Charles Darwin.

An Address,

By John Hopkinson.

CHARLES DARWIN:

AN ADDRESS

DELIVERED AT

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OF THE

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BY

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CHARLES DARWIN.

Ladies and Gentlemen,—

The history of science is a history of warfare,—of contests between reason and prejudice. From the earliest times of which we have any authentic record every new scientific idea has been opposed by some pre-conceived notion, and although reason has ever been victorious, prejudice is not yet completely vanquished. Science, however, is not aggressive and does not marshal her forces for direct attack; she conquers by convincing her adversaries of the justice of her cause and taking them into her own ranks, rather than by storming their position and driving them from the field of battle. The greatest of these contests in which science has been engaged in recent years is that with which the name of Charles Darwin will be for ever associated,—the contest between the essentially scientific idea of progressive development by the action of natural laws, and the absolutely unscientific notion of distinct acts of creation by supernatural decree.

Science has been defined as "the discernment, discrimination, and classification of facts, and the discovery of their relations or sequence." It is not a knowledge of things, but of causes and of natural laws. We much more often perceive things and infer causes, than we gain a knowledge of things by inference or of causes by perception. If, for instance, we knew nothing of the world on which we dwell, we might look around us on an open plain or on the sea and conclude that the horizon bounding our view was its limit. Changing our position laterally, we should find that it was more extensive than we first thought it to be; but we might still think that it was flat and had an abrupt edge, a view which was at one time held. By travelling round it, however, we should find it to be a globe. If we merely changed our position

vertically, we might come to the same conclusion, for we should find that the higher we were, the further would the horizon recede. This inference could not be formed without some knowledge of geometry, or at least without bringing our reasoning powers into use. It would therefore be a scientific inference, and we should find it much more difficult to convince others of the correctness of our conclusion than we should have done if we had travelled round the earth in different directions, measuring our course, and so had perceived that its form was globular or nearly so. But we should only have attained a knowledge of the thing,—the knowledge that the earth is a sphere or spheroid. To complete our investigation we must arrive at a knowledge of the cause of its sphericity, and of the reason why it is not perfectly spherical, which can only be done by exercising our reasoning and imaginative faculties, and in such ways we build up science.

As the cause of any natural phenomenon can very seldom be directly perceived, our first attempt to ascertain it, after having fully investigated, by observation or experiment, all the facts connected with it, is usually by forming an hypothesis; and if our hypothesis accounts for most of the facts, and does not appear to be at variance with any, it becomes a theory; if no other explanation seems to be possible, it may become a scientific doctrine.

To discover a law, the exercise of our reasoning and imaginative faculties is still more imperative, for we can never perceive a law of nature. We may, however, as in the case of gravitation, discover a law without knowing the cause.

That the earth is a globe was inferred by astronomers long before it was circumnavigated. This was therefore a scientific inference. It gave rise to the first recorded battle between reason and prejudice, being opposed and derided on Scriptural grounds, and so dogmatically that most of the Fathers of the Church denied the possibility of salvation to those who believed it, and thought that the earth might be inhabited on opposite sides.

The theory of Copernicus that the earth and planets revolve around the sun, was ridiculed on the same grounds. It was a scientific conception opposed to the direct evidence of our senses, and to the literal interpretation of certain passages in Scripture. Copernicus died on the very day that his great work on the 'Revolution of the Heavenly Bodies' was published, and so escaped persecution. The same theory was afterwards proclaimed by Giordano Bruno, before the world was prepared to receive it, and for this and other heresies he was imprisoned for six years and then burned alive. The belief that the great astronomical truths

which Galileo revealed were hostile to religion, might have brought on him a similar fate, had he not, after imprisonment and under threat of torture, in his seventieth year, publicly recanted before the Inquisition, abjuring "the error and the heresy of the movement of the earth," though convinced that it did move. Kepler then disproved the Aristotelian doctrine of the movement of the heavenly bodies in perfect circles, and gave to the world the three astronomical laws which bear his name, for which he too was persecuted and imprisoned. And yet he was so much impressed with the sublimity of the laws which he discovered, that he exclaimed: "I do think the thoughts of God."

Now all this is changed. Our earth is universally acknowledged to be but one of several planets revolving in ellipses around one of many suns. Newton, by showing that every particle of matter attracts every other particle directly as the mass and inversely as the square of the distance, proved the general accuracy of the propositions of Copernicus and corrected errors in his application of them, and also assigned a physical cause to Kepler's empirical laws.

And yet not entirely changed. The battle between reason and prejudice still continues, but it is fought on another field; it is fought over the grandest scientific conception of modern times,—the conception of progressive development.

It is not many years since the belief was almost universal that the whole visible universe was created in its present state out of nothing in a brief period of time; that every species of animal and plant was independently created in its existing form; and that everything extraneous to our globe was created expressly for its benefit, and everything on our globe expressly for the benefit of man. These ideas must have been formed at a very early age, when the earth was believed to be the centre of the universe, immovable, and inhabited only "on the top," and when the planets were thought to be guided in their seemingly erratic course by angels. They accord with a literal interpretation of the biblical account of the creation; and they appear to pay a flattering tribute to the dignity of man. They are deeply-rooted and prejudiced ideas with which science finds it hard to contend. The persistence of the belief in the immutability of species is also due in part to the fact that it is apparently borne out by our experience. To those who have not made a special study of any department of botany, zoology, or palæontology, every species seems to be distinct, one never appearing to pass imperceptibly into another; nor can we detect progressive change in any living thing in its natural or wild state, although we have modified to a considerable extent, and still

continue to modify, certain species, once wild, which we have brought under our culture or control—our cultivated plants and domesticated animals.

When, therefore, towards the close of the last century, the nebular hypothesis was propounded by Kant and elaborated by Laplace, and the theory of the origin of species by evolution was successively advocated by Buffon, Erasmus Darwin, Geoffroy St. Hilaire, Goethe, Lamarck, and other men of less note, but little credence was given to their views, the general belief in the permanency and distinctiveness of species scarcely even being shaken, for, said Prejudice in the garb of Authority, were we not told that the sun was created to give light to the earth which was at first in darkness, and that man was made out of the dust of the ground? How then could the earth have been evolved from the sun, or both have been formed at the same time out of a revolving and condensing nebula; how then could man be a modified descendant of some lower animal? Surely such ideas were absurd; those who held them, heretics!

When Lord Rosse's telescope was directed to the nebulæ, and many of those hitherto believed to be gaseous were resolved, one after another, into clusters of stars, the nebular hypothesis seemed to be shaken to its foundations, for the inference was natural that with sufficient telescopic power all the nebulæ could be resolved. But the doctrine of evolution received only a temporary repulse, for, upon the discovery of spectrum analysis, it became possible to distinguish a glowing gas from an incandescent solid, and many of the nebulæ were proved to be really nebulous. The nebular hypothesis, and with it the more general doctrine of evolution, revived, and it is now generally accepted. Although it is still an hypothesis, it rests upon a solid superstructure of well-ascertained facts. The theory of natural selection bears the same relation to organic evolution as the nebular hypothesis bears to cosmic evolution, and together they show us how the present material universe, and the various forms of life on our globe and perhaps on others, may have been developed by gradual metamorphosis.

Creation is not now to us, as it was to our forefathers, a series of independent acts, but a continuous process of development, and we are irresistibly led, as Goethe was, to look upon "formation, transformation," as "the Eternal Mind's eternal recreation," this formation and transformation proceeding in accordance with natural laws. Thus may we form an infinitely more exalted idea of the Supreme Lawgiver than has ever before been possible. For this grand conception of creation and its general reception in the present

day, we are indebted to Charles Robert Darwin infinitely more than to any other man. Many before him had advocated the theory of the origin of species by evolution; some had even arrived at the conclusion that variations are perpetuated and accumulated into specific differences by natural selection; but Darwin has brought forward a mass of evidence so overwhelming, that however prejudiced against his theory anyone of at least ordinary intelligence may be, after a thorough study of it the conviction cannot be resisted that species are genetically allied, or have been more or less gradually evolved one from another and not separately created, the fittest only having survived and reproduced their kind in the struggle for existence in which all living things are perpetually engaged.

