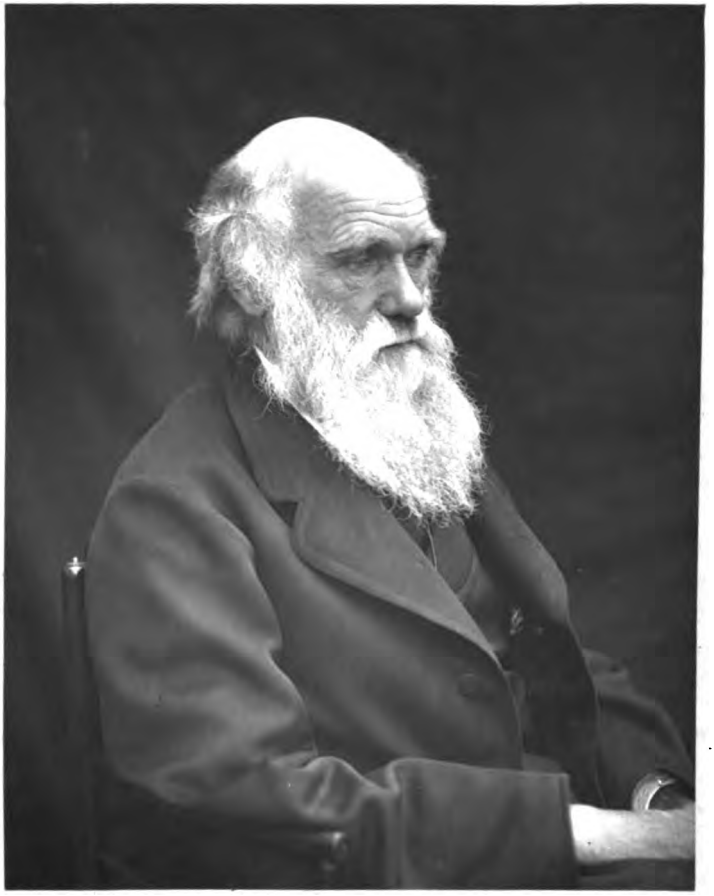
CONTEMPORARY PORTRAITS.

NEW SERIES.—No. 8.

CHARLES DARWIN, F.R.S.

CHARLES ROBERT DARWIN was born on the 12th of February, 1809, at Shrewsbury. His father was Dr. Robert Waring Darwin, F.R.S., his grandfather the celebrated Dr. Erasmus Darwin, and his maternal grandfather Josiah Wedgwood, F.R.S., the well-known potter. He was educated at Shrewsbury, under Dr. Butler, from whence he proceeded to the University of Edinburgh; there he stayed two years, and then entered Christ's College, Cambridge, where he took the degree of Bachelor of Arts. In 1831 he sailed with Captain Fitzroy in the "Beagle," on her voyage round the world, returning at the close of 1836. In 1839 he married his cousin, Miss Emma Wedgwood, and ever since 1842 he has lived at Down, near Bromley, in Kent.

Mr. Darwin's journal of researches into the natural history and geology of the countries visited by H.M.S. "Beagle" is universally admitted to be one of the most instructive and most charming books of travel in the English language. During his voyage he paid much attention to the interesting problem presented by the peculiar conformation of coral islands, and in the year 1842 he published his celebrated work on this subject. The circular or oval shape of so many reefs, each having a lagoon in the centre closely surrounded by a deep ocean, and rising but a few feet above the sea level, had long been a puzzle to the physical geographer. The favourite theory was that these were the summits of submarine volcanoes, on which the coral had grown. The great size of some of these "atolls" was, however, a serious difficulty. Again, as coral does not grow at greater depths than about twenty-five fathoms, the immense number of these reefs formed an almost insuperable objection to this theory. The Laccadives and Maldives, for instance, meaning literally the "lac of islands" and the "thousand islands," are a series of such atolls; and it was really impossible to imagine so great a number of craters, all so nearly of the same altitude. Mr. Darwin showed, however, that so far from the ring of coral resting on a corresponding ridge of rock, the lagoons on



