MR. WALLACE'S *ISLAND LIFE*.[1]

EVERY great scientific theory passes through two stages, the inductive and the deductive. First of all it is built up by an accumulation of facts and inferences: the facts are traversed, the inferences are disputed, and a great battle rages over its general acceptance. But as time goes on, the induction becomes complete; assailants are won over, or silenced, or else die off; a younger generation is brought up in the new faith; and the doctrine passes at length as an ascertained truth into its deductive stage. Henceforth, instead of being fought over, it becomes an accepted principle for the interpretation of other facts in nature. Such has been the history of the Copernican theory, the Newtonian law of gravitation, and the Daltonian theory of atoms: such in our own time is the history of Mr. Darwin's hypothesis of natural selection, and Mr. Herbert Spencer's theory of evolution. Practically speaking, no biologist of note now refuses to believe in the development of all living plants and animals from one or more simple original types. Even our bishops hint a possible acceptance, and hesitate a mild dissent only as to certain real or supposed implications. As everybody quietly swallowed geology fifty years since, and yet compounded for Genesis, so everybody is quietly swallowing evolution to-day, and yet compounding for other equally irreconcilable beliefs. At any rate, the scientific world has long since got beyond the stage of arguing over Darwinism, and has taken the wiser and more fruitful course of applying Darwinian principles to the explanation of hitherto unsolved biological problems. Mr. Wallace was one of the first writers who thus abandoned the barren field of disputation for the real work of extending and tracing the consequences of the new discovery. From the moment when the great secret of natural selection first flashed upon his mind in the Malay Archipelago, as it had flashed upon Mr. Darwin's mind years before on reading Malthus, he has, apparently, had no doubts as to the final triumph of the truth. It was inevitable that in the end fresh facts and new explanations must break down the resistance of the old school; so instead of troubling himself by adding further arguments to the vast accumulation gathered by Mr. Darwin, he set himself to employ the evolutionist hypothesis, one of whose authors he might fairly claim to be, in the deductive explanation of zoological and botanical distribution. The results of his work he has already given us in more than one form: and his new volume on *Island Life* contains his latest views on the subject set forth in a clear and popular

(1) *Island Life*. By Alfred Russel Wallace. Macmillan & Co. 1880.

manner which should make them accessible to many readers who would not venture on the perusal of his more strictly scientific expositions. Moreover, the limitation of his subject in his new work to the special case of islands allows him to deal with those minor differences which are classed as specific merely; while his former volumes were restricted to the wider differences which characterize genera. Thus *Island Life* is essentially a new work, both as containing many later and more matured views, and as treating of a comparatively fresh and more limited area. Mr. Wallace has written nothing more clear, more masterly, or more convincing than this delightful volume.

Evolution is the key to distribution. Every great type must have originated in some particular spot, under the influence of certain special conditions: and from that spot it must have dispersed itself in various directions, according to the means of transport, and have undergone greater or less modifications to suit its altered habitats. At a very remote period, perhaps up to the dawn of the Eocene, Europe and Asia were peopled by no mammals except marsupials, like the kangaroo and the opossum. At that period, Australia had some land communication with the rest of the world, and it thus acquired a population including these marsupials, then probably the foremost type of animals upon the earth. At the beginning of the tertiary epoch, a new and higher type of mammals, the placental, appeared upon the scene in the great eastern continent, and soon wholly overran it. Splitting up first into sundry primary groups of hoofed and hoofless creatures, it shortly produced all the various races of ruminants, horses, elephants, carnivores, insectivores, rodents, and apes, which spread rapidly over the whole extent of Europe, Asia, Africa, and America. These placental mammals quickly lived down the less specialised and developed marsupials, of whom the opossums in America at last remained the sole representatives on either great continent. But before the rise of the placental group, Australia had become insulated from the neighbouring lands, with which it has never since had any direct connection. Accordingly, the higher mammals never reached Australia at all, till a few of them were carried there by man—the dingo by the black fellows; the horse, cow, and sheep by the European colonists. But on the other hand the marsupials had room to develop into numerous special forms, such as the kangaroos, the Tasmanian devil, and the wombats; because they were not kept down as in Asia and America by the competition of superior types. Thus the mere peculiarities of the Australian fauna sufficiently show us that Australia has never been united with Asia since the rise of the placental mammals—that is to say, at latest, since the end of the Cretaceous period, and probably far earlier: for if it had been so united, we know that some of

these superior forms must have invaded it, with the probable result of exterminating its native marsupials.