Darwin has revolutionised modern thought. Owing to him, Evolution, by the survival of the fittest in the struggle for existence, is no longer an hypothesis but an established scientific doctrine which has affected every science and has brought several sciences or departments of science into existence. Essentially biological, its influence has been felt in every one of the natural sciences, and that the fittest only will survive has become an axiom in philology, sociology, and all the relations of human existence. The life of Darwin ought therefore to possess an interest to all, and although it has no special local interest to us, there is a link between Darwin and this Society besides fellowship in our labours in the investigation of Nature: he was one of our Honorary Members.

Charles Robert Darwin was born on the 12th of February, 1809, at The Mount, Shrewsbury. He was the second son of Dr. Robert Waring Darwin, who for many years was the leading physician in Shrewsbury, owing his success chiefly to his acuteness in the diagnosis of disease, and his wonderful insight into the thoughts and feelings of his patients.

Both Charles Darwin's grandfathers were talented men, for Dr. Darwin was the son of Erasmus Darwin, the well-known poet and philosopher, and one of the earliest advocates of the doctrine of evolution, and he married the daughter of Josiah Wedgwood, the even better-known potter and philanthropist, inventor of the fine earthenware which bears his name, and founder of the village and pottery-works of Etruria. Six children resulted from this marriage, two boys and four girls, and Charles was the fifth child.

The Wedgwoods were Unitarians, and Charles Darwin, as a little boy, went with his mother to the Unitarian Chapel in Shrewsbury, but he was christened at St. Chad's, and brought up as a member of the Church of England, usually attending church

after his early boyhood. His mother died in July, 1817, when he was but little over eight years of age, and his school days had but just commenced, for it was in the spring of this year that he first went to a day-school, kept by the Rev. G. Case, minister of the Unitarian Chapel he attended. From this time his life may be divided into four well-marked periods:—(1) at school and college, 1817–31; (2) at sea in his voyage round the world, 1832–36; (3) in London, 1836–42; and (4) at Down in Kent, 1842–82.

In the 'Life and Letters of Charles Darwin,' a work in three volumes, edited by his son Francis, is an Autobiography, written near the close of his life for the perusal of his wife and children, without any thought that it would ever be published. In the following brief account of Darwin's career, free use has been made of this Autobiography.

A naturalist from his earliest school days, Charles Darwin, like many a schoolboy, has a strong passion for collecting,—an innate taste, he is convinced, as neither his brother nor any of his sisters ever had it. He collects with avidity "all sorts of things," but he has more consideration for the feelings of animals than most schoolboys have, taking only a single egg out of a bird's nest, and for long never killing an insect, being content to collect only dead ones. A keen sportsman very early in life, one thing only interferes with his full enjoyment of sport—his tenderness of heart. In angling with worms, he takes care to kill them with salt and water before putting them on the hook, at the want of some success. But he modestly attributes his humanity to the instruction and example of his sisters, and doubts whether humanity is an innate quality. Passionately fond of dogs, they soon find it out, so that he is "an adept in robbing their love from their masters." Long and solitary walks have a great attraction for him, and he often became absorbed in thought, once, when thus absorbed, falling off the foot-path on the old fortifications which surround Shrewsbury.

He attends Mr. Case's school only for a year, and in 1818 goes as a boarder to the Shrewsbury Grammar School, where he is under the tuition of Dr. Samuel Butler, afterwards Bishop of Lichfield. This school being strictly classical, he believes that nothing could have been worse for the education of his mind, for during his whole life he was "singularly incapable of mastering any language." During his school days the only qualities which promise well for the future are his strong and diversified tastes, great zeal for whatever interests him, and keen pleasure in understanding any complex subject. The clear geometrical proofs of

Euclid, which he was taught by a private tutor, give him intense satisfaction, and with great delight he receives from his uncle, the father of Francis Galton, an explanation of the vernier of a barometer. He reads various books with avidity, and is especially fond of poetry, all pleasure in which he lost, with great regret, later in life. He works with his brother at chemistry, and reads several books on the subject, but, although he considers this to have been the best part of his education at school, in showing him "practically the meaning of experimental science," he was nicknamed "Gas" by his fellow schoolboys, and publicly rebuked by Dr. Butler for "wasting his time on such useless subjects."

In 1825, as he was thought to be doing no good at school, his father sent him to Edinburgh University to commence the study of medicine; but he cannot bring himself to practice dissection, and, attending some bad operations at the Edinburgh hospital, he rushes away before they are completed, and cannot be induced ever to attend again. Although too tender-hearted for surgical cases, when at home he visits poor people in Shrewsbury, and makes up medicines for them under the advice of his father, who declares that he will make a successful physician, maintaining that "the chief element of success was exciting confidence," and that his patients would have confidence in him.

At Edinburgh appears the earliest indication of Darwin's future abilities, and especially of his keen observing faculties. When scarcely 17 years of age, he discovers that the so-called ova of *Flustra* have the power of independent movement by means of cilia, and are in fact larvæ, and also that the little globular bodies which had been supposed to be the young of *Fucus loreus* are the egg-cases of the worm-like *Pontobdella muricata;* and, early in the year 1826, he reads before the Plinian Society two short papers on these discoveries. At Edinburgh, also, he first becomes aware that his father will leave him "property enough to subsist on with some comfort," which he says "was sufficient to check any strenuous effort to learn medicine."

After he has spent two sessions at Edinburgh University, his father finds that he does not like the idea of being a physician, and proposes that he shall become a clergyman. The idea is congenial to him, but he has at first some religious scruples. However, after reading Pearson's 'Exposition of the Creed,' and other books on divinity, he came to the conclusion that he could fully accept the creed of our Church. He never formally gave up his intention to be a clergyman of the Church of England, but, as he says, it died a natural death during his voyage on the "Beagle."

To study for the Church he spends three years at Cambridge, but, "so far as the academical studies were concerned," his time is wasted almost as much as it was during the years he spent at Edinburgh and at school, the only part of the course of instruction of the least use to him in the education of his mind being the careful study of Paley's 'Evidences of Christianity,' and his 'Moral Philosophy;' the logic of the 'Evidences,' and of Paley's 'Natural Theology,' giving him as much pleasure as did Euclid. In January, 1831, he takes his degree of B.A. of Cambridge University, passing his examination, tenth on the list, "by answering well the examination questions in Paley, by doing Euclid well, and by not failing miserably in Classics."

But these three years at Cambridge are very pleasant ones, "the most joyful in my happy life," he says. In "excellent health, and almost always in high spirits," he eagerly collects beetles; hires the chorister boys to sing in his rooms, for he was passionately fond of music, though strangely had no ear for it, scarcely knowing one tune from another; reads with profound interest Humboldt's 'Personal Narrative of Travels to the Equinoxial Regions of the New Continent,' and Herschell's 'Introduction to the Study of Natural Philosophy,' books which, he says, influenced him more than any others he ever read; attends Professor Henslow's lectures on botany and his delightful botanical excursions; associates with men of science much older than himself, such as Dr. Whewell and the Rev. Leonard Jenyns (now Blomefield); and finally commences the study of geology, accompanying Professor Sedgwick, on leaving Cambridge, in a geological expedition through North Wales. To show his zeal for collecting beetles, he relates that one day, on tearing off some old bark, he saw two rare beetles and seized one in each hand; then he saw a third which he could not bear to lose, so he popped one into his mouth; but alas! it ejected some intensely acrid fluid which burnt his tongue so that he was forced to spit it out. Evidently entomology was his "first love."

