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Evolution

INTRODUCTION

THIS chapter belongs to Darwin. Not that his writings, which are cited under almost all headings, stand alone in the various places they appear. The point is rather that many of the topics are dictated by and draw their meaning from his thought, and that he figures in all the major issues connected with the origin of species, the theory of evolution, and the place of man in the order of nature. With respect to the matters under consideration in this chapter, the other writers in the tradition of the great books cannot escape from being classified as coming before or after Darwin, or as being with or against him.

Darwin's influence on later writers may be variously estimated, but it is plainly marked by their use of his language and their reference to his fundamental notions. William James's *The Principles of Psychology*, especially in its chapters on instinct and emotion, views the behavior of men and animals and the phenomena of intelligence or mind in evolutionary terms. The writings of Freud are similarly dominated by the genetic approach and by an appeal to man's animal ancestry in order to explain the inherited constitution of his psyche in conformity with the doctrine of evolution.

Outside psychology the concept of evolution is reflected in theories of progress or of a dialectical development in history; as, for example, in the dialectical or historical materialism of Marx and Engels, which is set forth in the latter's *Dialectics of Nature*. An even more general reorientation of philosophy, which stems from an evolutionary way of thinking, is to be found in the writings of Bergson and Dewey, such as *Creative Evolution* and *The Influence of Darwin on Philosophy*. These give some measure of the influence of Darwin on philosophical thought. In the biological sciences, Darwin's ideas have guided the direction of virtually all later research. Later works on biological evolution, such as Dobzhansky's *Genetics and the Origin of Species*, continue to support the broad outlines of Darwin's theory while offering refinements in understanding of the mechanisms of evolution, particularly the processes of heredity, mutation, and the genetics of populations.

WITH REGARD TO Darwin's predecessors the question is not so much one of their influence upon him as of their anticipation, in one way or another, of his discoveries, his conceptions, and his theory.

The observation made in antiquity concerning a hillside deposit of marine fossils is sometimes taken as implying an early recognition of the evolution of terrestrial life. More apposite perhaps is the statement by Lucretius that "the new earth began with grass and brush,/ And then produced the mortal animals/Many and various." Lucretius also speaks of strange monsters which nature did not permit to survive:

> . . . this weird assortment earth produced
> In vain, since nature would not let them grow.
> They could not reach to any flourishing,
> Find nourishment, be joined in acts of love . . .
> Many attempts were failures; many a kind
> Could not survive; whatever we see today
> Enjoying the breath of life must from the first
> Have found protection in its character.

Apparently susceptible to similar interpretation are Aristotle's statements that "nature proceeds little by little from things lifeless to animal life"; that "there is observed in plants a continuous scale of ascent toward the animal";

and that "throughout the entire animal scale there is a graduated differentiation in amount of vitality and in capacity for motion." Augustine's commentary on the first chapter of Genesis seems even more explicitly to contemplate the successive appearance of the various forms of life. Plants and animals did not actually exist when the world began. Though their causes were created by God and existed from the beginning, the actual production of plants and animals in their various kinds is, as Aquinas tells us while summarizing Augustine's view, "the work of propagation"—not of creation.

Like Aristotle, both Aquinas and Locke represent the world of living organisms as a graduated scale ascending from less to more perfect forms of life. But where Aquinas tends to conceive that graduated scale as a hierarchy involving essential differences, Locke sees an almost perfect continuity involving only differences in degree. "In all the visible world," he writes, "we see no chasms or gaps." To illustrate this, he points out that "there are fishes that have wings, and are not strangers to the airy region; and there are some birds that are inhabitants of the water, whose blood is cold as fishes . . . There are animals so near of kin to both birds and beasts that they are in the middle between both: amphibious animals link the terrestrial and aquatic together . . . and the animal and vegetable kingdoms are so nearly joined, that, if you will take the lowest of one and the highest of the other, there will scarce be perceived any great difference between them: and so on, till we come to the lowest and the most inorganical parts of matter, we shall find everywhere that the several species are linked together, and differ but in almost insensible degrees."

But for the theory of evolution the observation of a hierarchy in nature, or even of a continuity in which the species differ by "almost insensible degrees," constitutes only background. What the theory of evolution brings to the fore is the notion of a developmental or genetic relation among the various forms of life. Because it seems to contain this insight, the anticipation of Darwin to be found in Kant's *The Critique of Judgement* is perhaps the most remarkable; even though, in a closely related passage in which Kant discusses epigenesis, he uses the word "evolution" in a sense quite contrary to Darwin's conception.

