ISSUED BY DEFENSE COUNSEL, STATE OF TENN vs. JOHN T. SCOPES.

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STATEMENT BY PROFESSOR HORATIO HACKETT NEWMAN:
(Zoologist, University of Chicago)

(Biography.--- He was dean of the colleges of science at that university for nearly seven years, having charge especially of premedical and medical students. He has been teaching zoology since 1898. He received his bachelor's degree at McMaster University, and his doctor's degree at Chicago University. He has memberships and fellowships in the American Association for the Advancement of Science, the American Society of Zoologists, etc. He has attracted widespread attention in the scientific world by his studies of experimental embryology, and in other zoological subjects. He was among the earliest in this country to organize large classes in various universities for the study of evolution and heredity. His publications include many technical monographs and the following books:-

Evolution, Genetics and Eugenics;

Vertebrate Zoology;

Outlines of General Zoology;

The Biology of Twins;

The Physiology of Twinning.)

STATEMENT BY PROF. HORATIO HACKETT NEWMAN:

The evolutionist stands for and believes in a changing world. Evolution is merely the philosophy of change as opposed to the philosophy of fixity and unchangeability. One must choose between these alternate philosophies, for there is no intermediate position; once admit a changing world and you admit the essence of evolution. The particular courses of change or the causes of any particular kinds of change are matters that the expert alone is in a position intelligently to discuss. We know with certainty some few things about the course of evolution, and we believe that we have discovered some important phases of the mechanism of evolution, but these are controversial matters and in no way affect the question as to the validity of the principle. Whether or not evolution may lay claim to rank as a law of nature depends upon the strength, the coherency, and the abundance of the so-called evidences of evolution.

THE NATURE OF THE PROOF OF ORGANIC EVOLUTION:

There are two distinct types of evidences of evolution, one of which has to do with changes that have occured during past ages, the other with changes that are going on at the present time. The evidences of changes that have taken place in the remote past must in their very nature be indirect and to some extent circumstantial, for there are no living eye-witnesses of events so far removed from the present and there are no documentary records written in human language. Records of past events are written, however, for him who has learned the language, in the rocks, in the anatomical details of modern species, in the development of animals and plants, in their classification, and in their geographic distribution past and present. Evidences that species are changing to-day are quite direct in character, for more or less radical hereditary changes have been seen in the act of taking place, though as yet we have little knowledge of the causes responsible for them. The discovery that species are changing at a noticeable rate at the present time is in itself strong evidence that they have changed in the past, and doubtless in the same ways and at the same rates of speed as those observable to-day; for even the convinced special creationist would hardly claim that species have remained immutable since their creation only to begin to change during the present era. Little can be learned about the large changes involved in organic evolution by observing the relatively small changes of the present, for it takes immense periods of time for the larger waves of change to run their course and reach their culmination. For the study of past evolutionary events we use the historical method so successfully employed in archaeology and ancient history; for the study of present evolution we make use of the methods of direct observation and experiment. The findings in one field strongly support and supplement the other.

When we admit that the evidences of past evolution are indirect and circumstantial, we should hasten to add that the same is true of all other great scientific generalizations. The evidences upon which the Law of Gravity are based are no less indirect than are those supporting the Principle of Evolution. Like all other great scientific generalizations, the Law of Gravity has acquired its validity through its ability to explain, unify, and rationalize many observed facts of physical nature. If certain facts entirely out of accord with the Law of Gravity were to come to light, physicists would be forced either to modify the statement of the law so as to bring it into harmony with the newly-discovered facts or else to substitute a new law capable of meeting the situation. Laws of nature are no more or less than condensed statements about the facts of nature and therefore are valid only in so far as they agree with the facts. The Nebular Hypothemis and its modern rival, the Planetesimal Hypothesis, are both deductions from facts; they both seem to agree with many of the observed data, but neither of them is as yet fully adequate to account for all. In the field of physical chemistry we had first the Molecular Theory, then the Atomic Theory, then the Ionic Theory, and now the Electron Theory; each of these has appeared in direct response to the decessity of explaining new sets of facts, and none of them is so well founded as is the Theory of Evolution. No one has ever seen a molecule, an atom, an ion, or an electron; the existence of and the properties of these entities have been deduced from the behaviors of various chemical substances when subjected to experimental conditions.

The Principle of Evolution stands in the first rank among natural laws not only in its range of applicability, but in the degree of its validity, the extent to which it may lay claim to rank as an established law. It is the one great law of life. It depends for its validity, not upon conjecture or philosophy, but upon exactly the same sorts of evidence as do other laws of nature.

Evolution has been tried and tested in every conceivable
biological facts have been examined in the light of this pri way for considerably over half a century. Vast numbers of
way for considerably over half a century. Vast numbers of biological facts have been examined in the light of this principle and without a single exception they have been entirely

compatible with it. Think what a sensation in the scientific world might be created if some one were to discover even one well-authenticated fact that could not be reconciled with the Principle of Evolution! If the enemies of evolution ever expect to make any real headway in their campaign they should devote their energies toward the discovery of such a fact.

The exact nature of the proof of the Principle of Evolution is that when great masses of scientific data such as are involved in those branches of biology known as taxonomy, comparative anatomy, embryology, serology, paleontology, and geographic distribution, are looked upon as the result of evolutionary processes, they take on orderliness, reasonableness, unity, and coherency. Not only this, but each subscience becomes more closely linked with the others and all turn out to be but different aspects of the one great process. No other explanation of biological phenomena that in any sense rivals the evolution principle has ever been offered to the public. This principle cannot be abandoned until one more satisfactory comes forth to take its place. To revert to the thoroughly discredited and unscientific idea of special creation would be as utterly impossible as to revert to the ancient geocentric conception of the universe, according to which a flat earth was thought to occupy the center of the universe and the sun, moon, and stars to revolve about it.

Let us reiterate that a theory or a principle is acceptable only so long as it accords with the facts already known and leads to the discovery of new facts and principles. Whether or not the Principle of Evolution meets these requirements the reader must judge for himself after a perusal of the facts that lie at the basis of the principle.

The evidences of evolution that we shall investigate are contained within the following fields of biology:

1. Comparative anatomy or morphology, the science of structure.
2. Taxonomy, the science of classification.
3. Serology, the science of blood tests.
4. Embryology, the science of development.
5. Paleontology, the science of extinct life.
6. Georgraphic distribution, the study of the horizontal distribution of species upon the earth's surface.
7. Genetics, the analytic and experimental study of evolutionary processes going on to-day.