UNIVERSITY MAGAZINE. 1878 WOODBURY MECHANICAL PROCESS

Charles Darwin

the contrary now occupy the place which was once the highest land. He pointed out that some lagoons, as for instance, that of Vanikoro, contain an island in the middle; while other islands, such as Tahiti, are surrounded by a margin of smooth water, separated from the ocean by a coral reef. Now, if we suppose that Tahiti were to sink slowly, it would gradually approximate to the condition of Vanikoro; and if Vanikoro gradually sank, the central island would disappear, while on the contrary the growth of the coral would neutralise the subsidence of the reef, so that we should have simply an atoll, with its lagoon. The same considerations explain the origin of the "barrier reefs," such as that which runs, for nearly one thousand miles, along the north-east coast of Australia. Thus, Mr. Darwin's theory explained the form and the approximate identity of altitude of these coral islands. But it did more than this; because it showed us that there were great areas in process of a subsidence, which, though slow, was of great importance in physical geography.

His monograph of the Cirripedia or barnacles, a curious group of abnormal crustacea, long supposed to belong to the class of molluscs; and even by the older naturalists imagined, probably from their feathery legs, to stand in a mysterious connection with the barnacle-geese, is universally admitted amongst naturalists to be a most masterly work, but is, of course, of a special character. Perhaps the most interesting point is the discovery that certain minute creatures, found adhering to the female barnacles, are really the males. They are, in some species, almost rudimentary, and very short lived, being, indeed, incapable of taking any food. For these little creatures he proposed the term "complemental males."

In the year 1858, Mr. Darwin communicated to the Linnean Society a short, but most important memoir, "On the Variation of Organic Beings in a State of Nature," in which he briefly indicated the views which, under his name, have since become so famous. Mr. Wallace, also, simultaneously and independently arrived at similar results. Mr Darwin's great work "On the Origin of Species by Means of Natural Selection, or the Preservation of Favoured Races in the Struggle for Life," in which these views were developed with masterly ability, appeared in the following year, and may truly be said to have constituted an epoch in natural history.

The conclusions to which he arrived were as follows: "That the theory of descent with modification embraces all the members of the same class. I believe that animals have descended from at most only four or five progenitors, and plants from an equal or lesser number." . . . . "Therefore, on the principle of natural selection with divergence of character, it does not seem incredible that, from some such low and intermediate form, both animals and plants may have been developed.

And, if we admit this, we must admit that all the organic beings which have ever lived on this earth may have descended from some one primordial form." . . . . . "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; and that, whilst this planet has gone cycling on according to the fixed laws of gravity, from so simple a beginning endless forms most beautiful and most wonderful have been, and are being, evolved."

These views were supported by close reasoning, and an immense array of facts. Mr. Darwin commenced by discussing the variability of animals under domestication and nature, showing the difficulty of distinguishing between varieties and species; and the differences which man had been able to produce in such cases as that, for instance, of our domestic pigeons, all unquestionably descended from a common ancestor. He then referred to the doubtful species, showing that wide ranging, much diffused, and common species vary the most, and that species of the larger genera in each country vary more than those of the smaller. He then called attention to the effect of the struggle for existence, a phrase which has since become an household word, in killing out the individuals less perfectly adapted to their environment, thus exercising in fact a true, though unconscious selection, comparable in its effect to that exercised by man on domesticated animals and plants. He then proceeded to discuss the laws of variation, and to point out, with characteristic candour, the difficulties of his theory. The absence of intermediate varieties between species, he accounted for by the imperfection of the geological record; and he then proceeded to show that the geographical distribution of animals and plants, the fauna and flora, for instance, of oceanic islands, the absence of batrachians and terrestrial mammals, the relation of the inhabitants of islands to those of the nearest mainland, afforded powerful arguments in support of his views. The remarkable facts presented by embryology, and the existence of rudimentary organs, were also shown to point clearly in the same direction.

