THURSDAY, JUNE 1, 1882

CHARLES DARWIN[1]

III.

THE influence which our great naturalist has exerted upon zoology is unquestionably greater than that which has been exerted by any other individual; and as it depends on his generalisations much more than upon his particular researches, we may best do justice to it by taking a broad view of the effects of Darwinism on zoology, rather than by detailing those numberless facts which have been added to the science by the ever vigilant observations of Darwin. Nevertheless, we may begin our survey by enumerating the more important results of his purely zoological work, not so much because these have been rarely equalled by the work of any other zoologist, as because we may thus give due prominence to the remarkable association of qualities which was presented by Mr. Darwin's mind. This association of qualities was such that he was able fully to appreciate and successfully to cultivate every department and ramification of biological research—whether morphological, physiological, systematic, descriptive, or statistical—and at the same time to rise above the *minutiæ* of these various branches, to take those commanding views of the whole range of nature and of natural knowledge which have produced so enormous a change upon our means of inquiry and our modes of thought. 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.

Taking the purely Zoological work in historical order, we have first to consider the observations made during the voyage of the *Beagle*. These, however, are much too numerous and minute to admit of being here detailed. Among the most curious are those relating to the scissor-beak bird, niata cattle, aëronaut spiders, upland geese, sense of sight and smell in vultures; and among the most important are those relating to the geographical distribution of species. The results obtained on the latter head are of peculiar interest, inasmuch as it was owing to them that Mr. Darwin was first led to entertain the idea of evolution. As displaying the dawn of this idea in his mind we may quote a passage or two from his "Voyage of a Naturalist," where these observations relating to distribution are given:—

"These mountains (the Andes) have existed as a great barrier since the present races of animals have appeared, and therefore, unless we suppose the same species to have been created in two different places, we ought not to expect any closer similarity between the organic beings on the opposite sides of the Andes, than on the opposite shores of the ocean."

"The natural history of these islands (of the Galapagos Archipelago) is eminently curious, and well deserves attention. Most of the organic productions are Aboriginal creations, found nowhere else; there is even a difference between the inhabitants of the different islands; yet all show a marked relationship with those of America, though separated from that continent by an open space of ocean, between 500 and 600 miles in width. The archipelago is a little world within itself, or rather a satellite attached to America, whence it has derived a few stray colonists, and has received the general character of its indigenous productions. Considering the small size of the islands, we feel astonished at the number of their aboriginal beings, and at their confined range. Seeing every height crowned with its crater, and the boundaries of most of the lava-streams still distinct, we are led to believe that within a period, geologically recent, the unbroken ocean was here spread out. Hence, both in space and time, we seem to be brought somewhat near to that fact—that mystery of mysteries—the first appearance of new beings on this earth."

Next in order of time we have to notice the Monograph of the Cirripedia. This immensely elaborate work was published by the Ray Society in two volumes, comprising together over 1000 large octavo pages, and 40 plates. These massive books (which were respectively published in 1851 and 1854) convey the results of several years of devoted inquiry, and are particularly interesting, not only on account of the intrinsic value of the work, but also because they show that Mr. Darwin's powers of research were not less remarkable in the direction of purely anatomical investigation than they were in that of physiological experiment and philosophical generalisation. No one can ever glance through this memoir without perceiving that if it had stood alone it would have placed its author in the very first rank as a morphological investigator. The prodigious number and minute accuracy of his dissections, the exhaustive detail with which he worked out every branch of his subject—sparing no pains in procuring every species that it was possible to procure, in collecting all the known facts relating to the geographical and geological distribution of the group, in tracing all the complicated history of the metamorphoses presented by the individuals of the sundry species, in disentangling the problem of the homologies of these perplexing animals, &c.—all combine to show that had Mr. Darwin chosen to devote himself to a life of purely morphological work, his name would probably have been second to none in that department of biology. We have to thank his native sagacity that such was not his choice. Valuable as without any question are the results of the great anatomical research which we are considering, we cannot peruse these thousand pages of closely written detail without feeling that for a man of Mr. Darwin's exceptional powers even such results are too dearly bought by the expenditure of time required for obtaining them. We cannot, indeed, be sorry that he engaged upon and completed this solid piece of morphological work, because it now stands as a monument to his great ability in this direction of inquiry; but at the same time we feel sincerely glad that the conspicuous success which attended the exercise of such ability in this instance did not betray him into other undertakings of the same kind. Such undertakings may suitably be left to establish the fame of great though lesser men; it would have been a calamity in the history of our race if Charles Darwin had been tempted by his own ability to become a comparative anatomist.