THE FUNDAMENTAL ASSUMPTION UNDERLYING THE EVIDENCES OF EVOLUTION.

A careful study of the situation reveals that the entire fabric of evolutionary evidences is woven about a single broad assumption:-- that fundamental structural resemblance signifies blood relationship; that, generally speaking, the closeness of structural resemblance runs essentially parallel with closeness of kinship. Most biologists would say that this may once have been only an assumption, but that it is now so amply supported by facts that it has become axiomatic. However obvious the validity of this assumption may be, it is the plain duty of one who attempts to justify the evolutionary principle to avoid taking steps that are in the least open to serious criticism. If we cannot rely upon this principle we can make no sure progress toward the proof of evolution.

The assumption we are now discussing is tantamount to an affirmation of the principle of heredity: that like tends to produce like. We continually employ this principle in everyday life. We fully expect the offspring of sparrows to be sparrows, of robins to be robins; and if we should ever find an instance to the contrary, we would be greatly surprised and shocked. Furthermore, we have learned by experience that offspring not only belong to the same species as the parents, but resemble the parents more closely than they do other people. Whenever we see two people whose resemblance is closer than usual we immediately come to the conclusion that such persons are relations, probably offspring of the same parents. Every one has had the experience of meeting two persons so strikingly alike that it is almost impossible to distinguish them apart, and the natural assumption is that such persons are duplicate or identical twins. Twins of this sort are vastly more closely related than are brothers or sisters, or even than are fraternal twins who are usually no more alike than are brothers and sisters of closely similar ages. It is practically established that duplicate twins are products of the early division of a single germ cell. No closer degree of kinship can well be imagined than this, for the two individuals bear the same relationship to each other as do the two bilateral halves of one body.

The writer has had an exceptional opportunity to determine the exact degrees of resemblance existing between separate offspring derived from a single egg. It so happens that a peculiar species of mammal, the Nine-banded Armadillo, almost always gives birth to four young at a time. These quadruplets are invariably all of the same sex in a litter and are nearly identical in their anatomical details. A study of their embryonic history has proven beyond question that in every case the four embryos are produced by the division of a single normally fertilized egg. Large numbers of advanced sets of quadruplet fetuses were studied statistically with the idea of determining the exact degree of their resemblance. An average of a considerable number of determinations revealed the somewhat startling fact that their coefficient of correlation is .93, which is merely another way of saying that they are 93 per cent identical. The remarkable closeness of this resemblance may be fully appreciated when it is realized that the only structural resemblances belonging to this order of closeness are those existing between the right and left halves of single individuals, and that the next order of resemblance is that between siblings (brothers or sisters), who are only 50 per cent identical.

This then is a crucial test of the validity of the assumption that closeness of resemblance is a function of closeness of kinship, for here we have the closest approach to identity in connection with what is also the closest possible blood relationship.

Employing the principle of heredity in a somewhat broader way, and in a way that is hardly likely to be questioned even by the most captious, we account for the common possession of certain structural peculiarities by all members of a given kind or species of animal by saying that characters have been derived from a common ancestor. It is only a short step in logic to conclude that two closely similar kinds or species of animal have been derived one from the other or from a common species. Once having taken this step we are on the road that leads inevitably to an evolutionary interpretation of natural groups. If the principle of heredity holds for fraternities, for races, for species, where are we to draw the line? It does not seem reasonable to admit that structural resemblances within the fraternity, the race, the species, are accounted for as a product of heredity, and to deny that equally plain resemblances among the species of a genus or among the genera of a family have a hereditary basis. It is logically impossible to draw the line at any level of organic classification, and say that fundamental structural resemblance is the product of heredity up to such and such a level, but that beyond some arbitrarily settled point heredity ceases to operate.

EVIDENCES FROM COMPARATIVE ANATOMY

The foundation stones of comparative anatomy are the principles of homology and of analogy. The former implies heredity and the latter variation.

The Principle of Homology

Any one who has at all seriously studied comparative anatomy must have been impressed with the fact that the animal kingdom exhibits several distinct main types of architecture, each of which characterizes one of the grand divisions of the kingdom. Within each of these great assemblages of animals characterized by a common plan of organization there are almost innumerable structural diversities within the scope of the fundamental plan. These major or minor departures form the ideally generalized condition remind one of variations upon a theme in music; no matter how elaborate the variation may be, the skilled musician recognizes the common theme running through it all. This fundamental unity amidst minor diversity of form or of function is looked upon as a common inheritance from a more or less remote ancestor. In animals belonging to the same group and therefore having the same general plan of organization we find many organs having the same embryonic origin and the same general relations to other structures, but with vastly different superficial appearance and playing quite diverse functional roles. Such structures are said to be homologous.

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A common example of homologous structures is presented by the fore limbs of various types of backboned animals (vertebrates): such, for example, as that of man, that of the whale, that of the bird, and that of the horse. The arm of man is by far the most generalized of these; it is not far from the ideal prototypic land vertebrate fore limb, in that it is not specialized fo for any particular function but is a versatile tool of the brain. The flipper of the whale is a short, broad, paddle-like structure, apparently without digits, wrist, fore arm or upper arm; but on close examination it is seen to possess all of these structures in a condition homologous almost bone for bone and muscle for muscle with those of the human arm. The wing of the bird, a highly specialized organ of flight, appears superficially to have nothing in common with the arm of man; but a study of its anatomy shows the same bony architecture and muscle complex, modified rather profoundly for a different function and with the thumb and two of the fingers greatly reduced or entirely unrepresented in the adult stage. The fore leg of the horse is a specialized cursorial appendage, and in accord with this function has but one functional toe with a heavy toe-nail or hoof. Two other toes are represented by the so-called splint bones, mere vestiges of once useful structures. In other respects the horse's leg is quite homologous with that of other land vertebrates. The evolutionary explanation of the fact that these several types of limbs (each playing an entirely different role in nature and each so unlike the other in form and proportions) have the same fundamental architecture, is that they have all inherited these characters from some distant common ancestor. In each case the inheritance has undergone modification in harmony with the life needs of the organism. This of course implies descent with modification, which is no more or less than evolution.