This familiar instance may be taken as typical of the class of questions with which Mr. Wallace undertakes to deal. It sufficiently exemplifies the two main elements in the problem, of which one is biological and the other physical; the latter, of course, being at present most in need of explanation. But the physical question, again, depends mainly upon the changes undergone by our earth in past times. We have to consider, not merely the existing distribution of land and water, of polar ice and tropical forest, of glaciated mountains and warm ocean currents, but also their previous distribution throughout the whole history of our earth. To recur once more to the example of Australia: if that great isolated land had ever been joined to the mainland of Asia since the beginning of the tertiary period, then we should find it now inhabited by mammals of the common Asiatic types. On the other hand, if it had ever been wholly submerged at any one time since the date of its separation, we should find it wholly devoid of land mammals, such as the kangaroo and the other marsupials. The old-fashioned geologists would have led us to suppose that Australia had been sunk bodily beneath the ocean half-a-dozen times in that interval, and had been joined again sometimes to a great Antarctic continent, sometimes to South America, sometimes to Asia, sometimes perhaps to some vast mountain region now buried beneath five miles' depth of the Pacific. But if this were so, the fauna of Australia would be wholly different from what it is at the present day. We should find in it fragments of all the other faunas which were once able to invade it: instead of which we find a very ancient, very peculiar, and wholly endemic fauna, having no resemblance to anything which has existed in any other country since the later Eocene age. Thus the existing distribution of organic forms is at once a clue to the former distribution of land and water, and itself a result of that distribution. We can infer the cause from the effect; though we are often able to bring up independent evidence which forcibly strengthens and confirms our inferences.

Everything then depends upon the question whether, in the past, continents and oceans have had anything like permanence, or whether they have been in that perpetual state of flux and interchange which the old geologists imagined. If a deep sea now and then occupies the site of the eastern continent, from England to Japan; if a vast mainland occasionally bridges over the Pacific from China to Patagonia; if an open ocean often fills up the north temperate region, while a system of continents gathers around the south pole—then, of course, the task of tracing out the interactions between organic evolution and geographical features would be impossible. But we have

seen already that in the case of Australia the fauna itself sufficiently points out the true facts of geological history: and the faunas and floras of the larger continents also tell a similar though slightly varied tale. Mr. Wallace, however, does not rely entirely or even mainly upon arguments of this nature. He shows by several independent lines of reasoning that the present distribution of land and water approximately represents the distribution throughout an immense period of past time, at least ever since the opening of the secondary epoch. It is true that the earliest secondary deposits are quite modern in age, compared with the whole lapse of time since the first evolution of life upon the earth; but then, we are little concerned with the distribution of those lower and chiefly marine forms of life which existed almost alone in the long primary epoch; while we are greatly interested in the higher and chiefly terrestrial forms which first appear in the secondary and tertiary epochs—the birds, mammals, and flowering plants. Mr. Wallace himself believes that the continents have always existed since palæozoic times, in a circle around the North Pole, with three southward extensions, as at present: but he thinks they have undergone a constant development, which only reached its full form at the glacial period. Hence the real and practical question for our present purpose resolves itself into this—what evidence have we of the comparative permanence of our oceans and continents throughout the secondary and tertiary epochs?

To this question Mr. Wallace has always given satisfactory answers, which he now recapitulates and strengthens by further arguments. The continents which we see at the present day have probably almost always occupied much the same positions as those which they occupy in our own time. It is true every part of them has at one time or other been under water; but still these submerged parts were, nevertheless, high submarine banks lying in the immediate neighbourhood of dry land. They were, in fact, parts of continental bosses, slightly depressed beneath sea-level. It seems likely that from a very early period the three great oceans—Atlantic, Pacific, and Indian—have filled the same deep hollows in which they now lie. It seems equally probable that two or three great masses of land, compactly grouped around the North Pole, and tapering towards the south, sometimes united and sometimes separated by shallow seas, but always essentially connected with one another, have almost invariably occupied the positions now held respectively by Europe, Asia, and North Africa, by South Africa, and by North and South America. Even Australia seems to have been relatively constant in position ever since the beginning of the Eocene age, and probably far earlier. It should be added, however, that Mr. Wallace alleges

reasons for believing in the permanence of the actual continents even in palæozoic times.