But as we have said—and we repeat it lest there should be any possibility of misstating what we mean—the results which attended this laborious inquiry were of the highest importance to comparative anatomy, and of the highest interest to comparative anatomists. The limits of

[1] Continued from p. 75.

this article do not admit of our giving a summary of these results, so we shall only allude to the one which is most important. This is the discovery of the "Complemental Males." The manner in which this discovery was made in its entirety is of interest, as showing the importance of remembering apparently insignificant observations which may happen to be incidentally made during the progress of a research. For Mr. Darwin writes:—

"When first dissecting *Scalpellum vulgare*, I was surprised at the almost constant presence of one or more very minute parasites, on the margins of both scuta, close to the umbones. I carelessly dissected one or two specimens, and concluded that they belonged to some new class or order amongst the articulata, but did not at the time even conjecture that they were cirripeds. Many months afterwards, when I had seen in Ibla that an hermaphrodite could have a complemental male, I remembered that I had been surprised at the small size of the vesiculæ seminales in the hermaphrodite *S. vulgare*, so that I resolved to look with care at these parasites; on doing so I now discovered that they were Cirripedes, for I found that they adhered by cement, and were furnished with prehensile antennæ, which latter, I observed with astonishment, agreed in every minute character, and in size, with those of *S. vulgare*. I also found that these parasites were destitute of a mouth and stomach; that consequently they were short-lived, but that they reached maturity; and that all were males. Subsequently five other species of the genus Scalpellum were found to present more or less closely analogous phenomena. These facts, together with those given under Ibla (and had it not been for this latter genus, I never probably should have struck on the right line in my investigation), appear sufficient to justify me in provisionally considering the truly wonderful parasites of the several species of Scalpellum, as Males and Complemental Males" (vol. i. pp. 292-3).

The remarkable phenomena of sexuality in these animals is summed up thus:—

"The simple fact of the diversity in the sexual relations, displayed within the limits of the genera Ibla and Scalpellum, appears to me eminently curious. We have (1) a female, with a male (or rarely two) permanently attached to her, protected by her, and nourished by any minute animals which may enter her sac; (2) a female, with successive pairs of short-lived males, destitute of mouth and stomach, inhabiting the pouches formed on the under sides of her two valves; (3) an hermaphrodite, with from one or two, up to five or six similar short-lived males without mouth or stomach, attached to one particular spot on each side of the orifice of the capitulum; and (4) hermaphrodites, with occasionally one, two, or three males, capable of seizing and devouring their prey in the ordinary Cirripedal method, attached to two parts of the capitulum, in both cases being protected by the closing of the scuta."

With reference to these Complemental Males (so called "to show that they do not pair with a female, but with a bisexual individual") Mr. Darwin further observes: "Nothing strictly analogous is known in the animal kingdom; but amongst plants, in the Linnean class, Polygamia, closely similar instances abound;" and also that "in the series of facts now given we have one curious illustration more to the many already known, how gradually nature changes from one condition to the other, in this case from bisexuality to unisexuality" (ii. 29).

Lastly, to give only one other quotation from this work, he writes:—

"As I am summing up the singularity of the phenomena here presented, I will allude to the marvellous assemblage of beings seen by me within the sac of an *Ibla quadrivalvis*, namely, an old and young male, both minute, worm-like, destitute of a capitulum, with a great mouth and rudimentary thorax and limbs, attached to each other and to the hermaphrodite, which latter is utterly different in appearance and structure; secondly, the four or five free, boat-shaped larvæ, with their curious prehensile antennæ, two great compound eyes, no mouth, and six natatory legs; and lastly, several hundreds of the larvæ, in their first stage of development, globular, with horn-shaped projections on their carapaces, minute single eyes, filiform antennæ, probosciform mouths, and only three pairs of natatory legs. What diverse beings, with scarcely anything in common, and yet all belonging to the same species!" (i. 293).

