EVOLUTION

A SUMMARY OF EVIDENCE

A LECTURE DELIVERED IN MONTREAL, MARCH, 1883

BY

ROBERT C. ADAMS

NEW YORK
G. P. PUTNAM'S SONS
27 & 29 WEST 23D STREET
1883

Press of
G. P. Putnam's Sons
New York

EVOLUTION.

The Germans say, "What is true is plain," but many persons who begin to read about Evolution meet the assertions, that the development of life proceeds from the homogeneous to the heterogeneous, and that changes in the environment lead to differentiation; and, as these statements lack plainness, the readers say: "What is obscure is false." Much prejudice has been excited against Evolution by the use of long words, which, though most serviceable to the learned, are perplexing to the uninitiated.

An abstract of many books is here presented in plain language, and for a fuller exposition of the subject, in a remarkably lucid and interesting manner, the reader is earnestly referred to a work lately issued by Messrs. Chatto & Windus of London, and republished by Messrs. G. P. Putnam's Sons of New York, "Chapters on Evolution," by Professor Andrew Wilson of Edinburgh, a work which has been of much service in the preparation of this paper.

In earlier times it was believed that the earth was a flat surface of moderate extent, roofed over by a solid sky, under which were placed sun, moon, and stars, small orbs designed to give light to the earth around which they revolved. These people believed

that all the existing forms of nature were made out of nothing, at the word of a Creator, during six days of evening and morning. They thought that all forms of life were originally made in their existing form complete, whether insect or elephant, grass-blade or oak-tree; and they believed that since the day of creation each species had reproduced its kind without important variation.

These theories of the earth and heavens were generally accepted, until Copernicus and Galileo began to influence opinion by calling attention to evidences that the earth was round and that it moved; ideas that were afterward demonstrated by Kepler and Newton. But, although some thinkers suggested other views, the early theory of life remained without serious opposition till the present century, when Lamarck in 1801 formulated, and Darwin in 1858 supported, the theory of EVOLUTION.

These writers studied the laws of Evolution as applied to organic life upon the earth; but Herbert Spencer, prior to the publication of Darwin's great work, "The Origin of Species," began to treat of Evolution as the method of the universe, and to apply its doctrines to every department of material and mental existence.

In this broadest sense, Evolution is the theory that all the varied details of the universe are the result of a gradual development from simpler conditions, through the working of the laws of nature

which now surround us. Worlds, minerals, plants, animals, man, language, morals, laws, literature, arts and sciences, as they exist to-day, are the outcome of the unceasing successions of cause and effect that have taken place, through the preceding ages, in accordance with natural law.

But the term as popularly used refers more especially to life, and in this sense, Evolution is the theory that all existing forms of life have been produced from simpler forms by a gradual process of change. Instead of an unchangeable universe continuing just as it was first created, the Evolutionist, seeing constant variation in each kind or species of plants and animals, has learned that these variations may increase, until, in a long course of natural descent, forms are produced that appear to be distinct species. In the breeding of domestic animals and in the crossing of plants, such marked differences result in a short time, that it becomes certain such variation continued through a long period would produce forms appearing to differ in kind from their ancestors.

It is therefore seen to be both possible and probable that all existing forms of life have developed from a few simple forms, or even from one form, by slow processes of change continued through vast ages.

Natural Selection.

The great work of Darwin was to point out the

main process through which the evolution of forms takes place. More organisms come into life than the means of subsistence can support. This leads to a struggle for existence. There is some variety in the forms of individuals of each species of plants and animals, and those possessing the variations most suited to their conditions are enabled to survive, while those less adapted to the circumstances perish. This is called the survival of the fittest. These individuals reproduce in their offspring the variations that have benefited them, and new variations occur, those that are useful being perpetuated.

Thus there is a continual divergence from the parent stock, wherever there is a change of surrounding conditions that makes variations serviceable to existence. When these variations are long continued they form new species. But where there is no change in the circumstances of life, and the means of existence are abundant, there is little or no change in the forms of life. This process by which nature selects the forms best suited to their surroundings is called by Darwin NATURAL SELECTION.

Sexual Selection.

Darwin notes another cause of the variation of species, which he calls Sexual Selection. The male animals battle for the possession of the females. The strongest wins, and transmits his peculiarities to his descendants. In many cases the female selects the male possessing the most perfect form, the most pleasing voice, or the most attractive colors, and these advantages are perpetuated in their offspring. An improvement in the song and beauty of male birds arises from this selection. In savage races the females select the strongest men best qualified to be defenders; but in civilized races the choice is more influenced by intellectual and moral qualities, and in each case the race shows an increasing variation in the direction of these selections.

The Unity of Animal Life.

The proofs of the theory of Evolution extend over the whole realm of nature. The most prominent of these is the apparent connection of all forms of animal life, such as would exist if each order of life had grown out of the order below it. The students of nature are continually finding intermediate forms, or "missing links," between the established classes of the animal kingdom. As a tree from a single stem spreads out into numerous branches and twigs, so life appears to manifest itself in a series of forms, each closely allied to the other, or with such strong resemblances that a relationship appears certain.

The most marked distinction between animals is the possession or non-possession of a backbone. The theory of special creation was long supported by triumphant appeals to the gap between the backboned (*vertebrate*) and the non-backboned (*inverte-*

brate) animals. It was claimed such a change could only have been made by the special act of God in creating a new form.

But in the lowest fish, known as the lancelet or *amphioxus*, we find a soft rod in place of the backbone. This is called the *notochord*, and represents the commencement of the formation of the backbone in animals. This little fish is only one or two inches long, and inhabits sandy coasts. It has neither limbs, heart, nor brain, and a narrow fin is the only distinct fish appendage that it possesses; but in many respects it resembles the molluscs, or soft-bodied invertebrates.