Around all our existing continents there runs a belt of shallow water about 100 fathoms deep. Sometimes this belt stretches only 20 miles from the shore; more often it extends 100 miles; and in a few cases it forms a long bridge of several hundred miles between one continent and another. The depth of 1,000 fathoms, marking what may fairly be called deep sea, sometimes approaches within 30 miles of the actual coast, and sometimes recedes to 100 miles or more. The shallow ledge which thus fringes and often unites mainlands may be regarded as in reality a submerged or non-emerging portion of the continent. Now, the dredgings of the *Challenger* have shown that sedimentary deposits, consisting of detritus from the land, are only collected as a rule within about 50 or 100 miles of the coast, the finest mud being rarely carried to a distance of 150 or 200 miles. Beyond this point the ocean bed is covered with sediment of purely organic origin, consisting of small siliceous and calcareous shells. Hence it follows that by far the larger part of all stratified deposits, and certainly all those containing sand, pebble, or visible fragments of rock, must have been formed within 50 or 100 miles of then existing continents, or else in inland seas, receiving the waters of great rivers. But such rocks—sandstones, limestones, conglomerates, and shales—occupy the centre of all our great continents; and they were probably, therefore, deposited either in arms of the ocean, like the Mediterranean and the Red Sea, or in vast inland lakes, like the Caspian. Professor Geikie has already pointed out the arguments in favour of the littoral origin of the palæozoic rocks; and Professor Ramsay's inaugural address to the last meeting of the British Association points in the same direction. Mr. Wallace adds several fresh arguments of like implication. Even as regards the chalk, generally represented as a typical deep-sea deposit, he shows that its chemical composition differs considerably from that of the modern oceanic globigerina ooze; while similar ooze from coral reefs and other shallow places resembles it much more closely. Dr. Gwyn Jeffreys, one of our leading authorities on the mollusca, declares that the chalk fossils are distinctly shoal water forms. Moreover, even the chalk is found only in a comparatively restricted belt of Europe, from Ireland to the Crimea, and from Southern Sweden to Bordeaux. The sea in which it was formed was, therefore, probably an earlier and somewhat larger Mediterranean, extending across Central Europe, and bounded by the Scandinavian Highlands, Russia, Austria, and South Germany, and the south of France. In like manner the large number of fresh-water and shore deposits found in all countries also proves the comparative permanence of the great land areas.

The permanence of oceans, even more important, perhaps, in its implications than the converse truth, is shown by equally cogent arguments. As Mr. Darwin remarks, hardly one truly oceanic island possesses even a fragment of palæozoic or secondary formations—a fact which clearly proves that the ocean bed from which they have been elevated has never at any time formed part even of the littoral belt surrounding a continent. Had continents or continental islands ever existed in their neighbourhood, they would almost certainly have produced sedimentary deposits, as we know them to have done and to be still doing in the littoral belt of existing lands. Moreover, the deposits now being formed in the deep seas are wholly different from anything to be found in the formations which compose our continents.

Thus we find that our existing distribution of land and sea has persisted in the main throughout all time. But endless changes of detail have taken place from age to age; and upon these changes the distribution of animals and plants depends. Mr. Wallace will have nothing to do with those cheap and easy explanations which consist in running up a hypothetical continent across the bed of a vast ocean whenever you wish to account for any quite modern peculiarity of distribution. He refuses to bridge over the Pacific merely in order to explain the presence of tapirs in Sumatra and in Brazil; he demurs to the invention of a lost Lemuria between Madagascar and the Deccan, simply because some South Indian species resemble some Madagascar types; and he will not consent to manufacture a road from New Zealand to the Cape and to South America, for no better reason than because struthious birds are found at the present day in all three of them, and in no intermediate region. His wide grasp of facts, geological, palæontological, and biological, enables him to frame hypotheses which are less simple, it is true, but which have the merit of explaining all the facts instead of being contradicted by nine-tenths of them. He knows that ancestral tapirs once ranged in every country from Sumatra to Paris, and from Paris to North America; that ancestral ostriches swam about in the Western States or roamed over the plains of England; and that we can more easily explain the similarities of Indian and Madagascar species by other known principles than by such a clumsy and false expedient as that of a Lemuria, whose fauna is not to be found in any of its supposed existing fragments, Bourbon and Mauritius.

