Chapter 1

THE MORNING COMETH

The problem of the origin of species is of vital importance to everyone interested in the age-old controversy between science and religion. Various viewpoints have been held, and many solutions suggested. The theory of mechanistic evolution is built on the idea that nature operates by its own inherent power and is bound by rigid laws with which even God Himself could not interfere. Theistic evolution is based on the assumption that God has used evolution as a means of creating the present complex order of the earth and its life from a primitive state of existence. By admitting God into the process it avoids the atheistic implications of mechanistic evolution. Creationism has had many different interpretations. Some creationists have held that the present species of plants and animals have descended from the original ones without any change. Others believe in changes whereby the original type forms have been considerably modified since their creation.

A survey of the facts of systematic botany and zoology emphasizes the significance of the problem. With over a million species of plants and animals now collected and classified, and over ten thousand new species being added to the catalogues each year, the causes and extent of variation and the manner in which new species come into existence become one of the most intriguing questions in biology. The interest increases as new facts are brought to light. The situation is pregnant with possibilities, and promises worthwhile results no matter from which angle it is approached.

The idea of change in species is not a modern one. Anaximander, about 600 b. c, thought that man developed from a fish. Aristotle, about 350 b. c, taught that all living creatures came from a primordial mass of living matter. Augustine, in the fourth century after Christ, and Aquinas, in the thirteenth, established a dualism in science and religion in which they taught that religious doctrines were given by revelation and scientific ideas by observation. Nature, they assumed, had a simple beginning, and had developed by natural laws to the complexity of the present.

In the Middle Ages the problem of the origin of species was not a serious one; writings on natural history were crude and meager,

consisting largely of stories for sermons or practical discussions on the value of plants and animals. Much of the material was inaccurately written, and rather than investigate nature itself when a point was in doubt, writers often quoted Aristotle or Pliny. Little concern was manifested in natural science. Men knew little and cared less for the problems regarding the origin of living plants and animals.

During the sixteenth century a genuinely scientific spirit in the study of nature began to appear. In 1558 Konrad von Gesner completed the Historia Animalium in four volumes of 3,500 pages, describing quadrupeds, birds, fishes, insects, and reptiles. His work was entirely descriptive, without any system of classification other than the major groups mentioned.

Some botanists made progress in the natural classification of plants, but their systems were awkward, often involving the use of descriptive Latin phrases in naming different kinds. One of the first simple plans of nomenclature seems to have been that used by Aldrovandi in 1599 for the naming of insects. He used a binomial system much like that used today. In the latter part of the seventeenth century John Ray developed a natural system of classification. Many of his ideas were similar to those held by modern scholars, but his knowledge of natural history was not sufficient to give his system true scientific value.

Modern systems of classification are largely based on the work of Carolus Linnaeus, who was born in Sweden in 1707. As a university student he worked out a system of classification of plants and animals, and when he was elected to the professorship of botany at Uppsala University in 1742, he was placed in a position to develop his ideas in a practical way. In his Systema Naturae, which ran through twelve editions before his death in 1778, he described and named thousands of species of plants and animals, and his names are still used except where later students have shown his classifications to be in error, or have made revisions in his groupings. On the whole he was endowed with a remarkable insight into the relationships of the living world, and just before his death he remarked that God had given him more knowledge of nature than had ever been known before.

His ideas regarding the fixity of species have caused a great deal of comment and controversy. In his early writings he made the following statement: "There are as many species as there were different forms produced in the beginning by the Infinite Being: these forms according to the laws of reproduction have produced more always like themselves." This definition of species was taken so literally that many

students of natural history would not admit of any forms not already described by Linnaeus. Reading into the Genesis record a command for all future propagation, they concluded that variations of species were impossible.

