

A THEORY OF BIRDS' NESTS:

SHEWING THE RELATION OF CERTAIN SEXUAL DIFFERENCES OF
COLOUR IN BIRDS TO THEIR MODE OF NIDIFICATION.

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ONE of the most remarkable and interesting characteristics of birds, is the habit which the great majority of them possess of forming a more or less elaborate structure for the reception of their eggs and young. In other classes of vertebrate animals, such structures are few and exceptional, and never attain to the same degree of completeness and beauty. Birds' nests have, accordingly, attracted much attention, and have furnished one of the stock arguments to prove the existence of a blind but unerring instinct in the lower animals. The very general belief that every bird is enabled to build its nest, not by the ordinary faculties of observation, memory, and imitation, but by means of some innate and mysterious impulse, has had the bad effect of withdrawing attention from the very evident relation that exists between the structure, habits, and intelligence of birds, and the kind of nest they construct. It will be necessary to point out a few of these primary relations, since they have an important bearing on the subject we are about to discuss.

A considerable number of birds form no nest whatever, but lay their eggs and hatch their young upon the bare ground. Such are a large portion of the wading and swimming birds, many of the Gallinaceæ, and, among perching birds, almost all the Caprimulgidæ. These may be considered to form one extremity of the scale, while such birds as the Icteridæ, the weaver birds, and the wren, which build elaborately woven, domed, or pensile nests, are at the other. Now, the general structure and mode of life of the birds in question, almost of itself explains this difference. The large head and excessively small broad bill of the Caprimulgidæ, and their small weak feet, with scarcely any power of grasping, render them physically unable to weave together grass, or moss, or fibres, or wool, into a strong and well-constructed nest. The feet of terns or of sandpipers are equally ill adapted to this purpose; and while engaged in seeking their food, they chiefly frequent places where no materials for making a nest are to be found. Those birds, on the other hand, which form the most elaborate

and perfect nests, are the most highly organised of the class, having powerful and yet delicate grasping feet, a well formed pointed bill, and extreme rapidity of motion. The places where they seek their daily food are those where all the materials used in their nests are abundant; and their intelligence is shewn by their not unfrequently modifying the position, the form, or the materials of their nests, to suit the changed conditions with which the presence of man surrounds them.

If we descend more into detail, we find the same principles manifested; and we are often able to understand the reason of the particular position and material of a nest, by a consideration of the mode of life of the bird that has made it. The kingfisher, seeking his food in rivers and streams, makes his nest in their banks. His strong and sharp-pointed bill, is a weapon which readily pecks away sand or earth; and the disgorged bones of the fishes he has devoured, form a rude nest at the bottom of the hole. The woodpecker, who is daily engaged in boring holes in trees to seek his food, enlarges one of these holes, and makes a cavity within which he can bring up his young in safety. The toucan, whose huge weak bill, imperfect feet, and clumsy motions incapacitate it from building a nest, makes use of the holes formed by woodpeckers, squirrels, or other animals, which it finds in the trees among which it seeks its daily food. The rook lines its nest with roots and fibres, the crow with wool or rabbits' fur. It is no blind instinct that leads birds so much alike to use such different materials, but simple convenience. The rook hunts for grubs in ploughed fields and pastures, and has continual experience of roots and fibres. The crow frequenting moorlands and warrens, and feeding on dead lambs and rabbits, finds wool and fur continually, and uses them in its nest. The wren constructs its beautiful nest almost entirely of moss, because while hunting about in hedgerows for small insects and molluscs, moss is continually before its eyes.*

We see, then, that a consideration of the structure, the food, and other specialities of a bird's existence, gives us a clue, and sometimes a very complete one, to the reason why it builds its nest of certain materials, in a definite situation, and in a more or less elaborate manner. There are, however, two other factors in the problem, whose effect in any particular case we can only

* For other examples, see "The Philosophy of Birds' Nests;" *Intellectual Observer*, July, 1867.

