward end, and is usually provided with teeth. Also an air bladder is generally present and serves as a hydrostatic organ or float, though in certain forms it acts as a lung and assists the gills in respiration. The skin is either soft and naked, or more commonly, protected by the development of spines, overlapping scales, or bony plates known as scutes. The principal organ of locomotion is the powerful and very flexible muscular tail, which is assisted by the paired fins, of which the forward set, known as the pectoral limbs, lie just behind the gills, and the rear pair, or pelvic limbs, are placed farther back. Fishes also usually possess a variable number of unpaired fins which are used mainly as balancing organs; those on the back are called dorsal fins, those on the under side between the anus and tail are known as anal fins, and the tail represents a caudal fin. All the fins are supported by skeletal bars or rays, called fin rays, and are covered by muscles and skin. Fishes do not have ears and therefore there is no ear drum or tympanum (ear cavity) and no tympanic membrane. The main nerve trunk line lies on the upper or dorsal side of the vertebrae (the main skeleton consists of the vertebral column made up of joints known as vertebrae) which extend from the brain case to the tail, and it is more or less protected by a bony arch known as the neural arch. Beneath the vertebral column are situated the digestive and reproductive organs. A few words about the tails may be necessary. The tail presents three general types. (1) The vertebral column may be straight at its posterior end, continue in constantly diminishing joints nearly to the end of the animal, and there may be surrounded by a symmetrical vertical tail fin. (2) In others, the vertebral column bends upward toward the dorsal side and terminates with diminishing joints in the upper lobe of the dorsal fin. (3) The modern bony fishes also have a symmetric tail, but, while the vertebral column here again bends upward, it ends rather abruptly and from the terminal joints the fin rays develop in such a way as to form a symmetric tail. The first type is the most primitive and was very common among the Devonian fishes and is known as the diphycercal or symmetrical tail. The second type is most common in the Paleozoic fishes and is known as the heterocercal tail because of the inequality of the lobes. While the third type is most common among the modern fishes and is known as the homocercal type because it is symmetric and has only two lobes.

In spite of the fact that fishes have bony skeletons and that they are known back to the Ordovician, their early ancestors are still undiscovered. Even among the vast horde of living forms and their embryos their ancestry has not been determined, nor as yet has the missing link between the invertebrates and the vertebrates been found. The oldest fossil vertebrates are undoubted fishes, seemingly of elasmobranch character and while vertebrates of a lower type may yet be found it seems as if natural conditions are against this possibility, because the earliest vertebrates must have been not only small but also without hard parts. Among the unsegmented worms (nemertians) the closest approach to the lowest type of vertebrate ancestors in animals often spoken of as half-vertebrates (Hemichordata) is found. Stilll the structural gap between them is, however, great. The Hemichordata are worm-like animals, with a distinct head and tail, and breathe through the anterior region of the intestine (intestinal breathers). In this group in Balanoglossus the rudiments of the future gills, the breathing organs of fishes, are seen. Furthermore, the main nerve-cord is situated dorsally and the intestinal tract ventrally, and these are the fundamental structures around which the vertebrate organization has been evolved.

Balanoglossus burrows in sand and mud in almost all seas. The anterior end is formed of the burrowing proboscis, beneath which on the ventral side is the mouth, followed behind by the collar, then the region of gill slits, and finally a long, soft, slightly coiled portion. There is a dorsal nerve-cord, often tubular, and like a typical spinal cord. The dorsal region of the pharynx is respiratory and the water passes through the gill slits, which open dorsally on the exterior.

The next step is seen among the sea-squirts (tunicates). These animals are greatly degenerate in adult life, due to their sedentary habit, and their vertebrate affinity is only shown in the earliest stages of growth. They are on border line between the invertebrates and the vertebrates. Their tiny larvae are free and active animals and what is so important in these larvae of the sea-squirts is that they have in addition to the hemichordate structures a true notochord in the tail, the notochord being the rudiment out of which the vertebrated backbone of the higher vertebrates has evolved. Sea-squirts are therefore spoken of as primitive chordates, that is, vertebrate animals with the most primitive type of backbone, which, however, is not bone, nor even cartilage, but a gelatinous unsegmented material. The spinal cord or trunk nerve lies above or dorsally to the notochord.

Lancelets represent the third step toward the perfection of the vertebrates, but are an offshoot from the main line of ancestors to the fishes.

Nevertheless, they are a true prophecy of a fish and in them the notochord is well developed as a cylindrical rod of notochordal tissue. However, it is not yet cartiliginous. From the lancelets to the cyclostomes practically all of the intermediate steps are lost. Similarly, many steps are lost between the cyclostomes and the true fishes.

All of the fishes and the higher vertebrates are characterized by having articulating jaws, but there are other vertebrates without jaws which are lower in structure. These are known as Cyclostomata. They are without jaws and paired limbs, and the skeleton is wholly cartilaginous, except the horny teeth, which are set in the mouth in circular and radiating rows. The gills, usually seven in number are in pouches, the external and internal openings being small.

The seas after Middle Devonian time swarmed with corals, brachiopods, and shellfish, and in general the life was not very unlike that of the Silurian. The coral were widespread, and there were also many bryozoans, but the crinids were far less abundant. The blastids and starfishes were also abundant, likewise the trilobites, but which were very greatly reduced in variety. The fishes of this time were primitive in that they did not have well developed internal skeletons and in that they were more cartilaginous than bony. The median fins were often continuous, or a series of fins, extending along the dorsal and ventral surfaces and meeting around the end of the tail. The vertebral column often extended to the end of the tail, with the continuous fin all around it, a type of tail (diphycercal), nearly always present in the earliest stages of modern fishes. Of vertebrates higher than the fishes it is thought that there existed a salamander-like animal with a probable length of nearly three feet.

As we are about to enter the Late Paleozoic era it will be best for us to make a brief résumé of fishes, as fishes are very important in the evolution of animal life being the first vertebrates.

