secondary and collegiate. We may go quite farther than that and may well claim that the reality surpasses the fiction. No English novelist has given us an imaginary character equal to Arnold or Rugby. No American novelist has fashioned a teacher equal to Mark Hopkins of Williamstown. God's hand does better work than man's pen. Dickens gave us Dr. Marigold, the traveling auctioneer, who between his spells of noisy salesmanship instructed the blind Sophy and eventually brought her to the city that other teachers might enlarge the range of her inner vision. In Dickens' *American Notes* one can easily see that the imaginary Marigold was far surpassed by the actual Dr. Howe, who opened the world of sights and sounds to Laura Bridgman, the child of darkness and silence.

The greatest educational achievement in the life of one person is not to be found in any novel. It is found rather in a thrilling bit of American history. I think that you will agree that the case of Hellen Keller is the deepest, as well as the most dramatic, accomplishment of individual teaching in the records of the race. Helen Keller knew who was her deliverer. In her lecture on "Happiness" she kept repeating as a grateful refrain, "Love wrought this miracle in me." On the platform with her sat her life-long teacher, Anne Sullivan Macy, still watching every enunciation and capturing all chances for the instruction of her famous pupil. Anne Sullivan had led a child out of the threefold prison of darkness, deafness, and dumbness, until at last the world was met with an ever-increasing liberty and joy. Later, Helen Keller sought to reverse the current and to communicate the gifts of gratitude to her teacher.

We may well thank God that in our schools generally our teachers remain somewhat as embodied ideals. We do not go far astray when we follow them. Yet no hour like this is complete unless at last it admits the Highest. Long since, one came by night to the Master and said, "We know that thou art a teacher." Even so, the mightiest Teacher that ever lived! The holiest application that we can possibly give to the Apostle's suggestive call is to see to it that we, being taught of Christ, may communicate back to Him the deepest and best gifts of our own hearts and lives.

EDWIN HOLT HUGHES

GENETICS AND EVOLUTION

RELATIONSHIPS depend on similarity of appearances and community of origin. When we see two people who look very much alike, our first assumption is that they are related. Similarly, with animals, we can distinguish one kind from another by their anatomical differences, and we can determine the degree of relationship by observing the closeness of their mutual resemblances. Detailed resemblances indicate common descent. However, the more remote the common source, the more distant is the relationship. In human society, our records are limited and lose sight of the source. Thus we consider our acquaintances wholly unrelated even though the fundamental identities of structure and development would force us to recognize relationship.

There is an old saying, "Blood will tell." It helps, at least, in the determination of degree of relationship, for many experiments have been made with the blood of various animals. Precipitation tests, in which the blood of several different apes was added to anti-human serum, have been invaluable in that respect. A marked precipitate was formed in the case of the anthropoid ape, the reaction of the Old and New World monkeys was weak, and lower mammals showed no reaction at all. This tells us that man is closely related to anthropoid apes, more distantly related to Old and New World monkeys, and not at all to the lower mammals. Thus, we cannot believe that we were put on this earth, a class all to ourselves with independent origin, but

must turn to evolution for our answer.

The chief problem of evolution is the manner in which it occurred. There have been many theories and opinions on the subject, and neither the materialistic nor philosophical aspects seem adequate. They have, however, paved a way for further investigation.

The ideas of relationship and evolutionary development are not new in the field of science. The ancient Greeks did work that has led up to much that has been done in later years. At the beginning of the nineteenth century, Lamarck, a Frenchman, formulated a valuable theory. Charles Darwin's theory, also in the nineteenth century, has gained a permanent and prominent place in science. Since Darwin's time, refined equipment and improved working conditions have made possible examination of natural phenomena by more exact methods of observation and experiment. As a result, the more modern theories of mutations and kinetogenesis have been formed.

The gradual changes of evolution have been influenced mainly by heritage and environment. The former is a quality which man and all other organisms have, and without which they could not exist. Environment we know to be the surrounding conditions to which heritage responds within certain limits. These two factors go hand in hand and are practically inseparable.

Let us look at a number of evidences of evolution and then try to see how the factors mentioned above influenced them.

Ontogeny is the life history or development of an individual. In discussing ontogenetic succession, Lindsay says, "In studying the common characters of the vertebrates we have noticed the succession of forms characteristic of several phyla. That these forms may be looked upon as chronological succession, and not merely a succession in degrees of complexity, is made evident by the combination of anatomical and embryological facts. In the skeleton of vertebrates, for example, the occurrence in some fishes of a cartilaginous cranium alone, in others of such a cranium partly ossified together with external bony plates with characteristic arrangement, and in the higher classes of a skull which embryology shows to be made up of a similar cartilaginous portion in the beginning, from which certain bones are derived by ossification and to which others are added by development directly from mesodermal tissue, is indicative of relationship in chronological succession. The same applies to the other bones of the body. This gradual succession of stages during embryological development which correspond to those represented by adults of the several classes is clear evidence that the higher forms have come from lower in this phylum. We see in the few points mentioned that the formation of cartilage is not an essential step in the formation of bone, so the transition of some bones can mean only that they still pass through the stages which they have followed in the past."[1]

We find a similar condition existing in the development of the aortic arches in the circulatory system. In fishes, amphibia, and reptiles these arches are symmetrically paired, though in the last two, the number is reduced. In birds and man they are still further reduced and asymmetrically developed. In the development of the human embryo, six pairs of symmetrical arches are at first formed. The number is gradually reduced until it reaches the adult condition. Since nature does not usually form unnecessary structures, we must conclude that the higher forms are derived from fish-like ancestors.

