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SCIENTIFIC WORTHIES.

XXXVIII.—DR. ALFRED RUSSEL WALLACE,
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I N a retrospect of British biology during the "wonderful century" there stand out four men whose names will endure—Lyell, Darwin, Wallace, and Galton. The first three were closely kindred spirits whose work begins and ends a great epoch. Galton marked out his own way along quite an independent line, which will be the more appreciated the more the kinship of his ideas with those of Weismann and Mendel is recognised. Now that Wallace, the sole survivor of the group, has attained the ninetieth year of his age, and the sixty-fourth year of active service and productiveness, we may write of him in the spirit of the lines of Aristophanes: "Honour to the venerable man who, in the declining vale of years, continues to learn new subjects and add to his wisdom."

The distinction of endurance came to Lyell and Wallace through the readiness of each to grasp an opportunity in a revolution of thought such as can never recur, through a continued line of attack by precisely similar methods of reasoning over an extremely broad field. When Lyell faltered, Darwin and Wallace went on. As to the closeness of the intellectual sequence between these three men, those who know the original edition of the second volume of "The Principles of Geology," published in 1832, find it the second¹ biologic classic of the century, on which Darwin, through his higher and much more creative vision, built up his "Journal of Researches." Lyell and Darwin may be said to have united in guiding the mind of Wallace, because the young naturalist, fourteen years the junior of Darwin, took the works of both his seniors with him on his journey to South America, in which his career fairly began. From his observations during twelve years of life in the tropics, he will be remembered not only as one of the independent discoverers of the theory of natural selection, but next to Darwin as one of the great naturalists of the century. His range and originality are astounding in these days of specialism. His main lines of thought, although in many instances suggested somewhat suddenly, were

¹ Lamarck's "Philosophie Zoologique," published in 1809, may be regarded as the first biologic classic of the century.

developed and presented in a deliberate and masterly way through a series of papers and books.

Nature and nurture conspire to form a naturalist. Predisposition, an opportune period, and a happy series of events favoured Alfred Russel Wallace. He was born January 8, 1823, in Usk, Monmouthshire, of remote Scotch and Huguenot and of immediate English ancestry. His school life was uninspiring, and he feels that he owed more of his real education to the cultivating influence of his home in Hertford. At sixteen we find him as a land surveyor in Bedfordshire, also making his first observations on plants, and these early and serious studies in botany, continuing for four years, prepared him for the plant wonders of the tropics. At the age of twenty-one he came to London. He afterward regarded his difficulty in obtaining employment as the first turning point in his career, "for otherwise," he writes, "it seems very unlikely that I should ever have undertaken what at that time seemed rather a wild scheme, a journey to the almost unknown forests of the Amazon in order to observe nature and make a living by collecting." He also gives us, in his autobiographic volumes of 1905, "My Life, A Record of Events and Opinions," an interesting sketch of his state of mind at this time.

"I do not think that at this formative period I could be said to have shown special superiority in any of the higher mental faculties, but I possessed a strong desire to know the causes of things, a great love of beauty in form and colour, and a considerable but not excessive desire for order and arrangement in whatever I had to do. If I had one distinct mental faculty more prominent than another it was the power of correct reasoning from a review of the known facts in any case to the causes or laws which produced them, and also in detecting fallacies in the reasoning of other persons."

The parallel between Wallace's intellectual tendencies and environment and those of Charles Darwin is extraordinary. They enjoyed a similar current of influence from men, from books, and from nature. Thus the second turning point in the life of Wallace was his meeting with Henry Walter Bates, through whom he acquired his zest for the wonders of insect-life which opened for the first time for him the zoological windows of nature. It is noteworthy that the greater and most original part of his direct observations of nature were upon the adaptations of insects. Both naturalists fell under the spell of the same

books, first and foremost those of Lyell, as noted above, then of Humboldt in his "Personal Narrative" (1814-18), of Robert Chambers in his "Vestiges of the Natural History of Creation" (1844), of Malthus in his "Essay on the Principle of Population" (1798). It was, however, Darwin's own "Journal," published in 1845, and read by Wallace at the age of twenty-three, which determined him to invite Bates to accompany him on his journey to the Amazon and Rio Negro, which filled the four years 1848-52. In this wondrous equatorial expanse, like Darwin, he was profoundly impressed with the forests, the butterflies, and birds, and with his first meeting with man in an absolute state of nature. Bates, himself a naturalist of high order, was closely observing the mimetic resemblances among insects to animate and inanimate objects and introducing Wallace to a field which was subsequently made his own. Bates remained several years after Wallace's departure, and published his classical memoir on mimicry in 1860-61.

Wallace's "Narrative of Travels on the Amazon," published in 1853 when he was thirty years of age, does not display the ability of his later writings, and shows that his powers were slowly developing, to reach maturity during his eight years of travel between 1854 and 1862 in the Indo-Malay islands, the Timor Group, Celebes, the Moluccas, and the Papuan Group. It is apparent that his prolonged observations on the natives, the forests, the birds, and mammals, and especially on the butterflies and beetles, were gradually storing his mind for one of those discharges of generalisation which comes so unexpectedly out of the vast accumulation of facts. "The Malay Archipelago" of 1869, published seven years after the return, is Wallace's "Journal of Researches." Its fine breadth of treatment in anthropology, zoology, botany, and physiography gives it a rank second only to Darwin's "Journal" in a class of works repeatedly enriched by British naturalists from the time of Burchell's journey in Africa.