The earliest known fishes are the ostracoderms found in the Middle Ordovician. It is thought that freshwater fishes existed in the Ordovician and which evolved into the lung-fishes, animals that were then more or less adapted to double breathing, that is, had not only functional gills as have all fishes, but in addition lungs, of the Silurian and Devonian. Therefore it appears that the freshwater fishes of the Devonian consisted of spinous sharks, ostracoderms, lung-fishes and ganoids. Hence the most fundamental evolution among the fishes had taken place previous to the Devonian, and the vista in the Ordovician shows that the greater part of it had occurred before the middle of that period. When the seas spread over the land, the primitive fishes occupied their widened habitat, and when the continent emerged, some of them were probably retained in the relic seas. This possibly explains to some extent how fishes came to be found in inland lakes and rivers. Thus caught in the relic seas the ancestors of the spinous sharks were bound to be gradually changed into that of freshwater. There was thus set up a struggle for existence which it is thought eventually resulted in the production of air-breathing animals. The food of the freshwater fishes of the Devonian time must have been water plants and algae as it is known that there did not exist any water-living plants nor invertebrates of any kind except bivalves and myriapods.

There are many diverse methods in marine animals for the extraction of oxygen from the water but whatever the kind, it is always of the same fundamental type, a localized organ or organs having delicate canals with very thin membranes in which the blood circulates, bringing the red corpuscles into almost direct contact with the surrounding water. These red corpuscles have decided affinity for oxygen which they extract from the water and carry through the circulation of the blood to all parts of the animal's body.

Nowhere in the sea has any animal an additional organ for extracting oxygen directly from the air, excepting in such stocks as are known to have had land-living ancestors.

There is in all fishes above the sharks a structure known as the swimming bladder or air bladder, which is structurally a sac-like outgrowth, single or paired, of the alimentary canal. There are, however, two exceptions to this rule, first in those fishes which because they inhabit swiftly running waters, have developed quick darting movements and have therefore lost the air bladder; and, second, in the flounders that lie upon the bottom awaiting their prey. The principal function of this structure is to give buoyancy to the animals, and it is controlled by muscles in such a way as to permit its possessor to remain at any desired level in the water. The air bladder is the homologue of the lungs of the terrestrial vertebrates and is utilized by the so-called lung fishes as a respiratory organ supplementary to the gills. Stagnation of the water and a loss of free oxygen would bring the fishes to the surface to gulp down the air, and such pouches if supplied with blood-vessels would serve to aid in aerating the blood. Animals originating and living in permanent bodies of water and especially in the ocean have no need to breathe the air and therefore an alteration could have taken place only where the water failed the animals. It is thought that under the stimulus of climatic changes the gill-breathing fishes first adapted themselves to burrowing in the sand and thus protected in water and mud holes there was for a time moisture to pass over the gills. After many failures in their efforts to gulp the air into the pharynx, the lung-fishes gradually developed and perfected, their first appearance being in the late Silurian time.

In Waverlian times (the first division of the Mississippian period) life was most diversified, and the sea was filled with an abundance of crinids in great variety. Brachiopods, bryozoans and cup corals were also abundant but none attained the profusion of the crinids. Large sharks were becoming more and more plentiful and among cephalopods, the nautilids were no longer so prevalent as they were in earlier times. Their descendants, the goniatites, were more common than in the Devonian, and the trilobites were almost gone. The carnivorous or aggressive life of the Waverlian sea was therefore dominated by the pavement-toothed sharks. Of land life little is known other than plants and as I shall not discuss plant life, I shall refer the reader, if he be interested in the evolution of plant life, to a text-book on Historical Geology.

The marine life of the Tennesseian time differs in many ways from that of the Waverlian, but as it is largely a direct outgrowth of the latter it naturally cannot vary greatly. The crinids were no longer so diversified as in the preceding epoch, but the two other groups of echinoderms were far better developed. These were the blastids, described elsewhere, and, though far less common, the sea-urchins known as Melonechinus. Bryozoans were also characteristic of this epoch as were likewise the pavement-toothed sharks but which were rapidly dying out. There were many kinds of cup corals and one type of compound coral formed small reefs. Toward the close of this period there were many kinds of amphibians but as yet we know nothing of them.

The Pennsylvanian period first saw the rise of insects, but it is thought, however that they may have arisen in the Devonian. They were as a rule large in size and primitive in structure, and led an amphibious life, their youngest or larval stages being spent in the water. In general they were not carnivorous animals but as they had powerful chewing mouths it is thought that they fed on plants and dead animal matter. They had four straight wings, all alike which projected sideways like those of the modern dragon flies and could not be folded back over the abdomen as in modern insects. The thorax had three segments, followed by a long and slender abdomen in which the segments were alike, ending in two long appendages connected with the breathing organs, as in the living may flies. Their eyes were compound and their antennae simple. These primal, which are thought to have arisen from the trilobites, gave rise to several transitional stocks, which in turn changed into the modern insects, such as the dragon flies, cockroaches and grasshoppers.

The scorpions and many forms of rather stout spider-like animals, having a distinct cephalothorax (head-trunk) and usually a large abdomen are found in this period. Thousand-legs or Myriapoda are plentiful in this period but there is no evidence of land snails until the Middle Pennsylvanian.

The Amphibia are most common in the Pennsylvanian and their origin goes back to at least the Middle Devonian. The Reptilia, however, appeared first in the Upper Pennsylvanian. The evolution of the air-breathing vertebrate life of the Carboniferous is the most important phase of the whole progress of evolution, for at the close of this period forms foreshadowing the chief groups of modern times are found. The Amphibia, for the most part, were small creatures related to the living salamanders and known as branchiosaurs and microsaurs. They were rather sluggish animals living about or in the water and were more or less protected against their enemies by an external bodily armor. Some of the microsaurs, however, lost the dermal armor completely and became fleet of movement, which is best seen in the structure of the limbs.

As to the invertebrate life of the Pennsylvanian brachiopods are very common but toward the close of this period their places were being taken by the bivalves. While the brachiopods were vanishing, the shelled cephalopods in the goniatid and ammonid stocks were rapidly changing into a variety of forms. A few words might here be said about the Protozoa whose individual organization is contained in a single cell, and which represent the first form of animal life. These Protozoa were tiny, naked or shelled globules of streaming protoplasm, with a central, more solid sphere known as the nucleus, which is the seat of vital energy or life. They sometimes live singly but more commonly in colonies.

During the Middle Paleozoic, after the lands had been clothed by plants, a habitat capable of sustaining animal life was thus established and destined to be mastered by several stocks of invertebrates and dominated by vertebrates. Among the backboned animals, the first inhabitants of the dry land were the Amphibia, whose short reign lasted only through the Devonian and Mississippian. Then came the Reptilia, which began their ascendancy in the Pennsylvanian and ruled the lands and even the seas until the close of the Mezozoic. To understand this evolution, it will be necessary to study the organization of these two types of animals.

