

Until after the publication of Mr. Darwin's speculations, the colours of plants and animals had never been made the subject of careful and philosophical study. So far as any hypothesis was held concerning these phenomena, it was the vaguely conceived hypothesis that they are due to the direct action of such physical conditions as climate, soil, or food. But there are fatal objections to such an explanation. When Dr. Forbes Winslow, in his work on the "Physiological Influence of Light," tells us that "the white colour of animals inhabiting the polar regions is attributable to the absence of intense sunlight," it is an obvious objection that the polar regions are not pre-eminent for darkness. Though within the limits of the arctic circle the sun is below the horizon for six months together, it is none the less for the

other six months above the horizon ; and though its slanting rays do not cause excessive heat in the summer, the prolonged glare of light, intensified by reflection from the snow and ice, is described as peculiarly intolerable. The summer ought to tan the polar bears as much as the winter can bleach them. And to this it may be added that the Eskimos and Greenlanders, living under the polar circle, are not bleached. Several other facts, alike incompatible with the direct action of physical agencies, are mentioned by Mr. Wallace. While wild rabbits, for instance, are always tinted grey or brown, the same rabbits, when domesticated, give birth to white and black varieties, though there has been no change either in climate or in food. The case is the same with domestic pigeons. But even supposing that the most general features of animal colouring could be explained on this hypothesis—which they cannot be—there would still remain the more remarkable cases of tree-frogs, which resemble bark, and of the so-called leaf-butterflies, which when at rest are indistinguishable from leaves ; and the existence of such cases is a stumbling-block in the way of all theories save the theory of natural selection.

For according to the theory of natural selection each species of animals will be characterized by that shade of colour which is most advantageous to the species in the struggle for existence. Now, as Mr. Wallace observes, “concealment is useful to many animals, and absolutely essential to some. Those which have numerous enemies from which they cannot escape by rapidity of motion, find safety in concealment. Those which prey upon others must also be so constituted as not to alarm them by their presence or their approach, or they would soon die of hunger.” In striking harmony with this general principle, we find that the great majority of animals are so coloured as best to escape notice, and that animals which are not protectively coloured are animals whose habits of life are such as to enable them to dispense with secrecy. The polar

bear is white, as the California bear is grey and the Hindustan bear black, because with a coat thus coloured it can best escape notice and secure its prey. The polar hare has a permanent coat of white; but the alpine hare, the arctic fox, and the ermine, which do not live amid perpetual snow, have coats that are white in the winter only. Arctic owls, falcons, and buntings are coloured snowy white; and the ptarmigan is white in winter, while "its summer plumage so exactly harmonizes with the lichen-covered stones among which it delights to sit, that a person may walk through a flock of them without seeing a single birds" In the sandy deserts of Northern Africa, all birds, without exception, all snakes and lizards, and all the smaller mammals, are of a uniform sandy colour. The camel is tinted like the desert in which he lives, and the same is true of the antelope and the Australian kangaroo. The tawny lion, says Mr. Wallace, "is a typical example of this, and must be almost invisible when crouched upon the sand or among desert rocks and stones." His brother, the tiger, "is a jungle animal, and hides himself among tufts of grass or of bamboos, and in these positions the vertical stripes with which his body is adorned must so assimilate with the vertical stems of the bamboo, as to assist greatly in concealing him from his approaching prey. How remarkable it is that besides the lion and tiger, almost all the other large cats are arboreal in their habits, and almost all have ocellated or spotted skins, which must certainly tend to blend them with the background of foliage; while the one exception, the puma, has an ashy brown uniform fur, and has the habit of clinging so closely to a limb of a tree, while waiting for his prey to pass beneath, as to be hardly distinguishable from the bark."¹ Such nocturnal animals as owls, goat-suckers, mice, bats, and moles are dusky-coloured. In tropical forests, where the trees are laden with green foliage all the year round, we find brilliant green

¹ Wallace, *Natural Selection*, pp. 49, 53.