One of the molluscs, the sea-squirt, or *ascidian*, is a marine animal shaped like a bag. It attaches itself to stones at low-water mark, and when handled it squirts water from its orifices. Some of its species are found with a permanent tail, and the first sign of the notochord, the dawning backbone.

Here in the lancelet and sea-squirt we have connecting links between the two great classes of vertebrates and invertebrates, and the gap that was supposed to exist has been in a measure filled. The lamprey is another link above the lancelet, and other forms illustrate the gradual rise of backboned animals from the invertebrates.

The articulates, or jointed animals, such as insects and crustaceans (animals having a crust-like shell), are allied to the molluscs by a marine worm called

Balanoglossus, which has characteristics of both divisions, and appears to be an intermediate form or link between them.

The radiates, or rayed animals, as the starfishes, are also connected with the articulates by worm-like forms uniting peculiarities of both ; and through the sponges we find the radiates connected with the protozoans, or first forms of life, such as corals and sea animalcules.

Ascending from the fish, the lowest of the vertebrates, we find animals between the fish and the frog, and between frog and lizard, that link fishes and reptiles. The differences between reptiles and birds are very marked, and it would seem at first thought that no connection could be found between them, but the fossil *archæopteryx*, an ancient winged bird with a long, jointed tail and with teeth, is pronounced by Prof. Vogt to be an undoubted intermediate form between reptiles and birds. Fossils of flying reptiles are found, and of land reptiles that approach the structure of birds.

Birds and mammals are connected by living forms found in Australia. The duck-billed water-mole has webbed feet and a duck's bill, and the fur and tail of a beaver, and has teeth. It has no teats, but forces milk from little holes in one spot of its body. The *Echidna* makes a little advance upon this by having a pouch over these holes, and the kangaroo gives us a still more advanced form. A great distinction

appears between animals that hatch their young from eggs and those that give birth to living forms. But we find animals whose young break the egg as soon as it is laid, and others that bring forth their young in an imperfect state and nourish them in pouches until fully developed. These *marsupials* are intermediate forms, and suggest other connecting links.

The researches of Prof. Marsh among the Tertiary rocks in the Western States have revealed several intermediate forms between existing groups of animals. Fossils are found which combine characteristics of the bear and the beaver; others connect the rat and the ant-eater, the odd-toed and the even-toed animals, the whale and the seal, the swine and the ruminants. An eminent naturalist was asked, "Do you find the missing links?" "Yes, thousands of them!" was the reply.

The resemblance between apes and men is very marked, and Haeckel says: "It requires but a slight stretch of imagination to conceive an intermediate form between the lowest woolly-haired man and the highest man-like apes." A great outcry is made for the presentation of this missing link, that shall completely fill up the gap which exists. But the Evolution theory does not require, as many suppose, that man should have descended directly from the existing form of apes. The gorilla and man are at the top of different branches, which have sprung from the same limb of the tree of life. The connection

comes at some lower part of the tree, when, as Wilson says, "from a common ancestor the human and ape types took divergent roads and ways toward the ranks of nature's aristocracy."

Gabriel de Mortelet has just issued in Paris a scholarly work, which he claims establishes the fact "that during Tertiary times there existed a being intelligent enough to produce fire and to fabricate instruments of stone; but this being was not yet a man." More evidence needs to be accumulated before his conclusion can be considered to be proved; but all analogies of the animal kingdom point to the former existence of more man-like animals than have yet been found. Only the discovery of their bones will satisfy many minds, but what has already been observed of the connection of various species and classes of animals gives to others an assurance as to the relationship of man to animals that would not be increased by the presentation of any number of "missing links." One link proves the existence of a chain.

It must not be understood that every animal can be traced back by connecting links to a lower one, but that the types or great classes of animals are more or less connected. A great number of individuals, however, can be followed back to earlier forms, and analogy suggests that all might be thus traced had not time destroyed the records. Huxley says: "If one series of species has come into exist-

ence by the operation of natural causes, it seems folly to deny that all may have arisen in the same way." Although gaps still exist and missing links are looked for, descent is traced, in Huxley's words, "not in one straight series but by many roads, step by step, gradation by gradation, from man at the summit to specks of animated jelly at the bottom of the series"; or, as Prof. Clifford expresses it: "The theory is, that at a stupendous distance of time all species were alike, mere specks of jelly; that they gradually diverged from each other and got more and more different, till at last they attained the almost infinite variety that we now find."

Thus by observation of living animals and of their fossil remains we find that, although for convenience naturalists arrange animals into six or seven large divisions, there are many forms coming between these divisions, and it is hard to say where one begins or another ends. There is, therefore, evidence of the unity of all animal life,—a sufficient resemblance and connection to make it extremely probable that a relationship exists between all, and that they have sprung from a common origin.

The Unity of Plant Life.

Plants are divided into two great classes, the flowerless and the flowering. These are again divided into four classes, having hard names, and there are further subdivisions. It is found that the plant world

is composed of marked types, just as is the animal kingdom, and also that there are connecting links between each class. The sea-weeds are joined by intermediate forms to the lichens, and the ferns and club-mosses connect the flowerless with the flowering plants. The whole plant world is bound together by the evidence of a continued relationship from the lowest to the highest form.

The Unity of All Life.

We have seen that the animal world may be considered a unit, a more or less closely connected ascending series of diverging organisms. Then we have also seen that the plant world is linked together in a manner that suggests progressive development from its simplest to its most varied forms. But it is found that animals and plants are joined by intermediate forms that puzzle naturalists to tell which kingdom they belong to. Haeckel calls these forms *Protista*. They combine certain peculiarities of the lowest forms of the two realms of life, and thus establish the unity of all life that exists upon the earth. They represent a stage of existence, early in the world's history, before life divided into the two branches of animal and plant. Thus we find that the quarter of a million of species of animals and plants can be fairly assumed to have arisen from a common origin. If they were created at once in all these distinct forms, we are at a loss to see any mean-

ing in their construction, but if we conceive that the present condition of living things is the result of continued modifications of the parent forms, then the whole chain of life becomes intelligible to us.