Amphibia differ from fishes in that they have legs and not fins, each leg bearing fingers or toes. Nearly all of them breathe by gills when very young and may retain these organs throughout life; lungs are however, nearly always present in the adult. All Amphibia are cold-blooded animals and the name, which means living a double life, was given them because many of them live both on land and in fresh water. The sexes are always separate and in the great majority of species the small eggs are fertilized in the water and develop there without further care from their parents. The development is therefore very much the same as in fishes and very unlike that of the higher vertebrates. The eggs of frogs and toads for example, develop into small animals commonly known as tadpoles or polywogs, with a more or less large and rounded head and body terminating in a long and very flexible tail, which they wriggle in swimming, as do the fishes. These tadpoles have gills which at first project from the sides of the head, but are later covered by an operculum. In about two months they attain a stage which is the equivalent of the lung-fishes. They then undergo a marked metamorphosis, the hind legs appearing first and later the front pair, which are hidden under the operculum. The long tail shortens through internal absorption and the gills gradually are also absorbed or drop off. The lungs then appear, and for a time the young creatures are fully amphibious, breathing water through their gills and extracting the free oxygen from it, and also taking in air through the lungs; but soon the small frogs or toads take to the land and breathe air only.

All Amphibia in their youth are provided with two or three pairs of external gills or internal ones with external gill-clefts, soft feathery outgrowths situated at the back part of the head and rich in blood vessels. In the salamanders of the land and in all of the tailless Amphibia, the gills disappear and adult respiration is carried on wholly by lungs as in the higher vertebrates. While the gills are present, the air passages to the lungs through the nose do not open into the mouth, but assume this position as soon as the gills vanish and the lungs become functional. The air is then taken in through the nasal openings and in the frogs is forced into the lungs in a swallowing manner. In none of the fishes are there functional ears, though there are internal ones; but in the amphibians, however, there are distinct organs of hearing. In the frogs these are best seen where the tympanic membrane of the ear drum is a more or less large circular disc embedded in the outer skin on the sides of the head. The cavity behind the disc or drum connects with the back part of the mouth by a tube known as the Eustachian tube which is also present in all of the higher vertebrates. The first amphibians were known as Stegocephalia, a term which means covered or mailed head and has reference to the fact that the upper surface of the skull was roofed over by more or less thick dermal bones which were often much sculptured. As the reptilia developed out of the Stegocephalia, a brief description will be necessary.

Some were small and active, with well developed walking legs and relatively short tails; some were active swimmers, with long tails; others of medium size were thickset and sluggish in habit; while a few had the appearance of being gigantic and almost legless. Their heads were usually broad and flat, with very wide mouths almost the full width of the skull, but in some forms the heads were more or less elongated. They lived not only in fresh waters, but unlike their descendants also in brackish ones. Most of them were probably carnivorous and fed on shell-fish, worms and other water invertebrates, but more particularly on fishes, reptiles and small members of their own tribe. In the great majority, the limbs were well developed but short and stumpy, and the hind limbs were nearly always longer and heavier, and bore five toes on which the second and third were usually the longest. Another important fact is that in the armor or roof bones and those of the true skull was pierced not only by the lateral orbits in which the paired eyes were situated and by the pair of anterior nasal openings, but by also a single small orifice through the bone over the brain, and in it was situated a third eye known as the pineal eye. We have thus seen in all of the vertebrates so far discussed that their habitat is either wholly in the water or at least that the very small eggs are there laid and fertilized externally, and that the young are also borne and spend the days of their youth in this element. Of the higher vertebrates they remove themselves more and more from this habitat and none are developed directly from the eggs. The reptiles are oviparous, laying large eggs with a more or less quantity of food (yolk) and these eggs are fertilized internally by the males before they are laid by the females upon the land where they hatch by the warmth of the sun. This is the most fundamental difference between the lower vertebrates, the fishes and amphibians, and the higher vertebrates, the reptiles, birds and mammals.

The word reptile means crawling or creeping and has reference to an animal that goes on its belly like the snake, or moves with difficulty on short sprawling legs like the alligator. All living reptiles are cold-blooded like the fishes and amphibians, and their skin is never soft, but always more or less hardened by horny or bony material that occurs more often as scales than as armor plate. Each animal has a pair of lungs and the legs are either wholly absent or are mere vestiges buried in the flesh and in such animals locomotion is attained by wriggling movements either over the ground or through the water.

Whenever legs are present, the fingers and toes have claws, a feature which is very rare among the Amphibia. Eyelids are present in many reptiles and in most lizards, and in most lizards and fossil reptiles the pineal eye is well developed. The organs of smell and hearing are also well developed, but in the reptiles the vibrating, or tympanic membrane of the ear-drum is no longer external, as in frogs, but lies in a depression. All have teeth except turtles and in living forms these are usually pointed and often recurved to serve for the holding of their prey, whereas in the fossil forms they were adapted for cutting and more rarely for the mastication of food. The tongue in snakes and some lizards is slender and protruded in a darting manner, while in other reptiles it is flat and immovable being then attached to the floor of the mouth. In some living lizards and snakes the females are viviparous but in the great majority of reptiles, however, the females are oviparous. As the eggs of reptiles develop on land they must be different from those that hatch in the water. In the latter the embryos have functional gills for the use in the water, but in the reptiles a wholly different organ was developed to provide the growing young with the necessary oxygen. Reptile eggs are large and contain a great deal of yolk on which the embryo lives. At one pole of the egg lies the fertilized germinal vesicle which develops into the embryo. There is formed during its earliest growth at either end of the elongate embryo a two-layered, crescent-shaped fold, called the amniotic fold, which arches over the embryo and finally unites to cover it with a protective hood. This latter is the amnion and between it and the embryo there is a shallow cavity containing a watery amniotic fluid, bathing and protecting the outer surface of the embryo. While the amnion is being formed a sac grows out from the hinder end of the embryo. This sac, which is of the greatest importance to the animal, is never seen in fishes and amphibians, and is called the allantois. This allantoic sac provides the embryo with necessary oxygen, passing this and other gases through the porous shell. Finally the embryo breaks through the shell and begins to use its lungs. A brief description of some of the early reptiles might be helpful. The Cotylosauria were the solid-skulled reptiles and as they were the most primitive of the group, they retained many of the ancestral stegocephalian characteristics, but there was at least one pair of temporal openings and the teeth were not placed in grooves. The skull was armored with sculptured plates, the pineal eye was large and a skin armor was sometimes present. They (cotylosaurs) were small and all were carnivorous though some fed on plants. The Pelycosaurs were more active with longer tails which were however not used for swimming. They were fiercely carnivorous and in certain forms the teeth were enormous and in others somewhat flattened. They, like the cotylosaurs, lived from the late Pennsylvanian to the late Triassic period. Theriodontia were reptiles which lived only in South Africa during Permian and Triassic times and are of great interest for they indicate the probable group of reptiles that gave rise to the lowest or egg-laying mammals. We thus conclude the Paleozoic or ancient life and shall now enter the Mesozoic or Medieval life which is the age of reptiles.