"It is praiseworthy," Kant writes, "to employ a comparative anatomy and go through the vast creation of organized beings in order to see if there is not discoverable in it some trace of a system, and indeed of a system following a genetic principle . . . When we consider the agreement of so many genera of animals in a certain common schema, which apparently underlies not only the structure of their bones, but also the disposition of their remaining parts, and when we find here the wonderful simplicity of the original plan, which has been able to produce such an immense variety of species by the shortening of one member and the lengthening of another, by the involution of this part and the evolution of that, there gleams upon the mind a ray of hope, however faint, that the principle of the mechanism of nature, apart from which there can be no natural science at all, may yet enable us to arrive at some explanation in the case of organic life. This analogy of forms, which in all their differences seem to be produced in accordance with a common type, strengthens the suspicion that they have an actual kinship due to descent from a common parent. This we might trace in the gradual approximation of one animal species to another, from that in which the principle of ends seems best authenticated, namely from man, back to the polyp, and from this back even to mosses and lichens, and finally to the lowest perceivable stage of nature."

FINDING ANTICIPATIONS of Darwin involves judgments much more subject to controversy than tracing his influences. It is questionable, for example, whether the suggestive passages in Lucretius and Locke bear more than a superficial resemblance to Darwin's thought. The matter is further complicated by Darwin's own sense of his divergence from and disagreement with his predecessors—both immediate precursors like Buffon and Linnaeus and earlier philosophers and theologians.

Darwin tells us himself of his quarrel with

the theologians. His followers elaborate on the opposition between his conception of species and that of Aristotle, an opposition which Darwin intimates by the great stress he lays on the difference between a static taxonomy and a dynamic or genealogical classification of living things.

We must therefore try to locate the central points of Darwin's theory in order to judge comparable views for their agreement or disagreement.

As the title of his major work indicates, it is not evolution as a grand scheme of biological, or cosmic, history, but the origin of species with which Darwin seems to be principally concerned. He is concerned with establishing the fact that new species do originate in the course of time, against those who suppose the species of living things to be fixed in number and immutable in type throughout the ages. He is concerned with describing the circumstances under which new species arise and other forms cease to have the status of species or become extinct. He is concerned with formulating the various factors in the differentiation of species, and with showing, against those who think a new species requires a special act of creation, that the origin of species, like their extinction, is entirely a natural process which requires no factors other than those at work every day in the life, death, and breeding of plants and animals. Only as a consequence of these primary considerations does he engage in speculations about the moving panorama of life on earth from its beginnings to its present and its future.

Darwin looks upon the term "species" as "arbitrarily given," and for that reason does not attempt any strict definition of it. He uses it, moreover, like his predecessors in systematic biological classification, to signify "a set of individuals closely resembling each other"—a class of plants or animals having certain common characteristics. Darwin would probably agree with Locke's criticism of those who suppose that our definitions of species grasp the real essences or relate to the substantial forms inherent in things. As indicated in the chapter on DEFINITION, Locke insists that our notion of a species expresses only what he calls the "nominal essence"—a set of characteristics we attach to the name we give things of a sort when we group them and separate them in our classifications. "The boundaries of species, whereby man sorts [things], are made by men," he writes; "the essences of the species, distinguished by different names, are . . . of man's making." Advancements in the science of genetics, however, may lend support to the opposite position. Dobzhansky argues that species represent real genetic discontinuities in nature—arrays of genes which are preserved because of barriers to interbreeding. They are, in fact, "natural units."

Species is not the only term of classification. A *genus,* for example, is a more inclusive group than a *species.* Groups which differ specifically belong to the same genus if their difference is accompanied by the possession of common traits. As species differ from one another within a generic group, so genera are in turn sub-classes of more inclusive groupings, such as phyla, families, and orders. But there are also smaller groupings within a species. There are races or varieties and subvarieties, the members of which share the characteristics of the species but differ from one another in other respects. Ultimately, of course, within the smallest class the systematist bothers to define, each individual differs from every other in the same group with whom, at the same time, it shares certain characteristics of the race, the species, the genus, and all the larger classes to which they belong.

This general plan of botanical or zoological classification does not seem to give *species* peculiar status in the hierarchy of classes or groupings or to distinguish it from other classes except as these are more or less inclusive than itself. Why then should attention be focused on the origin of species, rather than of varieties or of genera?