His intercourse with Professor Henslow begets a warm and lifelong friendship. He had for him the highest admiration, and he speaks of his knowledge being great in botany, entomology, chemistry, mineralogy, and geology; of his being deeply religious, strictly orthodox, free from every tinge of vanity; and having the highest moral qualities, an imperturbably good temper, the most winning and courteous manners, and unbounded benevolence.

On returning home from his geological tour in North Wales, Charles Darwin finds a letter from Henslow informing him that "Captain Fitz-Roy was willing to give up part of his own cabin to

fail. The form of the orange-tree, the cocoa-nut, the palm, the mango, the fern-tree, the banana, will remain clear and separate; but the thousand beauties which unite these into one perfect scene must fade away; yet they will leave, like a tale heard in childhood, a picture full of indistinct, but most beautiful figures."

Again, in his retrospect of the voyage, he says: "Among the scenes which are deeply impressed on my mind, none exceed in sublimity the primeval forests undefaced by the hand of man; whether those of Brazil, where the powers of Life are predominant, or those of Tierra del Fuego, where Death and Decay prevail. Both are temples filled with the varied productions of the God of Nature;—no one can stand in these solitudes unmoved, and not feel that there is more in man than the mere breath of his body."

Then, turning to man in his aboriginal state, he says: "Of individual objects, perhaps nothing is more certain to create astonishment than the first sight of a savage in his native haunt,—of a barbarian,—of man in his lowest and most savage state. One's mind hurries back over past centuries, and then asks, Could our progenitors have been men like these?—men whose very signs and expressions are less intelligible to us than those of the domesticated animals; men who do not possess the instinct of those animals, nor yet appear to boast of human reason, or at least of arts consequent on that reason. I do not believe it is possible to describe or paint the difference between savage and civilised man. It is the difference between a wild and a tame animal; and part of the interest in beholding a savage, is the same which would lead every one to desire to see the lion in his desert, the tiger tearing his prey in the jungle, or the rhinoceros wandering over the wild plains of Africa."

He gives many instances of cruelty to slaves, and concludes with the following words:—"Those who look tenderly at the slave-owner, and with a cold heart at the slave, never seem to put themselves into the position of the latter;—what a cheerless prospect, with not even a hope of change! Picture to yourself the chance, ever hanging over you, of your wife and your little children—those objects which Nature urges even the slave to call his own—being torn from you and sold like beasts to the first bidder! And these deeds are done and palliated by men who profess to love their neighbours as themselves, who believe in God and pray that his Will be done on earth! It makes one's blood boil, yet heart tremble, to think that we Englishmen and our American descendants, with their boastful cry of liberty, have been and are so guilty: but it is a consolation to reflect that we at least have

made a greater sacrifice, than ever made by any nation, to expiate our sin."

Besides his 'Journal of Researches,' the voyage of the "Beagle" gave rise to several geological papers by him; to three volumes on the 'Geology of the Voyage of the Beagle,' published separately under the titles of 'The Structure and Distribution of Coral Reefs,' 'Geological Observations on the Volcanic Islands visited . . . ,' and 'Geological Observations on South America,' all by himself; and to five volumes on the 'Zoology of the Voyage of the Beagle,' by different naturalists, with notes by him on the habits and range of the species described. The Invertebrata and the plants were described by specialists in scientific publications.

The most important result of this voyage has yet to be told. We see in Darwin's 'Journal' the dawn of a great discovery, for surely the recognition that few only survive in the struggle for existence, is a necessary prelude to the conviction that the fittest survive. "We do not always bear in mind," he says, "how profoundly ignorant we are of the conditions of existence of every animal; nor do we always remember that some check is constantly preventing the too rapid increase of every organised being left in a state of nature. The supply of food, on the average, remains constant; yet the tendency in every animal to increase by propagation is geometrical. . . . Every animal in a state of nature regularly breeds; yet, in a species long established, any great increase in numbers is obviously impossible, and must be checked by some means." Again, there is no more cogent argument in favour of evolution than is furnished by the fact that the living and extinct species of the same continent are much more closely related than are the living species of one continent to the extinct species of another. "The relationship," he says, "though distant, between the *Toxodon* and the *Capybara*,—the closer relationship between the many extinct Edentata, and the living sloths, ant-eaters, and armadillos, now so eminently characteristic of South American zoology,—and the still closer relationship between the fossil and living species of *Ctenomys* and *Hydrochœrus*, are most interesting facts. . . . This wonderful relationship in the same continent between the dead and the living, will, I doubt not, hereafter throw more light on the appearance of organic beings on our earth, and their disappearance from it, than any other class of facts."

On the 2nd of October, 1836, Darwin is again in England, and, after spending a few months at Cambridge and elsewhere, and taking his degree of M.A., he settles in London early in 1837,

and for three years (1838–41) acts as one of the Secretaries of the Geological Society. In January, 1839, he marries his cousin, Emma Wedgwood, grand-daughter of the founder of Etruria, and in the same year he is elected a Fellow of the Royal Society.

The bustle and stir of London life are not congenial to him, and suit his health so badly that in 1842 he resolves to live in the country. In September of this year he buys a house at Down in Kent, with eighteen acres of land, and there he resided for the rest of his life,—a life henceforth entirely devoted to scientific work. In 1846 he writes to Captain Fitz-Roy: "My life goes on like clockwork, and I am fixed to the spot where I shall end it."

From 1837 to 1846 he is almost entirely occupied in writing the works above mentioned relating to the voyage of the "Beagle," part of the year 1845 being devoted to the preparation of a new edition of his 'Journal.' During these ten years he is also engaged upon his greatest work, 'The Origin of Species by Means of Natural Selection,' having opened his first note-book on the subject in July, 1837. But he had not then conceived the idea that specific differences arise by the advantage a favourable variation possesses in the general struggle for existence, for he says: "In October, 1838, that is fifteen months after I had begun my systematic enquiry, I happened to read for amusement Malthus 'On Population,' and being well prepared to appreciate the struggle for existence which everywhere goes on, from long-continued observation of the habits of animals and plants, it at once struck me that under these circumstances favourable variations would tend to be preserved, and unfavourable ones to be destroyed. The result of this would be the formation of new species. . . . But at that time I overlooked one problem of great importance. . . . . This problem is the tendency in organic beings descended from the same stock to diverge in character as they become modified. . . . . The solution, as I believe, is that the modified offspring of all dominant and increasing forms tend to become adapted to many and highly-diversified places in the economy of nature." Here are expressed the three leading principles of his theory of the origin of species—the struggle for existence, the survival of the fittest, and the adaptability of modified forms to their environment.

In 1846 he begins to work on the Cirripedia (barnacles), and in eight years he completes a monograph of the recent species, published by the Ray Society, and another of the fossil species, published by the Palæontographical Society.

From 1854 to 1859 he devotes nearly all his attention to

the 'Origin of Species,' and in 1856 he begins to write out his views on a scale three or four times as extensive as that which he afterwards followed. "But," he says, "my plans were overthrown, for, early in the summer of 1858, Mr Wallace, who was then in the Malay Archipelago, sent me an essay 'On the Tendency of Varieties to depart indefinitely from the Original Type'; and this essay contained exactly the same theory as mine." With some men such a circumstance as this might have led to a life-long jealousy, but not with men of such noble characters as Darwin and Wallace; with them it led to a life-long friendship. Darwin consults his two greatest scientific friends near at hand, Sir Charles Lyell and Sir Joseph Hooker, and they urge him to send to the Linnean Society, with Wallace's essay, an extract from his own MS. of his projected work on the 'Origin of Species,' written twenty years before. He is at first very unwilling to consent, thinking that Wallace might consider his action unjustifiable, for, he says, "I did not then know how generous and noble he was." Wallace's essay and Darwin's extract were published together in the 'Journal of the Linnean Society,' and attracted but little attention at the time.