The Mesozoic Reptilia were very diversified in form and adaptation. Out of these reptiles early in the Triassic arose the small and insignificant reptilian and egg-laying mammals, and from another stock came the reptilian birds, with an abundance of teeth. Both stocks at the close of the Mesozoic era began to modernize into suckling mammals and toothless birds respectively. Of the Paleozoic amphibians the stegocephalians vanished with the Triassic; likewise the trilobites, eurypterids, blastids, tetracorals and graptolites, while the crinids, echinids, and brachiopods were greatly modified. The bivalves and gastropods were also undergoing a great change and the ammonids of the Permian gave rise to a wonderful evolution but were almost exterminated at the close of this period. The lung-fishes of the Triassic were greatly reduced in number and the dominant forms were the ganoids with the bony fishes advancing toward our present type.

The vertebrates of the land were now very varied exhibiting much structural and adaptive progression over their late Paleozoic ancestors. Crocodile-like reptiles of the sprawling type and other active forms were common, but the dinosaurs, however, were the lords of the land and they were present in great variety and in great size. Some were herbivorous; others were carnivorous; some walked on all fours while others walked occasionally or habitually on two legs, after the manner of birds. We have seen how freshwater vertebrates were forced to adapt themselves to the land and now that the reptiles were firmly established on the land we see them going back again to the water, not only intermittently to the lakes and rivers but permanently to the seas and oceans where there was a more certain food supply. We therefore see to what a wonderful extent organisms can adapt themselves, for limbs have been changed from walking legs to swimming paddles, and the egg-laying method of rearing the young has been altered to that in which the young are born alive. As to the marine invertebrates the seas swarmed with ammonids in great variety. The bivalves and siphonate were in the ascendency though still common in some places were as a rule very rare. We shall now make a study of the dinosaurs, the rulers of the Mesozoic, before entering the Jurassic period.

There were two main groups of dinosaurs, one herbivorous and the other carnivorous. The carnivorous dinosaurs, to which the name Theropoda has been given and which means beast-footed, were active forms running upon their hind limbs and with hands and feet armed with increasingly powerful claws and jaws with slightly curved dagger-like teeth, with which they relied for sustenance and defense. The Theropoda verged into three lines of descent two of which remained carnivorous and terrestrial in habit, one being a smaller, more agile race preying upon the humbler reptiles and possibly upon the birds, the other growing more and more ponderous as time went on. One peculiar feature of their evolution was the arrest of the development of the fore limbs until they became so small as to be absolutely useless. The third race which evolved from the theropodan stock and which was named Sauropoda (meaning reptile-footed) had a very brief career. This group is represented by the majestic Brontosaurus, a creature ponderous of body and with a long tapering neck and tail. The teeth being blunted and often somewhat spoon shaped were so ill fitted for any type of food that we do not know the precise nature of the animal's diet. It is thought however that some plant that existed in great abundance at that time formed the chief food supply and which was not masticated but detached by the claws and teeth and swallowed intact. None of the Sauropoda were small, the Brontosaurus being of representative size. They inhabited the sluggish waters of an imperfectly drained country, which supported their huge bulk and supplied the plants upon which they fed. The other great dinosaurian race was exclusively plant feeding and bore within the mouth a wonderful battery of teeth. The teeth were few and simple at first but becoming as time went on more numerous until in Trachodon the dental battery contained no fewer than two thousand teeth.

These predentate dinosaurs, as they were called from the peculiar toothless bone that united the two halves of the lower jaw, soon differentiated into two distinct races, the unarmored bipeds and the armored quadrupeds, while from the latter arose a third, the horned dinosaurs or Ceratopsia. Of these three types, the unarmored Ornithopoda, or bird-footed dinosaurs depended for defense largely upon fleetness of foot. As they had a powerful compressed tail and their hands had a webbed character, they had the swimming powers of an alligator and still retained the ability to travel rapidly on land. When therefore they were hard pressed by the carnivores they could easily take to the water if they were unable to escape the onslaught by speed ashore. But all herbivorous dinosaurs were not of this defenseless type. The second race, the Stegosauria, or armored dinosaurs, had their bodies encased in an almost impregnable armor. Later the armor became more and more massive, the bony elements being welded into a broad protective shield or carapace covering the creature's back, while the heavily armored tail was like a huge battle mace. A most remarkable feature of Stegosaurus is perhaps its extremely small brain, the estimated weight of which is but two and a half ounces. They were very stupid, depending for defense upon the automatic control of the muscles after the feeble glimmer of thought had given the initial impulse. The final group of plant feeders, the Ceratopsia or horned dinosaurs mark the culmination of medieval time. These forms had a huge head upon which were horns two, three or five in number, borne upon the nose or above the eyes. The neck was protected by a wide spreading flange of massive bone with serrate edges and invested in a close fitting covering of a horny substance. The animals fought as a rhinoceros might by charging and impaling its enemy with a sweeping upward thrust of its head. It is thought that the bird-footed dinosaurs and the birds were derived from the same reptilian stock, as the structure of the shoulders and hip bones and the ankle joints are extraordinarily like those of the birds, and that in the birds the small grasping front limbs have been transformed into wings. This evolution probably took place earlier than the Upper Jurassic where reptilian birds are known. The dinosaurs ancestrally were doubtless water-loving quadrupeds, but the increasing aridity of the climate compelled them to travel rapidly and far in the search of food and drink. And this was probably the impelling force that raised these creatures from the prone gait and posture and stimulated their rapid evolution into the several types. As to extinction of this mighty race there are numerous conjectures. One is that a severe change of climate with a diminution of the necessary heat without which no reptilian race may thrive, or of the moisture with an accompanying change of vegetation was the cause. Another the internecine warfare amongst the dinosaurs themselves and another of the destructive slaughter, not of adults but of the young, possibly while yet in the egg, by some small bloodthirsty mammals. But nevertheless we have seen the rise, slow culmination, and dramatic fall of one of the greatest nations of antiquity.