Passing on to the problem of geological climates, so closely connected with the distribution and dispersal of plants and animals, Mr. Wallace arrives at conclusions which are, perhaps, somewhat more doubtful, certainly more opposed to received opinions, yet which seem conclusively reasoned out. It has for some time been

acknowledged that certain recurring astronomical conditions of our planet help us largely to account for those great changes of climate which we know to have often occurred in geological time: and it has usually been held as a corollary to this opinion, that glacial epochs in the northern and southern hemispheres respectively must recur at certain fixed though irregular periods. Dr. Croll has pointed out that a particular combination of astronomical revolutions —the precession of the equinoxes and the motion of the aphelion— brings about a change of position in a cycle of 10,500 years, so that the hemisphere which at the beginning of that period had winter in perihelion at the end has it in aphelion. At the present moment this cause probably accounts in great part for the difference between the climate of the two hemispheres: for the north has now a somewhat shorter and warmer winter than the south. But the eccentricity of the earth's orbit itself also varies largely and irregularly, though very slowly; and it is calculated that when the eccentricity is highest the differences in temperature brought about in either hemisphere by the cycle in question would be very much intensified. Dr. Croll points out that such a period of high eccentricity began about 250,000 years ago, and reached its maximum 210,000 years ago. He believes that the last glacial epoch, which formed the ice-worn boulders and moraines of our Welsh and English hills, began at this period of high eccentricity, and continued intermittently in either hemisphere with each cycle of 10,500 years, down to some 80,000 years since, warm interglacial periods occupying the intervals. This theory has been pretty generally accepted by all scientific men. But Dr. Croll also believes that similar glacial periods have probably occurred with each irregular period of high eccentricity. He even points out the probability that an ice age, far more severe than that with whose remains we are so familiar, occurred about 850,000 years ago, and coincided with some part of the Miocene period. To this latter portion of Dr. Croll's argument Mr. Wallace demurs. Accepting the general theory that the last glacial epoch was due in the main to a period of high eccentricity, he denies that every such period necessarily produces an ice age.

Mere astronomical changes are not in themselves sufficient to account for the climatic peculiarities of glacial epochs. Mr. Wallace shows that glaciation can only take place when the circumstances allow large accumulations of ice and snow. Such accumulations require high land at or near the poles. He then examines the tertiary formations of Europe, and points out that they contain no large deposits of presumably glacial origin, but that, on the contrary, they involve almost without exception the prevalence of a comparatively warm and almost tropical climate throughout the whole long period in which they were deposited. The Arctic flora

of tertiary and secondary times was also of a temperate character. Putting all the evidence together, he urges that since the Permian period, at least, the climate of Northern Europe and America was uninterruptedly warm (up to the last ice age), while that of the Arctic regions was comparatively mild. The last glacial epoch he believes to have been an exceptional phenomenon, due to the rise of much high land about the pole, coincidently with the coming on of a period of high eccentricity. On the other hand, the warm Arctic climates which prevailed throughout the secondary and tertiary ages, he attributes to the existence of an open polar sea, with currents of hot water setting towards it from the equatorial oceans. If this view be true—and it is enforced by all that wide and minute knowledge of facts in every department of science which is Mr. Wallace's speciality—we must in future regard geographical conditions as far more important than astronomical in producing alterations of climate. The alternate warm and cold spells supposed of necessity to accompany periods of high eccentricity need now only be expected in cases where special features of polar geography synchronize with unusual distance from the sun in winter.

In the second half of Mr. Wallace's work, the general principles of biological distribution are particularly applied to the special case of islands, which allow of detailed treatment impossible in wider stretches of land. Islands may be grouped in two great classes, oceanic and continental. The former are those which have never at any time formed part of any continent, and which, therefore, possess no indigenous terrestrial mammals. The latter are those which have once been united with the adjacent mainland, and which, therefore, possess the same general type of fauna and flora, more or less profoundly modified by local conditions in rough proportion to the length of time during which they have been isolated.

Oceanic islands are of volcanic or coralline formation, and contain few or no old sedimentary deposits. Their fauna and flora have been wafted to them over sea, and are, therefore, mere fragments of those which exist in the nearest mainland. Birds and flying insects form their chief animal inhabitants, because they can be carried out to sea for long distances on their own wings during heavy gales. Land snails, borne in the egg or in crevices of wood, are also common. On the other hand, mammals and amphibia are wholly wanting. Plants, whose seeds or spores can be readily borne by wind or waves, are comparatively abundant. The degree of local modification which the species have undergone in their new homes depends mainly on three conditions—the length of time during which the islands have existed; the frequency of fresh arrivals to keep up the purity of the old types; and the peculiarities

of the surface and other productions, reacting upon the various species.

