

of a handy Persian Grammar, and of a valuable English version of Spiegel's German translation of the 'Zend Avesta.' After spending some time in the Library of the British Museum, where his remarkable linguistic capacity rendered him very useful, he went out to the East during the Crimean War, and until the conclusion of peace held a post at Sinope. Refused readmission to the British Museum on his return, he worked for several years for the then well-known Parsee merchant, Mr. Muncherjee Hormusjee Cama, who employed him to bring out the English version of the 'Avesta,' a task for which his wide, if not profound, acquaintance with Oriental languages specially fitted him, and which he executed remarkably well.

MESSRS. MACMILLAN & Co. will publish shortly, under the title of 'A Year's House-keeping in Natal,' a new book by Lady Barker, describing the characteristic features of nature and man in that colony.

AN HUNGARIAN Correspondent writes :—

"M. Benjamin de Rállay, an Hungarian gentleman, who spent nearly eight years in Belgrade as Austro-Hungarian Consul-General, has just published a most elaborate work on the history of the Serbs, consisting of two volumes, and including the period between 1804-15, namely, the time during which the Serbs rose against their conquerors, led partly by Kara Gyorgye, partly by Obvenovic. In the first volume, reaching to 1806, is a sketch of the early history of the Servians, and of the beginning of the Russian influence. The second volume begins with a description of the affairs towards the end of the eighteenth century, gives a detailed account of the Austrian-Turkish War, and of the insurrection which ended in the present political position of Servia. Considering the means M. de Rállay had of procuring information from all classes of the Servian society, as well as the access freely granted to the private and public archives of the Principality, and considering, further, his full acquaintance with the various Slavonian languages, I do not hesitate to rank that newest history of Servia above Ranke's and Nil Popoff's works. It is to be translated into English."

DR. BERLINER has just published the Massorah to the Targum Onkelos, from a unique manuscript. As this treatise is so very important to the study of the Chaldee paraphrases, we hope soon to review the work.

A HEIDELBERG Correspondent writes :—

"The vacancy caused in the University of Heidelberg by the death of Prof. Kochly is now definitively filled up by the appointment of C. Wachsmuth in Göttingen, son of the historian and philologist Wachsmuth, who died ten years ago at Leipzig, after having lectured for one hundred half-yearly sessions. Successors must now be found here for Prof. O. Ribbeck, who goes to Leipzig in the place of Ritschl, and for Prof. E. Kuhn, who will succeed the late Prof. Haug, in Munich, as Professor of Comparative Philology."

MESSRS. CLARK, of Edinburgh, have in preparation, with the sanction of the author, a translation of M. Janet's well-known work, 'Les Causes Finales.'

SCIENCE

The Effects of Cross and Self-Fertilization in the Vegetable Kingdom. By Charles Darwin, M.A., F.R.S. (Murray.)

It is a question worth consideration whether Mr. Darwin would have secured so wide a

hearing if he had followed the usual plan of publishing his observations and experiments first, and the deductions from them afterwards. So far as the general public is concerned, there can be no question that, whereas details are obnoxious and unintelligible to them, they are fascinated by a theory which is put before them boldly and attractively, and this although it may seem paradoxical to them, though it may arouse antagonism or run counter to long-cherished opinion or prejudice. Compare, for instance, not to go beyond the domain of botany, the reception which Linnaeus's 'Prolepsis' received from the general reader of his day with that accorded to Goethe's theory of Metamorphosis. The one was speedily appreciated, partly no doubt on account of the language in which it was written, and the wider sympathies which a man like Goethe was capable of inspiring. The other, we venture to say, is quite unknown outside the botanical world. Linnaeus built up his theory painfully and laboriously. His basis of observed fact was large, his induction laboured, obscure, and often fanciful. Goethe, on the contrary, arrived at his conclusions with the rapid perception, or, as it has been termed, the anticipation, of a poetical mind, and, after the conception, of the central idea, set himself to work to seek out illustrations in support of it. This method of procedure is obviously contrary to the rules of induction, but it cannot be said to be unfruitful. What a deformed flower was to Goethe, a deer's skull was to Oken: the one furnished a clue to the structure of plants, the other led to the discovery of the true nature of the bony framework of animals. Linnaeus's 'Prolepsis,' always a sealed book to the general reader, is now all but forgotten, even by the naturalists to whom it was professedly addressed.