The later writings of Linnaeus show that he made some changes in his views regarding the fixity of species. As his investigations extended into wider fields, he found that some forms had apparently been derived from others; therefore in his later publications he wrote of several species as undoubtedly having been derived from certain others, or as having been produced by the influence of the environment, or as having arisen as variants of other forms. A careful study of his works indicates that his earlier views were considerably modified. It is not well, however, to jump at conclusions regarding his ideas. It must be recognized that in his time creationism was the orthodox view of the churches, and that evolutionary ideas were in a rudimentary stage. To claim that his later views in regard to variation or the origin of species by modification of already existing forms placed him in the category with the evolutionists of the present day is as erroneous as to say that he taught the absolute fixity of species. What he apparently did was to accept the Genesis record for what it purported to be - the record of original creation - and to recognize the changes from the original forms whenever he found them. He admitted what every field naturalist knows to be true, that there is a certain degree of modification in living forms, which must be recognized by evolutionist and creationist alike.

During the century following Linnaeus his ideas regarding the fixity of species held a dominant influence in the natural sciences. At the same time suggestions of a gradation between species were being put forward and defended by a few scientific men. Buffon, a contemporary of Linnaeus, regarded the ideas of the famous Swedish botanist as trifling and artificial. In 1749 he made the following statement:

"The gradations are so subtle that we are often obliged to make arbitrary divisions. Nature knows nothing about our classifications, and does not choose to bind herself to them without reserve. We therefore see a number of intermediate species and objects which it is very hard to classify, and which of necessity derange our system whatever it may be" - Histoire Naturelle, vol. 1, p. 16.

That he recognized the problem of variations is clear from a statement published in 1755:

"Although the different species of animals are separated from one another by a space which Nature cannot overstep - yet some of them

approach so nearly to one another in so many respects that there is only room enough left for the getting in of a line of separation between them." - Histoire Naturelle, vol. 5, p. 59.

Buffons exact views are hard to interpret. He fluctuates between the idea of variations' producing new species and that of original creation. He speaks of changes modifying forms, and also of the common design or plan in certain groups. Some historians attribute this vagueness to an attempt to couch his views on variability in such subtle language as to keep the favor of the ecclesiastical authorities, who were creationist in attitude. Others think it is due to the lack of definiteness in his own mind. Be this as it may, although he cannot be said to have produced a clear-cut theory of evolution, Buffon is plainly one of the earliest naturalists to recognize the mutability of species, as contrasted with the doctrine of fixity that was popular in his time.

Some writers give Goethe, the German philosopher, the credit for originating the modern theory of evolution. He showed that flowers were modified leaves, and applied this idea of metamorphosis in a rough way to animals, drawing the conclusion that changes in living organisms might result in transformation from one type to another. However, this statement was not made until 1790, whereas those of Buffon published in 1755 were quite definitely suggestive of evolution.

Erasmus Darwin, the grandfather of Charles Darwin, is suggested by some historians as the first to propound the basic principles of modern evolutionary theory. In 1794 he published a book, Xoonomia, in which he put forth definite ideas in regard to the changeability of form in animals; but the time was not ripe for such ideas, and scientific men paid little attention to them.

Lamarck, who was born in 1744, is usually recognized as the first to formulate a complete theory of organic evolution. He left school at an early age and joined the army, from which he retired after sustaining serious injuries. Then he went to Paris, where he entered upon the study of medicine. Here he became so attracted to the study of botany that he devoted most of his time to it for many years, and in 1778 published Flore Francaise (Flora of France). During the next fifteen years he gave his attention largely to the study of plants, traveling as tutor to the sons of Buffon, and acting as keeper of the herbarium at the Jardin du Roi in Paris.

In 1793 the French Revolution made profound changes in the "Garden," and its name was changed to Jardin des Plantes, a name suggested by Lamarck himself. The next year it was reorganized, and he

was appointed to take charge of the department of invertebrate zoology, of which almost nothing was known. Thus at fifty years of age he entered a new field of science, which he was destined practically to create and build up from the foundation, and in which his fame was to be perpetuated. The remarkable genius of Lamarck is evidenced by the changes in classification which he made during the next eight years. In 1799 he separated the crustaceans from insects, in 1800 the arachnids from insects, and in 1802 the annelids from other worms and the radiates from polyps. Although the latter two are today given different names, all these distinctions are recognized as valid. In 1802 he invented the term "biology" to cover the study of all living organisms.

