

## A BIRD'S EGG.

BY ERNEST INGERSOLL.

A BIRD'S egg may seem to the casual reader a very trivial subject for a magazine essay; yet no less a man of letters than Thomas Wentworth Higginson declared it the most perfect thing in existence. Poulton, an Oxford savant, tells us that "the most superficial glance over a collection of birds' eggs reveals hosts of interesting problems"; to which Alfred Newton, of the British Museum, adds that "hardly any branch of the practical study of natural history brings the inquirer so closely in contact with many of its secrets." There seems then to be reasonable support for one who should attempt to write something readable under this head-line.

Why not? Observe the variety in size and shape and texture, note the elegance, diversity, and beauty of the markings.

Surely this diversity and beauty mean something, and are suggestive of entertaining facts and correlations.

Consider the shape, for instance—the contour. Some eggs are spheres, others ellipses, ovals, or ovoids, many are cones with a rounded base, and a few are almost double cones, but none is quite symmetrical. In their essential part—the yolk—all eggs alike are globular; for the yolk is only a single cell, enormously enlarged in the case of birds by the accretion within it, in the ovary, of a great quantity of food-material for the sustenance of the future embryo. Having been fertilized, it is drawn down into the oviduct, and there the yolk is covered with successive layers of "white," outside of which are formed the shell and its ornamentation.\*

\* This process is fully as follows: The yellow ball or yolk familiar to us consists of granular protoplasmic matter, built up in concentric layers, and all of it is intended to serve as nutriment for the prospective embryo, except the germinal vesicle—cicatricle or "tread," the nucleus of the original cell—which appears as a clearer particle, floating on the surface, and having a cordlike attachment to a similar mass in the centre of the yolk. This vesicle contains the formative part of the yolk, and is the point where fertilization takes effect and embryonic growth proceeds. The yolk is completed in the ovary and ovisac, after which it descends into the oviduct, where it is fertilized, unless this has already occurred, and receives its outer coverings. The first deposit upon the yolk-ball is of the albumen or "white," the innermost layer of which is drawn out, by the spiral rotation of the egg in its progress, into threads at its opposite poles. "These threads, which become twisted in opposite directions . . . are called 'chalazæ'; they are the 'strings' rather unpleasantly evident in a soft-boiled egg, but serve the important office of mooring and steadying the yolk in the sea of white by adhesions eventually connected with the membrane

which immediately lines the shell. They are also intrusted with the duty of ballasting, or keeping the yolk right side up. For there is a 'right side' to the yolk-ball, being that on which floats the cicatricle or 'tread.' This side is also the lighter, the germinal yolk being less dense than the yellow; and the chalazæ are attached a little below the central axis. The result is that if a fresh egg be slowly rotated on its central axis the tread will rise by turning of the yolk-ball in the opposite direction, till, held by the twisting of the chalazæ, it can go no farther; when, the rotation being continued, the tread is carried under and up again on the other side, resuming its superior position as before." (Coues.)

After all the layers of white have been formed comes the deposition of a tough outer membrane, the egg-pod; and invested with this the egg passes on into a dilatation of the oviduct, where a thick white fluid, charged with lime, is poured over it from numerous villi, and crystals of chalk are deposited in and upon the texture of the "pod," forming the shell, which varies in structure, as revealed by the microscope, in the different groups of ornithology.

Now why do not these envelopes follow the form of the yolk, and a purely spherical egg result? or, at any rate, why is there not a fixed form for all eggs? We can see no reason in the anatomy of the bird, but we may often find reasons for the shape of any particular egg in its later history.