An equally significant situation comes to light in connection with the hind limbs of vertebrates. The leg of man, a specialized walking appendage, is much less versatile than is the arm; yet it is closely homologous with the latter. The hind limb of the whale is in some species entirely wanting in the adult or else is in vestigial condition. The leg of the bird is decidedly reptilian in structure and is believed to have retained in large measure the characteristics of that of the supposed reptilian ancestors. The hind limb of the horse, though somewhat stronger and heavier than the fore limb, resembles the latter closely both in form and function. Snakes are typically limbless vertebrates, but the python has small but clearly defined hind limbs, somewhat reduced in number of bones and almost entirely hidden beneath the scaly integument.

No other attempt to explain homologies such as those briefly outlined above has been made except that of special creation, and this implies a slavish adherence to a preconceived ideal plan together with capricious departures from the plan in various instances. A systematic attempt to apply the special creation concept to all cases of homologies involves one in the utmost confusion of ideas and leads almost inevitably to irreverence, which is abhorrent to evolutionist as well as to special creationist.

Vestigial Structures

These may be defined as functionless rudiments of structures whose homologues are found in a functional state in other members of a group with a common architectural plan. Thus the hind limbs of the whale and of the python, the thumb of the bird, the splint bones of the horse, are vestigial homologues of structures well developed in more generalized groups of vertebrates.

The case of the hind limb vestiges in the various species of whales may be emphasized as a crucial one. Several different degrees of rudimentation are found in different types of whales, ranging from a state in which the pelvic bones and those of most of the leg are clearly recognizable as such down to one in which these bones are entirely absent in the adult condition. In the cases where the bones are obvious, the situation is just this:-- deeply buried beneath the thick cushion of blubber in the pelvic region there lies a little handful of bones, ridiculously minute in comparison with the giant proportions of the other parts of the skeleton. These bones are immovable because their muscular connections are atrophied; they do no service in supporting the frame of the animal; in short, they cannot possibly function as bones at all. The somewhat peurile argument of the anti-evolutiomist that these vestigal limb bones play some useful though unknown role, else they would never have been created, cannot seriously be entertained in this case, for what can they make of the fact that some whales entirely lack these structures? More difficult even than this for the special creatiomist to explain is the fact that, even in those whales that lack vestigal limb bones in the adult condition, posterior limb buds appear in the early embryonic period and then slowly atrophy. The case just described is in no way exceptional or peculiar. It is, on the contrary, quite typical of a very general phenomenon.

of a very general phenomenon.

Vestigial Structures in Man:

There are, according to Wiedersheim, no less than 180 vestigial structures in the human body, sufficient to make of a man a veritable walking museum of antiquities. Among these are:-- the vermiform appendix; the abbreviated tail with its set of caudal muscles; a complicated set of muscles homologous with those employed by other animals for moving their ears, but practically functionless in all but a very few men; a complete equipment of scalp muscles used by other animals for erecting the hair but of very doubtful utility in man even in the rare instances when they function voluntarily; gill slits in the embryo, the homologues of which are used in aquatic respiration; miniature third eyelids (nictitating membranes), functional in all reptiles and birds, greatly reduced or vestigial in all mammals; the lanugo, a complete coating of embryonic down or hair, which disappears long before birth and can hardly serve any useful function while it lasts. These and numerous other structures of the same sort can be reasonably interpreted as evidence that man has descended from ancestors in which these organs were functional. Man has never completely lost these characters; he continues to inherit them though he no longer has any use for them. Heredity is stubborn and tenacious, clinging persistently to vestiges of all that the race has once possessed, though chiefly concerned in bringing to perfection the more recent adaptive features of the race.

Homology versus Analogy:

It is quite common to find different animals with certain structures that look alike and function alike but are not homologous. The eye of the octopus, a cephalopod mollusc, has a chorion, a lens, a retina, an optic nerve, and a general aspect decidedly like that of a fish. As an optical instrument it must obviously function in the same manner as does the eye of an acquatic vertebrate; but not one part of the eye of a cephalopod is homologous with that of a vertebrate. Because these two types of eye look alike and function alike, but arise from quite different embryonic primordia adapted to meet a common function, they are known as analogous structures. They are to be sharply contrasted with homologous structures, which may be widely different in form and function so long as they arise from equivalent embryonic primordia. Both homologies and analogies imply changes in relation to the environment and therefore plainly favor the idea of descent with modification.

Connecting Links:

If one group of animals has been derived by descent from another there should be some forms more or less intermediate between the two and with some characteristics of both groups. Many such connecting links actually exist at the present time. Almost every order of animals possesses some primitive members that have doubtless evolved at a slower rate than their relatives and have on that account retained a larger measure of ancestral traits than have the more typical representatives of the group. Thus there is a group of primitive annelid worms, represented by Dinophilus, Protordrillus, and Pollygordius that serve partially to bridge the gap between the two grand divisions, annelids and flatworms. The case of the several species of Dinophilus is especially noteworthy, for these little animals are so evenly balanced between the characteristics of one phylum and those of the other that some authors place them among the flatworms, others among the annelids, and still others are inclined to place them in an anomalous group by themselves. There is an interesting genus of primitive centipedes, called Peripatus, which possesses about as many annelid features as arthropod features. Among vertebrates we have the familiar example of the lung fishes with both the gills of fishes and lungs homologous with those of land vertebrates. And finally, we may mention those curious egg-laying mammals, momotremes, of Australia and New Zeland, which though obviously mammalian in most respects, possess, in addition to laying eggs after the fashion of reptiles, many other decidedly reptilian traits. The reader interested in following up in more detail this interesting branch of comparative anatomy will find the subject skillfully handled by Geoffroy Smith in a volume entitled Primitive Animals.

Comparative Anatomy is a mature and well organized science and involves a vast amount of technical data. No one but a trained comparative anatomist can reasonably be expected to appreciate the dependence of this subject upon the principle of evolution. Without evolution as a guiding principle comparative anatomy would be a hopeless mass of meaningless and disconnected facts; with the aid of the principle of homology, an evolutionary assumption, it has grown to be one of the most scientific branches of biology. This may be taken as an illustration of the nature of the proof of organic evolution; that when it is used as a working hypothesis or guiding principle, it really works in that it is not only consistent with all of the facts, but lends significance and interest to facts that would otherwise be drab and disconnected.