With "thirteen months and ten days' hard labour," Darwin then makes an abstract of his MS., and on the same reduced scale completes the 'Origin of Species;' and in November, 1859, his greatest work appeared. "Though considerably added to and corrected in later editions," he says in his Autobiography, "it has remained substantially the same book."

The 'Origin of Species' is not an easy book to read. It requires close attention and much thought. Although crowded with facts tending to support the argument, the presence of the thought that some persons may not be convinced by them is too evident. With excessive honesty Darwin brings prominently forward every conceivable objection to his theory, and although he refutes each one, the impression left on the mind of most readers must be less clear than if the work had been written on the assumption that it must necessarily carry conviction of the truth of the theory to every mind. In place of a brilliant impression, however, the work gives a deep conviction, and the more the facts and arguments are thought over, the more certain does it appear that species are not stable, but are modified descendants of other species, owing their differences to slight variations which have been perpetuated, with further modifications, by advantages thus accruing over unmodified forms in the perpetual struggle for existence. Although this work can never be so popular as the 'Journal of Researches,' which any

intelligent schoolboy may read with interest and pleasure, it has been translated into every European language, and its sale in England alone has reached nearly fifty thousand copies. It is a work which scarcely admits of criticism, for Darwin has in it criticised his own conclusions more rigorously than any other man could do. This he was enabled to do by having during many years made a note of every "published fact, new observation, or thought" opposed to his general results.

Nevertheless his views were at first accepted by a few advanced thinkers only,—by such men as Sir Joseph Hooker, Sir Charles Lyell, Professor Huxley, Herbert Spencer, and Darwin's own true knight, Alfred Russel Wallace. The necessary revolution in scientific thought required time for its development, and until nine years had elapsed since the publication of the 'Origin of Species,' it could not have been asserted, as it then was by Sir Joseph Hooker, in his presidential address to the British Association, that Natural Selection "is an accepted doctrine with almost every philosophical naturalist." Fourteen years later, the views promulgated in the 'Origin of Species' had gained so many converts, that, at a meeting of the Biological Society of Washington held as a memorial of Darwin about a month after his death, Dr. Theodore Gill spoke of his views as being "universally accepted" and "taken as the recognised platform of biologists;" and Dr. J. W. Powell said that he had demonstrated the laws of biologic evolution "in a manner so masterly that there lives not in the world a working biologist, a scientific man engaged in this field of research, who has not, directly or indirectly, accepted his great conclusions."

During the last few months of 1859, Darwin is fully occupied in preparing a new edition of the 'Origin,' and with an enormous correspondence. In January, 1860, he begins to arrange his notes for his work on the 'Variation of Animals and Plants under Domestication,' published in 1868 (second edition, 1875). In July, 1861, he commences his work on the 'Fertilisation of Orchids,' published in 1862 (second edition, 1877), but he had begun to study the "cross-fertilisation of flowers by the aid of insects" in 1839. In 1868 he begins to write his 'Descent of Man, and Selection in Relation to Sex,' published in 1871 (second edition, 1874), but he had begun to collect notes on the subject in 1837 or 1838, as soon as he had become "convinced that species were mutable productions." On the birth of his first child, in December, 1839, he commences to make notes on the first dawn of expressions, continuing to study the subject for more than

thirty years, the result being the publication, in the autumn of 1872, of his book on the 'Expression of the Emotions in Men and Animals.' In the summer of 1860 he first notices that the leaves of the sundew (*Drosera*) entrap insects, and for fifteen years, whenever he has leisure, he pursues his experiments, completing his book on 'Insectivorous Plants' in 1875. In 1865 he commences to make experiments on cross- and self-fertilisation, publishing his book on the 'Effects of Cross- and Self-Fertilisation in the Vegetable Kingdom' in 1876. In the same year his work on 'The Different Forms of Flowers on Plants of the Same Species' appears (second edition, 1880), this being a re-publication, with additions and corrections, of several papers originally published in the 'Journal of the Linnean Society.' In 1880 he completes, with the assistance of his son Francis, a book on 'The Power of Movement in Plants,' which he speaks of as "a tough piece of work." And, finally, in 1881, he works up a short paper, read before the Geological Society more than forty years before, into a book on 'The Formation of Vegetable Mould through the Action of Worms.' Any one of these works would have made the scientific reputation of any other man.

During all this time Darwin is contributing papers to various scientific societies and to scientific journals, and during all this time,—at least during the last forty years of his life,—he never knew one day of the health of ordinary men, his life being one long struggle against the weariness and strain of sickness.

On the 13th of December, 1881, not many days after the publication of his last book, he is seized with an attack at the heart; towards the end of February in the following year such attacks become frequent and more severe; and on the 19th of April he passed away, in the 74th year of his age, having worked up to the last, for, only two days before his death, he recorded the progress of an experiment in which his son Francis was engaged.

It was the wish of his family that he should be buried at Down, but they gave way to the wish of the nation, expressed in a letter to the Dean of Westminster signed by twenty members of Parliament, and the funeral took place on the 26th of April in Westminster Abbey.

The grave of Charles Darwin, the Newton of Biology, is a few feet from that of the Newton of Astronomy, and the tablet bears the following simple inscription:—

CHARLES ROBERT DARWIN.
Born 12 February, 1809.
Died 19 April, 1882.

A greater and more enduring monument has been raised by Darwin to himself in his writings than any that could be raised to him by others. "He thought," said 'The Times' on the day of his funeral, "and his thoughts have passed into the substance of facts of the universe. . . . The Abbey has its orators and ministers who have convinced senates and swayed nations. Not one of them all has wielded a power over men and their intelligence more complete than that which for the last twenty-three years has emanated from a simple country house in Kent. . . . Darwin, as he searched, imagined. Every microscopic fact his patient eyes unearthed, his fancy caught up and set in its proper niche in a fabric as stately and grand as ever the creative company of Poets' Corner wove from sunbeams and rainbows."

But interment in Westminster Abbey was not destined to be the only public honour paid to Darwin's memory. A movement for a national memorial of him was set on foot, and over £4000 were raised by subscription. About half the amount was expended on a statue, executed by Sir Edgar Boehm, R.A., and erected in the great hall of the British (Natural History) Museum at South Kensington, where it was unveiled by the Prince of Wales on the 9th of June, 1885; and the balance was entrusted to the Royal Society to be invested for the promotion of biological research.

Charles Darwin left a widow, five sons, and two daughters. His eldest son, William Erasmus, is a banker in Southampton; the second, George, is Plumian Professor of Astronomy at Cambridge University, and a Fellow of the Royal Society; the third, Francis, has done valuable botanical work, and is also a Fellow of the Royal Society; the fourth, Leonard, is an officer in the Royal Engineers, and has done good work in astronomy; and the fifth, Horace, is a mechanician, and his talents have been successfully devoted to the development of the Cambridge Scientific Instrument Company.

Every book which Darwin wrote is the result of keen observation, industrious collection of facts, and deeply thoughtful deduction, while most of his conclusions have only been arrived at after reflecting and experimenting for many years. His life shows what may be accomplished by indefatigable industry and dogged perseverance, without any remarkable original genius, unless the power to observe accurately and take infinite pains be genius. He was not a fluent writer, expressing his thoughts with difficulty, and he had neither a quick apprehension nor a retentive memory. But he rightly gives himself credit for "some power

of reasoning," "a fair share of invention and of common sense or judgment," superiority "to the common run of men in noticing things which easily escape attention, and in observing them carefully," industry "in the observation and collection of facts," a "steady and ardent love of natural science," and "patience to reflect or ponder for any number of years over any unexplained problem." Even with these qualities it is truly wonderful that he has accomplished so much without being able "to remember for more than a few days a single date or a line of poetry." He much regretted his want of mathematical knowledge, saying that men endowed with it "seem to have an extra sense."