pigeons and parrots; while the northern snipe resembles the marshy vegetation in which it lives, and the woodcock, with its variegated browns and yellows, is inconspicuous among the autumn leaves.¹ Arboreal iguanas are tinted leafy green; and out of many species of tropical tree-snakes there is but one which is not green, and this kind conceals itself during the daytime in holes. Flat fish, like the skate and flounder, are coloured like the gravel beneath them. Fishes which live among gorgeous coral reefs are magnificently tinted. The brilliant red hippocampi of Australia dwell among sea-weed of the same colour. And numerous other examples from the vertebrate sub-kingdom are given by Mr. Wallace, from whose remarkable essay the examples here given are culled.

Before going farther, let us note how completely these interesting phenomena are in harmony with the theory of natural selection. The variability of the hues of domestic animals descended from a monotonously-coloured wild species, shows that there is no direct physiological necessity for the production of animals of a single given style of colouring. But it is tolerably obvious that in the struggle for existence the most conspicuous among those animals which serve as food for others will be the soonest detected, killed, and eaten; while in general the most conspicuous carnivorous animals will be the most easily avoided, and hence will be the most likely to perish for lack of sustenance. And while it is not universally true of the higher animals, as it is of the lower animals and plants, that a much greater number perish than survive, the destruction of life is nevertheless so great that the fate of each creature must often depend upon apparently trivial circumstances. The explanation would therefore be satisfactory, even if protective shades

¹ The general principle is well stated by Emerson, in this pretty quatrain:

“ He took the colour of his vest
From rabbit's coat and grouse's breast;
For as the wild kinds lurk and hide,
So walks the huntsman unespied.”

of colouring could be regarded as circumstances of slight importance,—which they cannot.

Since, therefore, it is natural selection which keeps up the protective hues of animals, by killing off all save the least conspicuous individuals, we may understand why it is that animals which have for several generations been domesticated no longer retain, without considerable deviation, their protective style of colouring. Freed from the exigencies of wild life, there is no longer an imperious need for concealment, and hence the unfavourably coloured individuals survive like the rest, and variety appears among members of the same species. In the cat family, which appears to have been originally arboreal, there is a strong tendency to the production of stripes and spots. In the lion, which is not arboreal, and in the puma, owing to the peculiarity above mentioned, these variegated markings have been almost wholly weeded out by natural selection.¹ But in the domestic cat, along with these spots and stripes which occasionally show its blood-relationship with the leopard and tiger, we more often meet with colours not paralleled among the wild species; now and then we see cats which are coal-black or snowy white. Cows, horses, sheep, dogs, and fowl, furnish parallel examples. Thus too we may understand why the sable and the Canadian woodchuck retain their brown fur during the winter; for the one can subsist on berries, and is far more agile than any of its foes, while the other lives in burrows by the riverside and catches small fish that swim by in the water. And thus we may understand why it is that in the case of birds which build open nests, the female is dull coloured like the nest; while on the other hand, the females of birds which build domed nests are often as brightly coloured as the males.

¹ The variegated marking usually appears, however, in lion-cubs; thus showing that the variegated colouring of the leopard and tiger is relatively primary, while the monotonous colouring of the adult lion is relatively secondary.

Turning now to the insect world, we find a vast abundance of corroborative proof. Among the tiger-beetles examined by Mr. Wallace in the Malay islands, those which lived upon wet mossy stones in mountain brooks were coloured velvet green; others, found for the most part on dead leaves in the forest, were brown; others again, "never seen except on the wet mud of salt marshes, were of a glossy olive so exactly the colour of the mud as only to be distinguished when the sun shone," by casting a shadow. "In the tropics there are thousands of species of insects which rest during the day clinging to the bark of dead or fallen trees; and the greater portion of these are delicately mottled with grey and brown tints, which though symmetrically disposed and infinitely varied, yet blend so completely with the usual colours of the bark, that at two or three feet distance they are quite indistinguishable." Moths, which when resting expose the upper surfaces of their wings, have these dull-coloured. Butterflies, on the other hand, which rest with their wings raised perpendicularly and laid together so as to show only the under surfaces, have the upper surfaces brilliantly coloured, while the exposed under surfaces are dusky and inconspicuous, or even marked in imitation of leaves. Mr. Wallace describes an East Indian butterfly whose wings are superbly tinted with blue and orange: this butterfly is a very swift flyer and is never known to settle save among the dead leaves in the dry forests which it frequents. When settled, with its wings raised, it imitates a shrivelled leaf so perfectly that even the keen eye of the naturalist can hardly detect it. This protective colouring is found throughout the whole immense order to which belong grasshoppers, crickets, and locusts; the most remarkable instance being furnished by the so-called "walking-leaf," to which no description can do justice. On the other hand, hornets, bees, and wasps, which are protected by their stings, are brilliantly but not in general protectively coloured. Bugs