In the Jurassic, insects began to feed on the plants, but as yet few visited the inconspicuous flowers for their small amounts of honey. There were as yet no butterflies, but the caddis-flies, scorpion-flies and beetles were abundant. Other kinds of insects known from this time are cicadas, grasshoppers, locusts, cockroaches, ants and termites. The reptiles in this period attained a higher and more diversified development than in the Triassic. True lizards appeared with this period and turtles were very abundant. One of the most remarkable groups of Jurassic carnivorous reptiles was that of the flying dragons or pterosaurs (from the Greek words meaning wing-lizard). They appeared late in the Triassic and were characteristic and important in the Jurassic. They ranged in size from that of a crow to three feet across the wings. The fore limbs of these animals were modified into wings and, like the bats of today, they actually flew. Their heads were relatively large but lightly constructed and set at right angles with the neck as in birds. The legs, like those of the bats, were small and weak, and the tail was very short in some species and long in others. They were carnivorous animals, feeding in the main on fishes, small reptiles and crustacea. Of birds only one kind is known that appeared during this period. This bird, about the size of a large pigeon, is called Archoepteryx (from the Greek words meaning ancient wing), and has many points of resemblance to the reptiles, and many characteristics which recur only in the embryos of modern birds. The Ichthyosauria (Greek for fish-lizard) were a highly characteristic group, for though they appeared in the Triassic and continued into the Comanchian, the Jurassic and especially the Lower Jurassic was the time of their principal expansion. The ichthyosaurs were entirely marine in their habits and preyed upon fishes. Their limbs were converted into swimming paddles, and there was a dorsal fin and a large tail-fin, the latter being the principal organ of propulsion. The muzzle was drawn out into an elongated slender snout, armed with numerous teeth, which were set in a continuous groove, instead of in separate sockets. The neck was short and the skin very smooth. Another group of carnivorous reptiles was that of the Plesiosauria (Greek for near-lizard) which appeared in the Triassic and culminated in the Jurassic and which formed a curious contrast to the ichthyosaurs. The heads of these were very small and the jaws were provided with large, sharp teeth, set in distinct sockets. The neck was exceedingly long, slender, and serpent-like, and was marked off distinctly from the small, box-like body. The swimming paddles were much larger than in the ichthyosaurs and probably had more to do with locomotion. Of all the Paleozoic fishes all were absent in the Jurassic except the ganoids and lung-fishes. The former were now at their highest development, not only in the fresh waters but in the seas as well. The sharks of the seas had attained their modern development, and in the Jurassic the flat fishes known as rays made their appearance.

The seas of this period were replete with invertebrate life. Sponges were very common and crinids were at times. In the Lower Jurassic are found the largest forms of crinids that ever lived. Likewise sea-urchins were common, but not so the starfishes and brittle-stars, and those that were present were of the modern type. Brachiopods were still plentiful, also the gastropods, and the seas were full of small and large bivalves, but the most characteristic shell-fish of the Jurassic were the ammonids, to be described later. The crustaceans are represented by many kinds of lobsters and the ancestors of the modern crabs also appeared during this period.

As I have said, the Mesozoic seas were characterized by an abundance of the shelled cephalopods known as ammonids. These beautiful coiled shells, relatives of the nautilids, were exceedingly varied in size, shape, ornamentation and in the character of their septa. They exceeded the Paleozoic nautilids as much in size as they did in specific differentiation. They also appear to have been more active animals and better swimmers than the nautilids and therefore crawled less over the bottom of the sea. The belief that they did swim well is deduced from the nature of the very thin shells, the wide distribution of some of the species, and the small depth, or narrowness, of the coiled cones. The shells are somewhat like those of the nautilids but they differ in a number of respects. They are nearly always more ornate, narrower or less deep, and are often distinctly keeled along the center of the outer whorls. Also the mouth of the shells often has lobed extensions on the sides and there is also a median keel that may be drawn out into a sharp point, the rostrum. In nautilids the mouth of the shell is never closed by an operculum, but in the goniatids and ammonids it probably was closed in most forms by a covering when the animal was at rest. But these differences are, however, not so important as is the nature of the septa. In the nautilids these partitions in the chambered shell are simple and more or less concave, while in the ammonids they are simply only in the central part, and each septum becomes more and more fluted or wavy toward its junction with the outer shell. Late in the Silurian, the deep-shelled nautilids gave rise to small and narrow-shelled goniatids with sparingly lobed septa. In most goniatids of the Devonian, the suture line of the lobes and saddles terminates sharply, but in the Mississippian the majority of the species not only have more lobes and saddles, but these are nearly all rounded. Thus we see a gradual change in the narrow-shelled cephalopods, beginning as true nautilids, and passing into various stocks of more or less narrow-shelled goniatids that finally gave rise in the Carboniferous to many lines of evolution among the primitive ammonids. During the late Permian and early Triassic the greatest variation took place and at the close of the Triassic they mostly disappeared, probably due to a colder climate and oceanic water. In the Jurassic there was another rapid evolution out of two or three stocks only and the height of development was attained at this time. The waning of the ammonids began in the Comanchian and their complete extinction came at the close of the Cretaceous during the critical time of the Laramide Revolution.

In addition to the ammonids, the rise of the belemnites, the ancestors of the cuttle-fishes, took place during the Mesozoic. The belemnids were very active, highly carnivorous cephalopods, which fed on fish, crabs and molluscs. They had large and fully developed eyes, were devoid of external shells, and because they had but two internal gill-plumes, the name Dibranchiata has been given to them. They had ten arms, possibly eight short and two long protrusible ones. In the Mesozoic these arms were often provided with bent chitinous hooks for holding, and more rarely with holding suckers. They are all provided with an internal ink-sac containing sepia, a brown-black fluid that mixes readily with water; this the animals squirt in front of them when in danger and then make their escape backward away from the defensive screen of colored water. Like the other cephalopods, they are provided with a siphon through which water is shot forward thus propelling the animal forward. They can also swim with the aid of their side fins.