As soon as Lamarck had entered into the study of animals, we find a change in his views on fixity of species. In the Preface to the Systeme des Animaux Sans Vertehres, published in 1802, he says that nature, having formed the simplest organisms, "then with the aid of much time and favorable circumstances… formed all the others." Later he reaffirmed his views, and in 1809 devoted a great part of his Philosophic Zoologique to the demonstration of his theories. In it he emphasized two main points: (1) the effect of use and disuse, and (2) the inheritance of acquired characters. In 1815 he added a third item, the idea of "need" as a cause for change. He also emphasized the action of the environment, the balance of nature, the struggle for existence, the survival of the fittest, and isolation as a means of segregation of forms. He mentions almost every point that Darwin later used in developing his famous theory of natural selection.

Lamarck died on December 18,1829, at the age of 85 years, having made his name in the scientific world after the age of fifty years. That name was not, however, recognized during his lifetime, nor for half a century later. Contemporary influences prevented the scientists from accepting his ideas, and later, when the full significance of his work was seen, the popularity of Darwin's theories made those of Lamarck a subject of much dispute. There was, however, in his theories such a radically different viewpoint from those of Darwin that they furnished the opponents of Darwin with much material for debate.

However much modern biologists may criticize Lamarck, he must be credited with having recognized two points that are now generally accepted:

1. That species vary under the influence of external environment.

2. That a fundamental unity of plan underlies all diversity of species.

The idea of the inheritance of acquired characters was assumed as an explanation for the changes in species, and it is in regard to this idea that most of the criticism of Lamarck has been made. It is a peculiar fact, however, that discussion of these views did not take place until after Darwinism became the dominant influence in biological thinking. In the meantime, from Lamarck to Darwin, scientific thought was so dominated by the influence of Baron Cuvier that Lamarck made little impression on the minds of his contemporaries and of those living during the years immediately following.

Cuvier was the Professor of Comparative Anatomy at the French Academy of Sciences; in fact he might be called the father of comparative anatomy. In spite of his ideas regarding the immutability of types, he classified animals according to their natural relationships. He presents the anomaly of preparing the way for the acceptance of evolutionary views while at the same time exerting the most potent influence in retarding such acceptance.

In 1830 occurred two notable events. One was the debate between Geoffroy Saint-Hilaire and Cuvier in regard to the fixity of species. The other was the publication of Charles Lyell's Principles of Geology, which set forth the principle of uniformitarianism in geological action. The former event was a triumph for Cuviers ideas of fixity of species, and the latter was the beginning of a new viewpoint in geology that was destined to overthrow the catastrophic viewpoint of Cuvier in geology and prepare the world for the acceptance of the idea of long ages of gradual change in geological and biological history.

From 1830 until 1859, when Charles Darwin startled the scientific world with his theory of natural selection, men plodded along with little thought for the problems of evolution. Weismann said that when he was a student in the 1850*5, evolution was hardly heard of. When Darwin's theories became the subject of discussion, during the two decades following 1859, prominent among the opponents of Darwin were the Neo-Lamarckians, who claimed that Lamarck offered more hope for the explanation of variability in species than did Darwin.

The career of Charles Darwin links up chronologically with that of Lamarck; Darwin was born in 1809, the year that Lamarck published his Philosophic Zoologique. Lamarck's Historie Naturelle des Animaux Sans Vertehres had been finished only three years when Darwin, at the age of 16, entered the medical school at Edinburgh. It was here that one of his teachers eloquently praised Lamarck's theories regarding the origin of species. Darwin could not have failed to take notice, even

though he remained silent, inasmuch as the Lamarckian ideas were so nearly like those of Charles's grandfather, Erasmus Darwin.