Scattered through the "Origin of Species," the "Variation of Plants and Animals under Domestication," and the "Descent of Man," we meet with many purely zoological observations of much interest and importance as such, or apart from their bearing on the general principles and arguments for the illustration or fortification of which they are introduced. In this connection we may particularly allude to the chapters on Variability, Hybridism, and Geographical Distribution—chapters which contain such a large number of new facts, as well as new groupings of old ones, that we cannot undertake to epitomise them in a *résumé* of Mr. Darwin's work so brief as the present. Nor should we forget to mention in the present connection his experimental proof of the manner in which bees make their hexagonal cells, and of the important part played in the economy of nature by earthworms. Moreover, the hypothesis of sexual selection necessitated the collection of a large body of facts relating to the ornamentation of all classes of animals, from insects and crustacea upwards; and whatever we may think about the stability of the hypothesis, there can be no question, from a zoological point of view, concerning the value of this collection as such.

But without waiting to consider further the purely zoological results presented by the work before us, we must turn to consider the effects of this work upon zoological science itself. And here we approach the true magnitude of Darwin as a zoologist. 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 conceptions upon which the whole structure rested; and of no one can this be said with more truth than it can be said of Darwin. For although it is the case that the idea of evolution had occurred to other minds—in two or three instances with all the force of full conviction—it is no less certainly the case that the idea proved barren. Why did it prove so? Because it had never before been fertilised by the idea of natural selection. To demonstrate, or to render sufficiently probable by inference the *fact* of evolution (for direct observation of the process is from the nature of the case impossible) required some reasonable suggestion as to the *cause* of evolution, such as is supplied by the theory of natural selection; and when once this suggestion was forthcoming, it mattered little whether it was considered as propounding the only, the chief, or but a subordinate cause; all that was needed to recommend the evidence of evolution to the judgment of science was the

discovery of *some* cause which could be reasonably regarded as not incommensurate with *some* of the effects ascribed to it. And, unlike the desperate though most laudable gropings of Lamarck, the simple solution furnished by Darwin was precisely what was required to give a *locus standi* to the evidence of descent.

But we should form a very inadequate estimate of the services rendered to science by Mr. Darwin if we were to stop here. The few general facts out of which the theory of evolution by natural selection is formed—viz. struggle for existence, survival of the fittest, and heredity—were all previously well-known facts; and we may not unreasonably feel astonished that so apparently obvious a combination of them as that which occurred to Mr. Darwin should have occurred to no one else, with the single exception of Mr. Wallace. The fact that it did not do so is most fortunate in two respects—first, because it gave Mr. Darwin the opportunity of pondering upon the subject *ab initio*, and next because it gave the world an opportunity of witnessing the disinterested unselfishness which has been so signally and so consistently displayed by both these English naturalists. But the greatness of Mr. Darwin as the reformer of biology is not to be estimated by the fact that he conceived the idea of natural selection; his claim to everlasting memory rests upon the many years of devoted labour whereby he tested this idea in all conceivable ways—amassing facts from every department of science, balancing evidence with the soundest judgment, shirking no difficulty, and at last astonishing the world as with a revelation by publishing the completed proof of evolution. Indeed, so colossal is Mr. Darwin's greatness in this respect, that we doubt whether there ever was a man so well fitted to undertake the work which he has so successfully accomplished. For this work required not merely vast and varied knowledge of many provinces of science, and the very exceptional powers of judgment which Mr. Darwin possessed, but also the patience to labour for many years at a great generalisation, the honest candour which rendered the author his own best critic, and last, though perhaps not least, the magnanimous simplicity of character which, in rising above all petty and personal feelings, delivered a thought-reversing doctrine to mankind, with as little disturbance as possible of the deeply-rooted sentiments of the age. In the chapter of accidents, therefore, it is a singularly fortunate coincidence that Mr. Darwin was the man to whom the idea of natural selection occurred; for although in a generation or two the truth of evolution might have become more and more forced upon the belief of science, and with it the acceptance of natural selection as an operating cause, in our own generation this could only have been accomplished in the way that it was accomplished; we required one such exceptional mind as that of Darwin to focus the facts, and to show the method.