Although the name of Darwin will always be chiefly associated with the theory of the origin of species by means of natural selection, few men have done so much as he did to advance the sciences of geology, botany, and zoology, irrespective of the light thrown upon them by his theory.

His earliest geological researches were made during his voyage round the world, and the principal results were published in the three volumes of the 'Geology of the Voyage of the Beagle.' Of the first of these volumes, 'The Structure and Distribution of Coral Reefs,' Sir Archibald Geikie says: "This well-known treatise, the most original of all its author's works, has become one of the classics of geological literature. . . . . No more admirable example of scientific method was ever given to the world, and even if he had written nothing else, this treatise alone would have placed Darwin in the very front of investigators of nature." The last work which issued from his pen, 'The Formation of Vegetable Mould through the Action of Worms,' has doubtless had quite as powerful an influence upon geological thought, in showing the great results which are brought about by small causes long continued. But the chapter in the 'Origin of Species,' on the "Imperfection of the Geological Record," threw quite a new light upon the "Record of the Rocks." It is perhaps not too much to say that Darwin, in this single chapter, revolutionised the science of geology as completely as Lyell had done in the greatest geological work which has ever been written—'The Principles of Geology.' Lyell taught that we must interpret the past from our knowledge of the present, while Darwin showed how extremely fragmentary our record of the past must necessarily be, letting a flood of light upon some of the most perplexing problems with which geologists and palæontologists have to deal in applying existing agencies to the elucidation of past changes in the history of our earth.

What Darwin has done for geology, irrespective of his direct contributions to the science, cannot be better expressed than in the words of Sir Archibald Geikie. "No man of his time," he says, "has exercised upon the science of geology a profounder influence than has Charles Darwin. . . . When he began to direct his attention to geological inquiry, the sway of the Cataclysmal school of geology was still paramount. But already the Uniformitarians were gathering strength, and, before many years were past, had ranged themselves under the banner of their great champion, Lyell. Darwin, who always recognised his indebtedness to Lyell's teaching, gave a powerful impulse to its general reception by the way in which he gathered from all parts of the world facts in its support. He continually sought in the phenomena of the present time, the explanation of those of the past. Yet he was all the while laying the foundation on which the later or Evolutional school of geology has been built up. . . . That the Present must be taken as a guide to the Past, has been more fearlessly asserted than ever. And yet it has been recognised that the present differs widely from the past, that there has been a progress everywhere, that Evolution and not Uniformitarianism has been the law by which geological history has been governed. For the impetus with which these views have been advanced in every civilised country, we look up with reverence to the loved and immortal name of Charles Darwin."

The great progress of our knowledge of physiological and morphological botany in recent years is almost entirely attributable to the researches of Darwin. In showing that "the crossing of forms only slightly differentiated favours the vigour and fertility of their offspring," he opened up the most interesting of all botanical investigations, the relation of insects to flowers. His works on this subject are 'The Fertilisation of Orchids by the Agency of Insects,' and 'The Effects of Cross- and Self-Fertilisation in the Vegetable Kingdom.' His works on 'Insectivorous Plants,' on 'The Different Forms of Flowers on Plants of the Same Species,' and on 'The Power of Movement in Plants,' in the last of which he was assisted by his son Francis, were each of them revelations to botanists. It is wonderful that he should have been the first, if not actually to see, at least to realise the importance of so many phenomena in the life of plants. In the botanical portion of his work on 'The Variation of Animals and Plants under Domestication,' he shows that horticulturists have been unconsciously making experiments which tend to prove the truth of his theory ever since they first began to cultivate plants.

Darwin was not a systematic botanist, and does not appear to have described a single new species of plant. He "looked upon plants as *living things*. He did not study their forms so much as their *actions*. He interrogated them to learn what they were *doing*. The central truth, towards which his botanical investigations constantly tended, was that of the universal *activity* of the vegetable kingdom—that all plants *move* and *act*. He has, so to speak, *animated* the vegetable world. He has shown that whichever kingdom of organic nature we contemplate, to *live* is to *move*." (*L. F. Ward.*) "He made the dry bones live," said Dr. Masters; "he invested plants with a history, a biography, a genealogy, which at once conferred an interest and a dignity on them. Before, they were as the stuffed skin of a beast in the glass case of a museum; now they are living beings, each in their degree affected by the same circumstances that affect ourselves, and swayed, *mutatis mutandis*, by like feelings and like passions." Yet he evinced in a very practical manner his interest in systematic botany and his conviction of the importance of an exhaustive synonymic list of the plants of the world, by arranging, a few months before his death, to provide funds for the preparation and publication of a new edition of Steudel's '*Nomenclator*.' His original idea has been somewhat modified, and, under Sir Joseph Hooker's supervision, Mr. Daydon Jackson, who edited, for our Society, Pryor's 'Flora of Hertfordshire,' is now carrying out the colossal task of constructing, on the plan of Bentham and Hooker's '*Genera Plantarum*,' a list of all known genera and species of plants, with references.

The principal purely zoological work of Darwin is his 'Monograph of the Cirripedia,' published by the Ray Society, in two volumes of over 1000 pages and 40 plates, in 1851 and 1854. No other group of organisms has had so much light thrown upon it by any one author as the Cirripedia have had in this profound work. The most curious of the many discoveries which Darwin made in examining these animals is that of very minute parasites which he determined to be "complemental males," the name denoting that they do not pair with a female, but with a bisexual individual. He was much struck with the number of diverse beings comprised in some of the species, and by the great diversity in the sexual relations in others.

In the 'Origin of Species,' the 'Variation of Animals and Plants under Domestication,' and the 'Descent of Man,' are many zoological observations of much importance, irrespective of their bearing on the theory of natural selection; and our

chief knowledge of the habits of earthworms is derived from Darwin's work on 'The Formation of Vegetable Mould through the Action of Worms, with Observations on their Habits.'

But these contributions to zoology sink into the shade under the brilliant light thrown upon the science by the great truth which Darwin revealed. Mr. Romanes says: "The influence which our great naturalist has exerted upon zoology is unquestionably greater than that which has been exerted by any other individual. . . . No labourer in the field of science has ever plodded more patiently through masses of small detail; no master-mind on the highest elevation of philosophy has ever grasped more world-transforming truth. . . . Of very few men in the history of our race can it be said that they not only enlarged science, but changed it,—not only added facts to the growing structure of natural knowledge, but profoundly modified the basal conception upon which the whole structure rested; and of no one can this be said with more truth than it can be said of Darwin."

Anthropology and Psychology are scarcely within the province of our Society, and it will therefore suffice to say that Darwin has so completely transformed our conception of both these sciences, the former by his 'Descent of Man,' and the latter by his 'Expression of the Emotions,' that all who write upon these subjects after the publication of his works must perforce treat them in a totally different manner from that in which they had ever been treated before.

Beyond the limits of the scientific world, nine persons, perhaps, out of every ten, only think of Darwin as the originator of the notion that man has been developed from the anthropoid apes, the evolution of man, as well as of the lower animals, being due to the development of organs by use and the atrophy of organs by disuse. This is the view which Lamarck expounded half a century before Darwin published his views on evolution. So far from its being due to, or even entertained by Darwin, he nowhere states that he believes man to be a modified ape, but that man and the ape have had a common ancestor, a view, moreover, which does not appear in the 'Origin of Species,' but only in his more recent work on the 'Descent of Man,' and which may still be left out of consideration in judging of his theory of natural selection. Whether, also, modifications arise from the use and disuse of organs, is a question which may be disputed without affecting the validity of his theory. It is but one of many ways by which may be brought about deviations capable of transmission by inheritance.