and ground-beetles emit a disagreeable, pungent smell, and they are often conspicuously coloured. But the most wonderful of all are the cases of protective mimicry. The heliconidæ are among the most beautiful of South American butterflies. Being never eaten by birds, on account of a nauseous liquid which exudes from them when touched, they are not only very lazy flyers, but have the under sides of their wings as gorgeously tinted as the upper side, so that they can be seen from quite a long distance. From the same cause they are prodigiously numerous, swarming in all the tropical forests. Now it is obvious that if another butterfly, not protected by a disagreeable odour or taste, were to resemble the heliconia in colouring, it would be as efficiently protected as by imitating a dead leaf or dry twig; provided that there were but few of these butterflies among a large number of heliconias. For, as Mr. Wallace says, "if the birds could not distinguish the two kinds externally, and there were on the average only one eatable among fifty uneatable, they would soon give up seeking for the eatable ones, even if they knew them to exist." Now along with the heliconidæ there does, in fact, live a distinct family of butterflies, the pieridæ, most of which are white, and which are anatomically as distinct from the heliconidæ as a lion from a buffalo. But of these pieridæ there is one genus, the leptalis, which exactly resembles the heliconias in external appearance. So close is the resemblance that such expert naturalists as Mr. Bates and Mr. Wallace have been repeatedly deceived by it at the time of capture. Moreover, each species of this genus leptalis is a copy of the particular species of heliconia which lives in the same district. Every band and spot and fleck of colour in the heliconia is accurately reproduced in the leptalis; and besides this, the lazy mode of flight is also imitated. While in point of numbers, we find about one leptalis to a thousand heliconias. Nor is this the only instance. So pre-eminently favoured are these beautiful

insects by their disgusting taste, that they are exactly imitated by at least three genera of diurnal moths. In other parts of the world similar phenomena have been noticed. The relationship of the leptalis to the heliconia is repeated in India, in the Philippine Islands, in the Malay archipelago, and in various parts of Africa; the protected insect being, in all these cases, very much less numerous than the insect whose colours it mimics. In similar wise, bees and wasps are often imitated by beetles, by flies and even by moths.

For further details I must refer to Mr. Wallace's essay, which is a singularly beautiful specimen of inductive reasoning. The facts already cited are quite enough to sustain the general conclusion that the colours of animals are in the main determined by the exigencies of the struggle for existence. Where it is for the advantage of an animal to be concealed, as in the great majority of cases, its colour, whether brilliant or sombre, is such as to protect it. But where the animal is otherwise adequately protected—either by its peculiar habits, by a sting, a disgusting odour or taste, or a hard carapace—and where it is not needful for it to be hidden from the prey upon which it feeds, then there is usually no reference to protection in the colour of the animal. In some of these cases, however, a very conspicuous colouring becomes protective—as in the case of the jet-black toad which Mr. Darwin saw in La Plata, which emitted a poisonous secretion, and which, when crawling over the sandy plain, could not fail to be recognized by every passing creature as an object to be avoided.