It is noticeable, for instance, that the more spherical eggs, as those of owls, trogons, and the like, are usually laid in holes in the earth, rocks, or trees, where they cannot fall out of the nest, and that the eggs of the ordinary song-bird, which makes a well-constructed nest, are oval, while the slim, straight-sided, conoidal eggs, tapering sharply to a point, belong to birds that construct little or no nest—to the shore-birds, terns, guillemots, and the like. Why? Because these last drop them in small clutches, and with little or no preparation, upon sand or rock, where, were they spherical, they could only with difficulty be kept close beneath the sitting bird; but conical objects will tend always to roll toward a centre. An additional advantage is that eggs of the latter shape will take up less space—form a snugger package to be warmed. In the case of guillemots the single egg laid is especially flat-sided and tapering, and the species owes its perpetuation largely to this circumstance; since, were it not for the egg's toplike tendency to revolve about its own apex, the chances are that it would be pushed off the ledge of naked sea-cliff where the careless or stupid bird leaves it.

This suggests a word in reference to the popular fable that sitting birds carefully turn their eggs every day, or oftener, in order to warm them equally. No such thing is done, because unnecessary, since, as we have seen, the germinal part always rises to the top, and places itself nearest the influential warmth of the mother's body.

The texture of egg-shells varies greatly from the ordinary waxy appearance, and apart from the color—a most interesting matter, to be considered a few moments hence. Those laid in snug nests of warm materials have thinner shells than those laid upon the ground or in contact with substances that conduct away their heat rapidly. Many eggs exhibit a highly polished surface, a striking example being those of our common cat-bird; and many pure white eggs are porcelaneous in

texture, and, if they were not so fragile, would be prized as jewels, outshining pearls; but every one of this nature is laid in the darkness of a tree hole or earthen tunnel. The woodpeckers, kingfishers, and parrots furnish admirable examples, many of which are translucent, so that the contents shine through the shell and impart to it an opalescent beauty. That no such shining porcelaneous egg is ever exposed in an open nest may be because its glistening surface would attract eyes more greedy than æsthetic, but the true explanation is probably more prosaic. Tinamous lay opaque colored ones, resembling "more or less globular balls of highly burnished metal." Many water-fowl, particularly ducks, hatch eggs having an exterior so oily that it is difficult to write the cabinet number on them, and this may prevent the penetration of the dampness to which they are constantly exposed. In contrast to this is the chalky layer that half covers the true coat in certain sea-birds, the ani, and others. The pitting seen in those of the South African ostrich, the tubercles curiously covering the dark green eggs of the cassowary, and other peculiarities of grain, are due to varying structure.

An egg-shell consists of concretions of carbonate of lime (chalk), deposited in and upon the fibrous surface of the egg-pod, and smoothed and soldered together into polygonal plates of greater or less thickness, so that under the microscope the surface looks like a tessellated pavement. The microscope further discloses the interesting information that eggs of the different group of birds possess recognizable characteristics, so that a trained eye can tell, by examining a fragment of shell, the general character of the bird that laid it, if not its specific identity; and this ability has done service in enlarging our knowledge of fossil birds, some of whose eggs have been recovered unbroken. The shell is always permeated by minute canals that admit air to the growing embryo, for without the presence and aid of oxygen the processes of organic development could not go on. Close these pores by varnishing, and the embryo would quickly die; on the other hand, such an exclusion of the air is one of the methods in use for prolonging the edibility of fresh eggs by excluding air and microbes. As the embryo grows, the

air-pores enlarge, the shell becomes brittle, and its lining membrane splits at the large end, forming there a considerable cavity filled with air. When the chick has approached nearly to the time of bursting the shell, it ruptures the membrane—perhaps accidentally—and begins to breathe this air, and thus to get its lungs into working order. The beauty of this arrangement is that the tender youngling is thus provided with air warmed to the temperature of its blood, avoiding the chill of the outside atmosphere before its respiratory organs have grown strong enough to bear the shock. In order to enable it to break its way out of the shell, when its time comes, the tip of its soft little beak is armed with a temporary hard knob or excrescence, called an "egg-tooth," which falls off soon after the chick's emergence.