No one could read this work without admiration, but, although Mr. Darwin's views from the first received the adhesion of some of the most eminent naturalists, they were so much opposed to generally-received opinions, that they naturally aroused much opposition. It is, however, not going too far to say that they have gradually gained ground, not only amongst professed naturalists, but with all those who have taken the trouble carefully to weigh the evidence. Almost all, now, would probably admit that natural selection has greatly influenced the present forms of organised life, though there would still be much difference of opinion as to how far the results have been modified by other causes. Mr. Darwin's views would probably have attracted less opposition had it not been for their obvious bearing on the origin of the human race. Mankind,

indeed, is scarcely mentioned in the "Origin," but Mr. Darwin has dealt with this subject in a subsequent work, the "Descent of Man." In this he has boldly grappled with the question. He points out that man is constructed on the same type or model as other mammals—the bones in his skeleton, as well as his muscles, nerves, blood-vessels, and internal viscera, following the same law. Even his brain, as shown by Huxley and other naturalists, so closely resembles that of the quadrumana, that, as Bischoff, who is a hostile witness, admits, every chief fissure and fold in the brain of man has its analogy in that of the orang, though it is no doubt true that at no period of development do their brains perfectly agree.

Mr. Darwin points out that, even on minor points, the similarities are very striking; such, for instance, as the arrangement of the hair on the arms. In the case of the orang, this serves to throw off the rain, when, as is the custom of this animal, the arms are bent, with the hands clasped round a branch or over its own head. If the above explanation be correct, the hair on the human forearm assumes an unexpected significance, and offers a curious record of our former state, since, as Mr. Darwin observes, no one supposes that is now of any use in throwing off the rain, nor, in our present erect condition, is it properly directed for this purpose. Again, in every large collection of human skulls some may be found with the canine teeth projecting beyond the others, in the same manner as, though to a less degree than, in the anthropomorphous apes. "He," urges Mr. Darwin, "who regards with scorn the belief that the shape of his own canines, and their occasional great development in other men, are due to our early progenitors having been provided with those 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 muscle' (thus named by Sir C. Bell) so as to expose them ready for action, like a dog prepared to fight."

The main result at which Mr. Darwin arrives is that man is descended from some more lowly form, though he warns his readers not to suppose that our early progenitors were identical with, or even closely resembled, any existing ape or monkey. Such conclusions are, no doubt, highly distasteful to many minds, but, as Mr. Darwin points out, "we are not here concerned with hopes or fears, but only with the truth as far as our reason allows us to discover it. I have given," he adds, "the evidence to the best of my ability:" and, whatever the ultimate verdict may be, no one will deny that he has treated this question with the greatest ability, and most laudable candour.

In the "Origin of Species," Mr. Darwin derived a strong argument from the changes which had been produced by man in domesticated animals and plants. For if considerable modifications had been thus

produced during a comparatively short period, it was the less improbable that still greater alterations might have been produced by natural causes, acting through the far longer periods of geological time. In the year 1868, he published a special work on the "Variation of Animals and Plants under Domestication." In it he gave, under the head of each species, the facts which he had been able to collect, showing the amount and nature of the changes which animals and plants had undergone whilst under the dominion of man.

At the conclusion of the work Mr. Darwin set forth his "provisional hypothesis," as he calls it, of Pan-Genesis, namely, that "the whole organisation, in the sense of every separate atom or unit, reproduces itself. Hence ovules, or pollen grains, the fertilised seed or egg, as well as buds, include and consist of a multitude of gemmules thrown off from each separate atom of the organism." It is universally admitted that cells propagate themselves by self-division, and Mr. Darwin assumes that, besides this means of increase, they throw off minute gemms or atoms, which circulate freely throughout the system, and multiply by self-division, subsequently becoming developed into cells like those from which they were derived. He supposes that these gemmules are transmitted from the parents to their offspring, and are generally developed in the succeeding generation; but are sometimes transmitted in a dormant state during many generations.

At the close of the last century, Sprengel, a German naturalist, published a most suggestive work on flowers, in which he pointed out the curious relations existing between these and insects, and showed that the latter carry the pollen from flower to flower. Sprengel's observations, however, attracted little notice, until Mr. Darwin called attention to the subject.

The first of Mr. Darwin's important contributions to Botanical Science was his "Memoir on the Genus Primula," published in the *Linnean Journal* for 1862. It had long been known, not only to botanists, but even to village children, that the cowslip and primrose exist under two forms, about equally numerous, and differing from one another in the arrangement of their stamens and pistils; the one form having the stamens at the summit of the flower, and the stigma half-way down; while in the other the relative positions are reversed, the stigma being at the summit of the tube, and the stamens half-way down. This difference had, however, been regarded as a case of mere variability; but Mr. Darwin showed it to be a beautiful provision, by means of which insects unconsciously fertilise each flower with pollen brought from a different plant.