vaguely guess at, but which must have had an important influence in determining the existing details of nidification. These are—changed conditions of existence, whether internal or external, and the influence of hereditary habit; the first inducing alterations in accordance with changes of organic structure, of climate, or of the surrounding fauna and flora; the other preserving the peculiarities so produced, even when changed conditions render them no longer necessary. There are many facts which shew that birds do adapt their nests to the situations in which they place them. That of the Orchard Oriole of the United States (*Icterus spurius*), when built among the strong branches of a fruit tree, is a very shallow cup, but when suspended from the slender boughs of a weeping willow, it is much deeper, to prevent the young birds from being thrown out during violent winds. The common house sparrow builds a far less careful nest when it is placed in a hole, than when built in a tree; and the adoption of eaves, chimneys, and boxes, by swallows, wrens, and many other birds, shews that they are always ready to take advantage of changed conditions. It is probable, therefore, that a permanent change of climate would cause many birds to modify the form or materials of their abodes. The introduction of new enemies to eggs or young birds, might induce many alterations tending to their better concealment. A change in the vegetation of a country, would often necessitate the use of new materials. So, also, we may be sure, that as a species slowly became modified in structure, it would necessarily change in some degree its mode of building. Its work would be more or less delicate, and the materials used more or less fine, according to the modifications its external organs underwent.

During all these changes however, certain specialities of nest-structure would continue for a shorter or a longer time after the causes which had necessitated them had passed away. Such records of a vanished past meet us everywhere, even in man's works, notwithstanding his boasted reason. All the main features of Greek architecture, for example, are but reproductions in stone of what were originally parts of a wooden building. Our copyists of Gothic architecture often build solid buttresses, capped with weighty pinnacles, to support a wooden roof which has no outward thrust to render them necessary; and even think they ornament their buildings by adding sham spouts of carved stone, while modern water-pipes, stuck on without any attempt at harmony, do the real duty. So, when railways superseded coaches, it was thought necessary to

build the first-class carriages so as to imitate a number of coach-bodies joined together ; and the arm-loops for each passenger to hold on by, which were useful when bad roads made every journey a succession of jolts and lurches, were continued on our smooth macadamised mail-routes, and, still more absurdly, remain to this day in our railway carriages, the relic of a kind of locomotion we can now hardly realize. With these and a hundred similar facts everywhere around us, we may fairly impute much of what we cannot understand in the details of Bird-Architecture to an analogous cause. If we do not do so, we must assume either that birds are guided in every action by pure reason to a far greater extent than men are, or that an infallible instinct leads them to the same result by a different road. So many and such well-known facts are opposed to both these views, that I do not think it necessary here formally to refute them.

The preceding observations are intended to shew that the exact mode of nidification of each species of bird is probably the result of a variety of causes, which have been continually inducing modification in accordance with changed organic or physical conditions. The most important of these causes seem to be, in the first place, the structure of the species, and, in the second, its environment. If, therefore, we find less important and more easily modified characters than these correlated with peculiarities of nidification, we shall be justified in concluding that the former are dependent on the latter, and not *vice versa*. Such a correlation I am now about to point out.

Considering the main purpose of bird's nests to be the protection of the eggs and the security and comfort of the young birds, we may group them under two primary divisions, according as they more or less completely fulfil this important function. In the first, we place all those in which the eggs and young are hidden from sight, no matter whether this is effected by an elaborate covered structure, or by depositing the eggs in some hollow tree or burrow underground. In the second, we group all in which the eggs and young and sitting bird are exposed to view, no matter whether there is the most beautifully formed nest, or none at all. Kingfishers, which build almost invariably in holes in banks ; woodpeckers and parrots, which build in hollow trees ; the Icteridæ of America, which all make beautiful covered and suspended nests, and our own wren, which builds a domed nest, are examples of the former ; while our thrushes, warblers, and finches, as well as the crow-

shrikes, chatterers, and tanagers of the tropics, together with all raptorial birds and pigeons, and a vast number of others, in every part of the world, all adopt the latter mode of building.