Unity of Substance.

We have seen that all animal and plant life is allied in form, and we find further that *it is identical in substance.* The microscope discovers that the vegetable cells and the animal cells are alike composed of what is called *protoplasm*, or first form, which closely resembles the white of egg, a clear semi-fluid substance. One of the lowest forms of animal life, the *Amœba*, is just a speck of this substance, and in the nettle-hair the protoplasm is seen lining the woody matter that forms the wall of the cells that compose its structure. These cells of protoplasm increase by division, multiplying themselves and combining into varied structures. Microscopic examination shows that the human body, in all its parts, is built up of these little cells of protoplasm The blood carries these little specks, resembling the amœba, to the place where they are to combine in the structure.

Not only is the body composed of protoplasm, but it originates in a single cell of this substance, and the germs which produce men, dogs, sheep, or any of the highest class of animals, cannot be discovered to differ by any test of microscope or chemistry.

Protoplasm is therefore styled by Huxley, "the physical basis of life," and is seen to constitute the essential parts of every living thing, animal or plant, from the whale to the minnow, or the pine to the sea-weed.

We thus learn that there is not one life of animals and another of plants, but that their existences are similar in nature. The same "vital force" acts within each, and is seen at work also in the mineral kingdom, forming crystals and combining various elements into one form. As all material things are now supposed to be the variation of one original substance, so all the forms of matter are the results of one force manifested in different ways.

Thus we come to the unity of all nature. From the original existence of moving matter, the laws of Evolution construct the varied universe.

Embryology.

Not only do we trace the connection of all forms of life, by observing the relationship of living and fossil species, but we have a marvellous testimony to the common origin of all organic life, by the study of embryology, or the development of animals from the egg-speck or germ to the adult form.

It was supposed by many in the past that the germ contained the minute form of the perfected animal, which merely expanded to its final shape, or else had new parts suddenly added to existing organs.

Aristotle first maintained that the chick developed from a little speck on the surface of the yolk of the egg; and Harvey, discoverer of the circulation of the blood, declared that the forms were gradually developed from this speck through the action of the blood.

The great discovery of more recent times in this department is the fact, that the germs of all animals appear to be alike in their earliest stage, and they develop through similar forms until they assume the special features of their own species. The embryo of each animal successively resembles the embryos of the races below it, until they part company to attain their final form.

The lowest forms of life, the protozoans, reproduce themselves by division of their bodies, or the formation of buds, but all other animals produce eggs, which, when fertilized, divide and sub-divide till they form a mass of cells like a mulberry. The germ then gradually changes into a cup-form, called *gastrula*, having two different layers, called the primary-germ layers. The germs of all invertebrates pass through these changes, as do also those of the vertebrates, as far as observed. Other changes occur which are common to all animal germs, each one passing through the forms common to the races below it, and then diverging to its own peculiarities.

The development of man, as far as traced, agrees with that of lower animals: the *morula* or mulberry stage is shown, as in the sponge, sea-squirt, and

lancelet; and so on through forms resembling stages of the embryos of fish, reptile, and quadruped. Not that man is ever a fish or beast, but his embryo and that of a fish at certain periods are almost identical, and each diverges—the fish toward its final form, and man toward a resemblance to the embryo of a higher class, at a period before it assumes its complete shape.

Haeckel in "The Evolution of Man," gives a plate illustrating the development of the fish, salamander, tortoise, chick, hog, calf, rabbit, and man, which shows that at some period there is a correspondence of form between the embryos of each which demonstrates their relationship, and can only be explained by admitting the unity of the nature of all vertebrates.

What is the meaning of these remarkable facts? Is it probable that the Creator, after making all things at once in a perfect form, decided that all future structures should pass through all the gradations of lower forms before assuming their designed conditions, or do the facts suggest that *each individual declares to us the history of its race?* If in twenty-one days the chick passes through the forms common to sponges, shell-fish, fish, and reptiles, does it not suggest that its race may have developed through these lower races during vast ages? If in forty weeks a single man now develops through forms common to all the lower races of animals, may not the race of

man have slowly arisen through all the ranks of life below him, each great division leaving its record in the unfolding germ of the latest individual?

The embryos of all vertebrates, including man, have tails, and all show the gill-clefts of fishes in their early condition. Wilson says: "But reptiles, birds, and quadrupeds are lung-breathers and possess gills at no period of their life. Why should they develop gill-clefts, which bear no relation to the wants of their adult existence? Why does this useless expenditure of creative power exist?" The only answer is that the forms are inherited from early ancestors. Darwin says: "We have only to suppose that a former progenitor possessed the parts in question in a perfect state, and that under changed habits of life they became greatly reduced, either from simple disuse or through the natural selection of those individuals that were least encumbered with a superfluous part."

Metamorphosis.

It is not only in the egg or embryo that we see these developments. Many animals after birth change to higher forms. The frog appears first as a fish, then as a tailed newt, and finally as the tailless air-breathing frog. The development of the butterfly from the caterpillar is a familiar instance. The starfish is first a swimming worm-like creature. The flat sole begins life at the top of the water, with a

round body and eyes on each side of its head, then falls to the bottom, becomes flat, and one eye moves to its top side. The crab has at first a tail appendage like a lobster or shrimp. Although the frog usually develops from a fish form after birth, the Surinam toad brings forth perfect frogs, which, however, have passed through the fish stage when within the parent's body.

