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‘Dr. Wallace on the development theory.’

Dr. Alfred Russell Wallace, the distinguished evolutionist, delivered four lectures in the lecture course of the Peabody institute in Baltimore on Nov. 30, Dec. 2, 7, and 9. His general subject was ‘The development theory and protective coloring.’ The first lecture was devoted to a general outline of the Darwinian movement. The lecturer began by calling attention to a circumstance which he thought was too often neglected in evolutionary discussions; namely, the notions as regards species that existed before Darwin. At that time the fixity of species was regarded as an incontrovertible fact; and the origin of them, when explained at all, was referred to independent acts of creation. It is only by contrasting present zoölogical notions with the ones just mentioned that the immensity of Darwin's influence will be fully appreciated. It is true that before him a few writers had been bold enough to question the validity of the theory of the fixity of species. Foremost among them were Lamarck, Chambers, the author of the ‘Vestiges of creation,’ and others. But what was lacking in the speculations of these writers, and the reason why they were not as widely read as Darwin, was that they failed to produce any motive power sufficient to cause the transformation of species, and were not sufficiently acquainted with the facts that would suggest such a power. This was the distinctive work of Darwin, and through this the theory bears his name.

There are three main principles derived from the facts of nature from which the Darwinian theory and its consequences follow as an inference. The first of these is the high rate of multiplication of animal life, which makes it impossible for all the offspring to be sustained, and thus creates a necessary struggle for existence among themselves and with other animal forms. The intensity of this struggle depends on the rate of multiplication of the animal in question; and, when that is great, the life-period will be short, and the number who live to maturity correspondingly small. To appreciate how severe this struggle is, it may be mentioned that if a pair of partridges, a single species of birds, live for sixteen years, and breed, as they do, about eighteen young, and all these were to live and multiply at the same rate, then at the end of the sixteen years the whole surface of the earth, land and water, would not be sufficient to give all the partridges standing-room.

The second important principle is furnished by the variability of all parts of living tissue. It is difficult to appreciate the extent of this variation. Only by accurate measurements can it be realized that the variation within species is by no means as small or insignificant as is often supposed. The published writings of Darwin deal more with the evidences of artificial variation than of that in a state of nature. But evidences of the extreme variability of natural species are abundant. Diagrams representing the variation in the size of the chief parts of the body of specimens of several species of birds, of squirrels, and so on, were exhibited, and pictured not only the extent of this variation, but the independence of the variation in one part of that in another. Each part varies independently. It was shown, too, that while the ordinary probability curve represents the natural variation of an organ, the curve must be flat and long drawn out to express the extreme limits of variation and the comparatively slight tendency towards extreme crowding about the average form.

With these facts we pass to the third main principle, the hereditary character of these variations. The offspring of parents with similar variations will tend to preserve them: and the (though not the exclusive one, as Darwin knew) motive power which selects certain variations for preservation by hereditary transmission, and consigns the rest to oblivion, is natural selection. Those variations most in accord with the environment, best adapted to succeed in the struggle for existence, will survive as the fittest. To the objection that such favorable variations would be overshadowed by the other variations all with equal hereditary tendency, the answer was given that variation was sufficiently universal to insure the variation of many individuals in a similar direction, though in less degree, at any time. All variations are lying latent in the background, ready to assert themselves when the environment gives them an opportunity. The great rapidity of this change is shown in those cases where man makes artificial selections, and causes any part of a plant, for instance, which happens to be edible by him, to exhibit the greatest variability in size, nutrition, taste, and all else.

In conclusion, the lecturer expressed the view peculiar to himself, that the human mind is excluded from this evolution from more lowly forms, and that the belief in the gradual development of man's body is in no wise inconsistent with the belief that his soul springs from a higher source, and should yield to all those aspirations which religion is intended to satisfy.

In the second lecture, Dr. Wallace confined himself to the consideration of one of the devices by which animals rendered themselves the more fit to survive. This consists in adapting themselves to their environment by imitating it. The object of such imitation is primarily to escape observa-