It will be seen that this division of birds according to their nidification, bears little relation to the character of the nest itself. It is a functional not a structural classification. The most rude and the most perfect specimens of bird-architecture are to be found in both sections. It has, however, a certain relation to natural affinities, for large groups of birds undoubtedly allied, fall into one or the other division exclusively. The species of a genus or of a family are rarely divided between the two primary classes, although they are frequently divided between the two very distinct modes of nidification that exist in the first of them.

All the Scansorial, and most of the Fissirostral birds, for example, build concealed nests ; and, in the latter group, the two families which build open nests, the swifts and the goat-suckers, are undoubtedly very widely separated from the other families with which they are associated in our classifications. The tits, also, vary much in their mode of nesting : some making open nests concealed in a hole, while others build domed or even pendulous covered nests, so that they all come under the same class. Starlings vary in a similar way. The Mynahs, like our own starlings, build in holes, the glossy starlings of the East (of the genus *Calornis*) form a hanging covered nest, while the genus *Sturnopastor* builds in a hollow tree. One of the most striking cases, in which one family of birds is divided between the two classes, is that of the finches ; for, while most of the European species build exposed nests, many of the Australian finches make them dome-shaped.

Turning now from the nests to the creatures who make them, let us consider birds themselves from a somewhat unusual point of view, and form them into separate groups, according as both sexes, or the males only, are adorned with conspicuous colours.

The sexual differences of colour and plumage in birds are very remarkable and have attracted much attention ; and in the case of polygamous birds have been well explained by Mr Darwin's principle of sexual selection. We can, to some extent, understand how male pheasants and grouse have acquired their more brilliant plumage and greater size, by the continual rivalry of the males, both in strength and beauty ; but this theory does not throw any light on the causes which have made the female toucan, bee-eater, parroquet, macaw and tit, in almost every case as gay and brilliant

as the male, while the gorgeous chatterers, manakins, tanagers, and birds of Paradise, as well as our own blackbird, have mates so dull and inconspicuous that they can hardly be recognised as the same species.

This anomaly can, however, now be explained by the influence of the mode of nidification, since I find that, with but very few exceptions, it is the rule—that *when both sexes are of strikingly gay and conspicuous colours, the nest is of the second class, or such as to conceal the sitting bird; while, whenever there is a striking contrast of colours, the male being gay and conspicuous, the female dull and obscure, the nest is open and the sitting bird exposed to view.* I will now proceed to indicate the chief facts that support this statement, and will afterwards explain the manner in which I conceive the relation has been brought about.

We will first consider those groups of birds in which the female is gaily or at least conspicuously coloured, and is in most cases exactly like the male.

- I. Kingfishers (Alcedinidæ). In some of the most brilliant species of this family the female exactly resembles the male; in others there is a sexual difference, but it rarely tends to make the female less conspicuous. In some the female has a band across the breast, which is wanting in the male, as in *Halcyon diops*. In others the band is rufous in the female, as in several of the American species; while in *Dacelo gaudichaudii*, the tail of the female is rufous instead of blue. In most kingfishers the nest is in a deep hole in the ground; in *Tanysiptera* it is said to be in a hole in the nests of termites, or sometimes in crevices under overhanging rocks.
- II. Motmots (Momotidæ). In these showy birds the sexes are exactly alike, and the nest in a hole under ground.
- III. Puff-birds (Bucconidæ). These birds are often gaily coloured; some have coral-red bills; the sexes are exactly alike, and the nest is in a hole in sloping ground.
- IV. Trogons (Trogonidæ). In these magnificent birds the females are generally less brightly coloured than the males, but are yet often gay and conspicuous. The nest is in a hole of a tree.
- V. Hoopoes (Upupidæ). The barred plumage and long crests of these birds render them conspicuous. The sexes are exactly alike, and the nest is in a hollow tree.