The thickest, strongest eggs are those of struthious birds, such as the cassowary, rhea, and ostrich, which make serviceable bottles and utensils for the natives of the countries they inhabit. In the case of the ostrich this extraordinary thickness of shell may perhaps have been acquired as a shield for the chick, not only from occasional exposure to the terrible heat of mid-day—for the nest is a mere hollow on the open plain—but to prevent undue radiation during the extreme cold of night on the African karroo or the Patagonian pampas. Nature sometimes overdoes the matter, however, since ostrich-breeders must frequently assist a young bird to escape from the egg if it is too weak to break. It is stated that the cock-bird does substantially the same thing, leaning upon and breaking eggs that seem to him overdue, and then "shaking out" the youngster by lifting and tearing the tough enveloping membrane. This looks like a highly purposeful instinct or great intelligence, but more likely it is due to a fit of that impatience and ferocity to which the male ostrich is extremely liable, so that the resulting advantage is quite unintentional.

The maintenance of an equable temperature at about 100° Fahr. is supposed to be necessary for successful incubation; but eggs must have a wide limit of endurance below this figure in some species, if not in all, as some birds breed not only near the poles, but positively in winter weather. This is true of ravens, several owls, and a few other boreal residents,

which habitually nestle before the snow has left the woods or ceased to fall. It must be supposed that the eggs of such species have a greater resistance to cold than those of birds accustomed to warm latitudes. Brehm states that it requires one and three-quarter hours to freeze a living egg at a temperature of 15° Fahr. above zero. Many of the water-birds and game-birds nesting on the ground, even in tropical regions, are careful to cover up their eggs, when they leave them, with grass, leaves, or, in the case of ducks, with the breast feathers that constitute the lining of the nest—a custom to which we owe the larger part of our supplies of eider-down. This serves the added purpose, of course, of concealment, but its primary service no doubt is that of blanketing the eggs. It is quite likely that out of this custom, carried to excess, grew the mound-building of the megapodes.

Another noteworthy fact in oölogy is the diverse number of eggs in a "clutch" (*i. e.*, the complement for a single normal brooding), laid by birds even of the same group; also at different times by the same species or individual. The ordinary number among the great majority of small woodland and field birds ranges from four to six. This drops to two in some families among the smaller birds, and rises to ten or twelve among the tit-mouses; most of the game-birds try to rear as many as a dozen young annually, while the pelagic wanderers restrict themselves to only one or two.

It will be interesting to glance through a classified list with an eye to this matter, and examine what can be learned as to reasons for this diversity. Taking five as the average clutch among the small singing-birds, we may regard that as the normal number—the expression of the resultant of counteracting vicissitudes in the struggle for existence—needful to the perpetuation of small birds under ordinary circumstances in their interproportionate plenty. Any considerable departure from this normal number in a species or family must then be accounted for by some specific or tribal peculiarity in circumstances.

Beginning with the ostrichlike group at the bottom of the list, we find ourselves face to face with an interesting state of things, to which the number of eggs is an index. Ostriches, rheas, and cassowaries incubate large clutches—a dozen or more

—those inhabiting the continents of Africa and South America, however, producing twice as many eggs annually as their relatives of Australia and the neighboring smaller islands.

Immediately following and contrasting with them are the three groups characterized by the curious elephant-footed, often gigantic moas, and similar birds of Madagascar, Mauritius, New Zealand, and the Papuan region, which have become extinct within the historic period, except the kiwis, to be spoken of later. All of these, so far as we know, laid only one egg at a time, which, plainly enough, was sufficient to keep the race going in the limited space afforded to each species by its island, but which did not suffice to prevent an almost immediate extinction of these species as soon as mankind discovered that the birds and their eggs were serviceable. But providence, or nature, or natural selection, or whatever has been the ruling influence in determining means and limits for animal life, seems never to have taken man into account.

Turning now to the sea-birds—penguins, grebes, auks, petrels, guillemots, tropic birds, pelicans, and the like—we find that none of them is in the habit of laying more than one egg, as all breed on such remote and inaccessible rocks, often in holes, that harm can rarely happen to their young, and therefore a very high percentage comes to maturity. Many of these breed in companies, and are so unacquainted with danger that they make no attempt to hide their eggs or to leave the nest when the place is visited by some wandering naturalist or egging party.