Evidences From Classification:

The object of classification is to arrange all species of animals and plants in groups of various degrees of inclusiveness which shall express as closely as possible the actual degrees of relationship existing between them. In pursuance of this object we begin by grouping together as one species all animals that are essentially alike in their anatomical details. As an example of the methods of classification we may take the following familiar instance:-- the European wolf is a particular kind of animal constituting a species called lupus (the Latin word for wolf) all members of which are more like one another than they are like wolves of other sorts, for the reason that they have a common inheritance. There are not a few other species of wolves, each given a Latin name, and all of these wolf species, including dogs (believed to be domesticated and therefore highly modified wolves), are placed in one genus, Canis. Several other genera of more or less wolflike animals, such as jackals and foxes, are grouped with the genus Canis, and constitute the family Canidae, the assumption being that they are all the diversified descendants of some common wolflike ancestor. Other families, such as the Cat Family (Felidae), the Bear Family (Ursidae) and several other families of terrestrial beasts of prey, constitute the suborder Fissipedia. These in turn are grouped with the marine beasts of prey, such as seals, sea-lions, walruses (suborder Pinnipedia) to form the mammalian order, Carnivora. ~~The~~ Several other orders of animals with many characteristics in common are combined to form the class Mammalia, which is one of several classes belonging to the class Mammalia, which is one of several classes belonging to the subphylum Vertebrata, a branch of the phylum Chordata. A phylum is one of the grand subdivisions of the animal kingdom and is made up of species with the same fundamental plan of organization the common features of which are believed to be derived from a common ancestral type.

The underlying assumption of classification is the same that underlies comparative anatomy; that degrees of resemblance ~~xx~~ run parallel with degrees of blood relationship, that the most nearly identical individuals are most closely related and that those that bear the least fundamental resemblance to each other are either not genetically related at all or else had a common ancestor far back in the misty past when animal life was in process of origin. We have already shown that this assumption holds good in all cases where it has been possible to put it to the test. No further justification need be offered in this place for making use of the only adequate instrument of classification: the principle of homology.

What Is a Species?

The species is the unit of classification, but there is serious doubt as to whether species have any reality outside of the minds of taxonomists. Certainly it is extremely difficult, if at all possible, exactly to draw sharp boundary lines between closely similar species. When we examine a large number of individuals belonging to a given species we find that there are no two exactly alike in all respects. As a rule there is a wide range of diversity within the limits of the group we call a species and the extreme variants are often so unlike the type form that were it not for the intergrading steps between them they would often be adjudged distinct species. Moreover, the species of a prosperous genus are so variable that it becomes an almost impossible task to determine where one species ends andanother begins, so closely do they intergrage one into another. A species, then, is not a fixed and definite assemblage such as one would expect it to be if specially created as an immutable thing. On the contrary, intensive study of any widely distributed species gives the impression of an intricate network of interrelated individuals changing in a great variety of ways.

The completed classification of any large group, such as the vertebrates, presents itself as an elaborately branching system whose resemblance to a tree is unmistakable. The phylum branches into subphyla, some of the latter into several classes, classes into orders, orders into families, families into genera, genera into species, species into varieties. We may compare the phylum to one of the main branches coming off from the trunk, while the varieties may be thought of as the terminal twigs. This tree-like arrangement is exactly what one would expect to find in a group descended from a common ancestry and modified along many different lines. It is in reality a genealogical tree. If this striking arrangement is a part of the plan of special creation it is indeed strangely unfortunate that it speaks so plainly of descent with modification.

Man's Place in the System of Classification.

There is no greater difficulty in connection with the classification of man than in that of any other living species. Indeed there are scores, even hundreds, of species whose exact affinities with other groups are far less obvious than those of the human species. Anatomically, the genus Homo bears a striking resemblance to the anthropoid apes. Bone for bone, muscle for muscle, nerve for nerve, and in many special details, man and the anthropoid apes are extremely similar. Homologies are so obvious that even the novice in comparative anatomy notes them at a glance. Man is many degrees closer anatomically to the great apes than the latter are to the true monkeys, yet the special creationist insists upon placing man in biological isolation as a creature without affinities to the animal world. If a man is a creature apart from all animals it is extremely difficult to understand the significance of the fact that he is constructed along lines so closely similar to those of certain animals; that his processes of reproduction are exactly those of other animals; that in his development he shows the closest parallelism step for step to the apes; that his modes of nutrition, respiration, excretion, involve the same chemical processes; and that even his fundamental phychological processes are of the same kind, though differing in degree of specialization, as are those of lower animals.

Comparative anatomists recognize man as a vertebrate, for he has all of the characteristic features of that group. He is obviously a mammal, for he complies with qualifications of that class in having hair; in giving birth to living young after a period of uterine development; in suckling the young by means of mammary glands; in having two sets of teeth one succeeding the other; in having the teeth differentiated into incisors, canines, and molars; and in many other particulars of skeleton, muscular system, circulatory system, alimentary system, brain, and other parts of the central nervous system. Among mammals, man belongs to the well-defined order of Primates, an order anatomically about halfway between the most generalized and the most specialized of the mammalian orders. Apart from his extraordinary nervous specialization, man is a relatively generalized mammal as compared with such highly specialized types as, for example, the whales. The older taxonomists placedman and the other primates at the top of the genealogical tree, assigning to him the central tip of the central branch as though the goal of all organic evolution were man. Accordingly, those mammals such as the whales, which are least like man, were considered the lowest members of the class. There has been within recent years a pronounced reversal of this anthropocentric point of view, which has resulted in a complete revision of the arrangement of mammalian orders, with the Insectivora the lowest, the Cetacea (whales) the highest, and the Primates about intermediate in systematic position.

The Order Primates consists of two Suborders---Lemuroidea and Anthropoidea. The lemurs or half apes are small arborial animals with somewhat squirrel-like habits but with flat nails and certain other primate characters. They serve to link up the Primates with the most primitive of the mammalian orders, the Insectivora, which are now believed, on anatomical and paleontological grounds, to be ancestral not only to the primates but to most of the other modern mammalian orders. The anthropoid or man-like Primates are divided into four distinct families: the Hapalidae or marmosets; the Cercopithecidae or New World monkeys; the Simiidae or anthropoid apes; and the Hominidae or men. The family Hominidae includes four genera: The genus Pithecanthropus, represented by the fragmentary remains of an extinct Javan ape-man, the genus Paleanthropus, the genus Eanthropus and the genus Homo, including in addition to the existing species, Homo sapiens, several different extinct human species known as the Dawn Man, the Neaderthal Man, the Rhodesian Man, and others.