These two forms of Primula differ not only in the above points, but in several others, and especially in the form and size of the pollen-grains. By a series of most careful and elaborate observations and experiments,

Mr. Darwin showed that flowers fertilised with pollen from the other form yield more seed than if fertilised by pollen of the same form, even if taken from a different plant.

This paper led to more extended researches on the subject, collected in his work on "The Different Forms of Flowers on Plants of the same Species;" for "dimorphism," as he proposed to call it, turned out to be by no means confined to primulas, but to exist in many other genera—nay, in the case of *Lythrum salicaria*, the facts are even more complex, there being three distinct forms. It must not, however, be supposed that in all cases where a species has two distinct forms of flowers, the relation is always that which exists between the two forms of primula. On the contrary, in many cases, the one form is specially adapted to be fertilised by the agency of insects; while the other is so constituted as to be self-fertile. The latter type of flower is generally smaller than the former, and indeed in some cases, to which attention was first called by Kuhn, and which he appropriately named cleistogamic, they are so much reduced that they would scarcely be recognised as flowers at all. The complexity introduced by these interesting adaptations seems to reach its climax in *Oxalis sensitiva*, which bears no less than six kinds of flowers.

Self-fertilising flowers have, of course, the great advantage that in them fertilisation is more probable, and may even be rendered practically certain. This is necessarily a great benefit; but, on the other hand, it is counterbalanced by the fact that, as Mr. Darwin showed in a subsequent work, to which we shall immediately refer, cross-fertilised plants are more vigorous and healthy. Indeed, though we know of many cases in which self-fertilisation is impossible, there is not one of which the opposite can be predicated.

No group of plants present more complex and beautiful contrivances than the Orchids, to which Mr. Darwin devoted a special work, "On the various Contrivances by which British and Foreign Orchids are Fertilised by Insects." Many of these are very singular. In *Listera ovata*, for instance, the moment the insect touches a particular part of the flower, a drop of fluid is instantaneously secreted, which glues the pollen to the head of the insect. In *Cypripedium* the flower is so arranged that any bee which is once tempted into the hollow, shoe-like receptacle, from which the flower derives its name, is compelled to make its exit by a narrow passage, in passing through which it first of all rubs its head against a sticky surface, which renders it adhesive, and then against the stamen, from which it thus carries off a certain quantity of pollen. In *Cephalanthera*, when the flower is mature, the terminal portion of the labellum turns downwards, so as to form a sort of doorway through which insects can obtain access, and thus fertilise the flower. As soon as this object is effected the labellum rises again and shuts the triangular

door, thus completely closing the flower, and preventing the access of insects, which would then be useless or even mischievous. In *Catasetum*, one of the large tropical species, the flower is very large; one portion of it is highly sensitive, and as soon as it is touched by an insect the flower literally throws its pollen with unerring aim at the visitor. With such force is this effected, that the pollen may be thrown three or four feet.

It would be impossible, of course, within the limits of the present article, to allude, however briefly, to all of these beautiful cases.

But though Mr. Darwin and other botanists have succeeded in throwing much light on the peculiar and beautiful structures presented by orchids and other flowers, there are still many problems which remain to be solved, even amongst our English species. The Bee Ophrys, for instance, seems to be specially adapted for self-fertilisation, and insects very rarely visit the flowers. Mr. Darwin himself has never seen such a case. Robert Brown even supposed that the flowers resembled bees, in order to deter insects from visiting them. But though the conclusion arrived at by Mr. Darwin is probably the safest, that under unknown circumstances, and perhaps at very long intervals of time, one individual Bee Ophrys is crossed by another, still the case seems to be very puzzling.