- VI. Hornbills (Bucerotidæ). These large birds have enormous coloured bills, which are generally quite as well coloured and conspicuous in the females. Their nests are always in hollow trees, where the female is entirely concealed.
- VII. Barbets (Capitonidæ). These birds are all very gaily coloured, and, what is remarkable, the most brilliant patches of colour are disposed about the head and neck, and are very conspicuous. The sexes are exactly alike, and the nest is in a hole of a tree.
- VIII. Toucans (Rhamphastidæ). These fine birds are coloured in the most conspicuous parts of their body, especially on the large bill, and on the upper and lower tail coverts, which are crimson white or yellow. The sexes are exactly alike, and they build always in a hollow tree.
- IX. Plantain-eaters (Musophagidæ). Here again the head and bill are most brilliantly coloured in both sexes, and the nest is in a hole of a tree.
- X. Ground cuckoos (Centropus). These birds are often of conspicuous colours, and are alike in both sexes. They build a domed nest.
- XI. Woodpeckers (Picidæ). In this family the females often differ from the males, in having a yellow or white, instead of a crimson crest, but are almost as conspicuous. They all nest in holes in trees.
- XII. Parrots (Psittaci). In this great family, adorned with the most brilliant and varied colours, the rule is, that the sexes are precisely alike, and this is the case in the most gorgeous families, the lorries, the cockatoos, and the macaws; but in some there is a sexual difference of colour to a slight extent. All build in holes, mostly in trees, but sometimes in the ground, or in white ants' nests. In the single case in which the nest is exposed, that of *Pezoporus formosus*, the bird has lost the gay colouring of its allies, and is clothed in sombre and completely protective tints of dusky green and black.
- XIII. Gapers (Eurylæmidæ). In these beautiful Eastern birds, somewhat allied to the American chatterers, the sexes are exactly alike, and are adorned with the most gay and conspicuous markings. The nest is a woven structure, *covered over*, and suspended from the extremities of branches over water.

- XIV. *Pardalotus* (*Ampelidæ*). In these Australian birds the females are often very conspicuous, having brightly-spotted heads. Their nests are sometimes dome-shaped, sometimes in holes of trees.
- XV. Tits (*Paridæ*). These little birds are always pretty, and many (especially among the Indian species) are very conspicuous. They always have the sexes alike, a circumstance very unusual among the smaller gaily-coloured birds of our own country. The nest is always covered over or concealed in a hole.
- XVI. Nuthatches (*Sitta*). Often very pretty birds, the sexes alike, and the nest in a hole.
- XVII. ——— (*Sittella*). The female of these birds is often the most conspicuous, being white- and black-marked. The nest is, according to Gould, "completely concealed among upright twigs connected together."
- XVIII. Creepers (*Climacteris*). In these the sexes are alike, or the female most conspicuous, and the nest is in a hole of a tree.
- XIX. *Estrela*, *Amadina*. In these genera of finches the females, although more or less different from the males, are still very conspicuous, having a red rump, or being white spotted. They differ from most others of the family in building domed nests.
- XX. *Certhiola*. In these pretty little American creepers the sexes are alike, and they build a domed nest.
- XXI. Mynahs (*Eulabes*, *Sturnidæ*). These showy birds have the sexes exactly alike. They build in holes of trees.
- XXII. *Calornis* (*Sturnidæ*). These brilliant metallic starlings have no sexual differences. They build a pensile covered nest.
- XXIII. Hangnests (*Icteridæ*). The red or yellow and black plumage of most of these birds is very conspicuous, and is exactly alike in both sexes. They are celebrated for their fine purse-shaped pensile nests.

It will be seen that this list comprehends six important families of *Fissirostres*, four of *Scansores*, the *Psittaci*, and several genera, with three entire families of *Passeres*.

The cases in which whenever the male is gaily coloured, the female is much less gay or quite inconspicuous, are exceedingly

numerous, comprising, in fact, almost all the bright coloured Passeres, except those enumerated in the preceding class, and far exceeding them in number. The following are the most remarkable :—

- I. Chatterers (Cotingidæ.) These comprise some of the most gorgeous birds in the world, vivid blues, rich purples, and bright reds, being the most characteristic colours. The females are always obscurely tinted, and are often of a greenish hue, not easily visible among the foliage.
- II. Manakins (Pipridæ.) These elegant birds, whose caps or crests are of the most brilliant colours, are usually of a sombre green in the female sex.
- III. Tanagers (Tanagridæ.) These rival the chatterers in the brilliancy of their colours, and are even more varied. The females are generally of plain and sombre hues, and always less conspicuous than the males.