One part of the answer comes from the facts of generation or reproduction. Offspring tend to differ from their parents, as well as from each other, but they also tend to resemble one another. "A given germ," Aristotle writes, "does not give rise to any chance living being, nor spring from any chance one; but each germ springs from a definite parent and gives

rise to a definite progeny." This is an early formulation of the insight that in the process of reproduction, the law of like generating like always holds for those characteristics which identify the species of ancestors and progeny.

In other words, a species always breeds true; its members always generate organisms which can be classified as belonging to the *same* species, however much they vary among themselves as individuals within the group. Furthermore, the subgroups—the races or varieties—of a species are able to breed with one another, but diverse species cannot interbreed. Organisms different in species either cannot mate productively at all, or if crossbred, like the horse and the ass, they produce a sterile hybrid like the mule. From the viewpoint of genetics, this reproductive isolation is the defining characteristic of species. According to Dobzhansky, species differ from races or varieties only by virtue of the existence of isolating mechanisms which prevent interbreeding.

In the hierarchy of classes, then, species would seem to be distinguished from all smaller groupings by their *stability* from generation to generation. If species are thus self-perpetuating, they in turn give stability to all the larger groupings—the genera, phyla, families—which remain as fixed from generation to generation as the species which constitute them. Hence the question of origin applies peculiarly to species rather than to varieties or to genera.

On the supposition stated, no origin of species would seem to be possible except by a special act of creation. Either all the existing species of organisms have always existed from the beginning of life on earth; or, if in the course of ages new species have arisen, their appearance cannot be accounted for by natural generation. By the law of natural generation, offspring will always be of the same species as the parent organisms.

Spontaneous generation, of course, remains a possibility. A new species of organism might come to be without being generated by other living organisms. But apart from the question of fact (*i.e.*, whether spontaneous generation ever does occur), such origin of a form of life seems to lie outside the operation of natural causes and to imply the intervention of supernatural power.

The possibility of spontaneous generation was entertained in antiquity and the Middle Ages, and was even thought to be supported by observation, such as that of maggots emerging from putrefying matter. But modern science tends to affirm the biogenetic law that living organisms are generated only by living organisms. To Kant, the notion that "life could have sprung up from the nature of what is void of life," seems not only contrary to fact, but absurd or unreasonable. Yet, while affirming the principle that like produces like by insisting upon "the generation of something organic from something else that is also organic," Kant does not carry that principle to the point where it would make the generation of a *new* species impossible. "Within the class of organic beings," he writes, it is possible for one organism to generate another "differing specifically from it."

AGAINST THE BACKGROUND of these various suppositions, Darwin is moved to a new insight by the conjunction of certain types of fact: the results of breeding under domestication which exhibit the great range of variation within a species and the tendency of *inbred* varieties to breed true; his own observations of the geographical distribution of species of flora and fauna, especially those separated from one another by impassable barriers; the facts of comparative anatomy and embryology which reveal affinities in organic structure and development between organisms distinct in species; and the geological record which indicates the great antiquity of life upon the earth, which gives evidence of the cataclysmic changes in the earth's surface (with consequences for the survival of life), and which above all contains the fossil remains of forms of life now extinct but not dissimilar from species alive in the present age.

Briefly stated, Darwin's insight is that new species arise when, among the varieties of an existing species, certain intermediate forms become extinct, and the other circumstances are such that the surviving varieties, now become more sharply separated from one another in

type, are able to reproduce their kind, and, in the course of many generations of inbreeding, also tend to breed true. They thus perpetuate their type until each in turn ceases to be a species and becomes a genus when its own extreme varieties, separated by the extinction of intermediates, become new species, as they themselves did at an earlier stage of history. For the very same reason that Darwin says "a well-marked variety may be called an incipient species," a species may be called an incipient genus.

The point is misunderstood if it is supposed that when new species originate from old, both the new and the old continue to survive as species. On the contrary, when in the course of thousands of generations some of the varieties of a species achieve the status of species, the species from which they originated by variation ceases to be a species and becomes a genus.