In the Azores, we have an instance of an oceanic archipelago, where most species have remained fairly true to their original continental forms. Lying about nine hundred miles west of the Portuguese coast, they possess an indigenous fauna of wholly European character, only slightly modified in a few unimportant particulars. It consists of birds, insects, and land shells. Most of the birds are waders or swimmers; of the remainder, all but three are common European and North African species. Two out of the three exceptions belong to Madeira and the Canaries; while one, the Azorean bullfinch, is peculiar to the islands. Thus, a single bird alone has varied enough from its ancestral type to be considered as a separate species. The reason for this relative fixity of type is that the Azores lie in the belt of storms, and that stragglers from Europe arrive in the islands almost every season. The one species which has varied is the bullfinch, which does not migrate, and is, therefore, less likely to be blown out to sea. Among the insects, the butterflies are almost all European; but twenty-three beetles out of two hundred and twelve are peculiar to the islands, while a few others belong by origin or affinities to South America, to the Canaries, and even to Madagascar. As beetles must be reinforced by fresh individuals of their own species far less frequently than birds or butterflies, the greater divergence among them is perfectly natural. Lastly, land snails, which have least power of dispersal of all, show the largest amount of local peculiarity, nearly half being found in no other place. The Bermudas stand to America in much the same relation as the Azores to Europe, and their fauna and flora display almost exactly analagous features. Lying two hundred miles nearer the mainland, however, the chances of stray birds arriving from time to time are even greater than in the Azores; and so all the birds without exception belong to American species. The insects, too, remain true to type; but there are four peculiar snails and two ferns which have sufficiently altered to rank as separate kinds. These two insular groups are examples of recent oceanic islands, only just beginning to possess a peculiar fauna and flora of their own, and prevented from doing so more rapidly (if at all) by the great facilities which exist for intercourse from the continent.

The Galapagos Islands stand nearer to South America than do either of the previous groups to their nearest mainland. But they are probably of older formation, and they lie within the stormless equatorial belt. Hence their fauna and flora are far more peculiar. There are two large tortoises, derived from America, but now quite distinct from any American kind; and five lizards, three of which differ specifically from their ancestors, while two have so far diverged

as to be accounted separate genera. Among the birds, we find every gradation of difference, from those which are perfectly identical with continental species, to those which have varied widely enough to be classed as generically distinct; and this diversity bears an obvious relation to the facilities which each original species possesses for migration to the islands. The insects and land-shells are mostly peculiar; while a still larger number of the plants have adapted themselves to their new situation, sometimes out of all knowledge of their ancestors.

Continental islands differ in several important respects from those of oceanic origin. They are more varied in geological features, containing ancient and modern stratified rocks, and they always possess at least some terrestrial mammals. Recent continental islands, like Great Britain, are situated on submerged banks, connecting them with the mainland: they resemble the continent in their geological structure; while their fauna and flora are identical with those of the neighbouring mainland, or differ very slightly from them. Our own country forms, perhaps, the best example of this class. It possesses a modest mammalian fauna, identical with that of northern Europe, as far as it goes, but much poorer; while in reptiles and amphibia it is even more deficient. One of our birds, however, the red grouse, is decidedly peculiar; and two other varieties, the coal-tit and long-tailed tit, are sufficiently different to be ranked by competent authorities as separate species. Among fresh-water fish we have no less than fifteen kinds peculiar to Britain; and some of these have very restricted areas, being only found in one or two Scotch or Irish mountain lakes. This strong tendency to local variation is due to the difficulty or impossibility of intercourse between the inhabitants of one tarn and another. A good many insects are held to be more or less specifically British, and there are certainly a great number of marked varieties. These incipient differences are most noticeable in the outlying islands, such as the Isle of Man and the Shetlands. Among the mollusca, Ireland has a slug and a snail found nowhere else. Altogether, Mr. Wallace shows by a most exhaustive survey of the British fauna, that though it is still in the main identical with that of the continent, a considerable amount of variation already exists, and shows itself most markedly in the most isolated situations, or among the most scattered groups of organisms. Borneo and Java, though perhaps no older than Britain, display the same peculiarities even more distinctly, owing in part to the greater richness of tropical life, but still more, no doubt, to their wider separation from the adjacent continent.