The species Homo sapiens consists of at least four subspecies or major varieties, each consisting of numerous minor races and admixtures of these. This high degree of diversity within the species is evidence of rapid evolution. If a little over four thousand years ago, as the special creationists claim, one man was created and has become the ancestor of all men living to-day, evolution must have gone on at an extremely rapid rate in order to have produced so many widely different races, for there could scarcely have been more than one hundred and twenty generations in that time. If species are believed to be immutable it is difficult to understand why man should be such a diversified group as he is.

Evidences From Blood Tests.

The methods of classifying animals just outlined depend upon relatively gross criteria (homologies) as compared with the refinements characteristic of the serological teachnique used in blood testing. This latter method of classifying animals depends upon chemical similarities and differences in the bloods of various animals, and the basic assumption is once more that degrees of resemblance parallel degrees of blood relationship. Recent investigation has shown that certain materials in an animal's blood are even more sharply specific than are its visible structural characteristics. Chemical tests of extreme delicacy are used to reveal resemblances in b blood. Thus, if we wish to find out what animals are most like man in blood composition we can find it out in the following manner: Human blood is drawn and allowed to clot, a process that separates the solid materials in the blood from the liquid serum. The latterwatery fluid contains the specific human blood ingredients. Small doses of it are injected at two-day intervals into the blood vessels of a rabbit. At first the rabbit is sickened by the injection, thus showing a marked reaction to the foreign material. In the course of a short time, however, there is no further reaction, and we may conclude that the rabbit is immunized. What has happened is that some substance has been developed in the rabbit's blood which neutralizes the toxic effects of human blood. It is a sort of antitoxin and may be spoken of as anti-human serum, a material that may now be used as a delicate indicator of blood kinship. When this anti-human serum is mixed with serum taken from the blood of any human being an immediate and definite white precipitate is formed; when mixed with that of any of the anthropoid apes the precipitate is similar to that formed with human serum but less abundant and somewhat slower in appearing. The tests showed a less prompt and less abundant reaction with the blood of Old World monkeys, a slight but definite reaction with that of New World monkeys, and no noticeable reaction with that of lemurs.

The tests further indicated that, if strong enough solutions are used and time enough allowed for the precipitate to settle, there is an unmistakeable blood relationship among all mammals and that degrees of relationship run closely parallel with those based upon homologies. Not only this, but not a few affinities, the existence of which had been only vaguely suggested by comparative anatomy, are strongly emphasized by blood tests. One most remarkable revelation is that whales, the most specialized among mammals, are more closely related to the ungulates (hoofed animals), and especially to the swine family, than to any other group of the Class Mammalia-- a diagnosis that had previously been made by several anatomists on what appeared to be rather slender morphological grounds.

At the present time the technique of blood testing for animal affinities is rather difficult and very few workers have attempted to make use of it. The results so far attained, however, are so definite and clean-cut that there is every reason to expect a great future for this new type of evolutionary evidence. Many groups of animals have already been tested and in general the affinities indicated closely parallel those based on homologies. There is, however, no exactness about this parallel; nor could we expect such to be the case. For that matter there is no exact parallelism between the teeth and the feet, between the head and the tail. No two systems of an organism exactly keep pace in their evolution: one may remain relatively conservative while the other may become greatly specialized. Of all systems, the blood appears to have been the most conservative ~~xxxxxxxxxxxxxxxxxxx~~ and to have retained most fully its ancestral characters. It is on this account that blood tests are so valuable in revealing relationships that can scarcely be determined in any other way.

Far more important than any information as to animal affinities revealed by blood tests is the fact that the classification of animals based on blood tests is essentially the same as that based on morphology. Suppose, for the sake of argument, that these two modes of classification had revealed quite contrary arrangements: what a blow to our confidence in the validity of evolution! Conversely, what a strong support of the evolution principle is afforded by the fact that the two systems of classification point to the same lines of descent!

EVIDENCES FROM EMBRYOLOGY:

There should be no sharp division between the evidences from Comparative Anatomy and those from Embryology. These two branches of biology are inseparable: one must be interpreted in the light of the other. Comparative anatomy deals with the adult structures of organisms. Whenever there is any question about homologies of fully developed structures recourse is had to younger and still younger stages, for when structures are really homologous they tend to be more closely similar the younger they are. Structures that come from the same or similar embryonic primordia are by definition homologous. Therefore the only certain test of homologies is a study of embryology.

It is necessary to bear in mind that an individual is not merely his adult condition; that a species is not fully defined by a description of its adult characteristics. The species characteristics include those of the egg and the sperm, the cleavage pattern, the particular modes of gastrulation and of further differentiation. In brief, the species is fully defined only by a full description of its entire ontogeny. Very closely related species keep step nearly all the way through their ontogenies and diverge only toward the end of their courses. Distantly related forms diverge comparatively early in their developmental paths; while unrelated forms may have little or nothing in common from the beginning.

The most advanced groups of organisms travel a much longer journey before reaching their destination than do organisms of lower status. In many instances certain early stages in the development of an advanced organism resemble in unmistakable ways the end stages of less advanced organisms. There is, in fact, in the long ontogeny of members of higher groups, a sort of rough-and-ready repetition of the characteristic features of many lower groups. This fact has so impressed some biologists that they have embodied it into a law, the so-called biogenetic law; that ontogeny recapitulates phylogeny. In less technical language this means that the various stages in the development of the individual are like the various ancestral forms from which the species is descended, the earliest embryonic stages being like the most remote ancestors and the latter stages like the more recent ancestors. In still other words, the concept may be stated as follows: the developmental history of the individual may be regarded as an abbreviated resume of its ancestral history.

In the first place it is obvious that no embryonic stage can be in any real sense the equivalent of any adult ancestor. The most we can affirm is that while some embryonic characters of the higher group strongly remind us of some adult features of lower groups, the tout ensemble of the former is not at all closely similar to that of the latter. In the second place, it should not be forgotten that the embryonic and larval stages of organisms have much more pressing demands upon them than that of recording their ancestral attainments-- they must adapt themselves to their surroundings if they are to survive. As a result of this pressing necessity many larvae and even embryos are so profoundly modified in adaptive ways that their ancestral characters are largely obscured. Various larval or fetal organs commonly furnish the outstanding characteristics of developmental histories, and these purely temporary organs not only tell no story of ancestries but frequently so mask the ancestral story as to make it almost indecipherable. In the third place, different systems of organs develop at different rates, so that when one system has reached an advanced state of differentiation another system may be still in the primordial state. Thus, in the development of fishes the nervous system is far along its course of development before the circulatory system has even begun to differentiate. At such a stage as this the embryo is obviously not equivalent to any adult ancestor, for an organism with so discordant an organization could not survive.