tion from the animals that prey upon them, and to approach their own prey unobserved. The most striking characteristic of natural scenery is its color. Accordingly we find that protective coloring is the most widely distributed mode of mimicry, though the forms of natural objects are not infrequently imitated by animals. In a general way the animals in cold climates are more liable to be white, like the ice and snow among which they live, while those of tropical habitat present the wealth of color for which southern scenery is famous. The animals of the desert are quite generally of a sandy appearance, and many marine animals of a limpid, transparent tint. To account for this general correspondence between climate and color, the direct action of sunlight has been brought in as a sufficient cause. But apart from the fact that this cause has little explanatory power, it is inconsistent with the fact that many very tamely colored species abound near the equator, and attractive color is not infrequent in northern forms of animal life. Local influences are obviously of great importance. The theory that a direct photo-chemical action takes place, is in some instances undoubtedly true. Caterpillars, in passing into the chrysalis stage, have been observed to spin a dusky red cocoon when on a brick wall, a green one when on a twig, or a white one when on a white fence-paling. In these cases the change of color has been observed to take place within the few hours of spinning the cocoon, and is probably not analogous with the usual origin of protective coloring. In such unique cases as the chameleon, when the change of color is under voluntary control, the imitation of the environment is impossible if the creature be blinded. But, apart from these exceptional cases, the only sufficient explanation of color in the animal world is, that it must be a useful trait. In what way it is useful has already been stated. It is impossible to convey in a few words the cumulative effect of the instances of imitative coloring which Dr. Wallace presented. The stripes of the tiger, resembling the strong contrasts of light and shade caused by the shadow of dry grasses under a burning sun; the remarkable list of caterpillars aping the tint of the petals, and the curl of the tendrils, of the flowers and plants on which they live; and, more wonderful still, the leaf-butterfly of India, which even has the pink circles due to fungi on the leaves, which it imitates so closely that the lecturer had to point out on the screen which were leaves and which were butterflies,—these and many more give evidence of the great *rôle* that color plays in nature. And the evidence was still more remarkable, because it was largely taken from a work written many years before Darwinism and natural selection were much thought of.

Dr. Wallace next called attention to the facts that certain exceptions to this color-adaptation were apparent only, and that color had also other functions. The raven, for example, though living in the highest latitudes, is entirely black. But it is to be noted that there the raven is not preyed upon, and that its own prey is dead matter: hence it has no need of protection, and acquires no color-adaptation.

Again: color is sometimes assumed as a means of exciting terror in an attacking enemy. Certain harmless caterpillars have acquired the reputation of being deadly on account of such variegated appendages. Finally, Dr. Wallace pointed out the use of color as a means of recognition. The fact that a rabbit, when pursued, raises its tail, and shows its conspicuous white under surface, seems the opposite of a useful act. But by this means it is enabled to recognize its fellows, and run straight to its burrow, with the white tails of the others as a guide. And it often happens that defenceless animals, whose only defence is in flight, possess similar marks for recognizing one another.

In his third lecture, Dr. Wallace continued the discussion of color in the animal world with special reference to the facts of animal mimicry. Color is a normal feature of animal life, and it will be absent or subdued only when it is kept down by outside influences. For example: those insects that are strong, or protected by a sting, are very apt to be showy and conspicuous. They can afford to be so, because their hard shell (as in beetles) or the sting (as in bees and wasps) is a sufficient protection against attack.

A very peculiar and yet widely current mode of protection is by becoming distasteful and inedible to the attacking animal. A very large class, especially of tropical, butterflies have acquired an extremely disagreeable taste, so that birds and other insectivorous creatures soon learn to avoid them. And the remarkable point is, that such insects are almost invariably conspicuously marked (it is evidently well that they should be), and are usually slow of flight and without other protection. The direct experiment has been tried by Mr. Belt, of feeding birds with these insects, and they are invariably refused. In beetles the same phenomena occur. A great many species with a soft shell, that invites attack, are protected by their inedibility, and are usually lustrous and bright. A tame monkey refused one of these beetles at once, though greedily eating all others.

We see, then, that the acquisition of certain superficial forms and markings will be a protec-

tion to the animal acquiring them; and, after the birds have once learned that such and such insects are inedible, any insect, whether inedible or not, that gets itself mistaken for one of the inedible species, will enjoy a similar immunity from attack. This device is current in nature, and is termed ‘animal mimicry.’ Dr. Wallace showed many striking examples of this,—a moth closely resembling in form and marking a powerful wasp, or a wasp imitating an inedible beetle, and a host of edible butterflies and caterpillars imitating to a nicety quite different species that are inedible. A superficial observer would readily mistake one for the other, but the entomologist finds them structurally distinct in almost every particular. In fact, a South American species brightly marked and striped is really our common white cabbage butterfly transformed for purposes of mimicry. The crucial test of all such mimicry lies in the fact that invariably the mimicking and mimicked species inhabit identically the same territory, and are frequently found together. An excellent illustration of this was given. Two different authors had written up the descriptions, the one of hard-shell, the other of soft-shell beetles of a southern climate; and Dr. Wallace selected from one volume many cases mimicking the forms pictured in the other volume, and invariably found, on referring to the text, that the two species occupied the same area.

A curious and for a long time a very puzzling series of facts was that many inedible species imitated one another. The utility of this is not very evident, and, when the number of examples of it was small, it was regarded as accidental. The explanation has been given by the distinguished naturalist Fritz Müller. It is this: a certain number of the inedible butterflies must be sacrificed in order to teach the young birds that they are inedible. The young bird must experiment, try two or three of them, and then will reason from that sample to the whole class. Now, if two inedible species are closely alike, the bird will only have to use up two or three of both species, instead of two or three of each species, before learning that they must be let alone. And thus by clubbing together, the butterflies mutually protect one another against these experimental inroads. This is not an insignificant advantage when the number of birds is large, and, especially if the two species are unequal in the number of individuals they possess, the smaller species derives a great advantage. Examples of butterflies maimed by the bills of birds were shown.