"The only distinction between species and well-marked varieties," Darwin writes, "is that the latter are known, or believed, to be connected at the present day with intermediate gradations, whereas species were formerly thus connected . . . It is quite possible that forms now generally acknowledged to be merely varieties may hereafter be thought worthy of specific names; and in this case scientific and common language will come into accordance. In short, we shall have to treat species in the same manner as those naturalists treat genera who admit that genera are merely artificial combinations made for convenience . . . Our classifications will come to be, as far as they can be so made, genealogies."

The *origin of species* thus seems to be identical with the *extinction of intermediate varieties,* combined with the survival of one or more of the extreme varieties. These seem to be simply two ways of looking at the same thing. Still another way of seeing the point may be achieved by supposing, contrary to fact, the survival of all the varieties ever produced through the breeding of organisms.

"If my theory be true," Darwin writes, "numberless intermediate varieties, linking closely together all the species of the same group, must assuredly have existed; but the very process of natural selection constantly tends, as has been so often remarked, to exterminate the parent-forms and the intermediate links." If one were to suppose the simultaneous coexistence of *all* intermediate varieties in the present day, the groups now called "species" would be continuously connected by slight differences among their members and would not, therefore, be divided into distinct species, as they now are because certain links are missing.

In *The Critique of Pure Reason,* Kant states the principle of continuity in the following manner. "This principle," he writes, "indicates that all differences of species limit each other, and do not admit of transition from one to another by a *saltus,* but only through smaller degrees of the difference between the one species and the other. In one word, there are no species or sub-species which . . . are the nearest possible to each other; intermediate species or sub-species being always possible, the difference of which from each of the former is always smaller than the difference existing between these." But, Kant adds, "it is plain that this continuity of forms is a mere idea, to which no adequate object can be discovered in experience," partly because "the species in nature are really divided . . . and if the gradual progression through their affinity were continuous, the intermediate members lying between two given species must be infinite in number, which is impossible."

Dobzhansky differs from both Kant and Darwin in his interpretation of continuity in nature. Since the differences among organisms represent differences in one or more genes, complete continuity would require the existence of every possible combination of genes. If we suppose such an extreme case, the result would not be an infinite number of species, but no species and genera at all. The array of plants and animals would approach a perfectly continuous series in which there would only be individual differences. In fact, existing species represent "only an infinitesimal fraction of the possible gene combinations," while most of the possible combinations intermediate between existing species would produce ill-adapted monstrosities, incapable of survival.

Species are groups of population the gene exchange between which is "prevented through one, or a combination of several, physiological isolating mechanisms." Only by means of such barriers to interbreeding can adaptive "constellations of genes" be preserved. Thus, from the viewpoint of genetics, biological species reflect real discontinuities in nature—not arbitrarily drawn categories. It is in this sense that Dobzhansky speaks of species as "natural units."

On Darwin's conception of the origin of species, its causes divide into two sets of factors: first, those which determine the extinction or survival of organisms and, with their survival, their opportunities for mating and reproduction; second, those which determine the transmission of characteristics from one generation to another and the variation of offspring from their ancestors and from each other. Without genetic variation there would be no range of differences within a group on which the factors of selection could operate. Without the inheritance of ancestral traits there would be no perpetuation of group characteristics in the organisms which manage to survive and reproduce.

For Darwin the operation of the first set of factors constitutes the process of natural selection whereby "variations, however slight and from whatever cause proceeding, if they be in any degree profitable to the individuals of a species . . . will tend to the preservation of such individuals, and will generally be inherited by the offspring." Darwin's understanding of natural selection is grounded in Malthusian principles: all organisms tend to produce more offspring than can survive without outrunning the food supply. By means of high rates of mortality, nature "selects" those organisms best equipped to survive and reproduce. This process takes place in many ways: through geological catastrophes which make certain areas of the earth's surface uninhabitable for all organisms, or for those types which cannot adapt themselves to the radically changed environment; through the competition among organisms for the limited food supply available in their habitat; through the struggle for existence in which organisms not only compete for food but also prey upon one another; and through the sexual selection which operates within a group when some organisms are prevented by others from mating and reproducing.