In spite of its faults and limitations, however, the idea that ontogeny tends to repeat phylogeny, if used intelligently and not over-applied, is a very useful one. Organisms inherit not only their adult characters from their ancestors, but also their general developmental patterns. It is therefore inevitable that many features that have been outgrown or subordinated in modern types should be found in a state more nearly ancestral during the embryonic stages. And especially is this the case when particular systems are studied separately. Thus, we find that the human circulatory system develops through a series of stages that are much like the adult conditions of a series of ascending vertebrate classes. The heart differentiates from a sheet of mesoderm lying beneath the pharynx. It has at first the form of two nearly straight tubes, which soon fuse for part of their length to form a single tube divided at the two ends into two tubes. Later the single tube differentiates lengthwise into two cavities, the auricle and the ventricle, and is now in the stage equivalent to that of an adult fish. The auricle next divides into two chambers, thus resembling that of an amphibian. Finally the ventricle subdivides also, giving rise to the four-chambered heart characteristic of mammals. The main arteries and veins of the head region are at first laid down with reference to what are known as the branchial arches, the structural framework of the branchial or gill apparatus of aquatic vertebrates. Later, the whole architecture of this system becomes profoundly modified in adaptation for lung respiration. While the arteries and veins are in the fish-like condition there appear at the anterior end of the body in the prospective neck region four pairs of crevices, gill slits, which in fishes open directly into the pharynx and furnish a surface for gills. In the human embryo, however, these clefts never break through, but, after persisting for some time without playing any useful role, gradually disappear. The only persistent residue of the gill slits is the Eustacean tube, which connects the pharynx with the middle ear. Never at any time do the gill slits function in a respiratory capacity, for they never possess any branchial tissue. Only one interpretation of these transitory gill slits of man can be seriously entertained, namely, that, although these structures are inherited from the early aquatic ancestry, adaptive demands have caused their suppression in favor of more useful structures. Inheritance causes their appearance; lack of function prevents their development and causes their disappearance or modification.

Nothing is to be gained by a multiplication of parallelisms such as the above. Suffice it to say that the nervous system, the alimentary system, the urogenital system and other systems go through stages similar to those described above and that these resemble adult stages of lower classes of vertebrates. The embryology of man is now pretty thoroughly known in spite of the great difficulty of obtaining the early stages. Step for step it is almost precisely like that of other primates, especially like that of the anthropoids, and it is only in the latest stages that it takes on distinctly human characteristics. This is not equivalent to saying that the expert embryologist is in any doubt as to the diagnosis of a human embryo no matter how early the stage, for there are specific features about all embryos from the egg stage on to the end of development that may be distinguished by any one sufficiently versed in the subject. In spite of these specific differences, however, there can be no question that the embryology of man and that of any of the anthropoid apes show the closest of resemblances at every stage and diverge sharply only in the late stages of pre-natal life. So close a resemblance in developmental histories is found only in species that are members of the same ancestral stock, for they have both inherited the characteristic features of their development from their common ancestors.

The evidence of human evolution as derived from a study of embryology is in no wise exceptional; on the contrary it is quite typical and may be taken as indicating that from the developmental standpoint man is atone with other animals.

EVIDENCES FROM PALEONTOLOGY:

Paleontology is the science of ancient life. Its materials are the more or less completely preserved remains of animals and plants that once lived. We call these remains fossils. Fossils are real; they cannot be explained away. If evolution has taken place and samples of every species that has lived were preserved for study it would still be a task of immense difficulty to work out the pedigrees of all types of organisms now living, and we might still be largely in the dark as to the causes of the observed changes. As it is, we have fossil remains ofperhaps only about one out of each thousand extinct species, a mere random sampling of the types that prevailed during the various past ages. Considering how many factors have been at work to prevent fossilization of large groups of species and how erosion and metamorphosis have worked together to destroy those fossils already preserved,we marvel that our fossil record is sufficiently complete to tell any sort of sequential story. The fact is that the record is surprisingly full and rich.

Age of the Earth:

According to the most recent computations based on the rate of radium emanation, 1,000,000,000 years have elapsed since the earth attained its present diameter. Various estimates as to the time since the first life appeared upon the surface of the globe range from 50,000,000 years to about ten times that figure. Even the lowest figure gives ample time for any sort of evolutionary change, no matter how slow.

The Earth's Strata as Time Markers

The crust of the earth is arranged in a series of horizontal strata of varying thickness. The lowest layers are obviously the oldest, except in a few localities where breaks and tilts have occured. Even in the most disturbed mountainous regions it is an easy task for the geologist to determine the original order of the strata.

(1) None of the animals of the past are identical with those of the present. The nearest relationship is between a few species of the past which have been placed in the same genera as those of to-day.

(2) The animals and plants of each geologic stratum are at least generically different from those of any other stratum.

(3) The animals and plants of the oldest geologic strata represent all of the existing phyla except the vertebrates, but the representatives of the various phyla are relatively generalized as compared with modern representatives of the same phyla.

(4) There is a gradual progression toward more highly specialized forms as one proceeds from lower to higher strata.

(5) Many groups of animals reached the climax of their

specialization long ages ago and have become extinct.

(6) Only the less specialized relatives of these most highly specialized types survived to become the progenitors of the modern representatives of the group.

(7) It is common to find a new group arising near the close of some geologic period when vast climatic changes were taking place. Such an incipient group almost regularly becomes the dominant group of the next period, presumably because it arose in response to the new conditions that accompanied the change from one period to another.

(8) The evolution of the vertebrate classes is more satisfactorily shown than that of any other group, probably because it arose within the period which is characterised by an abundant fossil record. Of the vertebrates, the mammals are best represented and show the most complete fossil pedigrees; this, because they are the most recent in origin and their remains have been least disturbed.

(9) Many practically complete fossil pedigrees have been worked out, connecting modern specialized types with simpler and more generalized ancestors. Such pedigrees have been worked out for the horse, the elephant, the camel, the rhinoceros and other equally specialized modern types. A single example of this type of evidence will be given: that of the horse. Many other pedigrees have been worked out that are equally complete and no less significant.