In the extensive families of the warblers (Sylviadæ), thrushes (Turdidæ), flycatchers (Muscicapidæ), and shrikes (Laniadæ), a considerable proportion of the species is beautifully marked with gay and conspicuous tints ; but in every case the females are less gay, and are very often of the very plainest and least conspicuous hues. Now, throughout the whole of these families the nest is open, and I am not aware of a single instance in which any one of these birds builds a domed nest, or places it in a hole of a tree, or underground, or in any place where it is effectually concealed.

In considering the question we are now investigating, it is not necessary to take into account the larger and more powerful birds, because these seldom depend much on concealment to secure their safety. In the raptorial birds bright colours are as a rule absent ; and their structure and habits are such as not to require much protection. The larger waders are sometimes very brightly coloured in both sexes ; but they are probably little subject to the attacks of enemies since the scarlet ibis, the most conspicuous of birds, exists in immense quantities in South America. In game birds and water-fowl, however, the females are often very plainly coloured, when the males are adorned with brilliant hues ; and the abnormal family of the Megapodidæ offers us the interesting fact of an identity in the colours of the sexes (which in Megacephalon and Talegalla are somewhat conspicuous), in conjunction with the habit of not sitting on the eggs at all.

Taking the whole body of evidence here brought forward, embracing as it does almost every group of bright-coloured birds, it

will, I think, be admitted that the relation between the two series of facts in the colouring and nidification of birds has been sufficiently established. There are, it is true, a few apparent and some real exceptions, which I shall consider presently ; but they are too few and unimportant to weigh much against the mass of evidence on the other side, and may for the present be neglected. Let us then, consider what we are to do with this unexpected set of correspondences between groups of phenomena which, at first sight, appear so disconnected. Do they fall in with any other groups of natural phenomena? Do they teach us anything of the way in which nature works, and give us any insight into the causes which have brought about the marvellous variety, and beauty, and harmony of living things? I believe we can answer these questions in the affirmative ; and I may mention, as a sufficient proof, that these are not isolated facts, that I was first led to see their relation to each other by the study of an analogous though distinct set of phenomena among insects, that of protective resemblance and "mimicry."

On considering this remarkable series of facts, the first thing we are taught by them seems to be, that there is no incapacity in the female sex among birds, to receive the same bright hues and strongly contrasted tints with which their partners are so often decorated, since whenever they are protected and concealed during the period of incubation they *are* similarly adorned. The fair inference is, that it is chiefly due to the absence of protection or concealment during this important epoch, that gay and conspicuous tints are withheld or left undeveloped. The mode in which this has been effected is very intelligible, if we admit the action of natural and sexual selection. It would appear from the numerous cases in which both sexes are adorned with equally brilliant colours (while both sexes are rarely armed] with equally developed offensive and defensive weapons when not required for individual safety), that the normal action of "sexual selection" is to develop colour and beauty in both sexes, by the preservation and multiplication of all varieties of colour in either sex which are pleasing to the other. The female bird, however, while sitting on her eggs in an uncovered nest, is especially open to the attacks of enemies, and any modification of colour which rendered her more conspicuous would lead to her destruction and that of her offspring. All variations of colour in this direction in the female, would therefore sooner or later be exterminated, while such modifications as

rendered her inconspicuous, by assimilating her to surrounding objects, as the earth or the foliage, would, on the whole, be preserved the longest; and thus lead to the attainment of those brown or green and inconspicuous tints, which form the colouring (of the upper surface at least,) of the vast majority of female birds which sit upon open nests.