It follows from these illustrations, selected from a vast and constantly increasing store of facts, that no animal is suddenly produced in the form of its parent. They pass in the egg or germ state through the successive stages of lower orders until they reach the perfect form, or, if they are born when the process has been only partially completed, they pursue the upward changes after birth by the process we call *metamorphosis*, or transformation. Therefore the development of all life is similarly from lower to higher forms, the difference being that sometimes the changes are wholly completed within the parent's body, and sometimes only partly there, the changes being finished after birth. Metamorphosis, therefore, is common to all, to the dog as well as the butterfly, the changes merely taking place under different circumstances.

Morphology.

Evolution is strongly supported by observation of the development of separate organs of the body, the

science of *Morphology*. One of the most striking proofs of the evolution of present organs from different pre-existing forms is furnished by the horse. The forelimb of the horse is modelled upon a type similar to that of the arm of man. The upper arm is concealed beneath the skin; the forearm reaches to the knee, which is the wrist, having only seven bones in it, while man has eight. Man has five palm bones, but the horse seems to have but one—the long shank, or "cannon-bone," which corresponds to the bone supporting the third finger. Below the fetlock comes this finger with three joints, having its nail enlarged into the hoof. Thus the horse walks upon one finger, the third in man. But alongside the cannon-bone are the two splint-bones, which are proved to be rudimentary palm bones of the second and fourth fingers. The proof of this is that the horse is traced back by means of fossil remains in Europe and India, and is found to have three toes fully developed. In 1870 Prof. Huxley predicted that a five-toed horse would be found, and in America a fossil has been discovered with four toes, and the rudiment of a fifth. Each increase of members is found in an earlier series of rocks, showing that the change has been progressive during vast periods of time.

Thus the present horse is proved to have developed from a five-toed animal. As far back as we can go we find animal forms changing by slow degrees. Analogy teaches that this has always been the order of nature. By these evidences from fossils, Huxley declares: "The evolution of many existing forms of animal life from their predecessors is no longer an hypothesis, but an historical fact."

The horse has changed the structure of his feet to conform to altered circumstances that make it desirable for him to possess speed. By natural selection and the survival of the swiftest, the variations toward the present hoof have been preserved. Some may wonder that such *degeneration* of parts is called evolution, but the changes that occur are for the advantage of the animal, and therefore are truly an advance.

All the organs of the body are traced upward in gradual stages from the simplest beginnings. A favorite appeal for the special-creation theory is to point to the marvellous structure of the human eye. But the eye, brain, heart, lungs, limbs, and digestive organs are found in different animals in conditions that show a gradual ascent in structure, from the merest suggestion of the organ to its most perfect form. From the air-bladder of the fish to the lungs of man we have an ascending series of forms, and in the mud-fish, that spends half the year in dry mud and half the year in water, we find the transition from the bladder to the lung,—another "missing link." Scales and feathers are developments of the skin, and in the penguin can be seen the intermediate forms, half scale and half feather.

Rudimentary Organs.

Strong evidence in favor of the descent of present species from other forms is furnished by what are called *rudimentary organs*—imperfectly developed and useless members. Crabs have eyes at the ends of stalks, but in the Mammoth Cave are crabs having stalks without eyes. Disuse has caused the eyes to disappear, probably growing smaller in each generation, but the stalks remain as rudiments and prove the former possession of eyes by the remote ancestors of the existing crabs. The right-whale has teeth before birth, which are gradually absorbed and disappear. The unborn calf has front teeth in the upper jaw beneath the gum, but the adults have none. The natural inference is that the ancestors of whales and calves had such teeth fully developed. Many birds, such as the ostrich and penguin, have abortive wings; their conditions of life not requiring the exercise of these organs, they have diminished in size. Rudiments of limbs are found in the python—a large snake. The tail is traced through the animal kingdom through various changes, till in some of the higher monkeys and in man it is only a rudiment. There it remains as evidence of the descent of man from tailed animals. Otherwise we must suppose that when the Creator made man out of the dust he decided to give him a useless tail-bone. Lord Monboddo, a Scotch lawyer of the last century, declared that men had worn off their tails by sitting on

them; but we know now that the disuse of an organ tends to its disappearance, and that a change in the surroundings, and therefore in the habits of animals, leads to changes in their structures.

Man has shrunken muscles in his cheeks, such as animals use to move their ears, and he has the remains of a third inner eyelid which is common to beasts. The finger can detect a little projection near the top of the ear that is the vestige of formerly pointed ears. All mammals have two little bones in the upper jaw, meeting in the centre of the face, and called the mid-jaw bone. These were believed not to exist in man, and their absence was claimed as a strong proof of man's separate origin. But Goethe, the great German poet and philosopher, was so fully convinced of man's descent from animals that he insisted that this mid-jaw bone must exist in man, and at last he found it. It always exists in the human embryo, but at an early period disappears by a union with the upper-jaw bone. Men have remnants of muscles used by animals to twitch the skin.

Darwin says: "He who rejects with scorn the belief that his own canines (teeth) and their occasional great development in other men are due to our early forefathers having been provided with these formidable weapons, will probably reveal, by sneering, the line of his descent. For though he no longer intends nor has the power to use these teeth as weapons, he will unconsciously retract his 'snarling

muscles' so as to expose them ready for action, like a dog prepared to fight."

Wilson also notes instances of rudiments in the plant kingdom.

Resemblance.

The similarity in the structure of animals of the same great divisions, though of different species, is a special proof of Evolution. The members of each great class are identical in their general plan. For instance,—the articulates, or jointed animals, have the heart in the upper part of the body, the digestive system in the middle, and the nervous system in the lower part. Lobsters, crabs, barnacles, butterflies, spiders, and all the thousands of species of insects agree in these particulars. In the vertebrates the position is reversed; the nervous system is on top and the heart is at the bottom of the body. There are always two pairs of limbs, represented in the fish by fins, in the bird by legs and wings, in beasts by four legs, and in man by legs and arms. Fish, frog, reptile, quadruped, and man all possess these peculiar features. The molluscs are distinguished by having the nervous system in three great masses. Oysters, cockles, snails, whelks, and cuttle-fishes all agree in this. The radiates have all their parts arranged uniformly in lines diverging from a centre, much like the parts of a flower. Sea-urchins, starfishes, etc., are of this type.