The habit of the king penguin deserves a note for itself. This big antarctic bird guards its one white egg from harm by carrying it, somewhat as a marsupial does its young, in a pouch formed by a fold of the skin of the belly between the thighs. Both sexes are provided with this contrivance during the breeding season, and relieve each other of the burden at intervals.

The gull tribe, however, are far more exposed to accident and enemies, both in adult life and as to their eggs and young, than are the penguins, petrels, etc., mentioned above; and here the rule is from two (skuas) to four (gulls and terns) eggs in a nest. When we come to the shore and marsh birds—the plovers, snipes, sandpipers, jacanas, all of which nestle on the

ground, usually near the shore of the sea or lakes—we judge them to be exposed to about the average of dangers, since their nest complement is from four to six; but their large tropical relatives, the sand-bitterns, seriemas, and trumpeter-birds, which reside in trees or bushes, and can well defend themselves, need lay only one or at most two eggs a season to maintain their full census. Similarly the Northern, tundra-loving cranes need raise few young, and hatch only two eggs; but when we come to the water-birds—the rails, gallinules, ducks, and geese—we find an extensive group whose nests average a dozen eggs in each set. Explanations are ready for this: the birds themselves are exposed to unusual peril, from weather as well as active enemies, since they mostly emigrate to the extreme North and nestle in the edges of marshes, where the sitting birds, eggs, and young are all subject to freezings, floods, and countless marauders, that depend largely upon them during the arctic summer, so that a heavy annual recruiting must be made to repair losses. Few birds are liable to so many misfortunes and mishaps and are so defenceless as the water-fowl, except perhaps the big and pugnacious swans, who can take good care of themselves, and lay only two eggs. The long-legged wading-birds also, such as the storks, ibises, herons, and the like, are fairly safe in the breeding season, because they nest on trees, as a rule, and consequently we here find only three or four young in the annual brood; so with the gannets, cormorants, and darters.

This brings us to the game-birds—the world-wide tribes of partridges, pheasants, grouse, turkeys, jungle-fowls, peacocks, and the like—which are of large size, run about on the ground, and are of interest to sportsmen and epicures. With few exceptions, these must put forth a large complement of eggs (eight to twenty) in order to bring to maturity enough young to replace the yearly mortality, for the ground-built homes and huddling chicks encounter a multitude of dangers to which birds in trees, or even the small-sized ground-nesters, are not exposed. The exception here singularly favors the rule, for the only member of this group that I know of laying less than six or eight eggs is the Thibetan pheasant *Plectrophenax*, which inhabits the heights of the Himalayas, where it has to contend with

only three or four nest-robbers, instead of the countless foes that infest the lower jungles; hence its ample breast warms but two eggs.

All the doves and pigeons lay only two eggs; but this seems to be due to the fact that their extraordinary powers of flight give them, as adults, unusual immunity from capture and famine, rather than to any special safety pertaining to their method of nidification.

As for birds of prey, the vultures and sea eagles lay, some one, others two eggs at a time, except the common "Egyptian" vulture of the Mediterranean countries, which often nourishes four fledglings; and this exception may possibly be a comparatively recent acquirement to meet the persecution which this species has undergone at the hands of man during the past four or five thousand years. Hawks and owls in general have four or five eggs, and as this is about the average number of the small birds on which they largely prey, it seems evident that their chances of life and the difficulty of sustaining it are, on the whole, no less than are met with by their victims. The owls, however, vary much among themselves in this respect, the snowy and hawk owls, whose breeding-home is in the snowy North, where a nest in the tundra moss is accessible to every marauder, and the burrowing owls, whose underground homes are constantly robbed, being obliged to lay twice as many eggs as the remainder of the family in order to overcome the high percentage of casualties due to these unfortunate situations.