Two years at Edinburgh proved that Charles Darwin was not made for the medical profession, and he was sent to Christ's College at Cambridge to prepare for the ministry. In 1831 he received his degree, but his newly awakened interest in science led him to enter other fields than those for w7hich he had been preparing. He was appointed naturalist on the ship "Beagle," which was sailing around the world on a scientific expedition. From 1831 to 1836 he remained with the "Beagle," making scientific collections and taking notes on the life of lands visited, especially life along the southern coast of South America.

The voyage of the "Beagle" was probably the turning point in Darwdn's career, and during the voyage occurred the event which was most likely the main factor in turning his mind definitely in the direction of evolution - the publication of Lyell's Principles of Geology in 1830, a defense of the doctrine of uniformitarianism in geology against the catastrophic views supported by Cuvier. Darwin read Lyell's work while on the "Beagle," and gradually came to believe in the uniformitarian views.

It is important to notice that at the same time that Darwin's mind was being turned in the direction of uniformitarianism, the minds of other students were being moved the same way. The St. Hilaire-Cuvier debates in 1830 were probably the expiring struggle of the eighteenth century catastrophism, and from then until i860 the minds of the rising generation were becoming accustomed to think in terms of long ages of gradual and uniform change. The stage was being prepared for the next struggle, between creationism and evolutionism in the field of biology.

After his return to England, Darwin was made secretary of the Geological Society. This brought him into continual contact with Lyell, who was one of the leading figures in British scientific circles. In 1838 Darwin read Malthus on Population, which gave him the idea of the struggle for existence. Here he found a fruitful notion, which he proceeded to apply to the problem of the origin of species in plants and animals. His attention was also directed to artificial selection as practiced by animal breeders as a means of improving their stock. He now had all the factors for his famous theory of natural selection - geological ages with the necessary time, the struggle for existence and survival of the fittest as the selecting agencies doing the same work in nature that the breeder does with his domestic animals. It only

remained for him to correlate these ideas into a harmonious system, and to gather evidence to support it. The first suggestion that he was doing this is found in a letter written in 1839, in which he hints of the evolutionary idea, and then in one written to Hooker in 1844, stating that he had come to believe in evolution.

In 1844 appeared the anonymous Vestiges of the Natural History of Creation, which was generally attributed to Robert Chalmers, a well-known editor and writer. The twelfth edition in 1884 appeared under his name. This treatise taught that the world was started by God, but once having been started, continued in the course of its development according to uniform physical and chemical laws. Life was supposed to have come about by means of chemicoelectric processes, by which germ cells were created. Once created, these were capable of producing others like themselves. New forms originated through "discontinuous gradations," or a series of graded forms arranged in serial order from simple to complex. The influence of this book is often overlooked, but it is regarded by many as one of the most potent agencies in preparing the way for the reception of Darwin's Origin of Species.

The publication of the Origin of Species was precipitated by a paper sent to the Linnaean Society by Alfred Wallace in 1858, setting forth the same views as those held by Darwin. Hooker and Lyell knew of Darwin's ideas, and to give him justice, they arranged for him to prepare an abstract of his manuscript on natural selection to be presented conjointly with Wallace's paper at a meeting of the society. Following this meeting, Darwin was urged to prepare his material for publication, which he did, bringing out his Origin of Species in 1859.

When the Origin of Species came from the press, the psychological state of the public mind gave it a ready hearing. The first edition of 1,250 copies was sold out on the day of issue. A second edition came out a month later, and a third one before the end of the year. The Hon. James Bryce, speaking at the 100th anniversary of Darwin's birth, said that everyone was excited over the question. Many journals ran articles on Darwin's ideas, and many debates were held. Whetham says: "Converging streams of evolutionary thought - cosmological, anatomical, geological, and philosophic, which, blocked by the prejudice in favor of the fixity of species, were yet collecting deeper and deeper behind the dam. Darwin's great torrent of evidence in favor of natural selection broke the barrier with irresistible force." - History of Science, page 297.