And now, having reached the terminus of our inquiry, let us look back over the course for a moment, that we may see the character of the progress we have achieved. Such a retrospect is here especially needed, because the complexity of our subject has been so great, and the range of our illustrations so wide, that the cardinal points in our argument have perhaps run some risk of getting overlaid and concealed from view, and in particular it may not be sufficiently obvious how completely we have attained the object set before us as the goal of the present chapter and its predecessor, namely, to explain the genesis of the psychical forces which wrought the decisive change from animality to humanity. That we may well appreciate the solid consistency of the entire argument concerning the Genesis of Man, let us therefore contemplate in a single view its various factors.

We have seen that the progress from brute to man has been but slightly characterized by change in general bodily structure in comparison with the enormous change which has been wrought in the cerebrum, and in those highest psychical functions which stand in correlation with the condition of the cerebrum. We have seen that the development of these highest psychical functions, in all their wondrous variety and complexity, has consisted at bottom in the increase of the power of mentally representing objects and relations remote from sense. By the reiterated testimony of many diverse kinds of illustrative facts, we have been convinced that in mere quantity of representative capacity, with its infinitely various consequences, the civilized man surpasses the lowest savage by a far greater interval than

that by which the lowest savage surpasses the highest ape ; just as the gulf between the cerebral capacity of the Englishman and that of the non-Aryan dweller in Hindustan is six times greater than the gulf which similarly divides the non-Aryan Hindu from the gorilla. And we have indicated in sundry ways how this increase in representative capacity itself a pre-requisite to any high degree of social combination, has been furthered by each advance in social combination, so that the enormous psychical progress achieved since mankind became distinctly human has been mainly dependent upon that increasing heterogeneity of experience which increasing social integration has supplied.

But in spite of the fact that the psychical progress achieved since mankind became distinctly human is so much greater in quantity than that which was required to carry it from apeness to manhood, we were led to adopt the Duke of Argyll's suggestion, that the boundary was really crossed when this preliminary and less conspicuous psychical progress had been achieved. And working out the happy thought which science owes to Mr. Wallace, we concluded that this comparatively inconspicuous but all-essential step in psychical progress was taken when the intelligence of the progenitors of mankind had reached the point where a slight increase in representative capacity came to be of greater utility to the species than any practicable variation in bodily structure. Here our first line of inquiry ended. So far as the mere subordination of physical to psychical modification is concerned, the character of the progress from apeness to manhood now became intelligible.

But at this point we were confronted with a new question, suggested by some of the conclusions obtained on our first line of inquiry. Having perceived that the intellectual progress, or increase in representative capacity, which distinguishes man from brute, is so intimately connected with man's capacity for social combination, it became needful

to search for the circumstances which begot in the progenitors of mankind the capacity for a kind of social combination more definite in the character of its relationships than that quasi-social combination, not uncommon among mammals, which is known as gregariousness. In other words, seeing that such thinkers as Sir Henry Maine have shown that the primordial unit of society, by the manifold compounding of which great tribes and nations have come into existence, was the aboriginal family group, with its nascently ethical relationships between the members, how shall we explain the genesis of these family groups, which have nothing strictly answering to them, either among non-human primates or among other gregarious animals?

The feature by which the most rudimentary human family group is distinguished from any collocation of kindred individuals among gregarious mammals is the permanent character of the relationships between its constituent members. Enduring from birth until death, these relationships acquire a traditionary value which passes on from generation to generation, and thus there arise reciprocal necessities of behaviour between parents and children, husbands and wives, brethren and sisters, in which reciprocal necessities of behaviour we have discerned the requisite conditions for the genesis of those ego-altruistic impulses which, when further modified by the expansion of the sympathetic feelings, give birth to moral sentiments. Accordingly the phenomenon which demands explanation is the existence of permanent relationships, giving rise to reciprocal necessities of behaviour, among a group of individuals associated for the performance of sexual and parental functions.

The explanation, as I have shown, is to be found in that gradual prolongation of the period of infancy, which is one of the consequences, as yet but partially understood, of increasing intelligence. Let us observe the causal connections

so far as we can trace them out, recalling some of the conclusions reached in the chapter on the Evolution of Mind.