For Darwin's immediate followers the essence of selection was thought to be captured in the notion that "the fittest survives." But whether survival is of the fittest alone, or whether the multiplication of inferior organisms also gives evolution another direction, has been disputed. According to Darwin, "natural selection works solely by and for the good of each being; all corporeal and mental endowments will tend to progress toward perfection . . . Thus, from the war of nature, from famine and death . . . the production of the higher animals directly follows." But Dobzhansky is more cautious. The process of natural selection is indeed creative, he argues, for it "gives rise to previously nonexistent coherent entities, new organisms fit to perpetuate themselves in certain habitats." But selection is also opportunistic, favors variants with immediate value, and possesses no foresight. It thus "involves risk of failure and miscreation." There is danger, he points out, in any application of our own notions of fitness to the products of natural selection. Organisms which appear to us monstrosities nevertheless survive and reproduce in nature. Waddington and Dobzhansky agree that any serious attempt to define fitness leads to a truism: Those organisms are considered fit which survive to reproduce. "The essence of selection," Dobzhansky writes, "is that the carriers of different genotypes in a population contribute differentially to the gene pool of the succeeding generations." Darwinian fitness is nothing more than the reproductive efficiency of a given genotype.

With respect to the factors of heredity and variation, tremendous advances since Darwin in the experimental science of genetics require revisions in this part of his theory of evolution. Writing before Mendel's classic experiments in hybridization, Darwin seems to suppose a blending of hereditary factors; whereas, according to Mendel, inheritance is particulate.

Distinct genetic factors combine to produce a certain somatic result without losing their separate identities. They can therefore be reassorted and enter into new genetic combinations in the next generation. With regard to the origin of variations Darwin was also in error. First, his theory of the effects of the use and disuse of parts, which in most respects follows Lamarck's ideas on the inheritance of acquired characteristics, was shown to be false. The researches of August Weismann, as James recounts, proved it "*a priori* impossible that any peculiarity acquired during the lifetime by the parent should be transmitted to the germ." Second, he made the error of assuming that the natural variation which occurs among all organisms because of the differential effects of the environment on development could be passed on to succeeding generations. His ignorance of the processes of heredity left him unable to distinguish, in other words, between variations caused by *genotype* and those produced by *phenotype*, the interaction of the genotype with the environment.

Darwin was cognizant of the occurrence of mutations, but they seemed to occur at much too slow a rate to account for the great variation in nature. The discovery that random mutations of genes are sufficient to account for all hereditary variation removed, according to Dobzhansky, the greatest difficulty in Darwin's theory. The discovery of abrupt mutations causing dramatic changes in a single generation seemed, for a time, to support the supposition that such mutations could act on their own as agents of evolutionary change. This has been proved not to be the case except in instances, found mostly in plants, where a multiplication of the number of chromosomes (polyploidy) can bring about the origin of an entirely new species in a single generation. For the majority of species, Darwin's maxim *natura non facit saltum*—"nature does nothing by jumps"—has been upheld. Because species differ in numerous genes, slowly acquired changes in what Dobzhansky calls "constellations of genes" have been shown to be much more important for the origin of species than isolated mutations. Spontaneous mutations of numerous genes in a single generation are unknown.

Advances in genetics since Darwin's day do not alter the main outlines of his theory. The mechanisms of heredity may be much more complicated than Darwin knew, and involve much of which he was ignorant, such as the structure of genetic materials, the nature of rates of mutation, or the various types, causes, and effects of hybridization. But that merely leads to a more elaborate or different explanation of genetic variation in offspring and the transmission of ancestral traits. No matter how these are explained, their occurrence is all that is needed to permit new species to originate through natural processes of heredity and selection. "Our present theory of evolution," writes Waddington, "can indeed be regarded as for the most part no more than a restatement of Darwinism in terms of Mendelian genetics." The achievement of 20th-century evolutionary theory has been in increasing our understanding of the interrelationship among various mechanisms that guide the evolutionary process. The relative contributions of mutation, genetic drift, geographical isolation, population size, rate of reproduction, migration, and natural selection to the evolutionary process and to the origin of species can now be understood in far greater depth than was possible in Darwin's day. "If Darwin were alive today," Julian Huxley writes, "the title of his book would have to be not the 'origin' but the 'Origins of Species.' For perhaps the most salient single fact that has emerged from recent studies is that species may arise in a number of quite distinct ways."

THE READER MUST judge for himself to what extent Darwin's theory of evolution was anticipated by those who, like Augustine, affirm the appearance of new species of life on earth at various stages in its history, or even by a writer like Kant, who seems to possess the germ of its insight.