The success of his theory is largely due to the painstaking methods which he used. The strong points were re-enforced by proofs, and the weaknesses were admitted before his opponents could point them out. Such a wealth of evidence was accumulated in favor of the theory of natural selection that opponents were decidedly at a disadvantage, whereas for every objection that they could bring, Darwin had an answer. Very often the objections were admitted, but they were overruled by overwhelming evidence on other points. All this was done during the years before the publication of the Origin, in order to make certain the invulnerability of the theory. It is not necessary to go into detail regarding an explanation of Darwin's theory of natural selection. In principle it was simple, involving the idea that the continuous variations occurring in nature were the material by which, through the struggle for existence, a survival of the fittest would take place. This process was called natural selection, by way of comparison with the selection of favorable stock by the breeder.

Many of the principles of Darwinism had been recognized long before 1859. Ten years earlier Tennyson had written these famous lines:

"'So careful of the type?' but no.
From scarp'd cliff and quarried stone
She cries, 'A thousand types are gone:
I care for nothing, all shall go.'"

The psychology of the masses made the acceptance of Darwin easy. Scientific and industrial advance had undermined religious and social life to such a point that a revolution was bound to come. "Skeptical of the teachings of the church and impatient of domination by the privileged classes, many could find in the doctrine of natural selection proofs that religion was a failure because the mythological statements of the Bible were contrary to the now easily demonstrated facts of observation." - L. T. More, The Dogma of Evolution, page 9.

It is unnecessary to multiply evidence that Darwin's Origin of Species came as a psychological coup d'etat that removed the last great objection to the acceptance of the uniformitarian doctrine upon which modern evolution has been built. When it appeared, there was little scientific opposition. The time was ripe for such a theory, and if Darwin had not presented it, someone else would have done so.

On November n, 1859, Darwin sent copies of the Origin to scientific men, asking them to give it consideration. The response was not slow in coming. Just two weeks later Huxley pledged his support,

stating that he was sharpening his talons for the fight that was bound to come. He especially favored Darwin's views because they freed him from the necessity of accepting the Biblical account of a literal creation, a doctrine that was odious to his sense of reason. About Christmas he reviewed the Origin in the London Times, which review was an important factor in the battle. As soon as Wallace, who was collecting in the East Indies, received a copy of the Origin, he hailed it with delight, saying that Darwin had given to the world a "new science."

Lyell and Hooker supported Darwin, although Lyell was hesitant for some time. He could not bring himself to believe in the descent of man from animal ancestry, but was in favor of the idea of a separate creation of man. In America Asa Gray defended Darwin against the attacks of his opponents, especially against Agassiz, who was irreconcilable. As late as 1880 Gray continued his defense of Darwin, appearing in that year before the Theological School of Yale College to speak in defense of natural selection, and to show the compatibility of Darwin's ideas with religion.

Scientific attacks on Darwin were largely from the older men, either from those whose ideas were too fixed to undergo revision, or whose prestige or authority might suffer from the acceptance of the new ideas. The same was true even in a greater degree in regard to the attack on religious grounds; it was a matter of authority against discovery and demonstration. Also, it might be noted that some of the scientists held certain religious or philosophical views that were hard to reconcile with the inevitable mechanistic conclusions which the theory of natural selection would involve.

Among those opposing Darwin were Adam Sedgwick, professor of geology at Cambridge University, Herschel the astronomer, Richard Owen, the famous anatomist, and others of high repute in the scientific world. Many wild attacks were made by those who were incapable of judging the scientific value of his ideas. Against all these attacks the champions of natural selection held their ground by citation of evidence, whereas the opposition used only scorn and ridicule, having neglected to assemble facts by which to combat the new ideas. The result was that as soon as the bluster and storm of protest died down, the array of evidence that Darwin had been accumulating for twenty years remained to support his theory, and the opposition was forced to cease its fight. Darwin gradually came to be accepted as one of the great men of his century. Although the French Academy refused to acknowledge him, on the grounds that his views were not science, but

speculation, his prestige increased, and in 1870 Oxford University gave him an honorary degree. When he died in 1882 he was buried in Westminster Abbey, among Britain's great men.