In reptiles we find poisonous snakes imitated by harmless ones; and in birds the phenomena of sexual coloring are especially marked. Whenever the coloring of the two sexes differs, the female is dull, and the male bright; and this for the reason that the female is more open to attack, especially when taking care of the young and at other times. But when the nest is built in the hollow of a tree or in other not exposed places, it is found that the male and female are equally brightly colored. So, also, in some butterflies the female alone imitates an inedible species.

The last lecture was devoted to the consideration of color in the vegetable world. Here color is not so generally related to the economy of the organism, but is much more the normal product of chemical action. The chlorophyl of vegetable green forms one of the normal characteristics of plant-life. Protective coloring is also not usual. A small plant of the African desert very closely imitates the pebbles among which it takes root. Another African plant has tubers that might pass for small stones.

Many cases of apparent plant mimicry have been shown to be the result of similar conditions of existence; as, for example, the strong resemblances of many alpine as well as of marine plants to one another. But a few cases of true mimicry exist. There is a rare non-poisonous fungus which imitates a common poisonous fungus, and is always found along with the common species. There are instances, too, of higher plants imitating an orchis that grows in its vicinity; but these are rare.

When we consider fruits (in the botanical sense) in detail, the phenomena of color become highly important. These colors are largely for the purpose of attracting the visits of insects and other animals; the ulterior object being the dissemination of the seeds. The main agencies by which this is effected are mechanical ones,—the wind, and by the visits of animals. A few general facts of color are at once explained by this view. Unripe fruit is of a protective green color, and where it is disseminated by mechanical agencies along the ground, as in nuts, it takes on a dull brown color. Nuts are protected by hard shells, sometimes also by bitter or by prickly surfaces and show very clearly that the seed within, though edible, was not meant to be eaten. Being sufficiently protected otherwise, it has not acquired the property of inedibility. On the other hand, what we popularly know as fruits are intended to be eaten: they are made attractive by a bright and juicy pulp, and the seeds are generally small and smooth, so as easily to be swallowed entire, and to pass through the body of the animal ready for fertilization. The seeds, too, may be bitter, or protected by a parchment-like covering, as in the crab-apple. We see, then, that fruits when

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ripe, and not before, offer attractive colors, generally red, so that the seeds contained in them may be swallowed by animals and then serve their normal function.

To understand the coloring of flowers, one must remember that the object is to have the pollen carried from the anther of one flower to the stigma of another, and thus to secure cross-fertilization. The well-known experiments of Darwin showed that self-fertilized flowers bear fewer and smaller seeds, and when these seeds are planted they develop into smaller, weaker plants, than those resulting from cross-fertilization. Dr. Wallace then described the familiar methods by which cross-fertilization is effected and self-fertilization avoided. The anther and the stigma ripening at different times, the mysterious self-sterility of some pollen, the bending-down of the stigma away from the anthers, and the separation of the stamens and pistils in two distinct flowers, are among the simple modes of avoiding self-fertilization. The more complex ways, such as varying the length of pistil and stamens in different flowers so that pollen from a short stamen will reach a long pistil, and *vice versa*; the innumerable kinds of springs and triggers and traps to retain insects and sprinkle their heads and backs with pollen,—all show the extreme harmony between the vegetable and the animal world. And if a still clearer demonstration of this is needed, we have it in the extreme specialization of some plants to particular insects. Such facts abound; and in the case of an alpine species the same flower, when growing in low regions, where bees abound, is adapted to them, and in high regions is adapted to the visits of butterflies.

Dr. Wallace then gave a brief explanation of the existence of self-fertilized plants. The object is not cross-fertilization, but a slight change in conditions. If the external conditions are rough and varied, self-fertilization is sufficient; but when the environment becomes equable and monotonous, then deterioration results, new blood is necessary, and the devices for cross-fertilization are evolved, and some may imagine that in the course of geological time, changes from the one to the other have gone on according as the desired variations could be best obtained. For example, if a self-fertilizing flower is tending to die out, it may adopt cross-fertilization; if the insects that visit it die out, it may return to self-fertilization.

In conclusion, Dr. Wallace expressed the view that insects had no aesthetic pleasure in color at all, but that this faculty was reserved for man alone, and served as a mark of his distinction.

Dr. Wallace also delivered a lecture on the 'Origin and characteristics of island life' before the students of Johns Hopkins university. The lectures were delivered in a clear and easy manner, and possessed that indefinable attractiveness which comes from many years of original research. It was a high privilege to listen to the words of one who had independently thought out the theory that bears Darwin's name, and has been intimate for years with Darwin himself.

The Alfred Russel Wallace Page, Charles H. Smith, 2021.