At the commencement of this article I have endeavoured to prove that the characteristic differences and the essential features of birds' nests are dependent on the structure of the species, and upon the present and past conditions of their existence. Both these factors are more important and less variable than colour; and we must therefore conclude that in most cases the mode of nidification (dependent on structure and environment) has been the cause and not the effect of the similarity or differences of the sexes as regards colour. When the confirmed habit of a group of birds was to build their nests in holes of trees, like the toucans, or in holes in the ground, like the kingfishers, the protection the female thus obtained, during the important and dangerous time of incubation, placed the two sexes on an equality as regards exposure to attack, and allowed "sexual selection" to act unchecked in the development of gay colours and conspicuous markings in both sexes.

When, on the other hand, (as in the tanagers and flycatchers) the habit of the whole group was to build open cup-shaped nests, in more or less exposed situations, the production of colour and marking in the female was continually checked by its rendering her too conspicuous, while in the male it had free play, and developed in him the most gorgeous hues. In cases, however, where there was more than usual intelligence and capacity for change of habits, the danger the female was exposed to by a partial brightness of colour or marking, might lead to the construction of a concealed or covered nest, as in the case of the tits and hangnests; so that the acquisition of colour and the modification of the nest might in some cases act and react on each other, and attain their full development together.

There exist a few very curious and anomalous facts in the natural history of birds which fortunately serve as a crucial test of the truth of this mode of explaining the inequalities of sexual colouration. It has been long known that in some species the males either assisted in or wholly performed the act of incubation. It has also been often noticed that in certain birds the usual sexual differences were reversed, the male being the more plainly coloured,

the female more gay and often larger. I am not, however, aware that these two anomalies had ever been supposed to stand to each other in the relation of cause and effect, till I adduced them in support of my views of the general theory of "Mimicry."* Yet it is undoubtedly the fact, that in the best known cases in which the female bird is more conspicuously coloured than the male, it is either positively ascertained that the latter performs the duties of incubation, or there are good reasons for believing such to be the case. The most satisfactory example is that of the gray phalarope (*Phalaropus fulicarius*, Linn.), the sexes of which are alike in winter, while in summer the female instead of the male takes on a gay and conspicuous nuptial plumage; but the male performs the duties of incubation, sitting upon the eggs, which are laid upon the bare ground.

In the dotterell (*Eudromias morinellus*) the female is larger and more brightly coloured than the male, and here, also, it is almost certain that the latter sits upon the eggs. The Turnices of India also have the female larger and often more brightly coloured; and Mr Jerdon states, in his "Birds of India," that the natives report that during the breeding season the females desert their eggs and associate in flocks, while the males are employed in hatching the eggs. In the few other cases in which the females are more brightly coloured the habits are not accurately known. The case of the ostriches and emeus will occur to many as a difficulty, for here the male incubates, but is not less conspicuous than the female; but there are two reasons why the case does not apply,—the birds are too large to derive any safety from concealment, and from enemies which would devour the eggs they can defend themselves by force, while to escape from their personal foes they trust to speed.

We find, therefore, that a very large mass of facts relating to the sexual colouration and the mode of nidification of birds, including some of the most extraordinary anomalies to be found in their natural history, can be shewn to have an interdependent relation to each other on the simple principle of the need of greater protection to that parent which performs the duties of incubation.†

* "Mimicry and other Protective Resemblances among Animals."—*Westminster Review*, July 1867.

† In his "Origin of Species," fourth edition, p. 241, Mr. Darwin recognises the necessity for protection as sometimes being a cause of the obscure colours of female birds; but he does not seem to consider it so very important an agent in

Considering the very imperfect knowledge we possess of the habits of most extra-European birds, the exceptions to the prevalent rule are few, and generally occur in isolated species or in small groups. The only marked exceptions I have been able to discover are the following:—