Others again, but let us hope very few, look upon Darwin as a man who has done his best to subvert the Christian religion and destroy our belief in God. Nothing could have been further from his intention; no such imputation more repugnant to his feelings. Never by a single word has he attacked our faith, and although doubts arose in his own mind as to the probability of supernatural interference with the laws of nature, and of divine revelation to man, he never expressed them in any of his published books or papers, nor can the inference be justly drawn from them that he held unorthodox views. He believed that he had discovered a great truth, and he honestly gave expression to his convictions, without any other motive than that of advancing our knowledge of nature and enabling us to penetrate some of her secrets. His religion did not consist in "faith in things unseen," or blind belief in the miraculous, but it was that "pure religion and undefiled" which leads a man "to visit the fatherless and widows in their affliction and to keep himself unspotted from the world." While undoubtedly the greatest naturalist, if not the greatest scientist who ever lived, he was one of the most humble, kind-hearted, and lovable of men. His affection for his friends was "of the warmest possible kind," and he had, "to an unusual degree, the power of attaching his friends to him." At Down he was most courteous to all the village people, and took an interest in everything relating to their welfare. He helped to found a Friendly Club, and served as treasurer for thirty years; and for the last thirty-six years of his life he was on the most friendly and indeed affectionate terms with the Vicar of Down, the Rev. Brodie Innes, who speaks of him as an active assistant in all parish matters, and ever ready with liberal contributions. Owing to the retired life which his ill-health necessitated, his friends were not numerous, but all who knew him seem to have been even more impressed with the beauty of his character than with the greatness of his attainments, vast as they were.

Professor Huxley says that "the more one knew of him, the more he seemed the incorporated ideal of a man of science. Acute as were his reasoning powers, vast as was his knowledge, marvellous as was his tenacious industry, under physical difficulties which would have converted nine men out of ten into aimless invalids; it was not these qualities, great as they were, which impressed those who were admitted to his intimacy with involuntary veneration, but a certain intense and almost passionate honesty by which all his thoughts and actions were irradiated, as by a central fire. . . . He found a great truth trodden under foot, reviled by bigots, and

ridiculed by all the world; he lived long enough to see it, chiefly by his own efforts, irrefragably established in science, inseparably incorporated with the common thoughts of men. . . . . "

Mr. Romanes says that "while we recognise in him perhaps the greatest genius and the most fertile thinker, certainly the most important generaliser and one of the few most successful observers in the whole history of biological science, we feel that no less great, or even greater than the wonderful intellect, was the character of the man. . . . . The genuine delight that he took in helping everyone in their work—often at the cost of much personal trouble to himself—in throwing out numberless suggestions for others to profit by, and in kindling the enthusiasm of the humblest tyro in science; this was the outcome of a great and generous heart, quite as much as it was due to a desire for the advancement of science. . . . On the whole, Darwin's character was chiefly marked by a certain grand and cheerful simplicity, strangely and beautifully united with a deep and thoughtful wisdom, which, together with his illimitable kindness to others and complete forgetfulness of himself, made a combination as lovable as it was venerable."

But however beautiful the character and however admirable the life of Darwin may have been; however greatly he may have added to our knowledge of all the sciences which are concerned with the phenomena of life and mind, past and present, with many, perhaps with most of us, his reputation is inseparably interwoven with the theory to which his name has been given. This theory has transformed Evolution from an hypothesis into a doctrine. For Evolution and Darwinism are not synonymous. Descent with modification might be imagined to take place without a struggle for existence in which the fittest survive by the destruction of the less fit, but without this the raising of the type would be inexplicable. If the type were not raised, it might still be quite true that "in the intellectual, as in the material world,"—

> "All changes, nought is lost; the forms are changed,
> And that which has been is not what it was,
> Yet that which has been is;—"

And we could dispense with the theory of natural selection. But while the forms change, the type *is* raised, and we cannot conceive it to be thus raised by any other process than that of natural selection. The evidences of descent with modification may therefore be considered quite apart from the evidences of the survival of the fittest, although without such survival we cannot account for the evolution of the present from the past.

That the present has been evolved from the past may be shown and illustrated in various ways. The whole of living nature may be likened to a tree. The root is as yet unknown, but it is probably represented by some such simple form of life, if life it be, as the *Bathybius* of the ocean. The trunk soon divides into two main branches, representing the vegetable and the animal kingdoms, but, before it does so, forms are developed which are intermediate between plants and animals, or which at one period of their life are animate, and at other periods possess merely vegetative powers. Each main branch, the vegetal and the animal, then ramifies; the secondary branches, branchlets, and twigs representing the sub-kingdoms, classes, orders, families, genera, species, and varieties of our natural system of classification. This system is natural, because, and only so far as, it is founded on genetic relationship. The closer any two organisms agree in structure, the nearer are they genetically related. But each sub-kingdom is formed after a type which is followed with modifications in every one of its ramifications up to the individual. And just as certainly as each single leaf of a tree is vitally connected with the root, has each individual plant and animal been developed, by a purely generative process, in the course of incalculable ages, from some simple or undifferentiated form of living matter. In the utmost diversity there is unity. All living things, from the lowliest plant to the highest animal, have similar functions, they feed, grow, and reproduce their kind; protoplasm is in all the physical basis of life; and all forms of protoplasm are built up of the same elements—carbon, hydrogen, oxygen, and nitrogen. A single origin for life alone suffices adequately to explain this agreement.

In animals, when typical structures are no longer useful, they frequently remain, usually as rudimentary organs, the presence of which can only be accounted for by genetic relationship and descent with modification, for they are organs which have dwindled owing to changed conditions rendering them useless. For instance, in the course of adaptation of terrestrial quadrupeds to aquatic habits, the hind-limbs dwindle. Thus, in the seals, the hind-legs, although retaining all their typical bones, are almost rudimentary; and in the whales they are not apparent at all externally, and are only represented internally by very rudimentary remnants. Again, in the snakes there are no vestiges of fore-limbs, and only in the python do we find vestiges of hind-limbs, as tiny rudiments under the skin, and therefore quite useless to their possessor. These are cases of degeneration of organs from want of use, but they are

accompanied by elaboration of other organs which are useful, and they do not therefore indicate degeneration of the type.

But the gradual modification of certain organs, and their special degeneration co-existent with a general elaboration of the type, are nowhere more distinctly seen than in the pedigree of the horse, which has been traced backwards in time from the recent and the slightly dissimilar fossil *Equus* with a single toe and two lateral rudiments, the splint-bones, to an Eocene ancestor, about the size of a fox, with "four well-developed toes and a rudiment of another on the fore-feet, and three toes behind." In America, between the recent *Equus*, which had become extinct there before that continent was discovered by Europeans, and the Lower Eocene *Eohippus*, at least five closely-related equine genera have been discovered by Professor Marsh, each genus showing, in comparison with the one preceding it in time, an increase in the size of the animal, and elaboration of certain organs such as the teeth, with a gradual development of the middle toe, and suppression of the others one by one. Surely this is, as Professor Huxley says, demonstrative evidence of evolution.

It may be thought that man should be excepted from the scheme of evolution, his intellect, by giving him the power to devise and use tools, and to form a language, having enabled him to raise himself infinitely above any of the lower animals, and to make himself "lord of the creation." There can be no question, either, as to his specific distinctness, for by common consent he has a genus to himself, and this genus, *Homo*, has but a single species, though one with many varieties, some of which, were there not connecting links, might be considered species. Yet the late Sir Richard Owen, than whom few men have more reluctantly accepted the theory of descent with modification, especially as applied to man, said, in 1857, two years before the appearance of the 'Origin of Species:' "Not being able to appreciate or conceive of the distinction between the psychical phenomena of a Chimpanzee and of a Boschisman or of an Aztec with arrested brain growth, as being of a nature so essential as to preclude a comparison between them, or as being other than a difference of degree, I cannot shut my eyes to the significance of that all-pervading similitude of structure—every tooth, every bone, strictly homologous—which makes the determination of the difference between *Homo* and *Pithecus*, the anatomist's difficulty."