Pedigree of the Horse

As recorded by Dendy, the course of evolution of the horse family (Equidae) "has evidently been determined by the development of extensive, dry, grass-covered, open plains on the American continent. In adaptation to life on such areas structural modification has proceeded chiefly in two directions. The limbs have become greatly elongated and the foot uplifted from the ground, and thus adapted for rapid flight from pursuing enemies, while the middle digit has become more and more important and the others, together with the ulna and the fibula , have gradually disappeared or been reduced to mere vestiges. At the same time the grazing mechanism has been gradually perfected. The neck and head have become elongated so that the animal is able to reach the ground without bending its legs, and the cheek teeth have acquired complex grinding surfaces and have greatly increased in length to compensate for increased rate of wear. As in so many other groups, the evolution of these special characters has been accompanied by graudal increase in size. Thus Eohippus, of Lower Eocene times, appears to have been not more than eleven inches high at the shoulder, while existing horses measure about sixty-four inches, and numerous intermediate genera for the most part show regular progress in this respect.

"All these changes have taken place gradually, and a beautiful series of intermediate forms indicating the different stages from Eohippus to the modern horse have been discovered. The sequence of these stages in geological time exactly fits in with the theory that each one has been derived from the one next below it by more perfect adaptation to the conditions of life. Numerous genera have been described, but it is not necessary to mention more than a few."

The first indisputably horse-like animal appears to have been Hyracotherium of the Lower Eocene of Europe. Another Lower Eocene genus is Eohippus, which lived in North America, probably having migrated across from Asia by the Alaskan land connection. In Eohippus the forefoot had four hoofed toes of nearly equal size, the homologue of the thumb having been reduced to a vestige. In the hind foot the great toe had entirely disappeared and the little toe had been reduced to a splint bone. Then came Orohippus of the Upper Eocene, Mesohippus of the Lower Miocene, Protohohippus of the Lower Pliocene, Pliohippus of the Upper Pliocene, and finally, Equus of the Quarternary and Recent. This history, in so far as it concerns the characters already described, furnishes all of the intermediate conditions and perfectly connects the horses of the past with those of the present. One could hardly ask for a clearer or more conclusive story of evolution than this, and this is only one of many similar cases.

The Fossil Pedigree of Man

There is nothing peculiar or exceptional about the fossil record of man. It is considerably less complete than that of the horse, the camel, the elephant, and other purely terrestrial mammals, but it is far more complete than that of birds, bats, and several types of arboreal mammals. Much has been said by the anti-evolutionists about the fragmentary nature of the fossil record of man, but many other animals have left traces far less readily deciphered and reconstructed.

The outstanding fact brought out by a study of human paleontology is that of man's antiquity. According to the most expert testimony available, the oldest fossil in the human series is about half a million years old; and even this estimate makes man a recent product of evolution as compared with many contemporaneous animals. The earliest fossil remains of the present species of man (Homo sapiens) have been very conservatively estimated as 25,000 years old, while other species of extinct man date back to a period at least 100,000 years ago. In addition to several species of the genus Homo, anthropologists distinguish theree other genera of the man family (Hominidae): Pithecanthropus, Paleanthropus, and Eoanthropus, all more primitive than any members of the genus Homo. A brief,but frank, statement about each of these links in the human pedigree is all that is necessary for our purposes.

Pithecanthropus erectus.

This is the so-called Java Man, formerly called the Ape Man or Missing Link, but now adjudged to be definitely human. The fossil remains consist of a complete calvarium or skull cap, three teeth, and a left thigh bone. These were scattered over twenty yards of space and were discovered at different times. There is no proof that these remains belong to the same individual or even to the same species, but they are all human in their anatomical characters and they occured in fossil-bearing rock about 500,000 years old. Many pages of scientific romance have been written about this species; all sorts of more or less justifiable pictures and models of this hypothetical species have been published. It is thenrefreshing to read the coldly scientific statement of Gregory:

"The association of gibbonlike, skull-top, modernized human femur and subhuman upper molars with reduced posterior moiety, if correctly assigned to one animal, may, perhaps, define Pithecanthropus as an early side branch of the Hominidae, which had already been driven away from the center of dispersal in Central Asia, by pressure of higher races. But whatever its precise systematic and phylogenetic position, Pithecanthropus, or even its constituent parts, the skull-top, the femur and the molars, severally and collectively testify to the close relationship of the late Tertiary anthropoids with the Pleistocene Hominidae."

Paleanthropus Heidelbergensis

This genus and species, commonly known as the Heidelberg Man, is based soley upon a single lower jaw in an excellent state of preservation, with all teeth in place. The strong points about this find are, first, that it was found in a stratum whose age had been well established; and second, that its discoverer ranks among the leading experts in the field. The age of this venerable relic has been determined as at least 400,000 years, a little more recent than Pithecanthropus. The jaw is very primitive, heavy, and clumsily constructed as compared with that of modern man. It lacks the chin prominence, as does the jaw of the gorilla. The teeth are strictly human, though rather larger than those of modern man. This apelike jaw with human teeth forms an authentic link in the series connecting man with the anthropoids.

Eoanthropus Dawsonis

The most ancient English human relic has been called the Dawn Man of Piltdown. Owing to the fact that the skull fragments had been badly damaged and scattered by workmen before they came into scientific hands, there has been a great deal of controversy as to their significance. Until the experts arrive at an agreement about this type it might be well for others to reserve judgment. There can be no doubt as to the fact that these remains show a curious admixture of simian and human characteristics, the jaw and teeth being even more simian than that of the Heidelberg Man, while the skull, though primitive, is distinctly human. The age of the Dawn Man is placed at about 200,000 to 300,000 years.

In striking contrast with the fragmentary character of the remains just described are those of three distinct species of the genus Homo, which are now to be briefly characterized.

Homo neanderthalensis

The well-established race known as Neanderthal Man is represented by many individual skeletons of varying degrees of completeness and showing a considerable range of diversity. Specimens have been found in France, Spain, Belgium, Germany, and Austria. This species of primitive man was of low stature, about five feet three inches in the males and less in the females. The posture was somewhat stooping. The relatively large head was long and flat, with apelike brow ridges and scarcely any forehead, and was borne on an immensely muscular neck in such a way that the face was thrust forward in simian fashion. The lower jaw was heavy and lacked a chin prominence. The teeth were of a type known as taurodont, adapted to a coarse vegetable diet and quite different in structure from those of modern man. The brain of this ancient homo-neanderthalensis was large and specialized in some parts, but deficient in those parts associated with the higher mental functions.

There can be no question that Neanderthal Man was much

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more primitive, more simian in organization, than modern man. Expert opinion, as expressed by Keith, looks upon him as "a separate and peculiar species of man which died out during or soon after the Mousterian period." This dates him back to about 50,000 years ago.