The critical test in every case is whether those who affirm the occurrence of *new* species by natural processes rather than by special creation, think of them as simply *added* to the organic forms already in existence without any change in the status as species of the preexisting forms. Those who think in this

way do not have Darwin's idea of the origin of species; for in conceiving an increase in the number of species as merely a matter of addition, they necessarily attribute stability to each species, n :w as well as old. By this test, not even Kant seems to be near the center of Darwin's hypothesis of the origin of species by the extinction of intermediate varieties.

In comparing Darwin with certain of his predecessors, notably Aristotle and Aquinas, it seems necessary to apply another kind of test. Here the problem is not so much one of discovering affinities or disagreements, as one of determining whether they are talking about the same thing and therefore, when they appear to disagree, whether the issue between them is genuine. They do not seem to conceive a species in the same way. Certainly they use the word differently. This affects the way in which the whole problem of origins is understood. The controversies concerning the fixity or mutability of species, concerning evolution and creation, and concerning the origin of man involve genuine issues only if those who seem to disagree do not use the word "species" in widely different senses.

It is *possible* that certain forms of life do not originate by descent from a common ancestor and do not derive their status as quite distinct types from the mere absence of intermediate varieties—varieties which once must have existed but are now extinct. If such forms were to be called "species," the word would have a different meaning from the meaning it has when applied to types of pigeons, beetles, or rats.

The first of these two meanings may express the philosophical conception of a living species as a class of organisms having the same essential nature, according to which conception there never could have been intermediate varieties. The second meaning may be that of the scientific taxonomist in botany or zoology who constructs a system of classification, genealogical or otherwise. On this meaning, one million and a half would be a conservative estimate of the number of plant and animal types classified by the systematist as "species." In contrast, the number of species, in the philosophical sense of distinct essences, would be extremely small.

Darwin, for example, says, "I cannot doubt that the theory of descent with modification embraces all the members of the same great class or kingdom. I believe that animals are descended from at most only four or five progenitors, and plants from an equal or lesser number. Analogy would lead me one step farther, namely, to the belief that all animals and plants are descended from some one prototype. But analogy may be a deceitful guide." It is immaterial to the theory of evolution, he adds, whether this inference, "chiefly grounded on analogy . . . be accepted."

The issue between Darwin and the theologians may or may not be genuine according to the interpretation of this passage, and according to the possibility of a double use of the word "species"—for both the small number of progenitors from which all the extant types of plants and animals have evolved, *and* for a very large number of those extant types. If the theologians use the word "species" in the first sense, and Darwin in the second, they need not be in disagreement. The "view of life" which Darwin attributes to certain eminent authorities, he himself does not flatly reject, namely, that life, "with its several powers [has] been originally breathed by the Creator into a few forms or into one."

Is there common ground here in the admitted possibility that life may have been originally created in a small number of distinct forms and that these are to be regarded as species in one conception, though not in another? If so, the affirmation of a certain fixity to species would apply only to a few primordial forms. Concerning forms which have appeared with the passage of time, two questions would have to be answered. First, are they species in the philosopher's sense of distinct and immutable essences, or species in the scheme of systematic biological classification? Second, is their first appearance at a historical moment due to a special act of creation, to spontaneous generation, or to evolution from already existing organic forms by "descent with modification"?

To join issue with Darwin, it would seem to be necessary for the person answering these questions to use the word "species" in the bi-

ologist's sense and at the same time to account for the historical origin of the new species by special creation or spontaneous generation. But in the tradition of the great books, theologians like Augustine and Aquinas do not attribute to God any special acts of creation after the original production of the world, except to explain the origin of individual human souls.

"Nothing entirely new was afterwards made by God," Aquinas writes, "but all things subsequently made had in a sense been made before in the work of the six days . . . Some existed not only in matter, but also in their causes, as those individual creatures that are now generated existed in the first of their kind. Species also that are new, if any such appear, existed beforehand in various active powers; so that animals, and perhaps even new species of animals, are produced by putrefaction by the power which the stars and elements received at the beginning. Again, animals of new kinds arise occasionally from the connection of individuals belonging to different species, as the mule is the offspring of an ass and a mare, but even these existed previously in their causes, in the work of the six days."

WHETHER OR NOT the theologian's conception of a historical development of the forms of life conforms to the evolutionist's hypothesis, even though it does not offer the same type of explanation, is a matter which the reader of the texts must decide. But one issue, which still remains to be discussed, can leave little doubt of a basic controversy between Darwin and some of his predecessors, especially the theologians.