Professor Huxley, also, has shown that man, in the early stages of his development, is far nearer to the apes than the apes are to the dog; that in limb-proportion man differs less from the gorilla

than the gorilla differs from the other apes; that in cranial capacity men differ more from one another than they do from the apes, and no more from the apes than the apes differ from one another; that the differences between the skull of man and that of the gorilla are less than those between the skull of the gorilla and that of some other apes; and that the dentition of man differs less from that of the higher apes than the dentition of the higher apes differs from that of the lower apes. And he finally sums up the results of his comparison with this remark :—"Thus, whatever system of organs be studied, the comparison of their modifications in the ape series leads to one and the same result—that the structural differences which separate man from the gorilla and the chimpanzee are not so great as those which separate the gorilla from the lower apes."

If we had, in the rocks, a complete epitome of the history of our earth and its inhabitants, no doubt the pedigree of all our plants and animals, including that of man, might be traced as certainly as in the case of the horse, but the strata now existing, as Darwin has shown, are but fragments of the deposits which have been formed, and the fossils we find in them are but hap-hazard samples of the organisms which have been entombed. Our rocks are worn away by the action of water, and the sediment is carried into the sea, but only to form new rocks which are upraised and have no sooner become dry land than they are again worn down by rain and rivers, this process continually recurring, so that we only here and there catch a glimpse of the past in the strata which have escaped denudation, and in these strata we only here and there find a fossil, or a group of fossils, which has escaped destruction or obliteration. Nevertheless missing links are constantly being discovered,—links between mammals and amphibians, between birds and reptiles, between amphibians and fishes, and even between the Vertebrata and the Invertebrata (through the Tunicata); and also innumerable links between genera and species, so that it is getting more and more difficult to define a species, they run so imperceptibly one into another.

As Evolution is now an established doctrine, it is needless to multiply evidences of genetic relationship: but the question is yet to be considered as to how far Darwin's theory of natural selection is adequate to explain how evolution has taken place.

Most of the pre-Darwinian evolutionists considered that all living things possess an inherent faculty of progressive development, but the acceptance of such a view as an *efficient* cause of progress is almost as likely to stifle investigation as is the belief in special creation. It will be sufficient to give a brief outline of the views

The attempt to account for the origin of life from an aqueous solution acted on by an electric current was the greatest flaw in the work of Chambers, and he erred in many points, especially in deriving the mammals from the birds, their pedigree being from the fishes through the amphibians; yet he certainly prepared the way for the reception of Darwin's theory, as Darwin himself acknowledges, for the 'Vestiges' had a large sale and gave rise to a very extensive controversy. But, without the principle of natural selection, no theory of evolution could be satisfactory.

The fundamental principles of the origin of species by means of natural selection are thus stated by Darwin:—"As many more individuals of each species are born than can possibly survive; and as, consequently, there is a frequently-recurring struggle for existence, it follows that any being, if it vary however slightly in any manner profitable to itself, under the complex and sometimes varying conditions of life, will have a better chance of surviving, and thus be *naturally selected*. From the strong principle of inheritance, any selected variety will tend to propagate its new and modified form."

These principles may perhaps be more clearly apprehended if stated in a somewhat different manner, and slightly modified and elaborated.

1. In every species many of the offspring do not attain maturity, owing to all living things being perpetually engaged in a struggle for existence.

2. Few, if any, animals or plants are exactly alike in all respects at any stage of their existence.

3. However slightly one individual may differ from another, if the variation gives one a better chance of living than the other, that one will be the most likely to survive.

4. External conditions vary from time to time, the alteration usually being gradual and progressive.

5. If in any species some of the offspring differ from the parent in any way which makes them more suited to new conditions than the offspring which more nearly resemble the parent, they will have the best chance of living.

6. Any beneficial variation in the offspring will most probably be transmitted to *their* offspring; and if the external conditions then remain the same, or if they continue to change in the same direction, this variation will be perpetuated.

7. A new variety, better adapted for new conditions than the normal form, may, and in the struggle for existence most probably will, oust the normal form, which will gradually die out.

Each of these propositions is indisputable and complete in itself. Their general result is to demonstrate how beneficial variations may be perpetuated, a modified form being thus *naturally selected*, gradually acquiring and transmitting, through many generations, characters which, by a cumulative process of variation, may ultimately make it specifically distinct from the original form, that form dying out, so that one species gives rise to another.

The destruction of life is immense. How few of the innumerable spores of fungi ever even germinate! What a small proportion of the spawn of fishes ever attains maturity! Of seedlings which spring up, how few survive! What a great destruction of insects is wrought by birds! Examples without end could be given of great loss of life. Why is it that so many more individuals of every species are generated that can possibly survive? If each species were independently created to fill the place prepared for it in the world, and if no species could improve itself in its struggle for existence, this waste of life would be wanton, suffering and early death inexplicable.

"Are God and Nature then at strife,
That Nature lends such evil dreams?
So careful of the type she seems,
So careless of the single life.

. . . . . .

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

If the views of the special creationist were correct, Tennyson might well ask if God and Nature are at strife. Nature is careless of the single life, and careless of the type, that the type may be raised, for if the weakly survived equally well with the strong, there could be no progress. Here at least natural causation and teleology are in harmony, for, "good will be the final goal of ill" because each death "subserves another's gain."

That this view of progress in the past is an earnest of progress in the future has been well expressed by Dr. J. W. Powell, Director of the United States Geological Survey. He says: "Had philosophers discovered that the generations of living beings were degenerating, they would have discovered despair. Had they discovered that life moves by steps of generations in endless circles—that what has been is, and what is shall be, and there is no progress, the gift of science to man would have been worthless. The revelation of science is this: Every generation in life is a step in progress to a higher and fuller life; science has discovered *hope*.

What Man has been doing for the last few thousand years, Nature has been doing for untold ages. But there is this difference. Nature selects only the best individuals, or those which have some advantage in the struggle for existence, or some special adaptability to changed circumstances. Man selects those which have characters he wishes to perpetuate, not those which give their possessors any advantage in their life-struggle, in fact more often those which would place them at a disadvantage if left to themselves and allowed to revert to their feral condition; and therefore, while a variety raised by Nature will be preserved, or further modified in the same direction, a variety raised by Man will tend to lose the characteristics which he has endeavoured to impress upon it. This is called reversion to the original type, and the fact of such reversion has by some been thought to furnish one of the chief arguments against the theory of Darwin. It rather furnishes an argument in favour of it, for reversion of domestic animals and cultivated plants allowed to run wild, to a type advantageous to them in their life-struggle, is really an example of the beneficial effects of natural selection. Moreover, characters acquired by domestication and cultivation which are not disadvantageous are seldom entirely lost, although it is evident that they are not so likely to be perpetuated as are characters acquired under natural conditions.

The struggle for existence amongst plants is chiefly against competing plants of their own or other species, the winners in the one case varying from the original type in some way by which they obtain an advantage, and transmitting that variation to their offspring, and in the other case driving out the competing species by having greater vigour or more adaptability to any changing circumstances. It is also a struggle against the depredations of animals, the winners then being those which possess the best means of defence, such as thorns or poisonous properties, or which are the most inconspicuous. But flowers which are inconspicuous will not attract insects, and therefore all such flowers depend, for the continued existence of their species, upon self-fertilisation. All flowers which require to be cross-fertilised are conspicuous, brightly coloured, or highly scented, so that insects may be attracted to them. This is especially the case with orchids, in many of which the adaptations for cross-fertilisation by the agency of insects are exceedingly complex. Thus the development of floral envelopes to the reproductive organs, and of the scent of flowers, may be traced to the visits of insects, for whenever any variation appears, if that variation increases the attraction of the flower to

insects, more seeds, or more vigorous seeds, will be perfected in that variety, and it will thus have a better chance of perpetuating itself than will the original form.