Wallace's first trial at the evolution problem was his essay sent to the *Annals and Magazine of Natural History* in 1855, entitled "On the Law Which has Regulated the Introduction of New Species." This paper suggested the *when* and *where* of the occurrence of new forms, but not the *how*.

"It has now been shown," he concludes, "though most briefly and imperfectly, how the

law that 'Every species has come into existence coincident both in time and space with a pre-existing closely allied species,' connects together and renders intelligible a vast number of independent and hitherto unexplained facts."

In February, 1858, during a period of intermittent fever at Ternate, the *how* arose in his mind with the recollection of the "Essay" of Malthus, and there flashed upon him all the possible effects of the struggle for existence. In two days the entire draft was sketched and posted to Darwin, who had been working upon the verification of the same idea for twenty years. The noble episode which followed of the joint publication of the discovery was prophetic of the continued care for truth and carelessness of self, of the friendship, mutual admiration, and cooperation between these two high-minded men, which affords a golden example for our own and future ages. Each loved his own creations, yet undervalued his own work; each accorded enthusiastic praise to the work of the other.

This discovery again turned the course of Wallace's life. In his autobiography he writes:—

"I had, in fact, been bitten with the passion for species and their description, and if neither Darwin nor myself had hit upon 'natural selection,' I might have spent the best years of my life in this comparatively profitless work, but the new ideas swept all this away. . . . This . . . will perhaps enable my readers to understand the intense interest I felt in working out all these strange phenomena, and showing how they could almost all be explained by that law of 'Natural Selection' which Darwin had discovered many years before, and which I also had been so fortunate as to hit upon."

It is a striking circumstance in the history of biology that Wallace's rapidly produced sketch of 1858 "On the Tendencies of Varieties to Part Indefinitely from the Original Type" not only pursues a line of thought parallel to that of Darwin, except in excluding the analogy of natural with human selection, but embodies the permanent substance of the selection theory as it is to-day after fifty-four years of world-wide research. It may be regarded as his masterpiece. The attempt has been made by De Vries and others to show that Wallace in his "Darwinism" of 1889 differed from Darwin on important points, but whatever may be true of this final modification of the theory, a very careful comparison of the Darwin-Wallace sketches of 1858 shows that they both involve the principle

of discontinuity; in fact, fluctuation in the sense of plus and minus variation was not recognised at the time; the notion of variation was that derived directly from field rather than from laboratory notes.

The distinctive features of the later development of the theory in Wallace's mind were his more implicit faith in it, his insistence on utility or selection value, his rejection of Lamarckism, his dependence on spontaneous variations as supplying all the materials for selection. This confidence appears in the following passages from his militant reply in the volume of 1889 to the critics of Darwinism:—"The right or favourable variations are so frequently present that the unerring power of natural selection never wants materials to work upon. . . . The importance of natural selection as the one invariable and ever-present factor in all organic change and that which can alone have produced the temporary fixity combined with the secular modification of species." The principle of discontinuity is less clearly brought out; the selection of fluctuation is favourably considered. The laws and causes of variation are, however, assumed rather than taken up as a subject of inquiry. These opinions of 1889 were the summation of twenty-nine years of work.

The colouring of animals as observed in the tropics and the Malayan Islands was the subject in which Wallace made his most extensive and original contributions to Darwinism. Returning from the Archipelago in 1862, he published in 1864 his pioneer paper, "The Malayan Papilionidæ or Swallow Tailed Butterflies, as illustrative of the Theory of Natural Selection," in which he at once took rank beside Bates and Müller as one of the great contributors to the colour characteristics of animals. We see him step by step developing the ideas of protective resemblance which he had fully discussed with Bates, of alluring and warning colours, and of mimicry, pointing out the prevalence of mimicry in the female rather than in the male. The whole series of phenomena are believed to depend upon the great principle of the utility of every character, upon the need of colour protection by almost all animals, and upon the known fact that no characteristic is so variable as colour, that, therefore, concealment is most easily obtained by colour modification. Protective resemblance in all its manifold forms has ever been dominant in his mind as a greater principle than that of the sexual selection of colour which Darwin favoured.

NO. 2224, VOL. 89]

In 1867 Wallace advanced his provisional solution of the cause of the gay and even gaudy colours of caterpillars as warnings of distastefulness in a manner which delighted Darwin; in 1868 he propounded his explanation of the colours of nesting birds, that when both sexes are conspicuously coloured, the nest conceals the sitting bird, but when the male is conspicuously coloured and the nest is open to view, the female is plainly coloured and inconspicuous. His theory of recognition colours as of importance in enabling the young of birds and mammals to find their parents was set forth in 1878, and he came to regard it as of very great importance. In "Tropical Nature" (1878) the whole subject of the colours of animals in relation to natural and sexual selection is reviewed, and the general principle is brought out that the exquisite beauty and variety of insect colours has not been developed through their own visual perceptions, but mainly and perhaps exclusively through those of the higher animals which prey upon them. This conception of colour origin, rather than that of the general influence of solar light and heat or the special action of any form of environment, leads him to his functional and biological classification of the colours of living organisms into five groups, which forms the foundation of the modern more extensive and critical classification of Poulton. Twelve years later he devoted four chapters of his "Darwinism" to the colours of animals and plants, still maintaining the utility, spontaneous variation, and selection theory.