Not only is there a resemblance in the general structure of animals, but the organs of the members of each class show a striking similarity. The arm of man, the wing of the bird, the forelimb of the horse, the paddle of the whale, and the forelimb of the frog show essentially the same structure and have the same number of bones.

Spencer says: "What now can be the meaning of this community of structure among these hundreds of thousands of species filling the air, burrowing in the earth, swimming in the water, creeping about among the sea-weed, and having such enormous differences of size, outline, and substance, as that no community would be suspected between them? Why under the down-covered body of the moth and under the hard wing-cases of the beetle should there be discovered the same number of divisions as in the calcareous framework of the lobster? It cannot be by chance that there exist just twenty segments in all these hundreds of thousands of species. There is no reason to think it was necessary in the sense that no other number would have made a possible organism. And to say that it is the result of design—to say that the Creator followed this pattern throughout, merely for the purpose of maintaining the pattern, is to assign a motive which, if avowed by a human being, we should call whimsical."

He says that Evolution alone gives a rational interpretation to these facts. If organic forms have

arisen from common stocks by perpetual changes, such as were required to adapt them to their surroundings, then there would result these variously modified forms, retaining traces of the characters of ancestral races.

Evolution, therefore, shows that animals of each type resemble each other because they have a common ancestry. *Descent with modification* is a phrase that explains the existing facts. All the allied forms have had a common origin, but have developed different peculiarities in consequence of having been placed in differing circumstances. When a variation of an organ occurred that was of advantage it was perpetuated by natural selection.

The resemblance of man to animals is not only observed as to structure, but many peculiarities are possessed in common. Parasites infest their bodies, their functions follow lunar periods, the same diseases afflict them, and can be transmitted from one to the other—colds, inflammations, fevers, apoplexy, etc., assail each. Drugs affect both alike,—opium, quinine, tobacco, alcohol, all produce similar results in each and prove a likeness of constitution. Their wounds heal by the same process. The laws of reproduction are, in Darwin's words, "strikingly the same, from the first act of courtship of the male to the birth and maturing of the young." The mental powers and moral sense are of the same character, only differing in degree, and the manner of expressing emotions is in many respects similar among men and beasts.

Degeneration and Reversion.

But the evolution of forms is not always an advance, backward steps are often taken, and there is retrogression as well as progress. Yet these facts endorse the Evolution theory that organisms alter to suit their surrounding conditions; if the forms degenerate, it is because the assumed form is more suitable to the changed circumstances. Some forms are found to exist unchanged from very early ages. The fossil lampshells in the chalk resemble almost exactly those living in our own seas, the reason being that the conditions of their marine life are unaltered. The king-crab of the West Indies, the nautilus, and some fishes correspond closely to-day to their fossil ancestors; they have not been forced in the struggle for existence to make use of changed forms.

Darwin points out two great facts in nature. First, that there is a tendency to vary and change; and second, that when a change of surroundings occurs, any variation of form that is of advantage in sustaining existence in the changed conditions is perpetuated by the survival of the possessor of the improved organs, while less favored ones perish. Thus variation and natural selection account for the progressive changes. But if, on the other hand, the variations are of no advantage in the struggle for life, they do not supplant the parent form; or if earlier conditions are restored, the same tendency of nature leads to a reversion to the previous form of organs.

Thus retrogression, stability, and progression are all accounted for and harmonize with the theory of Evolution.

The *Axolotl*, a Mexican newt or small lizard that retains the early fish gills with the later lungs, when removed to Paris was found to develop into a different animal, a gill-less newt named *Amblystoma*, proving the power of changed circumstances to alter the species. This case may be a reversion to an earlier ancestral form.

Retrogression is shown in parasites. The ship barnacle is at one time a swimming animal with varied organs, but after attaching itself to its life abode it degenerates to a lower form, because in its dependent life the higher development of organs is useless. The horse and mule sometimes have stripes on their legs similar to those of the zebra, suggesting that their ancestors have had that peculiarity. In Madeira two hundred out of over five hundred species of beetles "are so deficient in wings that they cannot fly." The beetles that flew well were blown out to sea, but those with smaller wings, or that were indolent, remained and perpetuated their peculiarities, the wings growing smaller from disuse.

Men and women sometimes show reversion to the forms of animals, such as hairy bodies, supplementary breasts, and animal teeth; one man in sixty has certain muscles peculiar to quadrupeds, and muscles

in the neck peculiar to apes. In Darwin's "Descent of Man" many striking facts of this nature are noticed. Is there any plausible explanation of these facts except that they show peculiarities of remote ancestors?

Mimicry.

The theory of Evolution is supported by what Wallace calls *mimicry*. This is the resemblance shown by some animals and plants to other animals or plants, perhaps very different, or to other natural objects. The "walking-leaf" insect looks like some vegetable growth, and on the other hand some orchids resemble insects. Insects are found that resemble pieces of bamboo, bits of bark, twigs, and drops of dew, and many animals conform in color to their surroundings, being of a sandy color in the desert or green and brown in the forest. A butterfly in South America has a strong odor that prevents its being devoured by creatures that eat other butterflies. There are some very different butterflies that lack this peculiar odor, but which imitate the strong-smelling kind in appearance.