An odd feature in the nidification of some of the arctic-breeding owls, where the nesting must take place at an unseasonably early and cold date in order to give the fledglings time to reach mature strength before the succeeding winter assails them, is that these birds deposit their eggs at intervals of a week or ten days. In this way the mother can envelop in her plumage and keep thoroughly warm one egg and a callow fledgling at a time, and is assisted, in respect to the later eggs and fledglings, by the warmth of the older young in the nest.

The parrots are a widespread and numerous tribe, and none need lay more than two eggs, for they protect them in deep holes in the earth or in trees, and are able to defend them. The same is true of the toucans; while the hornbill,

by sealing itself (the female) up in its little cavern during nidification, is so adequately protected that a single egg in each family suffices to keep the race going; since practically every one is brought to maturity. Of the host of smaller and weaker birds nestling in cavities, two, three, or four eggs are the usual quota. This brings us up to the tribes of little singing-birds with which we started, whose average is about five; but a few interesting exceptions may be noted. Our whippoorwills and night hawks, for instance, lay only two eggs. These are placed on the ground in the woods, surrounded by no nest, and are so precisely the color of the dead leaves that nothing but the merest accident would lead to their discovery by the eye alone. The same is eminently true of the bird itself. Here we have one of the cases—more rare than has been supposed—where there seems to be tangible evidence of protective resemblance being of actual service to its possessor. A similar economy in racial loss has been reached by the extensive tribe of South American ant thrushes through forming their nests into impregnable castles of thorn; while none of the almost uncatchable humming-birds needs to lay more than two eggs in order to recruit the ranks of its species to the full quota permitted it in the numerical adjustment of local bird life.

I have gone into this matter somewhat at length, though by no means exhaustively, because I am not aware that the matter has ever been exploited, and because it embodies a general law or principle that *the nest complement of eggs of any bird is in exact proportion to the average danger to which that species is exposed*. I believe that this factor is fairly constant for species or tribes of similar habits, and that exceptions indicate peculiarities of circumstances, which in many cases we can easily perceive, because I believe that nature is strictly economical of energy, allowing no more eggs to be laid, and consequently young to be produced, than the conditions justify in each case. Thus the uniformity of avine population—the balance of bird life—is maintained.

Another derivative generalization is, that although by ingenuity in nest-building or other acquirement an individual or species may seem to benefit itself, this benefit does not accrue to the total en-

hancement of that species or race (in respect to numbers, at least), because nature counteracts the effort towards numerical improvement by reducing proportionately the fecundity or reproductive ability in that group.

Two broods are regularly hatched during the summer by many of the smaller birds, and all will try to bring out a later brood if they lose the first one. No migratory bird breeds in its winter home, nor any bird out of its proper season except when changed by domestication. Some wild birds, however, will continue to produce many eggs when all but one have been removed, in an effort to complete a nest complement, and these later eggs are likely to be deficient in size and color. This pathetic constancy is taken advantage of in Jutland by the islanders, who day after day gather the eggs of the sheldrake, which resorts to their coasts to breed in artificial burrows; and it is the basis of profit in rearing domestic poultry. It seems to show that birds are able to count up to the proper limit of their nest complement, or, at any rate, to know when that number has been reached, and cease oviposition accordingly. Most wild birds, however, will not make the continued effort to escape disappointment, and will abandon a despoiled nest, or content themselves with rearing the one egg left to them.

Let us turn next for a few moments to the matter of the size of eggs, which vary in capacity from the tiny humming-bird's translucent pearl, filled by a rain-drop, to the two-gallon measure that would not overflow an egg-shell of the gigantic æpiornis, equal to a gross of ordinary hen's eggs. A curious and suggestive fact, however, is that were you to spread out a collection of eggs according to size, grading them carefully from the least to the greatest, you would find that this gradation did not at all correspond with a similar arrangement of the bodies of the mother-birds; in other words, birds of like size do not always lay eggs of equal bigness. I am speaking now, of course, of *races*. Hewitson's standard work on British birds' eggs tells us, for instance, that the raven and guillemot are of about equal bulk, but that their eggs vary as ten to one, the latter's being as big as those of an eagle. The English snipe and blackbird differ little in weight, but the former's eggs are as large as those of a partridge.