It seems almost needless to turn from this aspect of our subject to enlarge upon the influence which a general acceptance of the theory of descent has had upon biology. We do not state the case too strongly when we say that this has been the influence which has created organisation out of confusion, brought the dry bones to life, and made all the previously dissociated facts of science stand up as an exceeding great army. Let any one turn to the eloquent prophecy with which the pages of the "Origin of Species" terminate—a prophecy which sets forth in order the transforming effect that the doctrine of evolution would in the future exert upon every department of biology—and he may rejoice to think that Mr. Darwin himself lived to see every word of that prophecy fulfilled. For where is now the "systematist . . . incessantly haunted by the shadowy doubt whether this or that form be a true species"? And has it not proved true that "the other and more general departments of natural history will rise greatly in interest—that the terms used by naturalists, of affinity, relationship, community of type, paternity, morphology, adaptive characters, rudimentary and aborted organs, &c., will cease to be metaphorical, and will have a plain signification?" Do we not indeed begin to feel that "we no longer look at an organic being as a savage looks at a ship, as something wholly beyond his comprehension; and when we regard every production of nature as one which has had a long history, when we contemplate every complete structure and instinct as the summing up of many contrivances, each useful to the possessor, in the same way as any great mechanical invention is the summing up of the labour, the experience, the reason, and even the blunders of numerous workmen, when we thus view each organic being," may we not now all say with Darwin, "How far more interesting—I speak from experience—does the study of natural history become?" And may we not now all see that "a grand and almost untrodden field of inquiry on the laws of variation, on correlation, on the effects of use and disuse, on the direct action of external conditions" *has* been opened up; that our classifications, *have* become "as far as they can be made so, genealogies, and truly give what may be called a place of creation;" that rules of classifying *do* "become simpler when we have a definite object in view;" and that "aberrant species, which may fancifully be called living fossils," actually *are* of service in supplying "a picture of ancient forms of life?" And again, must we not agree that "when we can feel assured that all the individuals of the same species and all the closely-allied species of most genera, have, within a not very remote period, descended from one parent, and have migrated from some one birth-place; and when we better know the many means of migration, then, by the light which geology now throws, and will continue to throw, on former changes of climate and of the level of the land, we shall surely be able to trace in an admirable manner the former migrations of the inhabitants of the whole world?" And who is now able to question that "by comparing the differences between the inhabitants of the sea on the opposite sides of a continent, and of the various inhabitants on that continent in relation to their apparent means of migration, some light can be thrown on ancient geography?" Or, if we turn to "the noble science of geology," do we not see that we are beginning "to gauge with some security the duration of intervals by a comparison of the preceding and succeeding forms of life?" And last, though not least, have we not found this one short sentence so charged with meaning that a new and extensive science, second in importance to none, may be almost said to have grown out of what it states:—"Embryology will often reveal to us the structure, in some degree obscured, of the prototypes?'"

If the progress of science during the last two-and-

twenty years has in so astonishing a measure verified the prophecy of the "Origin of Species," surely, in conclusion, we are more than ever constrained to agree with the sentiments expressed by its closing words :—"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 Cambrian 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 ; and that, whilst this planet has gone cycling on according to the fixed law of gravity, from so simple a beginning endless forms most beautiful and most wonderful have been, and are being evolved."

(*To be continued.*)

ECLIPSE NOTES [1]

III.