The evolution of a modern species cannot be better illustrated than by the elephant or horse, because fossil remains tell the complete story.

The earliest ancestors of the modern

[1] A. W. Lindsay—*Textbook of Evolution and Genetics*. The Macmillan Company. 1929.

elephant, with which we are all familiar, were found in Africa in the deposits of the upper Eocene period. The animal had an enlargement of the nasal openings in the skull, elongation of the incisors of both jaws, and faintly ridged molars, an important characteristic. It became extinct in the Oligocene period, about 110,000,000 years ago.

Next in line came the Paleomastodon of the Oligocene period, whose fossil remains were found in both Asia and Africa. This animal showed an advance in the development of the characteristics of its immediate ancestor. The incisors of the upper jaw had become well developed tusks.

The Miocene period, about 90,000,000 years ago, produced the Dinotherium, which had the peculiar development of a deflected lower jaw and tusks, while there was a complete lack of tusks in the upper jaw. Here we find the development of the proboscis or trunk. Otherwise, they were generally well developed, but no present-day forms are descended from them.

Three other genera arose in the Miocene in Europe, Asia, Africa, and North America. These forms still had the elongated lower jaw and lower tusks. Those particular characteristics did not disappear until the appearance of the Dibelodon in the same period. The Mastodon also arose in the Miocene and included several different species. These animals were much like the elephant in size and structure of the various characters, but were very primitive.

The genus Stegodon, produced by the Mastodon, was much like the modern elephant, and was in fact the link between them. Its fossil remains have been found only in southern and southeastern Asia, which was in all probability the region in which true elephants developed.

The evidences of evolution of the horse are similarly complete, and in the history of man we have a continuous line (fairly complete) from the common ancestors of apes and men up through the most primitive of men to modern man.

From these evidences let us turn to the theories that have been expressed as to their causes. As previously mentioned, we know that environment consists of the external or surrounding conditions. Its effect may be felt in various ways such as change of climate (extremes of heat or cold, as in the warm and glacial periods of the earth's history) and change of food supply due perhaps to soil conditions.

The other factor mentioned, inheritance, involves a comparatively new science which rests upon principles discovered in the eighteen sixties by Gregor Mendel, a German who entered an Austrian monastery and conducted many of his experiments in a little garden there. Work of recent years with the aid of the microscope has confirmed his principles and added to the science of genetics.

However, before Mendel's experiments, Lamarck expounded his theory of inheritance of acquired characters and development through use. His first law was that constant use of an organ will strengthen, develop, and enlarge it, while disuse will cause degeneration. His second law states that everything which nature has caused individuals to acquire or lose is preserved by heredity and passed to new individuals of the next generation. This view has been criticized harshly, but scientists are not completely united against the idea.

Darwin's theory was that of natural selection, i. e., that more individuals are produced in every species than can survive. The result is a struggle for existence in which survival is determined by the inherent characters which control variation, and in which surviving individuals alone will perpetuate the species and determine its characters.

Variations, the basis of these two theories, are of three kinds: morphological, physiological, and psychological, all of which are closely related but may differ in degree.

Continuous variations are ones which

grade through a long line of individuals without any apparent break. An example which illustrates gradations from minimum to maximum is shown in the curliness of human hair. It varies from the straight-haired Mongolian races to the kinky hair of the Negro.

The variations, in structure, of the number of parts is not of the continuous type, for there can be no gradation between four and five digits. This type is called discontinuous variation.

A more fundamental classification has to do with three groups, namely modification, combinations, and mutations. Of the three, the last is the most important. Modifications do not affect evolution. They are merely changes which appear in an individual during the ordinary course of life, produced by environment and not heritable. In individuals they are controlled by inherited characters which allow various responses and adaptations.

Combinations are the result of biparental reproduction and are thus inherited because they are based on the rearrangement of heritable characters. They are limited to the range of characters found in the species and affect individuals.

Germinal mutations account for a large number of evolutionary changes. They are due to an abnormal behavior of chromosomes or a modification of genes, the parts of chromosomes which determine inheritance. The abnormal chromosomal behavior may be an interchange of parts of pairs or changes in number of those tiny bits of chromatin in the nuclei of our cells which control our inheritance. Because these sudden appearances of differences are heritable and constitute the permanent characters of the following generation, they have a very important part in evolution. As we saw in the cases of the development of the bony cranium, the successive reduction of the number of aortic arches, and in the development of the modern elephant, those changes or mutations, whatever their cause may have been, were passed on to the following generation. Thus from a series of mutations have evolved our existing forms of life.

Evolution as we know it today explains many facts, but at the same time leaves many unexplained. No theory yet formulated tells the whole story, and man still knows relatively little about the "forces that have placed him where he stands today." But step by step, scientists are, through observation and experimentation, furnishing a guiding principle to increased knowledge.

JANE BEERY

PROSPECTS FOR NATIONAL LEGISLATION

"Education has its greatest opportunity in the life of our Government with the opening of the 76th Congress because we have a chance to guarantee to each state the opportunity and the right to guarantee the fundamentals of education to every person within its borders under a plan in which the state's own teaching methods remain paramount. The federal aid to education bill properly applied by our school superintendencies promises the most far-reaching educational development of all time, particularly in states which have been compelled by finances to make a relatively poor record in instructing their people. There may be many educational bills in the minds of Senators and Congressmen, but only those which add to rather than detract from the states' own powers and ambitions will survive. It must not be forgotten that the library is one of the foundation stones of education, and the possibilities of multiplication of library services are almost inestimable."—*Senator Elbert D. Thomas, chairman, Education and Labor Committee, United States Senate.*