Still more remarkable for disproportionate bigness are the eggs of the Australian megapodes, especially *Megapodius tumulis*, which measure  $3\frac{1}{4}$  by  $2\frac{1}{2}$  inches, although the hen is only about the size of a common fowl; and the eggs of the extinct moas, æpiornids, and queer-looking existing kiwis (*Apteryx*), are yet more disproportionate in magnitude. The smallest egg, relatively, of all birds, is that of the parasitic European cuckoo, a fact explained by the necessity she is under of carrying it in her bill to the nest of its future foster-parents.

My friend Mr. George Iles, of New York, first called my attention to the significance of these facts, which he regarded as of high philosophical import, in view of the coincidence that the chicks that came out of relatively large eggs are highly precocious, being able to run about at once and care for themselves, while those hatched from eggs small as compared with the mother's size require much parental care and training in order to survive. But I am inclined to think my friend has made too much of this.

It is true that the young of those birds laying proportionately large eggs are precocious, but it is also true that there are many birds—a majority, indeed—whose young are equally precocious yet whose eggs are of normal relative bulk; for that matter, wide variation in dimensions may be observed between good eggs of the same species or individual. This is, in fact, a matter of organization far wider than any account of the egg alone could complete. All the small land-birds and birds of prey (*Gymnopedes*) are hatched quite naked, but soon assume a downy covering, replaced by feathers before they are ready to leave the nest. In another class, perhaps numerically smaller, the young one is not hatched until the second stage has been reached, so that the downy covering is obtained before leaving the shell; such are the domestic fowls, runners, sea-birds, etc. (*Dasypedes*). There remain a very few (the mound turkeys, *Tallegallus*) where the young are born in the third stage, that is, fully fledged and able to fly; and it is well they should be, for in some of the species, at least, no old ones are at hand to help them, parental duty ending as soon as the pair have made a mound of rotting vegetation and left the eggs buried therein, to be hatched by chem-

ical heat in this most primitive of artificial incubators or hot-beds.

It is evident that when a young bird is required to remain inside an egg until it has reached an advanced degree of growth it must be provided not only with a larger chamber, but with a greater supply of nourishment (food-yolk) for its prolonged embryonic sustenance; and this implies just so much more drain upon the physical resources of the mother, amounting in the case of the kiwi to the production of an egg equal to nearly a quarter of her total weight. It is plain that few such eggs can be produced by a single mother. Hence we find that in every case where eggs of excessively disproportionate bulk are laid only a single egg is deposited at one breeding, and that, as a rule, few eggs in a brood mean relatively large ones—even down to humming-birds.

A coincidence between this relative bigness of egg and a low degree of mental endowment also certainly exists, but if there be any genetic relation between the two facts it must be widely indirect.

Now let us take up the more pleasing study of ornamentation—what it is, and what is its purpose, if it has any.

“The first thing which strikes the eye of one who beholds a large collection of egg-shells is the varied hues of the specimens. Hardly a shade known to the colorist is not exhibited by one or more, and some of these tints have their beauty enhanced by the glossy surface on which they are displayed, by their harmonious blending, or by the pleasing contrast of pigments which form markings as often of the most irregular shape.”

That is a flower from the desert of the *Encyclopædia Britannica!*

There is no need to go into a description of these markings here, since the accompanying illustrations show them in the fullest variety that pictures can, and I may hasten on to broader considerations. The colors flow from pigment-pores in the uterine dilatation of the oviduct where the shell is formed, and partially accompany that process, all eggs showing submerged stains; but they are for the most part laid on after the shell has been finished, and the streaking and marbling distinguishing many are due to the slow progress and rotation of these kinds while the color is still exuding upon them. Newly laid eggs will some-

times smear, or the color may be washed off. Mr. Hewitson, the pioneer of British authorities on oölogy, ascertained long ago that “fear, or anything which may affect the animal functions, influences the color” of a bird’s egg, and says that the eggs of birds he has captured on their nests during the time that they were laying, and has kept in close confinement, have thus been deprived of much of their color. Age showed itself in a similar way, size and color increasing from youth to maturity, and declining beyond that.