Malaxis paludosa seems to offer strong evidence in favour of Mr. Darwin's general views as to the origin of species by natural selection. In the normal flower, from which the Orchids may be assumed to have descended, the part which is known as the labellum is properly directed upwards; but in the majority of the Orchids, it has become desirable that it should be at the lower side of the flower, and this is effected by a partial twisting of the ovary. In *Malaxis paludosa*, on the contrary, the labellum is directed upwards, and this is effected by an additional twist being given to the ovary; whereas, if the plant had been directly created, one can see no reason why the ovary should be twisted at all. It would, of course, be a much simpler arrangement that each flower should be fertilised by its own pollen. These arrangements, however, presuppose that "cross-fertilisation" is an advantage, and Mr. Darwin's work, "The Effect of Cross and Self Fertilisation in the Vegetable Kingdom," is devoted to showing, which he does by the most careful and conclusive experiments, that plants produced from cross-fertilised flowers are really more vigorous than those from self-fertilised ones. In *Ipomœa*, for instance, the general average of a number of experiments gives the size of the crossed as compared with that of the self-fertilised plants as 100 to 77, and in fertility as 100 to 51. If an equal number of both were grown together in a pot, where there was not room for all, the cross-fertilised plants tended to crowd out and smother the others. The cross-fertilised plants also seemed to be more capable of resisting cold. The action of insects, therefore, not only renders our flowers beautiful, but more fertile, vigorous, and healthy likewise.

It is very curious that crosses between flowers grown on cuttings from the same plant, do not give any beneficial result.

In by far the majority of cases, the relation between flowers and insects is one of mutual advantage. In his work, however, on "Insectivorous Plants," Mr. Darwin deals with a variety of interesting species, in which we meet with a very different state of things. The first observation on insect-eating flowers was made about the year 1768, by our countryman Ellis, in *Dionæa*, a North American plant, the leaves of which have a joint in the middle, and thus close over, seize, and actually digest any insect which may alight on them. The plant has recently been studied by an American botanist, Mr. Canby, who fed it with various substances, with different results. He found that cheese, for instance, disagrees horribly with the leaves, turning them black, and finally killing them.

In the summer of 1860, Mr. Darwin's attention was attracted by the large number of insects caught on the leaves of our common sundew (*Drosera rotundifolia*), which are covered with glutinous glandular hairs or tentacles—on an average about two hundred on a full-sized leaf. The glands are each surrounded by a drop of an exceedingly viscid solution, which, glittering in the sun, has given rise to the name of the plant. If any object be placed on the leaf, these glandular hairs slowly fold over it, but if it be inorganic, they soon unfold again. On the other hand, if any small insect alights on the leaf, it becomes entangled in the glutinous secretion, the glands close over it, their secretion is increased, and they literally digest their prey. Mr. Francis Darwin has recently shown that plants supplied with insects grow more vigorously than those not so fed. It is very curious, that while the glands are so sensitive, that even an object weighing only $\frac{1}{78740}$th of a grain placed on them is sufficient to cause motion, yet they are "insensible to the weight and repeated blows of drops" of even heavy rain.

Another genus of insect-eating plants is *Pinguicula*, which frequents moist places, generally on mountains. The leaves are concave, with incurved margins, and the upper surfaces are covered with two sets of glandular hairs. In this case, the naturally incurved edges curve over still more, if a fly or other insect be placed on the leaf.

Another English insectivorous plant is *Utricularia*, an aquatic species, bearing a number of small bladders or sacs, which have been supposed to act as floats. Branches, however, which bear no bladders, float just as well as the others, and there seems no doubt that their real use is to capture small aquatic animals, which they do on a large scale. The bladders, in fact, are on the principle of an eel-trap, having an entrance closed with a flap, which permits an easy entrance, but effectually prevents the exit of the unfortunate victim.

We have not space to refer to Mr. Darwin's other works, such as

"The Expression of the Emotions," and "Climbing Plants," or his numerous scientific memoirs; but we append a list of them, taken from *Nature* of June 4, 1874.

It is hardly necessary to say that Mr. Darwin has received many scientific honours. He is an honorary member of various foreign scientific societies; he has received the Wollaston Medal from the Geological Society; and from the Royal Society, in 1853, one of the Royal Medals; and, in 1864, the Copley Medal. No man living has exercised so great an influence on biological science. In German scientific catalogues "Der Darwinismus" is a recognised heading; and indeed, there is scarcely one of Mr. Darwin's works which may not be said not only to have been a valuable contribution to our knowledge, but to have pointed out relations hitherto unsuspected, and to have opened up new lines of thought. A list of Mr. Darwin's works may be found useful for the student, and is appended below. We are glad to be able to add that more than one of Mr. Darwin's sons has already made valuable contributions to science.