In the Comanchian period, the reptiles probably attained the zenith of differentiation, when the dinosaurs were present, not only in the greatest variety, but in the greatest size as well. The most characteristic ones were the Sauropoda described above. The flesh eating dinosaurs of this period were also large and terrible, but neither so large nor so ferocious as those of the next period. Also it is interesting to note that the oldest American frogs made their appearance during this period, but as they were very small they apparently were not of much significance in the animal world of their time. The ammonids were still plentiful though less so than in the Jurassic. In the Comanchian they began to show a great loss of vitality, in that only a few stocks arose, while old ones were evolving toward a loss of characters and an unwinding of the shell. The belemnids were still abundant and flourishing. As to the other invertebrate life of the sea, the sea urchins were very varied and prolific in the warmer seas while the heart urchins here and in the Cretaceous attained their climax of evolution. Among the bivalves, the ribbed oysters and the oyster-like Gryphaeas were very abundant. In the equatorial waters there arose remarkably aberrant stocks of bivalves, in which one valve was cemented to some object, the shell growing upward into a short or long, twisted, thick cone, while the covering valve was either twisted or a thickened and simple hood. These were the chamids and rudistids, which also continued into the Cretaceous and then gave rise to the caprinids and larger rudistids, shells that were veritable reef-builders.

The life of the Cretaceous was the culmination of the dinosaurs, pterosaurs and reptilian mammals that began in the Triassic, the toothed birds of Jurassic origin and the marine faunas of Jurassic time and it was the final expression of medieval life and out of it arose the modern world of organisms. The invertebrate animals of the Cretaceous were much like those of the Comanchian with the difference that the ammonids were making their last stand as I have explained by the uncoiling and unnatural twisting of their shells. The belemnids were still present but not so abundant as in the Jurassic. The unionids or pearl shells were common, also freshwater snails and land snails.

Of this period, the most common and characteristic of the herbivorous dinosaurs were the Ceratopsia, which were horned animals, sometimes twice as heavy as and larger than elephants. Their name is derived from the Greek *keras*, a horn, because they have on their heads two or three large horns. Of all the large theropod dinosaurs there were several kinds, but the most terrible of all in size and weight and ferocity was the form known as the King Tyrant Saurian (Tyrannosaurus rex) probably the mightiest flesh eater of all time, carrying his head sixteen feet above the ground and measuring forty feet along the vertebral column. Flying reptiles or pterosaurs of early Cretaceous time are known in gigantic species. They were without teeth and tail, the head being more than three feet long, and narrow, while some forms had a long, rudder-like crest extending backward from it two feet. They soared over the sea and, diving like ospreys, picked out of it the fishes on which they fed. The seas of this period continued to be dominated by reptiles. The ichthyosaurs were vanishing but as to the plesiosaurs, they attained their culmination during this period. The most interesting of the newly appearing animals were the scaled reptiles known as mosasaurs which were confined to the Cretaceous. They were gigantic in size, carnivorous, marine lizards ranging in length up to twenty-three feet, with their limbs modified into swimming paddles. In the early Cretaceous, oceans began to spread over the continents and it is therefore interesting to note that there was great opportunity for expansive evolution, but few new marine stocks appeared. But it was a time of death instead to many characteristic ones. In the late Cretaceous, ammonids, belemnids, rudistids and other stocks of molluscs disappeared. Likewise there was a great reduction among the reef corals, the replacing of the dominant ganoids by the teleosts or bony fishes, and, finally the complete dying out of the various stocks of marine saurians. On the land the dragons or pterodactyls vanished, likewise the dinosaurs and birds with teeth. In the sea the reptiles were displaced by the teleost fishes; on the land they were overwhelmed by the rise of the mammals; in the air they yielded to the more finely organized birds, or, in other words, the reptilian dominance was destroyed with the end of the Mesozoic era, during which entire time they had been the characteristic animals of the sea and even more of the land.

We now enter the third era, the Cenozoic, or the time of modern life. The lands of this era were dominated by mammals, and the seas and oceans were not devoid of them. Mammals were as characteristic of the Cenozoic as reptiles were of the Mesozoic. They, however, had their origin in the Triassic but at no time during the Mesozoic did these small animals take the lead among organisms. Mammals, structurally the highest group of animals, are warm-blooded vertebrates with glands that secrete milk when the females are nursing young. These glands which vary in number from one to eleven pairs, are the mammary glands or breasts, the structures from which the class has taken its name, for mamma means breasts. They are also present in males but are rudimentary and non-functional.

Mammals are all more or less covered with hair and these growths of the skin are as characteristic of mammals as feathers are of birds. The body cavity differs from that of all other vertebrates in that it is completely divided into two parts by a muscular membrane, the diaphragm, which separates it into a thoracic cavity containing the heart and the lungs, and an abdominal cavity containing the remaining viscera. There are two sets of teeth in most mammals, the milk dentition or temporary teeth which eventually fall out, and the permanent teeth which succeed them. The heart is four-chambered as in the other class of warm-blooded animals, the birds, and the course of the blood through it is the same in both. For a better description of the heart and the motion of blood in animals Harvey's "On the Motion of the Heart and the Blood in Animals" is an excellent treatise. Most mammals have a completely terrestrial habit while the seals, sea-lions, sea-cows, whales and porpoises live in the ocean. One order of wide distribution, the bats, have developed the front limbs into wings, while other stocks have lateral or body membranes between the limbs, and spreading these, glide from tree to tree.