Mr. Darwin was favourably known as an author for many years prior to the publication of the 'Origin of Species,' and his works in some departments of Geology and Natural History were greatly appreciated by his colleagues. They contain, however, few or no indications of the theory that has since made his name, as it were, a household word. If the analogy be not pressed too closely, it may be seen that Mr. Darwin seized the attention of the public, much in the way that Goethe did, by the enunciation of what was virtually a new theory of life and development. Of the success of the plan there can be no doubt. But while it has thus been proved to be the best, if the attention of a large circle of general readers is to be secured, it is clear that to satisfy the requirements of scientific men another course must be pursued. Goethe's Metamorphosis at first was coldly received by the botanists, not so much owing to the paucity of facts brought forward in support of the great poet's views, as to the limited area from which they were derived, and still more to the distrust which the botanists of the time felt about the competence and special knowledge of his subject possessed by Goethe, who was known as a poet, or as anything rather than a botanist.

No such doubt or mistrust can be felt in the case of Mr. Darwin. His earlier volumes and scientific papers long since furnished proof of his capacity as an observer and systematizer. Nevertheless, he has shown that he is far from thinking that his pre-

viously published memoirs furnished a basis of fact wide enough to satisfy his scientific critics. Hence we find him bringing forward, in various works, his accumulated stores of personal observations, and records of the observations of others, and marshalling them in a manner so effective for his purpose as to command the admiration even of those who doubt his conclusions. But Mr. Darwin has not confined himself to making and recording observations, he has adopted the more valuable method of direct inquiry or experiment. Of this we have already had examples in his works on Insectivorous Plants, in his papers on the Fertilization of Primroses, and now in the still more important work upon which it is our duty to offer some remarks.

Though confined to the fertilization of plants, and indeed of flowering plants, Mr. Darwin's book is really of the very widest interest, for there can be no question that, making allowance for the differences of circumstances, the same general principles apply in the case of all living creatures. The social philosopher, the statesman, and the political economist, will do well therefore to make themselves familiar with the leading results of Mr. Darwin's experiments. It may seem at first sight far-fetched, if not absurd, to bracket together the health, the welfare, and the multiplication of nations and of the human race generally, with such seemingly insignificant questions as the visits of a butterfly to a cabbage-garden, the number of peas in a pea-pod, or the size and vigour of the juvenile seedlings. It admits of no doubt, however, that the same conditions which are of vital consequence to the multiplication of plants and the production of vigorous offspring, are of equal importance in questions affecting the welfare and perpetuation of the human race. From this point of view it must be conceded that Mr. Darwin and his followers are rendering, and have rendered, practical services to humanity, beyond what the metaphysicians have ever been able to accomplish. While much even that the statesman and social reformer do is necessarily only of temporary importance, the work of the natural philosopher will be of advantage throughout all time.

Mr. Darwin's present work is mainly one of detail and statistics, so that a reviewer can do but little in the way either of criticism or analysis. It must suffice to give some general idea of its contents, and of the consequences which flow from the propositions established in it. Since the publication of the author's work on the 'Fertilization of Orchids,' it has become widely known, even amongst those who are not specially botanists, that the ripening of the seed of any particular flower and the vigour of the seedling are most perfect when fertilization is effected by pollen derived from a different flower of the same species. Some flowers, indeed, are absolutely sterile with their own pollen, though fertile when pollen from some other flower on the same individual plant is applied to them; and still more so when the farina from a blossom of another plant of the same species is employed.