In an animal whose relations with its environment are very simple, resulting in an experience which is but slightly varied, the combinations of acts requisite for supporting life take place with a regularity and monotony approaching the monotonous regularity with which the functions of the viscera are performed. Hence the tendency to perform these actions is completely established at birth in each individual, just as the tendency of the viscera to perform their several functions is pre-established, all that is required in addition being simply the direct stimulus of outward physical opportunity. And the psychical life of such an animal we call purely instinctive or automatic. In such an animal the organized experience of the race counts for everything, the experience of the individual for nothing, save as contributing its mite towards the cumulated experience of the race. But in an animal whose relations with its environment are very complex, resulting in an experience which is necessarily varied to a considerable extent from generation to generation, the combinations of acts requisite for supporting life must occur severally with far less frequency than in the case of the lower animal just considered. Hence the tendency to perform any particular group of these actions will *not* be completely established at birth in each individual, like the tendency of the viscera to perform their several functions. On the other hand, there will be a multitude of conflicting tendencies, and it will be left for the circumstances subsequent to birth to determine which groups of tendencies shall be carried out into action. The psychical life of such an animal is no longer purely automatic or instinctive. A portion of its life is spent in giving direction to its future career, and in thus further modifying the inherited tendencies with which its offspring start in life. In such an animal the organized experience of the race counts for much, but the

special experience of the individual counts for something in altering the future career of the race. Such an animal is capable of psychical progress, and such an animal must begin life, not with matured faculties, but as an infant. Instead of a few actually realized capacities, it starts with a host of potential capacities, of which the play of circumstance must determine what ones shall be realizable.

Manifestly, therefore, the very state of things which made psychical variation more advantageous to the progenitors of mankind than physical variation, this very state of things simultaneously conspired to enhance the progressiveness of primeval man and to prolong the period of his infancy, until the plastic or malleable part of his life came to extend over several years, instead of terminating in rigidity in the course of four or five months, as with the orang-outang. Upon the consequences of this state of things, in gradually bringing about that capacity for progress which distinguishes man from all lower animals, I need not further enlarge. What we have here especially to note, amid the entanglement of all these causes conspiring to educe humanity from animality, is the fact, illustrated above, that this prolongation of infancy was manifestly the circumstance which knit those permanent relationships, giving rise to reciprocal necessities of behaviour, which distinguish the rudest imaginable family group of men from the highest imaginable association of gregarious non-human primates.

In this line of inquiry, which, so far as I know, has never yet been noticed by any of the able writers who have dealt with the origin of the human race, it seems to me that we have the clew to the solution of the entire problem. In this new suggestion as to the causes and the effects of the prolonged infancy of man, I believe we have a suggestion as fruitful as the one which we owe to Mr. Wallace. And the most beautiful and striking feature in this treatment of the problem is the way in which all the suggestions hitherto

made agree in helping us to the solution. That same increase in representativeness, which is at the bottom of intellectual progressiveness, is also at the bottom of sociality, since it necessitates that prolongation of infancy to which the genesis of sociality, as distinguished from mere gregariousness, must look for its explanation. In this phenomenon of the prolonging of the period of infancy we find the bond of connection between the problems which occupy such thinkers as Mr. Wallace and those which occupy such thinkers as Sir Henry Maine. We bridge the gulf which seems, on a superficial view, for ever to divide the human from the brute world. And not least, in the grand result, is the profound meaning which is given to the phenomena of helpless babyhood. From of old we have heard the monition, "Except ye be as babes, ye cannot enter the kingdom of heaven." The latest science now shows us—though in a very different sense of the words—that, unless we had been as babes, the ethical phenomena which give all its significance to the phrase "kingdom of heaven" would have been non-existent for us. Without the circumstances of infancy we might have become formidable among animals through sheer force of sharp-wittedness. But, except for these circumstances, we should never have comprehended the meaning of such phrases as "self-sacrifice" or "devotion." The phenomena of social life would have been omitted from the history of the world, and with them the phenomena of ethics and of religion.