Darwin's book created a greater stir among the theologians than among the scientists, and resulted in perhaps greater changes in viewpoint. To understand this, it is necessary to go back to the early part of the nineteenth century, which was a theological age in England and America. Religious beliefs were sharply defined, and had changed little since the Reformation. Personal salvation was the keynote of religion. Right or wrong, religious beliefs played a large part in the life. The authority of the Bible was accepted; it was an inspired book from Genesis to Revelation; any doctrine that could be supported by texts from the Bible was bound to be given consideration. Sunday was rigidly observed; churchgoing was universal; communion was celebrated monthly. Family worship was conducted in almost every home. Faith in a personal God was very real; hell-fire and heaven were doubted by none except skeptics and atheists, who were regarded with horror.

The liberalism of the French Revolution came into America but slowly. Up to 1823 atheist writers were liable to prosecution. The influence of the French and American revolutions upon religious life were largely held in check by the "Great Awakening" that occurred during the early part of the nineteenth century. The years from 1800 to 1845 constituted a period of religious fervor culminating in the advent movement begun by William Miller in 1831. All over the world the prophecies of Daniel and the Revelation were preached, foretelling the literal return of Christ to the earth, until in 1844 there were several hundred thousand persons who were confidently expecting to see the end of the world.

In the meantime French rationalism was working underneath the surface, and steadily gaining ground; and in 1835 German Biblical criticism was "exploded" upon America. Thus the literalism of the Adventists and the liberalism of the skeptics developed simultaneously. When the Adventists were disappointed in 1844, there was a sudden revulsion of feeling, and the critical influences in theology rapidly replaced the attitude of implicit faith that had characterized the Advent movement.

When the theory of natural selection was thrown open for discussion at the meeting of the British Association for the Advancement of Science on June 28,1860, it was plain to be seen that a theological rather than a scientific debate was to take place. Bishop

Wilberforce and several other of the clergy who had scientific standing were on the platform. Huxley had reluctantly consented to attend, and to him the champions of Darwin looked for support of the theory of natural selection. The debate was a complete victory for the advocates of evolution. Wilberforce could only appeal to ridicule, directing his principal argument against the idea of the ape ancestry of man. Huxley's cool logic and the well-knit arguments in the Origin were invulnerable against the dogmatic attacks of the theologians, and the day w7as won for the new ideas.

Church authorities held out for a while against Darwinism. Dr. Whewell refused to allow a copy of Origin to be placed in the Cambridge library. Dr. Westwood proposed the endowment of a permanent reader to oppose Darwinian ideas. Reviewers of the Origin claimed that it destroyed all ideas of design and purpose in nature, that it opposed teleology, and that it introduced mechanical formalism into the universe. Some claimed that it was atheistic, and opened the way for all kinds of evils.

One of the most bitter attacks in the theological field was that of Dr. Samuel Butler, son of one of Darwin's former instructors at Cambridge. He claimed that Darwin had rejected purposiveness, in spite of the fact that Darwin had clearly stated that he did not intend to deny the presence of design in the universe. Butler maintained that adaptation of structure to function, and of the organism to the environment, implied design, and pointed to the "older men," Buffon, Erasmus Darwin, and Lamarck, as examples of the true interpretation. An evolutionist himself, Butler defended the Lamarckian view. He believed that a biological "memory" was responsible for adaptive modifications, and could not accept the mechanistic interpretations that he saw in Darwin's theory.