Mr. Darwin has worked out in detail the peculiarities of the mechanism by means of which these results are necessarily secured. He has made known to us the facts that in some flowers the pollen is ripe at one time, the stigma and the ovules at another, and has

hence proved how necessary it is that the pollen from the one should be transported to the other description of flower. He has proved that in many cases the visits to the flowers of insects, or, it may be, of birds, are absolutely requisite to insure the full production of seed. With admirable sagacity and ingenuity he has made manifest the intimate relation between the conformation, colour, perfume, and other attributes of the flowers, and the structure and habits of the various insects which frequent them. He has shown how, in the absence of insects of the required structure, fertilization does not take place at all; how, if insects are deficient in number, the seed crop is proportionately small. In other instances he has pointed out how, in cases where the action of insects is not necessary, the flowers are wanting in the bright colours and sweet perfumes which serve to allure the winged visitors in other cases. The wind here serves as the pollen carrier, and an entirely different set of structural adaptations is consequently developed.

These adaptations are often widely different in closely allied plants. In other words, the physiological characteristics of plants closely related one to the other in point of structure are often widely diverse. On the other hand, we sometimes see whole orders characterized by the same structural adaptations. The flowers of the great order of Crucifers—the cabbage tribe—require, with few exceptions, the aid of insects to set their seeds. One exception, a very curious one, is that of the Kerguelen Island cabbage (*Pringlea antiscorbutica*). The flowers of this plant it seems are fertilized by wind-wafted pollen, a fact co-related by Mr. Darwin with the remarkable absence of winged insects in the island.

Mr. Darwin, it is true, was by no means the first or the only observer to make these facts known; but by the manner in which he has extended and systematized these observations, and the way in which he has applied them in the working out of his theory, he deserves all the credit attaching to a great and an original observer. This is shown by the influence his researches have had in stimulating the observations of his fellow naturalists. Though Sprengel and others worked in the same fields, their labour was barren in the sense that it had no influence in stimulating the researches of others.

The work before us is the complement and sequel to the author's other researches, and it is full of records of observation and of the results of direct experiments carried out with well-nigh unrivalled patience and skill for the last thirty-seven years. Of all his works, then, this, we venture to say, is the one which, apart from that in which the evolution theory was first propounded, will be longest remembered by scientific readers, and the one upon which the author's fame as a patient and careful investigator of facts will be based. It may be said to have owed its origin to some experiments carried on for another purpose. In the course of these experiments, it was observed that crossed plants of the common toad flax (*Linaria*)—that is, seedling-plants raised by means of the agency of the pollen of one flower on the ovules of a different one of the same species—were taller and more vigorous than those which were the result of self-fertilization, that is, the operation of the pollen on

the ovules of the same flower. Starting from this point, extremely numerous comparative observations were made with the care necessary to ensure accurate and strictly comparable results. These observations were in many cases followed out through ten successive generations, a fact which in itself testifies to the enormous labour and patience of the experimenter. The general results from all these observations are the same. In the great majority of cases the crossed plants yielded seeds in greater profusion, and that seed grew into healthier, more vigorous progeny than in the case of the so-called self-fertilized plants. The means by which this excess of vigour was tested was by simple measurement. The comparative weight, which of course affords a better test, was not tried in all cases, which is to be regretted. It would also be desirable in future to make some experiments as to the comparative amounts of oxygen gas evolved by the two classes of seedlings, because it is evident that the mere measurements do not by any means necessarily give an idea of the whole amount of chemical and physiological work done in the plants.

The proofs adduced of the advantages of cross-fertilization are overwhelming, and the evil effects of self-fertilization are shown to be remedied by cross-fertilization or, in other words, by the infusion of new blood.

The advantages arising from crossing do not depend merely on the commingling of the elements of two distinct individuals, but upon the circumstance that those two individuals have necessarily been exposed to different conditions of life. The progenitors of these individuals, in their turn, were exposed to varying conditions of life for ages, hence the benefit arising from a cross is, in proportion, great.