Although Mr. Darwin has done so great an amount of scientific work of the very highest class, he has for many years past been in very delicate health. This has prevented him from taking any active part in the management of our scientific bodies, and from mixing much in general society. No man, however, is more beloved by those who have the privilege of his friendship.

General Works.

"Journal of Researches into the Natural History and Geology of the Countries visited by H.M.S. Beagle." 1845.

"On the Origin of Species by Means of Natural Selection." 1859.

This was preceded by a sketch, entitled, "On the Variation of Organic Beings in a State of Nature." Published in the *Journal of the Linnean Society*, vol. 3 (Zool.) 1859, p. 46.

"The Variation of Plants and Animals under Domestication." 2 vols. 1868.

"The Descent of Man and Selection in Relation to Sex." 2 vols. 1871.

"The Expression of the Emotions in Man and Animals." 1872.

Zoological Works.

"The Zoology of the Voyage of H.M.S. Beagle." Edited and superintended by C. Darwin. 1840. Consisting of five parts.

"A Monograph of the Cirripedia: Part I., Lepadidæ." Ray Soc. 1851, pp. 400.

"A Monograph of the Cirripedia: Part II., the Balanidæ." Ray Soc., 1854, pp. 684.

"A Monograph of the Fossil Lepadidæ." Pal. Soc. 1851, pp. 86.

"A Monograph of the Fossil Balanidæ and Verrucidæ." Pal. Soc. 1854, pp. 44.

"Observations on the Structure of the genus Sagitta." Ann. Nat. Hist., vol. xiii., 1844.

"Brief Description of Several Terrestrial Phanariæ and of some Marine Species." Ann. Nat. Hist., vol. xiv., 1844, p. 241.

Botanical Works.

"On the Various Contrivances by which British and Foreign Orchids are Fertilised." 1862. Second edition, 1877.

"The Movements and Habits of Climbing Plants." 1875. (Bot.), p. 1.—This paper has also been published as a separate work.

"On the Action of Sea Water on the Germination of Seeds." Jour. Linn. Soc., vol., i., 1857 (Bot.), p. 130.

"On the Agency of Bees in the Fertilisation of Papilionaceous Flowers." Ann. Nat. Hist., vol. ii., 1858, p. 459.

"Insectivorous Plants." 1875.

"The Effects of Cross and Self Fertilisation in the Vegetable Kingdom." Second edition. 1878.

"The Different Forms of Flowers on Plants of the same Species." 1877.

Geological Works.

"The Structure and Distribution of Coral Reefs." 1842, pp. 214.

"Geological Observations on Volcanic Islands." 1844, pp. 175.

"Geological Observations on South America." 1846, pp. 279.

"On the Connection of the Volcanic Phenomena in South America, &c." Trans. Geol. Soc., vol. v.; read March, 1838.

"On the Distribution of the Erratic Boulders in South America." Journ. Geol. Soc. vol. vi.; read April, 1841.

"On the Transportal of Erratic Boulders from a lower to a higher level." Journ. Geol. Soc., 1848, p. 315.

"Notes on the Ancient Glaciers of Carnarvonshire." Phil. Mag., vol. xxi. 1842, p. 180

"On the Geology of the Falkland Islands." Journ. Geol. Soc., 1846, pp. 267.

"On a Remarkable Bar of Sandstone off Pernambuco." Phil. Mag., Oct. 1841, pp. 257.

"On the Formation of Mould." Trans. Geol. Soc., vol. v., p. 505; read Nov. 1837.

"On the Parallel Roads of Glen Roy." Trans. Phil. Soc., 1839, p. 39.

"On the Power of Icebergs to make Grooves on a Submarine Surface." Phil. Mag., Aug. 1855.

"An Account of the Fine Dust which often Falls on Vessels in the Atlantic Ocean." Proc. Geol. Soc., 1845, p. 26.

"Origin of the Saliferous Deposits of Patagonia." Journ. Geol. Soc., vol. ii., 1838, p. 127.

Part "Geology," in the Admiralty Manual of Scientific Inquiry, 1849; third edition, 1859.