The struggle for existence amongst animals is too obvious to require illustration. Their increase is chiefly checked by one species preying upon another, by disease, and by insufficiency of food. As with plants will the healthiest best withstand the attacks of insects, so with animals which prey upon one another will the strongest or most wary gain the victory. In both, the effect of the struggle must be to perpetuate and increase beneficial modifications. In animals which have no means of defending themselves against attack, some subtle device is necessary, and that is generally some mode of concealment. The most efficient way to escape notice or attack is to resemble something else which is not subject to attack. This is the origin of mimicry, which takes several forms. Many insects escape destruction by resembling the flowers, leaves, twigs, or bark of the trees on which they feed. Certain beautiful and conspicuous butterflies have a disagreeable odour which renders them obnoxious to birds; others, belonging to a different genus, and having no offensive odour, resemble these in their habits and colour, and so escape destruction. Natural selection offers the only conceivable explanation of both these forms of mimicry, the tendency to mimicry being increased by the most mimetic individuals having the best chance of surviving and bearing offspring which inherit their peculiarities.

These are merely a few illustrations of the application of the principle of natural selection to the explanation of phenomena which without it are utterly inexplicable. But, after all, this principle merely supplies a missing link in a chain of causation still discontinuous, unless we accept an inherent tendency to vary as an efficient cause of variation. It enables us to understand how, when a beneficial variation takes place, that variation is perpetuated, but it does not show why beneficial variations occur. Natural selection is merely a term for the survival of the fittest by the destruction of the unfit. It cannot produce anything, but it is a necessary factor in evolution, for without it the less fit would be as likely to endure as the fittest, and there would be no progress. It embraces the theory of Lamarck, for by natural selection only can the modification of organs by use and disuse owing to changes in environment, be preserved and accumulated in the right direction for progress; and it accounts for living things fitting the conditions of their existence without being

designed to fit them, for those which did not fit these conditions have perished in the struggle for existence; but it nevertheless requires the aid of some pre-ordained guiding or determining principle, and that necessitates the existence of a Presiding Intelligence. Nothing happens by chance; everything must have a cause; and every cause must have a prior cause; so we are logically brought to see the necessary existence from eternity of a Great First Cause, of infinite power and wisdom, who has decreed the existence of matter and ordained the laws of force which govern it. Even if we could ascertain the mode in which life has been acquired by matter, and could see the quivering molecules in the protoplasm of organised beings striving with each other, some trying to pursue the course they have hitherto pursued, and others trying to pursue a new course, so that we could actually see Heredity and Variability striving for the mastery, we should still have to account for the origin of this strife, which must have been coeval with the origin of life, and for the determining principle by which the progress from simplicity to complexity is a progress, through intellectual man, towards his conception of the Supreme Intelligence.

Darwin, while clearly seeing that variability may arise from the movement and activity inherent in all life, vegetal and animal, recognises the necessity of a determining principle, when he says: "The birth both of the species and of the individual are equally parts of that grand sequence of events which our minds refuse to accept as the result of blind chance." Again, alluding to the view, now no longer held, that each species has been independently created, he remarks: "To my mind it accords better with what we know of the laws impressed on matter by the Creator, that the production and extinction of the past and present inhabitants of the world should have been due to secondary causes, like those determining the birth and death of the individual. When I view all beings, not as special creations, but as the lineal descendants of some few beings which lived long before the first bed of the Silurian system was deposited, they seem to me to become ennobled. . . . There is grandeur in this view of life, with its several powers, having been originally breathed by the Creator into a few forms or into one," from which "endless forms most beautiful and most wonderful have been, and are being, evolved."

Professor Huxley, also, in treating of the place which Man occupies in Nature, says that "thoughtful men, once escaped from the blinding influences of traditional prejudice, will find

in the lowly stock whence man has sprung, the best evidence of the splendour of his capacities; and will discern in his long progress through the Past, a reasonable ground of faith in his attainment of a noble Future. . . . And, after passion and prejudice have died away, . . . our reverence for the nobility of manhood will not be lessened by the knowledge that Man is, in substance and in structure, one with the brutes; for he alone possesses the marvellous endowment of intelligible and rational speech, whereby, in the secular period of his existence, he has slowly accumulated and organised the experience which is almost wholly lost with the cessation of every individual life in other animals; so that now he stands . . . far above the level of his humble fellows, and transfigured from his grosser nature by reflecting, here and there, a ray from the infinite source of truth."

Goethe sees in Nature "the living visible garment of God," and Tennyson thus beautifully expresses this idea, together with that of the divine origin of the spiritual nature of man:—

"The sun, the moon, the stars, the seas, the hills, and the plains—
Are not these, O Soul, the Vision of Him who reigns?

Is not the Vision He? tho' He be not that which He seems?
Dreams are not true while they last, and do we not live in dreams?

Earth, these solid stars, this weight of body and limb,
Are they not sign and symbol of thy division from Him?

Dark is the world to thee: thyself art the reason why;
For is He not all but thou, that hast power to feel 'I am I?'"

The doctrine of Evolution, as established by Darwin, has completely broken down our conception and definition of species, for a species is now seen to be but a variety so far removed from its nearest allies, by the dying out of intermediate forms, that we are enabled to frame a distinctive description of it. A similar view of the artificial character of genera has long been held. Now, a species exists not in Nature; we give to it a name merely for our own convenience; so that henceforth all controversies as to what is and what is not a true species, are at an end, and we have only to consider which forms are sufficiently distinctive to bear specific names. It has broken down our belief in the distinctiveness of the animal and vegetable kingdoms; it has shown us the reason why all living things, both plants and animals, are alike "in their chemical composition, their cellular structure, their laws of growth, and their liability to injurious influences;" why in plants and animals "sexual reproduction seems to be essentially similar;" why there are

organisms which botanists claim to be plants, and zoologists claim to be animals; why we need not wonder that some of these organisms at one period of their lives have the nature, movements, and even instincts of animals, and at another period lead a purely vegetative existence and reproduce themselves by spores; and why all such denizens of the debatable land are lowly in their organization. It has shown us the meaning of the terms of relationship used by Naturalists of the old school, unconscious of their real value and purport,—comparative anatomy, affinity, community of type, morphological unity, adaptive mimicry, etc.;—and it has explained the reason of the existence, utterly incomprehensible before, of rudimentary and abortive organs.

It has done much more. It has taught us that all things are working together, or striving against each other, for the general good. It has taught us how, by famine, disease, and premature death, the weakest succumb that the strongest may have room to live; how by the best of each race increasing, and multiplying, and replenishing the earth, low forms of life become high, out of unity and simplicity arising diversity and complexity, beauty and joy. And it teaches us still another lesson; it teaches us that we ought to work, each and all, for the general progress of mankind; that the more intellectual, the happier, and the more holy we are, the more intellectual, the happier, and the more holy will our descendants be; and that it is within our power, by always striving to subordinate the pleasures of sense to those of mind and soul, so to influence our offspring, unconsciously by heredity as well as consciously by example and precept, that the type of our race may be raised, and in the course of incalculable ages Man may advance, intellectually and spiritually, nearer and nearer to the image of his Maker.

And when prejudice has completely succumbed to reason, the doctrine of Evolution by Natural Selection will be taught in all our schools as a fundamental truth of natural science, and will be universally admitted to afford one of the most convincing proofs of the wisdom and beneficence of God, as showing how "thro' the ages one increasing purpose runs,"—

> "That mind and soul, according well,
> May make one music as before,
> But vaster."