A clue is thus obtained as to the origin of sexual differences. In some of the lowest animals and plants such differences exist, if at all, only in a minor degree, but as a cross is shown to be so beneficial, so it may be assumed, on the principle of natural selection and the preservation of what has proved beneficial, that the differences between the sexes would become more and more marked, owing to the advantageous results therefrom accruing; and so in time the most complete separation of the sexes would become effected, as in cases where a structurally hermaphrodite flower is absolutely sterile with its own pollen.

It is very interesting to compare these phenomena with those of hybridism. It is generally known that mule or hybrid plants and animals are more or less unproductive and frequently completely sterile, and that if a plant's own pollen be placed on the stigma some time after foreign pollen—that is, from a distinct species—has been applied to it, any effect from the latter is quite obliterated. The phenomena which take place in the case of the crossing of different individuals of the same species, and of individuals of two separate species, are thus seen to be precisely reversed. The bearing of the inquiries which form the subject matter of this book on the doctrine of evolution is shown in the following passage:—

"The most important conclusion at which I have arrived is that the mere act of crossing by itself does no good. The good depends on the individuals which are crossed differing slightly in constitution, owing to their progenitors having

been subjected, during several generations, to slightly different conditions, or to what we call in our ignorance spontaneous variation. This conclusion . . . is closely connected with various important physiological problems, such as the benefit derived from slight changes in the conditions of life, and this stands in the closest connexion with life itself. It throws light on the origin of the two sexes, and on their separation or union in the same individual, and, lastly, on the whole subject of hybridism, which is one of the greatest obstacles to the general acceptance and progress of the great principle of evolution. The disadvantages of self-fertilization depend," continues the author, "on the two parents which are combined in the same hermaphrodite flower having a closely similar constitution. A certain amount of differentiation in the sexual elements seems indispensable for the full fertility of the parents, and for the full vigour of the offspring."

Here we must stop; the book is so crowded with facts and statistics, that it is by no means light reading, and it is by no means easy to give an adequate idea of its contents. We have said enough, we trust, to show the importance of the issues raised, and to give some idea of the way in which they have been handled.

PROF. POGGENDORF.

A REPRESENTATIVE man, whose name has been associated with the *Annalen* since 1824, has been removed from amongst us, at the ripe age of eighty-one years.

Poggendorf was born at Hamburg on the 29th of December, 1796. His first studies were carried on in that city, and his education completed in Berlin, where he became Professor of Physics in 1834. He commenced his scientific career by the publication of a paper, 'On the Magnetism of the Voltaic Pile' ('Ueber den Magnetismus der voltaischen Säule'), in 1821, in which he developed, for the first time, the principles of the application of the multiplier.

The *Annalen der Physik und Chemie* had been published by Gilbert until 1824, when Poggendorf became its editor, and rapidly gained for it the position of the first scientific journal in Germany. He undertook, in partnership with Liebig and Woehler, the publication of a chemical dictionary ('Wörterbuch der Chemie'). In 1838 Poggendorf was elected a member of the Académie des Sciences.

In 1853 Poggendorf published 'Studies to Serve for a History of the Exact Sciences,' and in 1858 he commenced the publication of a more special character, 'A Biographical, Bibliographical, and Historical Dictionary of the Exact Sciences' ('Biogr.-literarisches Handwörterbuch zur Geschichte der exacten Wissenschaften'). The scientific researches of Poggendorf were principally devoted to electricity and magnetism. He invented a galvanometer for measuring the calorific action of the current, and devised several beautiful arrangements for determining the force of the voltaic currents which corresponded with the deviations of the needle of the galvanometer, and measuring the exact force of the battery. His works on galvanic polarization and on dia-magnetism—all of which were published in his *Annalen*, which forms a series of considerably above one hundred volumes—will long preserve his name.

THE GOVERNMENT GRANT.

THE time within which applications for grants from the Government Fund were to be made has now expired, and the Committees which the Royal Society has appointed for the different branches of science are meeting to consider the requests made to them. We are glad to learn that one of the suggestions urged by this journal has been adopted. It has been decided, by a considerable majority, that it is not expedient to set the cat to look after the cream; and, consequently, any member of a section of the Committee, who applies to