- I. King crows (*Dicrourus*). These birds are of a glossy black colour with long forked tails. The sexes present no difference, and they build open nests. This apparent exception may probably be accounted for by the fact that these birds do not need the protection of a less conspicuous colour. They are very pugnacious, and often attack and drive away crows, hawks, and kites; and as they are semi-gregarious in their habits, the females are not likely to be attacked while incubating.
- II. Orioles (*Oriolidæ*). The true orioles are very gay birds; the sexes are in many Eastern species either nearly or quite alike, and the nests are open. This is one of the most serious exceptions, but it is one that to some extent proves the rule; for in this case it has been noticed that the parent birds display excessive care and solicitude in concealing the nest among thick foliage, and in protecting their offspring by incessant and anxious watching. This indicates that the want of protection consequent on the bright colour of the female makes itself felt, and is obviated by an increased development of the mental faculties.
- III. Ground thrushes (*Pittidæ*). These elegant and brilliantly-coloured birds are generally alike in both sexes, and build an open nest. It is curious, however, that this is only an apparent exception, for almost all the bright colours are on the under surface, the back being usually olive green or brown, and the head black, with brown or whitish stripes, all which colours would harmonise with the foliage, sticks, and roots about the nest, and thus serve as a protection to the female bird.

modifying colour as I am disposed to do. In the same paragraph (p. 240) he alludes to the fact of female birds and butterflies being sometimes very plain, sometimes as gay as the males, but apparently considers this mainly due to peculiar laws of inheritance, which sometimes continue acquired colour in the line of one sex only, sometimes in both. Without denying the action of such a law (which Mr. Darwin informs me he has facts to support), I impute the difference, in the great majority of cases, to the greater or less need of protection in the female sex in these groups of animals.

- IV. *Grallina Australis*. This Australian bird is of strongly contrasted black and white colours. The sexes are exactly alike, and it builds an open clay nest in an exposed situation on a tree. This appears to be a most striking exception, but I am by no means sure that it is so. We require to know what tree it usually builds on, the colour of the bark or of the lichens that grow upon it, the tints of the ground, or of other surrounding objects, before we can say that the bird, when sitting on its nest, is really conspicuous. It has been remarked that small patches of white and black blend at a short distance to form grey, one of the commonest tints of natural objects.
- V. Sunbirds (*Nectarineidæ*). In these beautiful little birds the males only are adorned with brilliant colours, the females being quite plain, yet they build covered nests in the few cases in which the nidification is known. This is a negative rather than a positive exception to the rule, since there may be other causes besides the need for protection which prevents the female acquiring the gay colours of her mate. In this case, too, the facts are very imperfectly known, and there is one curious circumstance which tends to elucidate it. The male of *Leptocoma zeylanica* is said to assist in incubation. It is possible, therefore, that the group may originally have used open nests (which, for all we know, may still be the case in many species), and some change of conditions, leading the male bird to sit, may have been followed by the adoption of a domed nest.
- VI. Superb warblers (*Maluridæ*). The males of these little birds are adorned with the most gorgeous colours, while the females are very plain, yet they make domed nests. It is to be observed, however, that the male plumage is nuptial merely, and is retained for a very short time ; the rest of the year both sexes are plain alike. It is probable, therefore, that the domed nest is for the protection of these delicate little birds against the rain, and that there is some unknown cause which has led to the development of colour in the males only.

I think I have now noticed all exceptions of any importance to the law of dependence of sexual colour on nidification. It will be seen that they are very few in number, compared with those which support the generalization ; and in several cases there are cir-

cumstances in the habits or structure of the species that sufficiently explain them. If the views here advocated are correct as to the various influences that have determined the specialities of every bird's nest, and the general colouration of female birds, with their action and reaction on each other, we can hardly expect to find evidence more complete than that here set forth. Nature is such a tangled web of complex relations, that a series of correspondences running through hundreds of species, genera, and families in every part of the system, can hardly fail to indicate a true causal connexion; and when, of the two factors in the problem, one can be shewn to be dependent on the most deeply seated and the most stable facts of structure and conditions of life, while the other is a character universally admitted to be superficial and easily modified, there can be little doubt as to which is cause and which effect.

But the explanation of the phenomenon here attempted does not rest alone on the facts I have been able now to adduce. In the article on "Mimicry" already referred to, it is shewn how important a part the necessity for protection has played in determining the external form and colouration, and sometimes even the internal structure of animals.