Spectrum analysis shows that all the many tints of birds’ eggs, multiplied and varied by blending, immersion in the shell, etc., are due to seven pigments, each so singular as to merit a name. Their chemical properties closely connect them with hemaglobin, the coloring matter of the red corpuscles of the blood, and with the bile pigments, the latter lot furnishing blues and yellows, which in mixtures form various clear greens. The ordinary color of such eggs as are not white is some tint of blue or green, varying in one direction towards olive, and in the other to “robin’s-egg” blue; and the commonest pigment in markings is reddish-brown, rarely absent in some tint. Where an egg is self-colored, the substance of the shell appears to be dyed, and any spots are applied later, as upon white eggs. Many have an incomplete top-coat of chalky material, but I believe that in every such one the ground tint is blue or green.

Some eggs are speckled or blotched all over nearly uniformly, but in most the markings are densest around the larger end, where they form a pretty wreath—the record apparently of a period of rest and pressure against a zone of pigment-pores. The egg passes down the oviduct large end first (although the opposite progress, like a round wedge, would seem at first glance more natural), because that is head-foremost for the embryo, following the rule of animal births.

While the eggs of some birds are remarkably constant in color and markings, most of them exhibit considerable variety and inconstancy, amounting to diversity of ground tint as well as of ornamentation. Spotted examples of normally plain eggs, and the opposite, are frequent occurrences.

These particulars have been given not

only because they were thought to be interesting in themselves, but because they show how purely a matter of organic function is the painting of a bird's egg—something over which the hen has no voluntary control whatever.

The why and wherefore of the colors of birds' eggs has been a favorite theme for speculation, from the quaint surmising of Sir Thomas Browne to the solemn guess-work of Shufeldt, in his ten "biological laws explanatory of the variation in color of the shells of the eggs in class Aves."\* Hewitson piously concludes that the beauty of these elegant and often exquisitely attractive objects is intended for the delight of human eyes; hence, as he says, eggs simply white are put out of sight in holes! He also sees in the larger number of eggs laid by game-birds a provision by a benevolent Providence for the joy of the sportsman and the delectation of the epicure. Next comes a man who assures us that the colors of eggs are due to the influence of their respective surroundings on the imagination of the hen birds—the old story of Jacob's little trick on Laban in the matter of young cattle. This school instances as an example the red blotches prevalent on the eggs of falcons, regarded by it as a record of the bloody experiences of the parents; but it does not explain why the equally rapacious owls produce pure white eggs, or the bloodthirsty skuas and shrikes lay greenish ones. Other equally fallacious theorizings might be noted.

Mr. Darwin seems to have left the subject untouched, but Mr. Alfred Russel Wallace, who found in the matter of color in animal life a somewhat new field for the exploitation of his view of natural selection, has devoted much space, in his *Darwinism* and elsewhere, to an attempt to show that the eggs of birds are examples of protective mimicry in color, as a result of natural selection. More recently Poulton has indorsed, if not enlarged, this proposition; yet I believe its unsubstantiality can be made evident.