The Tertiary opens with an archaic indigenous mammal fauna, a most curious, strange and bizarre assemblage, which is an advanced and diversified fauna, the descendants of Mezozoic mammals. Later appear the modern animals and their introduction sounds the death knell of the archaic forms, for one stock after another vanishes and most of them are gone before the close of the Eocene. It is usually thought that the modern mammals originated in Asia, although we do not know for a certainty. A most striking feature of the life of early Eocene time was the appearance in considerable numbers of diminutive horse-like forms, fleet-footed rhinoceroses, tapirs, the first ruminants and pig-like forms, squirrel-like rodents, insectivores, carnivores, lemurs, monkeys and possibly also marsupial opossums. It was in other words the mammalian life of a mountainous country, superior in foot and tooth structure to the indigenous archaic fauna, and of a higher intelligence. In the later Eocene, the changes were largely toward greater size, more muscular power, and the origination of new indigenous forms. There were many hoofed animals and all were browsers. During this period appeared tiny camels, true tapirs, oreodonts (an extinct group of ruminating hogs peculiar to America), giant pigs, armadillo-like animals with leathery shields, and primitive dog-like forms. Also there were many hoofed forms such as the titanothers and the very characteristic uintathers, mammals unlike anything living now, and fleet-footed rhinoceroses. It was during the Oligocene that mammals for the first time took on a modern aspect, for here nearly all were progressive forms. In this period we get our first knowledge of the varied mammalian life of the plains and of grazing mammals. Rodents were common, such as beavers, squirrels, pocket gophers, mice and hares. Among the ruminants, peccaries were numerous, the entelodonts were of large size, and the oreodonts, not unlike the peccaries and wild boars in appearance and size, were exceedingly abundant, varied, and ran in great herds. Among the carnivores, small dogs were remarkably abundant and diversified. The last of the archaic creodonts occurred here and as they vanished their place was taken by dogs and later by wolves and first sabre-tooth cats; true cats, however, were not yet present. At the time of the Miocene period there were large numbers of horses, camels, ruminants and rodents with high-crowned, persistently growing, grinding teeth. There were also four-tusked, browsing, long-faced mastodons, the short-legged rhinoceroses, the cats, and beavers. The most prominent of the Miocene mammals were the horses, which roamed the plains in great herds. All were three-toed and at first all were still browsers, but later in the Miocene the grazing type predominated. Likewise the camels were plentiful and rhinoceroses were present in great variety, some hornless, others with a single horn on the end of the nose, and still others with an additional horn on the forehead. Peccaries abounded, and the last of the giant pigs, the entelodonts, were present, one of them, in the Lower Pliocene, being over six feet tall. The first true deer appeared in the Lower Miocene, and in addition there were hornless deer and antlered deer-antelopes that were slender and graceful little creatures. Among the carnivores, the dog kinds were in great variety, some small, others as large as the largest bears. True cats appeared here for the first time, and the sabre-toothed tigers were plentiful though not large. There were also weasels, martens, otters and raccoons. During the Pliocene, of the mastodons there were several species; the horses in considerable variety remained three-toed; llamas and the tallest giraffe-like camels continued to live; rhinoceroses with and without horns were present; sabre-toothed tigers and true cats existed, some of them as large as a lion. Strange to say that as it is assumed that all mammals had their origin in Asia with the exception of camels, which originated in the Upper Eocene of North America and had a complete development in the Tertiary, they are today found in Asia, and likewise the llamas are at the present time found in South America. The most striking mammals of the Pleistocene in North America were the three species of elephants and the one of mastodon. The last named was most abundant in forested regions and rarer in the plains country. Of the elephants, the most interesting and widely distributed was the Siberian woolly mammoth, an animal of the cold climate and coming to North America by way of Alaska. The mammoth also migrated from Asia into Europe. The Columbian elephant was closely related to the mammoth but being of taller stature. It lived during the earlier half of the Pleistocene time in the warmer portions of North America roaming over the whole of the United States. The horses were very numerous and also the peccaries, camels and llamas. The caribou and modern moose were likewise present while the stag-moose was a late arrival. Among the carnivores the sabre-tooth tiger was the most formidable. Of the rodents the giant beaver was the most interesting and as large as black bear. The ground sloths were represented by a large and widely spread form, while the giant southern had a body as large as that of an elephant, though shorter in limb. Of ruminants related to the musk-ox they occurred later in the period and of the bison there were at least seven kinds.

We have thus seen how life originated and how it has evolved through countless ages. We have witnessed the formation of small animals from inanimate inorganic matter. Animals that were composed of only one cell, small microscopical animals, whose period of activity, by this I mean the time when they were the only form of animal life on this earth, is known as the age of unicellular life. Then came the dominancy of the trilobites, the first invertebrate animals and which were followed by the rise of shelled animals. Following these came the rise of the nautilids, armored fishes and corals. With the first air-breathing animals, namely the scorpions, we have become acquainted and also with the lung-fishes, fishes that had lungs in addition to gills. When the oceans spread over the continents and new lands emerged we have seen how these lung-fishes, due to inadequate amounts of free oxygen in inland waters, and in which these lung-fishes remained, gradually changed into amphibians, animals that in addition to gills had lungs, and that sometimes lived on land and at other times in the waters. We, also at this time, made a comprehensive study of fishes, the first vertebrates and ancestors of our modern mammals. The rise of echnoderms and sharks then occurred, likewise the primitive reptiles and insects, the descendants of the trilobites, the first invertebrate animals. Then came the modern insects and ammonites and first land vertebrates. The dinosaurs made their first appearance at this time and continued to be the dominant animals for a long time. Chief among which was the King Tyrant Saurian, the mightiest flesh eater of all times.

Following the dinosaurs the birds made their appearance, the oldest of which is known as the Archaeopteryx. During the same time we see the rise of the flying reptiles or pterosaurs. At the close of this era the great reptiles began to vanish but they were followed by the rise of the archaic mammals which were however reptilian. But they soon however vanished due to the rise of the higher mammals. It being assumed that the modern mammals had their origin in Asia we have seen that by migration these animals have spread all over the earth, and strange to say that camels which originated in North America are today found in Asia and South America, but it is not that point that I wish to be emphasized, but the fact that camels were the only mammals that had their origin in a different land, and why this is so, no one knows. We have thus made a brief review of the evolution of animal life and shall now discuss the origin and evolution of man.

There are today two theories or beliefs, as to the origin of man, which have been accepted by the civilized world, namely the theological and scientific. Let us state the theological theory as follows: And God said, Let us make man in our image, after our likeness; and let them have dominion over the fish of the sea, and over the fowl of the air, and over the cattle and over all the earth, and over every creeping thing that creepeth upon the earth. So God created man in his own image, in the image of God created he him; male and female created he them.

The scientific theory expounds the fact that man descended from the animals, namely the apes, and this theory is based on the fact that the skeleton of man is identically the same to that of a gorilla, excepting that the bones of the gorilla are somewhat larger. Also, organ for organ, they are similar. We therefore perceive that these two theories differ greatly. What then is to hinder us from forming a third theory?