Natural selection explains these things by supposing that these resemblances, occurring first in slight measure as variations from parent forms, have preserved the existence of their possessors by assisting their concealment. The insects and animals nearest in color to the leaves, bark, or ground upon which

they live, have escaped the attacks of enemies, or have been better able to secure food, while those less favored for concealment have perished. The butterfly that most closely resembled the disagreeable kind had the least chance of being devoured. The plants that most resembled insects secured the visits of the insects necessary to distribute their pollen and ensure the propagation of their kind. Thus the survival of the fittest is secured by these resemblances, and the tendency in successive generations is toward greater likeness to protective or useful forms.

This mimicry of animals is one of the hardest things to explain upon the special-creation theory. The Creator is supposed to have made all these distinct forms; but some, especially adapted to be the food of others, he has gifted with powers of concealment, while others are left without protection, a seeming exhibition of injustice and partiality.

Distribution.

The distribution of animals and plants over the earth's surface is made intelligible by the Evolution theory that all the individuals of the same species have proceeded from some one source, and have been scattered by various means, such as winds, currents, seeds attached to the feet of birds, and the migrations of animals. It explains why oceanic islands have few inhabitants, and often of a peculiar

kind; why many organisms are absent from islands; and how barriers of mountains or deep straits affect the character of life in the lands on either side.

It was the observation of the absence from the Gallapagos Islands of many animals that can neither fly nor swim that led Darwin, in his voyage in the *Beagle*, to the reflection that produced his theories. Why the Creator should not have made frogs in islands is a question that the special-creation theory does not answer. Frogs cannot swim far, and have stayed at home on the continents. The life upon islands corresponds to that of the mainlands nearest to them, and consists of such kinds as can be transported.

It was wondered why kangaroos and some other types of life were confined to Australia. Wallace has pointed out the deep channel which severed Australia from the nearest land, and prevented the migration of animals. Australia was formerly joined to the continent of Asia, and possessed similar forms of life; but becoming separated, she has preserved the types that have perished elsewhere by the competition of other animals, that the conditions of her climate did not tend to develop, and were prevented by the Straits of Lombok from coming to her lands.

The regions that have been most completely separated from others have the most distinct types of life, and where facility for the migration of animals and for the conveyance of seeds has been greatest, there we find the greatest variety of forms.

The Fertilization of Flowers.

The study of the fertilization of flowers shows, as Wilson says, "that the production of new races and varieties, and through these of new species, is part and parcel of nature's constitution."

It was found by Darwin "that close interbreeding diminishes vigor and fertility, and a cross with another individual is occasionally indispensable." Therefore the necessities of existence lead to new varieties of form. The plant kingdom shows a law of development similar to what prevails in the animal kingdom.

The manner in which cross-fertilization is produced by winds and insects conveying the pollen of one flower to the pistil of another, and the wonderful adaptation of the forms of flowers to insects, and of insects to flowers, is a fascinating study that will reward the reader of the works of Darwin and Gray. Each peculiarity of color and form is believed to be an element in the reproduction of its kind, and the old theory that each sort of flower was created solely for the enjoyment or use of man is disproved. The flower that has produced variation in color that attracts the insect whose visit is needed for its fertilization, or that which has varied in form in a way best to deliver its pollen to the visitor, or to receive it, is perpetuated, and its variation is preserved and increased in subsequent descendants, while the forms less adapted to attract or make use of the visits of

insects die out. Thus the adaptation of flowers to insects, and the formation of new species by cross-fertilization, is found to be due to Natural Selection, not to special creative design that formed them in their present shape and color.

Geology.

Geology gives the strongest support to the theory of Evolution. The life-bearing rocks are supposed to represent a thickness of about 130,000 feet. These rocks were formed from deposits of ooze, at the bottom of the waters, which gradually hardened into stone. Vast ages were required for these formations, and for the elevations and depressions which they have undergone. In the lower half of these strata the only forms of life are of the lowest order, and the vegetable life is mainly of sea-weeds. In the next higher strata we find the remains of fishes and ferns. Above these come reptiles and pine forests, and birds first appear; and here the intermediate form is found of birds with toothed jaws and lizard's tail. The first sign of mammals is found here, the teeth of a small animal of the kangaroo type. In still higher strata appear mammals and leaf forests, and the animals nearest to man are found. Finally, in the latest deposit we find the remains of man and of cultivated forests. But this era of man is not one two-hundredth part of the vast ages through which organic life has existed, and he appears only as the high-

est outcome of nature's development, the top branch of the tree of life. And yet, though so late in the world's history, it is probable than man has existed upon the earth for hundreds of thousands of years. The evidence for the antiquity of man may be found in the writings of Lyell, Lubbock, and Dawkins.

The rocks, therefore, show that both animal and plant life have developed gradually from lower to higher forms, from the simple structures in the earliest ages to the most varied and elaborate organisms of the present. If the special-creation theory is true, and each order of life was made at once, we should find all the ranks of each order in the rocks of one period; whereas, the lower forms always come before the higher, proving conclusively that no race or species has been made all at once, and that the forms of life have not degenerated as under a curse, but that the course of nature is an onward march of progress. "Of special creation the rocks tell no tale."

The Imperfection of the Record.

That the geological record is not more perfect is easily explained. Only the hard parts of animals are preserved and the soft-bodied animals would not leave many traces, though the tracks of sea-worms and even the impress of a jelly fish have been found. Many animals have existed at a distance from bodies of water, which are necessary for the preservation of

fossils. The rocks have been subject to convulsions and heat, which, in many cases, would destroy their records. It is to be remembered also that the variation of species is usually a very slow process. We have been accustomed to consider that all changes have occurred within six thousand years, but when we extend nature's operations to millions of years, it is not so surprising that the records of her action are not more fully preserved. Comparatively little of the earth's surface has yet been scientifically explored, and it is too early to say what the rocks may not disclose.

Threefold Evidence.

Scripture tells us, "A threefold cord is not quickly broken"; and we have three great classes of evidence that all existing life has been developed from lower forms.