It concerns the origin and nature of man. It can be stated in terms of two views of human nature. One is that man is a species in the philosophical sense, essentially and abruptly distinct from brute animals; the other, that man is a species in the biologist's sense, and differs from other animals only by continuous variation.

On the first view, *either* man would have to be created, in body as well as soul; *or* if the human species has an origin which in part or whole involves the operation of natural causes, it must be conceived as *emerging* from a lower form of life. The rational soul, Aquinas maintains, "cannot come to be except by creation." But it is not only man's soul which, according to Aquinas, "cannot be produced save immediately by God." He also insists that "the first formation of the human body could not be by the instrumentality of any created power, but was immediately from God." He does not reject the suggestion of Augustine that the human body may have preexisted in other creatures *as an effect preexists in its causes.* But he adds the qualification that it preexists in its causes only in the manner of a "passive potentiality," so that "it can be produced out of pre-existing matter only by God." A Christian theologian like Aquinas might entertain the hypothesis of emergent evolution as applied to the human organism, but only with the qualification that natural causes by themselves do not suffice for the production of man.

On the second view, which is Darwin's, man and the anthropoid apes have descended from a common ancestral form which is now extinct, as are also many of the intermediate varieties in the chain of development—unless, as it is sometimes thought, certain fossil remains supply some of the missing links. "The great break in the organic chain between man and his nearest allies, which cannot be bridged over by any extinct or living species, has often been advanced," Darwin admits, "as a grave objection to the belief that man is descended from some lower form; but this objection," he continues, "will not appear of much weight to those who, from general reasons, believe in the general principle of evolution. Breaks often occur in all parts of the series, some being wide, sharp and defined, others less so in various degrees, as between the orang and its nearest allies—between the Tarsius and the other Lemuridae—between the elephant, and in a more striking manner between the Ornithorhynchus or Echidna, and all other mammals." Furthermore, Darwin insists, no one who has read Lyell's *The Geological Evidence of the Antiquity of Man* will lay much stress . . . on the absence of fossil remains"; for Lyell has shown "that in all the vertebrate classes the discovery of fossil remains has been

a very slow and fortuitous process. Nor should it be forgotten that those regions which are the most likely to afford remains connecting man with some extinct ape-like creature, have not as yet been searched by geologists."

On either of these two conflicting views, the organic affinities between man and the most highly developed mammals would be equally intelligible, though they would be differently interpreted by Aquinas and Darwin. But according to the doctrine of man's creation by God, or even on the hypothesis of emergent evolution, there need not be—strictly speaking, there *cannot* be—a missing link between ape and man, for the emergent species is a whole step upward in the scale of life. Man is thus not one of several organic types which have become species through the extinction of intermediate varieties, and hence he differs from other animals not in an accidental, but rather in an essential manner—that is, he differs in kind rather than degree.

This issue concerning human nature is discussed from other points of view in the chapters on ANIMAL and MAN. Here the issue, stated in terms of man's origin, seems to involve three possibilities: special creation, evolution by descent from a common ancestor, and emergent evolution. But these three possibilities apply not only to man, but to the origin of every species which did not exist at the first moment of life on earth.

The hypothesis of special creation does not seem to be held by the theologians, at least not in the tradition of the great books. The hypothesis of emergent evolution raises questions concerning the factors—natural or supernatural—which must be operative to cause the emergence of higher from lower forms of organic matter. Whether or not Aristotle and Aquinas can supply an answer to these questions in terms of their theory of matter's potentiality for a variety of forms, Darwin's theory of descent with modification seems to be definitely opposed to the hypothesis of emergent evolution. Speaking as a Darwinian, James says that "the point which as evolutionists we are bound to hold fast to is that all the new forms of being that make their appearance are really nothing more than results of the redistribution of the original and unchanging materials . . . No new *natures,* no factors not present at the beginning, are introduced at any later stage."

In this dispute between two theories of evolution, does not the solution depend in every case upon a prior question concerning the relation of the species under consideration—whether or not it is possible for them to be or to have been developmentally connected by intermediate varieties? If, for example, the evidence were to prove that man and ape, as they now exist in the world, are essentially distinct—different in kind—then no intermediate varieties could ever have existed to account for their descent from a common ancestor. If, on the other hand, the evidence were to prove that they differ only in degree, then no difficulty stands in the way of the Darwinian hypothesis. The ultimate issue concerning the origin of species would thus seem to reduce to the problem of which meaning of "species" applies to the organic types in question.