Although vigorously opposing Darwin, church leaders were strangely at a loss for effective weapons with which to oppose the new ideas. By the middle of the nineteenth century the growth of geological ideas had forced many of the theologians to revamp their views in regard to the days of creation, and when Darwin introduced his theories, the clergy were very much at sea as to the interpretation to put on the book of Genesis. They had no consistent line of argument, and could not present a united front to what they felt to be destructive elements in the new ideas. They had themselves virtually accepted all the elements of the mechanistic interpretation, and by introducing critical scholarship into their theology, they had adopted the scientific

method of dealing with theological questions, rather than following the dogmatic method of settling disputed points by reference to the authority of the Bible. Being thus on the same basis as the scientists, they had to meet them on their own ground. Here they found themselves unable to meet the scientifically organized arguments of Darwin.

The chief objections to Darwin's theories were the anthropological implications; the clergy objected to the idea of animal ancestry. Being so attentive to this point, they overlooked the logic and cumulative proofs of the theory of natural selection, and made practically no impression upon the theory as a whole. They wasted their strength attacking the theory of ape ancestry, while the real lines of argument in regard to the factors and methods of selection were overlooked by them almost completely.

The collapse of the theological opposition to Darwin was not long in coming. Aided by the powerful agnosticism of Haeckel and Huxley, free thought won its way rapidly, and in 1887 Huxley triumphantly said that theologians had ceased to oppose evolution; they either denied the reality of Genesis or tried to reconcile it with evolution.

German scholars eagerly picked up the natural selection theories, made Darwinism a school of philosophy, and taught it systematically in a way never done in England. The older German scholars rejected the new ideas with indignation, but often through prejudice rather than because of scientific reasons. The younger men accepted more readily. Increasing materialism and radicalism made it easy for them to do this. Darwinism became connected with socialistic tendencies in politics and with liberalism in religion, and for this reason was vigorously opposed by the church and by the more conservative elements in politics. Virchow threw all the weight of his influence against it. The suppression of the Social Democratic party in 1877 was a hard blow to Darwinism. By 1893 it had become obsolete as a system of thought, and was replaced by other philosophies.

It should be carefully noted that the foregoing remarks apply to Darwinism as a philosophy and not to the theory of natural selection as a biological theory. Nevertheless, powerful arguments were brought against the scientific aspects of Darwin's theory. In 1874 Albert Wigand, the German botanist, produced one of the most complete arguments ever given. He claimed that Darwinism was no science, but a mere massing of facts which explained nothing. Differences in

animals were as hard to explain, he said, as the nature and origin of light or of electrical energy in the universe.

Many other German scholars opposed Darwin on similar grounds. They claimed that he had confused description with explanation, causes with motives, and chronicles with plan or design. They pointed to the latter set of categories, and were not content to accept his idea of a systematic method in nature, but demanded that a philosophy be made of his ideas.

In strictly scientific circles the work of August Weismann from 1890 onward led a determined revolt against Darwin. In one of his later works Darwin had developed the theory of pangenesis, whereby the germ cells were supposed to contain minute particles, or "pangenes," derived from all parts of the body. In this way he explained the manner in which any change in the body would be transmitted to the next generation. Weismann reasoned that body cells and germ cells were separate one from the other, and that there was no mechanism whereby body changes could affect the germ plasm. This distinction between body and germ cells was believed by many to be an impassable barrier against the effects of the environment upon heredity. Right or wrong, it became the forerunner of a large series of determined attempts to discredit Darwin. From 1896 to 1904 the German scientific revolt was especially strong, and more than once Darwinism was supposed to have been brought to its "deathbed."

The coming of Mendelism at the beginning of the twentieth century added a new element to the problem. Hitherto a score or more theories had prevailed regarding the nature and mechanism of heredity, but no experimental work had produced any tangible results. In 1900, Mendel's laws were discovered simultaneously by three botanists, De Vries of Holland, von Tschermak of Austria, and Correns of Germany. Bateson in England, Cuenot in France, and Castle and Davenport in America, extended the application of Mendelian principles to animals. Thus the scientific world became possessed of a clue to the puzzle. Thousands of research workers all over the world immediately entered into a mad race to discover the inner secrets of plant, animal, and human heredity. Chromosomes were mapped, and the heredity factors were located so accurately that on a tiny filament of protoplasm invisible to anything but a powerful microscope, the genes were plotted within a tenth of one per cent of their relative positions. Their distribution was observed during reduction divisions and fertilization

processes, and the whole question of heredity promised to become a science of the most exact mathematical precision.