Perhaps the most wonderful specimen of ingenious reasoning in the whole book is contained in the singularly clever and intricate chapters on New Zealand, classed with Celebes among anomalous

islands. The fauna and flora of New Zealand have long formed an insoluble crux for the geographical biologist: and Mr. Wallace's explanation, though it perhaps makes rather large demands upon our powers of assent, has at least the merit of perfectly harmonizing all the facts. Whether the series of changes which he supposes to have taken place are actually those which did take place or not, it is at any rate certain that such changes would have resulted in the state of things which we do as a matter of fact now find existing. It would be impossible adequately to summarise his arguments without employing many pages; but the gist of his actual conclusions is this:—

During the Cretaceous period, Australia was divided into two large islands, one of which, the western, was temperate in climate, and almost as extensive as the existing continent. The other or eastern island was a long and narrow strip of land, extending from Cape York on the north to a point beyond modern Tasmania on the south, and so stretching from the tropics into the heart of the temperate zone. Between these two islands lay a sea, in whose bed cretaceous and tertiary deposits are now found uniting the two halves of the continent. From New Zealand, a long submarine spur or bridge runs north-westward towards Cape York. At some time or other a land connection must have existed along this spur, by its temporary elevation above the sea level. But this connection was only with tropical eastern Australia, while between New Zealand and temperate Australia a deep sea channel has always lain. In this manner those Australian plants and animals which already inhabited the tropical portion of the eastern island were enabled to invade New Zealand; but those which inhabited the western island were unable to do so, unless they had already established themselves at an earlier period by stray accidents in the sister land. At an epoch subsequent to the re-insulation of New Zealand, the two Australias became united by the upheaval of the cretaceous and tertiary sea-bottom, and the faunas and floras of both halves were enabled freely to mingle with one another. Accordingly, at the present time, the flora of New Zealand presents the most apparently capricious relations to that of Australia, many families being common to both, while others are unaccountably absent. Unaccountably, that is to say, before Mr. Wallace's ingenious solution had been offered: for if he is right, the common families and genera are those of the old tropical Australia, altered and modified of course by change of circumstances; while the families and genera found in Australia but not in New Zealand are those of the separate western temperate island. So that now temperate New Zealand has relationships not with the temperate but with the tropical portion of the Australian plant-life.

So much is sufficient to account for the main peculiarities of the New Zealand flora; but other facts are implied by its fauna. The large number of wingless birds, extinct or living, in so small a country, calls for special explanation. Fifteen species of apteryx and moa have within recent times inhabited New Zealand. Hence we must suppose that when the ancestral form of these wingless birds first established itself in the island its area must have been far larger than at the present day. Again, the large island thus postulated must have split up at a later period into several smaller but still considerable islands, on each of which a local species of moa or apteryx was developed. Then once more the various islands must have been reunited by an elevation of the great submarine bank which still probably marks their sites; and the various local species must thus have spread themselves over the whole area. Lastly, the larger part of this new land must afterwards have subsided again, leaving all the species crowded together in the comparatively narrow space of the existing New Zealand. Thus, by the combination of various facts, botanical, zoological, geological, and geographical, which he knows so well how to co-ordinate, Mr. Wallace evolves order from the chaos of various isolated observations, and builds up for us a complete history of New Zealand and the surrounding lands, every one of whose items is a masterpiece of connected reasoning. Even if we allow that the whole result is perhaps too hypothetical for implicit acceptance, we must at least recognise the wonderful skill with which the evidence has been pieced together, and the reconstructive power by which it has been made to yield a consistent and probable story. If we are not certain that Mr. Wallace's account is exactly what took place, we may at any rate feel sure that it is very near the actual truth.

As a whole, *Island Life* is almost above criticism. Mr. Wallace brings to his task a rare combination of qualities not usually compatible with one another—the faculty for wide and far-seeing generalisations, and the faculty for minute and painstaking scrutiny of facts. He takes his subject-matter from all the sciences, and he builds it into a new and harmonious whole. Every page is interesting merely in virtue of the special facts which it details; but the entire work is a thousand times more interesting in virtue of the consistent thread of reasoning which runs through it, and of the general light which it throws upon the whole course of organic evolution, and the whole physical history of our planet.

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