The study of geographic distribution of animals also sprang from the inspiration of the Malayan journey and from the suggestiveness of the eleventh and twelfth chapters of "The Origin of Species" which Wallace determined to work out in an exhaustive manner. Following the preliminary treatises of Buffon, of Cuvier and Forbes, and the early regional classification of Sclater, Wallace takes rank as the founder of the science of zoogeography in his two great works, "The Geographical Distribution of Animals" of 1876, and "Island Life" of 1881, the latter volume following the first as the result of four years of additional thought and research. His early observations on insular distribution were sketched out in his article of 1860, "The Zoological Geography of the Malayan Archipelago." Here is his discovery of the Bali-Lombok boundary line between the Indian and Australian zoological regions which has since been generally known by his name.

In these fundamental works Wallace appears as a disciple of Lyell in uniformitarianism, and a follower of Dana as regards the stability and permanence of continental and oceanic areas, for which he advances much original evidence. He taxes his ingenuity to discover every possible means of dispersal of animals and plants other than those which would be afforded by hypothetical land connections; he considers every possible cause of extinction other than those which are sudden or cataclysmal. "Island Life" is in itself a great contribution, the starting point of all modern discussion of insular faunas and floras. The conservative theory of dispersal is applied in an original way to explain the arctic element in the mountain regions of the tropics, as opposed to the low-temperature theory of tropical lowlands during the Glacial Period; his explanation is founded on known facts as to the dispersal and distribution of plants, and does not require the extreme changes in the climate of tropical lowlands during the Glacial Period on which Darwin founded his interpretation. The causes and influence of the Glacial Epoch are discussed in an exposition of Croll's theory. In this connection may be mentioned one of Wallace's original geological contributions, in the article "Glacial Erosions of Lake Basins," published in 1893, namely, his theory of glacial erosion as a means of explaining the origin of valley lakes of glaciated countries.

The natural trend of Wallace's thought as to the ascent of man is first shown in the three anthropological essays of 1864, 1869, and 1870, contained in the volume "Contributions to the Theory of Natural Selection." This work, published in 1871, includes all his original essays from 1855 to 1869 on selection, on colour, and human evolution, which foreshadow the later development of his speculative philosophy. In his article of 1864, "The Development of Human Races under the Law of Natural Selection," he first pointed out that so soon as man learned to use fire and make tools, to grow food, to domesticate animals, to use clothing, and build houses, the action of natural selection was diverted from his body to his mind, and thenceforth his physical form remained stable, while his mental faculties improved. His subsequent papers, "The Elements of Natural Selection as Applied to Man" of 1869, "On Instinct in Man and Animals" of 1871, mark the gradual divergence of his views from those of Darwin, for in his opinion natural selection is believed to be inadequate

to account for several of the physical characteristics of man, as well as his speech, his colour sense, his mathematical, musical, and moral attributes. Here is found the opinion that a superior intelligence is guiding the development of man in a definite direction and for a definite purpose, which finds final expression in the largely metaphysical volume of 1911. It is also prophetic of later thought that we find at the end of the closing pages of "The Malay Archipelago" the first statement of the feeling which so many travellers have experienced from a comparison of the natural and so-called civilised condition of man that "social evolution from barbarism to civilisation" has not advanced general human welfare. These humanitarian and partly socialistic ideas are developed in a series of recurrent essays between 1882 and 1903, including "The Nationalisation of Land," and "Studies Scientific and Social."

Our perspective has covered a long, honourable span of sixty-five years into the beginnings of the thinking life of a natural philosopher whose last volume, "The World of Life," of the year 1911, gives as clear a portrayal of his final opinions as that which his first essay of 1858 affords of his early opinions. We follow the cycle of reflection beginning with adaptation as the great problem, adaptation as fully explained by selection, and closing with adaptation in some of its phases as entirely beyond human powers of interpretation, not only in the evolution of the mind and spiritual nature of man, but in such marvellous manifestations as the scales of butterflies or the wings of birds. From our own intellectual experience we may sympathise with the rebound of maturity from the buoyant confidence of the young man of thirty-five who finds in selection the entire solution of a problem which has vexed the mind and aroused the scientific curiosity of man since the time of Empedocles. We have ourselves experienced a loss of confidence with advancing years, an increasing humility in the face of transformations which become more and more mysterious the more we study them, although we may not join with this master in his appeal to an organising and directing principle. Younger men than Wallace, both among the zoologists and philosophers, of our own time have given a somewhat similar metaphysical solution of the eternal problem of adaptation, which still baffles and transcends our powers of experiment and of reasoning.

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