As illustrating this latter point, I may refer to the remarkable hooked, branched, or star-like spiculæ in many sponges, which are believed to have the function chiefly of rendering them unpalatable to other creatures. The *Holothuridæ* or sea-cucumbers possess a similar protection, many of them having anchor-shaped spicules embedded in their skin, as the *Synapta*; while others (*Cuviera squamata*) are covered with a hard calcareous pavement. Many of these are of a bright red or purple colour, and are very conspicuous, while the allied *Trepang*, or *Beche-de-mer* (*Holothuria edulis*), which is not armed with any such defensive weapons, is of a dull sand- or mud-colour, so as hardly to be distinguished from the sea bed on which it reposes. Many of the smaller marine animals are protected by their almost invisible transparency, while those that are most brightly coloured will be often found to have some protection either in stinging tentacles like *Physalia*, or in a hard calcareous crust, as in the star fishes.

In the struggle for existence incessantly going on, protection or concealment is one of the most general and most effectual means of maintaining life, and it is by modifications of colour that this protection can be most readily obtained, since no other character

is subject to such numerous and rapid variations. The case I have now endeavoured to illustrate is exactly analogous to what occurs among butterflies. As a general rule, the female butterfly is of dull and inconspicuous colours, even when the male is most gorgeously arrayed ; but when the species is protected from attack by a disagreeable odour, as in the *Heliconidæ*, *Danaidæ* and *Acroëidæ*, both sexes display the same or equally brilliant hues. Any general theory of the phenomenon of colour in animals must deal with both these cases, as well as with the whole series of facts presented by every degree and kind of protective and imitative tinting.

To some persons it will perhaps appear that the causes to which I impute so much of the external aspect of nature are too simple, too insignificant, and too unimportant for such a mighty work. But I would ask them to consider that the great object of all the peculiarities of animal structure is to preserve the life of the individual, and maintain the existence of the species. Colour has hitherto been too often looked upon as something adventitious and superficial, something given to an animal not to be useful to itself, but solely to gratify man or even superior beings—to add to the beauty and ideal harmony of nature. If this were the case, then, it is evident that the colours of organized beings would be an exception to most other natural phenomena. They would not be the product of general laws, or determined by ever-changing external conditions ; and we must give up all inquiry into their origin and causes, since (by the hypothesis) they are dependent on a Will whose motives must ever be unknown to us. But, strange to say, no sooner do we begin to examine and classify the colours of natural objects, than we find that they are intimately related to a variety of other phenomena, and are like them strictly subordinated to general laws. I have here attempted to elucidate some of these laws in the case of birds, and have shewn how the mode of nidification has affected the colouring of the female sex in this group. I have before shewn (in the article on “Mimicry” already alluded to) to how great an extent, and in how many ways, the need of protection has determined the colours of insects, and of some groups of reptiles and mammalia. Lastly, I would call particular attention to the fact that the gay tints of flowers, so long supposed to be a convincing proof that colour has been bestowed for other purposes than the good of its possessor, have been shewn by Mr Darwin to follow the same great law of utility. Flowers do

not often need protection, but very often require the aid of insects to fertilize them, and maintain their reproductive powers in the greatest vigour. Their gay colours attract insects, as do also their sweet odours and honeyed secretions ; and that this is the main function of colour in flowers is shewn by the striking fact, that those flowers which can be perfectly fertilized by the wind, and do not need the aid of insects, *rarely or never have gaily coloured flowers.*

This wide extension of the general principle of utility to the colours of such varied groups, both in the animal and vegetable kingdoms, compels us to acknowledge that the "reign of law" has been fairly traced into this stronghold of the advocates of special creation. And to those who oppose the explanation I have given of the facts adduced in this paper, I would again respectfully urge that they must grapple with the whole of the facts, not one or two of them only. It will be admitted that, on the theory of evolution, as worked out in detail by Mr Darwin, a wide range of facts with regard to colour in nature have been co-ordinated and explained. Until at least an equally wide range of facts can be shewn to be in harmony with any other theory, we can hardly be expected to abandon that which has already done such good service, and which has led us to the discovery of so many interesting and unexpected harmonies among the most common (but hitherto most neglected and least understood), of the phenomena presented by organised beings.