1. All living beings from the animalcule up to man show a connected resemblance of forms that warrants the comparison of animal life to the growth of a tree; and from sea-weed to oak tree a similar connection of all plant life to the forms below and above it shows that the same comparison may be made of the plant kingdom.

2. Each individual begins life in the lowest form of matter, and develops through forms common to all the species below it. A man has by turns the forms of the germs of plant, protozoan, mollusc, articulate, and vertebrate—fish, reptile, and mammal.

3. The existing orders of life are proved by fossils in the rocks to have developed progressively in time, the lowest forms being of the earliest date, the highest forms belonging to the latest period.

That is to say: 1. Animals and plants appear as they would have done if one race sprang from another. 2. Each being does spring from forms common to the races below it. 3. Life has appeared on the earth in the order that it would have done if each higher race had developed from a lower one.

If Evolution *appears* to have been the order of nature, does not reason compel us to believe that such has been its method?

Man's Animal Origin.

Some object to the animal origin of man as a matter of taste. It offends their sensibilities. But taste should not be an arbiter in the judgment of truth. Nor should this view be deemed offensive. It is nobler to ascend than to descend, and one should prefer to be an improved animal rather than a degraded angel. Civilized nations are the descendants of barbarians, as is proved by customs, belief, language, etc. Darwin says: "He who has seen a savage in his native land will not feel much shame if forced to acknowledge that the blood of some more humble creature flows in his veins. For my own part I would as soon be descended from that heroic little monkey, who braved his dreaded enemy in

order to save the life of his keeper, or from that old baboon, who descending from the mountains carried away in triumph his young comrade from a crowd of astonished dogs—as from a savage who delights to torture his enemies, offers up bloody sacrifices, practises infanticide without remorse, treats his wives like slaves, knows no decency, and is haunted by the grossest superstitions."

Mind.

Some who admit development of physical forms from lower orders still cling to the idea that the mind of man is a special creation. But consideration of nature's facts will show the gradual development of mind, from the instinctive movements of animalcules for the purpose of procuring food or propagating their kind, until its upward course culminates in the thoughts of a Newton and a Darwin. When the coral polyp throws out its lasso to capture the passing food, when a dog answers the dinner-bell, or when a man raises his umbrella to the rain, is not each giving evidence of the existence of what we call mind? There is a progressive development of the brain in the higher animals, and mental powers correspond in force with this growth.

Haeckel says: "The human mind is but a more highly developed ape-mind," and Wallace declares that there is less of a gap between the minds of a dog and a Hottentot than between the minds of a

Hottentot and a Newton. Dr. Gray gives instances of the exhibition of mind in plants, as when they catch and devour insects or reach out their tendrils toward supports. Büchner in "Mind in Animals," and Romanes in "Animal Intelligence" give this subject a very satisfactory treatment.

As force is in the muscles so thought is in the brain. The magnet, powder, steam, the sensitive plant, the lancelet burrowing in the sand, and the thinking man, all show the combination of force and matter which constitutes the universe. Mind develops in the child from bare consciousness to the thoughts of a philosopher. Why should it not have developed in the race of man by gradual process? The difference between the mental operations of animals and men is one of degree not of kind. Animals think the same kind of thoughts that men do as far as they extend.

Speech.

Evolution is manifest in speech and in human language. The origin of speech dates from the time of the development of the organs of the throat. Animals have the power of communicating ideas to each other, and we can observe the dawnings of speech in their cries. Our domestic dogs are descended from wolves and jackals, and have learned to bark in four or five distinct tones.

In language, we find the same law of Evolution

that governs physical forms. There are rudimentary words and letters—remains of ancestral forms; variations constantly occur, and a struggle for existence goes on between words, and also between various languages. The survival of the fittest perhaps will be evidenced in the future universality of the English tongue.

Morals.

Not only form, mind, and speech show the method of Evolution, but morals may be traced upward from the emotions of animals and by observation of savage races of men. Agassiz says that dogs have something very like a conscience. Animals show love and sympathy. Moral sense has been developed by the perception of what is serviceable; and intuitions of right and wrong, which we call conscience, are inherited from ancestors, and are the result of their experience. Therefore we may hope for progress as experiences accumulate, and may believe that in the future man will be better than in the past.

Arts.

All the arts and sciences, except sculpture and drawing, may be traced from animal origin up to their highest development by man, by the same orderly methods that prevail in the physical world. In fact, every department of nature proves that Evolution is Universal.

Nebular Hypothesis.

The nebular hypothesis, suggested by Swedenborg, Buffon, and Kant, and systematized by Herschel and La Place, assumes the former existence of a vaporous matter, extending beyond the orbit of the farthest planet, which by rotation gradually gained solidity, throwing off rings which broke up into planets and moons, the central mass forming the present sun. The existing solar system is satisfactorily accounted for by this theory, which is now generally accepted by learned men as the best explanation of the universe. All the other systems of stars are supposed to have originated in the same manner.

The earth being thus accounted for as the result of a natural process, the evolutionist sees that all forms of life upon it may have developed from the simplest cell-form of matter, for he can trace an almost continuous evolution from the plant cell upward, through all the grades of vegetable and animal life, to the highest development—man, thus establishing the unity and connection of all nature.

Spontaneous Generation.

Sir William Thomson has suggested that life originated on the earth from germs contained in meteoric stones that fell from inhabited planets. But this idea has not received much support. Haeckel and many others maintain that the first forms of life

came by spontaneous generation. Just as we see crystals form themselves to-day, so by a process, chemical and electrical, the atoms of carbon combined into the speck of protoplasm or "primitive slime," which constitutes the lowest living form—the Moneron. No one claims that organized beings have arisen spontaneously; it is only in the case of Monera—"structureless organisms without organs"—that spontaneous generation is assumed to have occurred at the first beginning of organic life upon the earth.