THE eclipse of 1882 is now over, and it is not too much to say that the observations have been most successful. Much more work has apparently been done in former eclipses, but it has been of a far more general nature, and, as the old saw has it, *dolus latet in generalibus*. This year the work has put on very much more of a quantitative look, and each observation therefore more or less means a real step in advance. And indeed the time had come when this should be so, for day by day the quantity of laboratory work done which can be more or less compared with eclipse observations is increasing, and in the case of general observations either in one case or the other comparisons are impossible. I have taken many prior occasions of insisting upon this point; but perhaps the reason why this principle has been so generally acted upon on the present occasion has been a capital example set to future eclipse parties. Some days before the eclipse there was a regular Congress of the leaders of the different expeditions and the chief observers, held under the presidency of Mahmoud Pacha, the astronomer at Cairo, and not only was the general plan of observations agreed upon but the necessity of a limited field of inquiry was generally acknowledged ; hence at the moment of the eclipse each worker had only a limited part of the spectrum to study, and the instrument to be employed whatever its form, and there were many forms employed, was carefully prepared for this part, and this part only, before totality.

In the way of dispersion, MM. Thollon and Trépied outdistanced all their *confrères*, as each had the most powerful form of Thollon spectroscope yet constructed. The dispersion in this instrument is about the same as that given by a Rutherfurd grating (of 17,000 lines to the inch) in the third order, with this important difference, that the quantity of light is much greater, so that a spectrum can be much better observed. With these spectroscopes, object-glasses of 9 inches aperture, and siderostats of a simple altazimuth focus were employed. All the other spectroscopic arrangements, whether for eye or photography, were mounted on equatorial stands. The instruments employed for exposing the rapid plates, which recent progress in photographic science has placed in the hands of the astronomers, were perhaps the most complicated Thus we had a camera with large lens some 5 feet focus ; on this a slitless spectroscope of the Fraunhofer form, similar to that employed in Siam in 1875, but with a prism of greater angle in front of the object-glass then a tele-spectroscopic camera of small dispersion with small image of the sun in the slit, and last of all an ordinary camera of small focus.

Perhaps before I go further it will be convenient to give a collective note agreed upon in a second congress held two hours after the eclipse. This will show the *general* opinion as to the general results.

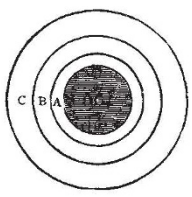
"Unprecedented facilities afforded by Egyptian Government for observation of the eclipse. The plan carried out was agreed upon by the members of the English, French, and Italian expeditions. The accord among the results is very satisfactory. Photographs of the corona and of its complete spectrum were obtained by Schuster on Abney's plates, H and K being the most intense lines. A study of the red end of the spectrum of the corona and prominences was made by Tacchini. A comet which was very near the sun, and a very striking object, was photographed and observed with the naked eye. Bright lines were observed before and after totality of different heights by Lockyer, and with intensities differing from the Fraunhofer lines by Lockyer and Trépied. An absolute determination of the place of the coronal line at 1474, of Kirchhoff's scale, was made by Thollon and Trépied. The absence of dark lines in the corona spectrum was noted by Tacchini and Thollon with very different dispersions. Many bright lines in the violet were observed in the spectrum of corona by Thollon, and were photographed by Schuster. Hydrogen and coronal lines studied in grating spectroscope by Puiseux, and in direct-vision prism by Thollon. Rings observed with grating by Lockyer, first, second and third orders. Continuous spectrum relatively fainter than in 1878, and stronger than in 1871. Intensification of absorption observed in group A at the edge of the moon by Trépied and Thollon.

"LOCKYER, TACCHINI, THOLLON."

Having given the collective note, I may be permitted to refer first to those observations which specially bear upon the matter dwelt upon in these notes—observations touching the bright lines seen before and at the moment of totality.

The importance of this part of the work arises from the following considerations :—If there be a layer of a certain height, by the absorption of which the lines of Fraunhofer are reversed, the lines visible under the stated conditions during eclipses will all be of the same height, and their intensities will all be those of the Fraunhofer lines; if, on the contrary, the reversing layer is a myth, as I believe it to be from a consideration of all the prominence and spot work done up to the present time, the lines will not be all of the same height, and the intensities will widely differ from those of the general spectrum of the sun, for the following reasons :—

As explained in my first batch of notes, it is most probable that the solar spectrum is built up of the absorption of different layers, and not of one, thus—



A, B, C, layers.

A, layer nearest the sun, and therefore hottest, and

[1] Continued from p. 52.