Have we not the privilege of thinking as we wish? We do not know and probably never will know how man originated. More and more members of the clergy are tending toward the scientific theory, forsaking the belief that they have been taught, for a belief that is based on fossil remains. I myself believe the scientific theory as to the origin and evolution of animal life, for that theory is reasonable and has been proven. But to the scientific theory as to the origin of man I strenuously object for it is complete with unexplained statements and with the famous missing link. Does this theory explain the origin of the white race? It surely does not. The advocates of this theory may claim that the white race descended from the apes. But what of the black race and the yellow race? Did they also come from the apes? Such a thought is ridiculous as well as impossible. They might claim that by migration man became accustomed to different climates and therefore turned white, black or yellow as the case may be. But can a white man today become black by living in a hot climate any more than he could at that time. A black man could become eventually white through an intermixture of breeds but surely not by living in a temperate climate. I do not wish to say that man did not evolve from animals, but this point I wish to be emphasized that the scientific theory does not explain the origin of the white race. As for the theological theory, the Bible has been rewritten so many times that it has finally become an inauthentic source of information on this point. This theory also cannot explain the origin of the black race. We have therefore two theories, one of which cannot explain the origin of the white race, the other which cannot explain the origin of the black race. Why can we not then formulate a third theory which will explain the origin of these different races, and which will at first seem incredulous but will become more and more plausible. We have seen how dead inorganic matter came to life in the form of small microscopical animals called animalcules. What then is to prevent us from assuming that at the close of the Cenozoic era man originated in a similar manner, not in the form of animalcules but in the form of small dwarfs. That dead matter came to life in the form of organisms which by mutual attraction formed small dwarfs, the early ancestors of man. Man is created in a somewhat similar manner today, not by dead matter coming to life, but by organisms formed by the union of a sperm and an egg of a male and female, so therefore this reasoning is not as inconceivable as was first supposed. Furthermore this conclusion is strengthened by the universal belief that man was created from dust. If we then assume this to be the case, these dwarfs by means of evolution gradually grew to the size of about five feet, three or four inches, the size of the prehistoric man.

But were these dwarfs light or dark, in other words what was their color? Were there different races or were they all alike? Let us here use our imagination to some extent, or better, let us visualize what, to my mind, took place. Let us paint a mental picture of the earth at the close of the Cenozoic era, draped in a beautiful splendor of plants and flowers, and inhabited by many of our modern animals. We then gradually see life manifest itself, in the form of animals? No, in the form of small dwarfs, the ancestors of man. Are they all of the same race? No, we see that in some parts of the earth, for example in Africa, they are black, in America, they are red, in Europe white and in Asia yellow. But how can we account for such a happening? We cannot form a theory simply on imagination. We cannot have weird thoughts and ideas and from such form a theory, by means of which we can claim that such happenings actually took place, just because no one can disprove it. Decidedly no! Such a theory would not be worth a candle and would only make its author appear as a ridiculous and incompatible fool. Have we not seen how inanimate inorganic matter came to life at the beginning of the Paleozoic era in the form of trilobites? Were these trilobites the only animals that came into existence at that time? Of course not! Beside the trilobites there were numerous other shelled animals. Then the question arises, were these organisms that were formed from this dead matter similar? Yes, in this respect that all the animals at that time were of one class, or in other words, they were all shelled animals, but, there were different kinds of shelled animals, such as trilobites, brachiopods, gastropods and cephalopods. It therefore stands to reason that these organisms that arose from this dead matter were similar in that they all formed shelled animals, but that they differed in that they formed different species of shelled animals. If the kind reader agrees with me thus far, we have then progressed splendidly. Now to come back to our former assertion, which was namely, that at the close of the Cenozoic era, life again manifested itself, in that dead matter came to life in the form of small dwarfs. Does this assumption then appear incredulous when we have seen how at the beginning of the Paleozoic era, dead matter likewise came to life, not in the form of dwarfs but in the form of shelled animals. I then continued to state that these dwarfs were not of the same color throughout the earth, that in different parts of the land they were of a different color. Does this assumption then also appear incredible when we have seen that organisms that formed shelled animals formed different kinds of shelled animals. Do you not agree to that? Why can we not then assume that organisms formed from inorganic matter, formed dwarfs as organisms formed shelled animals, and that these organisms formed different types, by this I mean different colors, of dwarfs as organisms formed different kinds of shelled animals.

Does not this theory appear as acceptable as the scientific theory, in which it is claimed that man descended from the ape, and in which no mention is made as to the color of man or as to the origin of the other races? Is not this theory as acceptable as the theological theory in which is claimed that man descended from Adam and in which no mention is made as to the origin of the other races?

We have also seen how our modern mammals have descended from small animals which had their origin during the Cenozoic period—even as far back as the Paleozoic, when the fishes arose, the ancestors of our modern mammals. What then is incredible in that modern man descended from the dwarfs? Is there not as much possibility in that we descended from those dwarfs as there is in that a horse, for example, descended from those fishes that had their origin in the Paleozoic era? You might at first not agree with me in that a horse descended from a fish, but were not fishes the first vertebrates? Are not horses vertebrates? You agree thus far? It therefore follows that a horse must be the descendant of a fish, not directly, I assure you, but indirectly, but nevertheless it must be so. If that be the case what is to prevent us from assuming that we are the descendants of the dwarfs? Is the latter assumption more preposterous than the first? No, not in my light. Another question might arise, namely: What right have I to assume that the ancestor of modern man was a dwarf? Why do I not assume that the ancestor of modern man was a giant? Fossils have been found during research work of prehistoric men, men that lived probably many hundred years before the Stone Age. These remains were found to measure approximately five feet, four inches. Then the average height of man at that time was about five feet four inches. The average height of man at the present time is approximately five feet six inches. So therefore these prehistoric men were smaller than we are. We have also seen from our study of animal evolution that certain animals that had their origin as small animals, never grew to a maximum height, and then gradually grew smaller and smaller. They either became extinct before attaining such a height or else due to their slow evolution are still in the process of attaining that height, for example the horse which descended from an animal about the size of a modern dog. So we therefore see that horses are tending toward a greater height. A million years from the present day they may be as large as an elephant or they may become extinct within a few years, the latter being the more likely, due to the rapid advancement of motor vehicles. Likewise with man. We are gradually tending toward a greater height, as seen from the remains of these prehistoric men. Whether we will become in the future, giants or eventually become extinct, I of course cannot say. Either will occur, there is no doubt as to that, if we may judge by past performances, and also such a happening will not occur probably within a million years. Therefore such is my reason for assuming that our earliest ancestors were dwarfs and not giants. I have thereby formed my theory, which is not due to a vague imagination, but which is based on a comparison of the evolution of animal life to the evolution of man, by the discovery of fossil remains and a systematical reasoning.