If the whole development of life and the formation of intricate organs proceed without supernatural aid, why should we assume that this principle, so contrary to all observed action of nature, must have acted to produce this simple beginning of life in the Moneron? Chemistry and electricity are conceivable agents.

Primeval Matter.

Dr. T. Sterry Hunt has stated the hypothesis that universal space is filled with a simple form of matter from which the worlds have been evolved by a process of chemical condensation. He found that this theory had been anticipated in some little known writings of Sir Isaac Newton, who suggested that all space may be filled with an ethereal substance which is the food of plants and the material principle of life. He says: "Thus, perhaps, all things may be originated from ether."

Dr. Hunt states that the earth has already abstracted from the air chemical elements, such as carbon, equal in weight to not less than two hundred times its atmosphere. These elements, which compose rocks, plants, and animals, he suggests have been supplied gradually to the air from this ether or gas that fills the space around earth and stars.

As we trace back human life to the plant cell, we can trace its earlier origin and present sustenance indirectly to the ether.

History of Evolution.

Evolution is by some considered to be a new doctrine, but like all the great discoveries of man, it has grown through the ages by slow gains of knowledge. Its principles are foreshadowed in the teachings of Greek philosophers two thousand years ago. Anaximander, Heraclitus, Empedocles, Democritus, the Roman poet Lucretius, and others, treated of the natural development of the world from simple elements, and of all life from atoms.

In later times, Kant, Laplace, Goethe, Wolff, Lamarck, Von Baer, and others, added to the advance of the theory; and in our own day, Darwin, Wallace, and Spencer have so classified facts that Evolution, in its main outlines, has become, to most scientific minds, no longer a theory, but a proved fact.

An eminent naturalist says: "With one exception, every man in the world who can properly be

called a naturalist has accepted the theory of Evolution."

Summary.

Now, to summarize the evidences previously alluded to, we find:—

1. The Nebular Hypothesis—the formation of worlds from the moving "star dust"—agrees with all known facts concerning the solar system, and is accepted as the best explanation of the universe.

2. All the orders of the animal world show a connection, more or less complete, by which an ascending tree of life spreads out from a common root.

3. All the classes of the vegetable kingdom are likewise allied by a continuous succession of forms.

4. Animal and vegetable life meet in the lowest forms and suggest a common origin.

5. All vegetable and animal life originate in cells of protoplasm which, to all appearance, are alike.

6. Every animal before reaching its adult form passes through forms common to the races below it. These changes occur either wholly before birth, as in the case of quadrupeds and man, or partly after birth, as with frogs and butterflies. The only intelligible way of accounting for this development of individuals is to suppose that the races to which they belong have developed in a similar manner from lower orders, and the history of their descent is repeated in the history of each individual. "Development repeats descent."

7. Animals and plants have rudiments of organs, which are useless and in some cases disappear in adult life. This can only be explained by the supposition that these forms are inherited from ancestors who possessed them fully developed.

8. Change of surroundings causes change in the organs of animals, in consequence of the survival of those who possess any peculiarity that makes them better fitted to endure the changes, and these peculiarities become fixed in their descendants.

9. These changes of surroundings sometimes lead animals to revert to the forms of lower organisms, making it probable that their race formerly arose from those forms through the influence of changed conditions, which ceasing, the new forms are no longer useful and disappear.

10. The mimicry by animals of resemblances that are useful shows that new species may arise by the perpetuation of useful variations of form or color.

11. The distribution of animals and plants over the earth shows that natural causes account for the presence of each kind in its locality.

12. The study of fossil remains of plants and animals reveals links between orders so separate that they have been regarded as special creations. But these intermediate forms show the transition from one species to another.

13. In the oldest rocks the lowest forms of life are found, and higher forms appear successively in later

deposits, the highest creature—man—being found in the latest strata, proving that the series of forms that we now observe in existing life have been gradually developed in the same ascending series during the vast periods of the past.

14. The development of mind is traced upward from the lowest instincts, as truly as is the development of organic forms from simpler organisms, showing no need for the theory of the special creation of man's reasoning powers.

15. The study of languages reveals an orderly, gradual development of speech, corresponding to the growth of forms of life.

16. Moral sentiments have unfolded in animals and man by a process of development, similar to what is observed in organic forms.

17. There is no evidence that any thing has suddenly come into existence in a completely developed form of varied structure. It is probable that the lowest and simplest form of life is the result of the combination of particles of matter by their own inherent energy, and that all subsequent developments have arisen from progressive changes that occurred in accordance with the same laws of nature that surround us to-day.

18. Finally, one of the principal causes of these progressive changes is observed to be the struggle for existence, which secures the survival of the fittest, or Natural Selection.

The First Cause.

But does Evolution solve all the mystery of life? No one pretends that it does. It only traces back the workings of natural law to the simplest and earliest combination of matter and force; the primary cause still eludes discovery. But beginning with the primeval ether or gas it accounts for all existing forms, by the action of the laws of nature that we now see in operation. The origin of matter and force and why they vary in their productions lie still in the region of the unknown, but we will not say "unknowable," for who shall prescribe limits to the future investigations of man!

Neither does Evolution necessarily question the existence of God. It only concerns itself as to *the manner in which the Supreme Power works*, and claims that IT ACTS THROUGH NATURAL LAW and not through miracle.

Truly, as Darwin says, "there is grandeur in this view of life"; and there is also a simplicity in it that is welcome to the perplexed mind that has pondered with dismay on the incomprehensible idea of a separate act of creation for every divergent form of life. We may now see the method through which the Infinite Power works out in orderly sequence the development of the universe. Man, its highest product, is brought into unison and sympathy with all nature, and is stimulated by the evidence of past progress to aspire toward future possibility.