Homo rhodesiensis

Rhodesian Man is represented by a perfect skull and a nearly perfect lower jaw, the tibia,both ends of a femur, collar bone and parts of the scapula and pelvis. Part of the upper jaw of a second specimen was found in the same locality, the Broken Hill mine in northern Rhodesia. This species is largely of technical interest, and need not be described in detail. Suffice it to say that in some respects it was as primitive as Neanderthal Man, but in other respects showed distinct tendencies toward the modern condition. Anthropologists have as yet not reached a decision as to the exact taxonomic status of Rhodesian Man, nor has its age been definitely determined.

Homo sapiens.

The earliest fossil evidence of the existence of our own species date back to about 25,000 years ago. At that time there lived a remarkable race,known to us as Cro-Magnons, a race said to be the most perfect physically of which we have any knowledge. Five essentially complete skeletons form the basis of the type description. This tall, strong, obviously intelligent, and artistic race, was different in several important particulars from any modern race. A detailed description of his characteristics would take us too far afield. Our chief interest in this race is that it serves to emphasize the antiquity of our own species.

In conclusion it may be said that the fossil evidences of man's ancestry are neither rich nor poor; that anthropology is a comparatively youthful science; and that new discoveries in the field are being made at a very satisfactory rate.

EVIDENCES FROM GEORGRAPHIC DISTRIBUTION

Just as paleontology deals with the vertical distribution or distribution in time of species, so georgraphic distribution deals with their horizontal distribution upon the earth's surface at any given period of time. Georgraphic distribution is a sort of cross-section of vertical distribution, giving a picture of the complex evolution of organisms at a given moment in the process. Explorers and collectors have amassed a vast amount of data as to the present and past ranges of animals and have mapped out the distribution of the majority of known species. A composite map of the geographic distribution of all known species would be the most intricate picture puzzle imaginable, and it would be almost impossible to make sense of it. A study of the distribution of limited groups, however, should lead to some reasonable explanation of their interrelations. Obviously animals are not distributed strictly according to climatic conditions or habitat complexes, for a given climate in one part of the world is associated with an entirely different fauna from a practically identical climate in another part of the world. Moreover, animals are not always or even very frequently located in those parts of the world that would offer them the best possible life conditions. This is borne out by the fact that not a few animals when taken out of the normal range and transferred to a distant region, thrive much better than in their native territory. Thus European rabbits, when carried to Australia, throve and multiplied beyond all expectation till they became a pest. Again, as may be easily observed, the English sparrow seems to find America much more congenial than the British Isles.

If animals are not distributed according to habitats, how, then, can we account for their distribution? It is not at all likely that species retain the same ranges for long periods; they are continually changing their locations. We know, also, that the likeliest places to look for two closely similar species are adjacent territories, separated by geographic barriers. A study of the distribution of the species of a large genus usually reveals the fact that the most generalized or type species occupies the central part of the area and that the most specialized species occupy outlying areas adjacent to or connected with the main range of the genus. Taking these and related facts into consideration, we are able to offer as an explanation of the distribution of groups of allied species that a parent species originates in one place, multiplies, and tends to migrate centrifugally in all directions, modifying as it goes to fit new conditions. Some of the extreme migrants became isolated from the main body of the species and, no longer interbreeding with them, become at first well-marked local varieties and in time new species. The above is the usual hypothesis employed in explaining geographic distribution, and it obviously implies evolution. When used as a means of unraveling the intricate tangle involved in the distribution of species, it has thrown a flood of light upon situations otherwise quite inexplicable. In brief, the evolution hypothesis rationalizes geographic distribution, makes a science of what was formerly a hopeless jumble, and has thus proven itself a valuable scientific agent.

The Inhabitants of Oceanic Islands

Oceanic islands are small isolated bodies of land of volcanic origin, far from continents. They are the tops of oceanic mountains. All such islands have their inhabitants, and a study of these should furnish a crucial test of the validity of the rival theories of special creation and of evolution. Both creationists and evolutionists agree that these islands must have obtained their populations from continental bodies. If then the island species are identical with those of the continent from which they have been derived, there is no reason to believe that evolution has taken place; if, however, they are different, the degree of difference should be an exact measure of the amount of evolutionary change that has taken place. What are the facts? Practically all species of animals inhabiting oceanic islands are types that are capable of transportation in the air during storms or on floating debris. All species belong to the faunistic groups characteristic of the most available continent, but the species are for the most part peculiar, thatis, different from species anywhere else. They may belong to the same genus or family as do those of the continent, but they are at least specifically, frequently generically, different from the latter. Such being the case, we are forced to conclude that new species have originated under island conditions. The extreme case is that of the island of St. Helena, 1,100 miles from Africa. On this little body of land there are 129 species of beetles, all but one of of which are peculiar. The species belong to 39 genera, of which 25 are peculiar. There are 20 species of land snails, of which 17 are peculiar. Of 26 species of ferns 17 belong to peculiar genera. The Azores, Bermudas, Galapagos Islands, Sandwich Islands, all tell much the same story, but their populations are not quite so peculiar.

EVIDENCES FROM GENETICS

Genetics may be defined as the experimental and analytical study of Variation and Heredity, the two primary causal factors of organic evolution. As such, genetics aim not so much at furnishing evidence of the fact of evolution as at discovering its causes. Incidentally, however, when man takes a hand in controlling evolutionary processes and actually observes new hereditary types taking origin from old, he is observing at first hand the actual processes of evolution. We shall merely say that the geneticist is an eye-witness of present-day evolution and is able to offer the most direct evidence that evolution is a fact.

SUMMARY OF EVIDENCES

All of the lines of evidence presented point strongly to organic evolution, and none are contrary to this principle. Most of the facts, moreover, are utterly incompatible with the only rival explanation, special creation. Not only do these evidences tell a straightforward story of evolution, but each one is entirely consistent with all of the others. Furthermore, each line of evidence aids in an understanding of the others. Thus embryology greatly illuminates comparative anatomy and classification; geographic distribution is aided by paleontology, and vice versa; blood tests and classification throw mutual light the one upon the other. The evolution principle is thus a great unifying and integrating scientific conception. Any conception that is so far-reaching, so consistent, and that has led to so much advance in the understanding of nature, is at least an extremely valuable idea and one not lightly to be cast aside in case it fails to agree with one's prejudices.