The materialists were jubilant, for here apparently lay the complete vindication of the mechanistic assumptions of Darwinism. The result of the new knowledge of heredity was a reversal of the scientific attitude toward natural selection. Whatever in the Origin of Species was found to agree with the newer discoveries was retained, and fortunately for Darwin's prestige this constituted the larger part of his work. Whatever in his theories were found to be out of harmony with Mendelism was rejected. On the whole, the biologists performed a major operation upon the body of scientific theory, and formed a graft of the new Mendelian principles upon the older Darwinian doctrines. Darwin began to come to his own, in spite of the attitude of some thinkers to the effect that Mendelism was a supplanter and destroyer of natural selection.

Observations on plants and animals in their native haunts revealed a host of characters that coincided with the Darwinian view of species. Experimental genetics brought workers face to face with facts that could not be explained by a morphological interpretation of species, but which fell into line with the principles of natural selection. A new Darwinism arose, which profited by the contributions of both friends and foes and retained the valid discoveries of all workers. This new "origin of species" oriented itself in terms of life processes rather than with anatomical features and bade fair to furnish a fairly satisfactory explanation of the meaning of species and the problems of their origin.

If the theory of natural selection as applied to species were all that was involved in Darwinism, there is little likelihood that it would have attracted more than a passing interest outside academic circles. But the principle of natural selection and many implications derived from it were applied to almost every phase of human thought and endeavor. Darwin should not be blamed for all of these. Each man or group of men has made whatsoever applications his opinions made him regard as most reasonable. The idea of the equality of man went overboard; human knowledge was interpreted in terms of evolution; comparative religions were studied in the light of their development and evolutionary ways been mollusks, echinoderms have always been echinoderms, arthropods have always been arthropods. There is not the slightest evidence for any other view. Whenever any fossil remains appear in the rocks, they belong to already existing groups, or else

appear suddenly, with no intermediate forms which would indicate transition from previously existing groups.

About the same time an English writer, Douglas Dewar, pointed out the incompatibility between many facts of nature and Darwin's theory of natural selection as a cause of evolution. He asserted, in the first place, that a great array of facts was impossible to reconcile with Darwinian evolution, thus making it necessary to find some other theory. In the second place, he declared that it was perfectly scientific to believe that each phylum, class, order, family, or genus, may have been created separately, and to have undergone differentiation since its creation.

These suggestions are strikingly similar to those made by A. H. Clark, to the effect that while there is not the slightest evidence for transition forms between one major group and another, within these groups there had been continuous and extensive change.

The latest and possibly the best material has come from the geneticists themselves. In 1937 Dobzhansky presented to the English-speaking scientists the results of recent researches in Russia, and in 1938 Goldschmidt published his Physiological Genetics, which was a summary of his lifetime studies, supplemented by researches of many world-renowned geneticists. The newer knowledge regarding chromosomes is sufficient, these men declare, to account for practically all the changes that could occur within the groups; at the same time the application of known principles of genetics to the problem of the origin of the major groups themselves is almost completely hypothetical, and without adequate support in actual fact.

"Watchman, what of the night?" "The morning cometh, and also the night." The prospects for a satisfactory solution of the problem of the origin of species appear brighter than at any time since Linnaeus. Converging lines of research have contributed their results. All the factors seem to be available for study. As far as species are concerned, all modern biologists agree that they are fluid units, capable of a considerable amount of change. The problem of the origin of the larger units appears to be as yet unsolved, and the evidence thus far leaves little but conjecture to build on.

Perhaps it is too much to hope for the dawn of a new day in scientific thought, but at least the skies are aglow with the light, and a careful consideration of the newer knowledge of genetics may possibly point the way through the shadows that have confused biologists for the past century and a half.