Mr. Wallace begins with the conspicuous fact that birds that breed in "concealed places" lay white or very pale eggs. "Such is the case with the kingfishers, bee-eaters, penguins, and puffins, which nest in holes in the ground; with

the great parrot family, the woodpeckers, the rollers, hoopoes, trogons, owls, and some others, which build in holes in trees or other concealed places; while martins, wrens, willow warblers, and Australian finches build domed or covered nests, and usually have white eggs." But to this there are many exceptions on both sides. The nuthatches, titmouses, eaves swallows, orioles and caciques, magpies, and many more, lay brightly colored eggs, equally well hidden from view, while a considerable number of birds place white or whitish eggs in nests near the ground, quite open to observation. Mr. Wallace argues in respect to these that the hens cover them when they leave them, and all sit very close; but of birds having the former habit, as many lay inconspicuous brown eggs (and cover them) as lay white ones, and experience disproves the latter statement. It is worth while to recall the fact in this connection, as tending to show lack of adequate fulfilment of the alleged purpose, that many members of this class (hole-nesters) must incubate more than the average number of eggs annually to keep their races going. In respect to the pigeons, most of which lay two white eggs on a loose platform, Mr. Wallace simply asserts that it is hard to see their eggs anyhow, because, in gazing upward, you look right through the nest, and can't distinguish them from patches of sky, while they are concealed from the sight of one looking downward by the foliage; but, if the latter is true, why do not the eggs appear plainly from below as white spots against that green shield of leaves?

Similarly he dismisses the diversity of brightly colored eggs laid by the woodland and field birds with the remark that "it is very doubtful whether they are really so conspicuous when seen at a little distance among their usual surroundings." The same argument is used in reference to the zebra, the tiger, brilliant insects, etc., which seem as far as possible from "adaptive" to anything short of an environment of circus posters; and really it is begging the question.

The theory of "adaptive coloration," then, as applied to birds' eggs, derives support only from a minority of circumstances—those instances, such as the shore-birds, many game-birds, the whip-poorwill and its kindred, the coots and some ground-breeders, that make no nest to speak of, and whose eggs certainly do

\* A pompous waste of valuable space in the annual report of the United States National Museum (Smithsonian Institution) for 1884.

resemble the beach or leaves or marsh upon which they lie, sometimes in a very striking degree, so that *human* collectors find it exceedingly difficult not to overlook them when in search of specimens.

Now right here seems to lie a cardinal weakness in the position taken by Wallace and his disciples. They seem to look at everything from the point of view of the human eye alone. This is only the long-despised teleology returning in a new guise. Wallace scouts the notion that the beauty of the eggs he admires is addressed to man's eye and æsthetic appreciation, yet implies that the browns and mottlings of a plover's egg have been perfected in order that one of his collectors may not easily see it!

We cannot properly include man in any supposed scheme of protective mimicry, or other phase or purpose of natural selection, or any other channel of animal evolution. He is probably too recent to have seriously influenced any organic changes adaptive toward him as either friend or enemy; and in civilized life, at least, he is too rapid for animal development to keep up with. As a matter of fact, such protection as is here being considered is totally unavailable against man. The savage new-comers to the islands inhabited by the dodo, moa, æpiornis, and their relatives quickly exterminated those birds, in spite of the fact that their eggs were hardly distinguishable from the dead grass upon which they rested. The fact that its eggs are sometimes almost invisible against the sky (*vide* Wallace) did not save our passenger pigeon from the next thing to extinction within a few years after the West began to be peopled. It is, indeed, against the *brute* robber—not against man—that birds must guard themselves and be guarded, and to few such is the color of the eggs likely to be of any consequence.

Who are these brute nest-robbers? First, perhaps, other birds, from the vulture that is reported to take a stone in its beak to enable it to smash the ostrich's egg, down to the swaggering blue-jay; but crows are the worst hereabouts. Do these depend on a glitter of color accidentally calling their attention to the tidbit? Not at all. You may see them diligently "prospecting" from tree to tree, searching every branch, and succeeding too well. Many mammals are despoilers of bird homes, none so ruthlessly as the cats. Mice eat eggs, and mice are

enormously numerous in the farming districts. Muskrats, otters, minks, etc., prowl around the marshes and raid the homes of water-birds; skunks, foxes, and weasels will take an occasional nest on the ground, but to think of one of them cocking his eye aloft and mistaking eggs for clouds is food for amusement. Barring house cats, almost the only quadrupeds the tree-nesting birds of the United States need fear are weasels and some squirrels; although the tropical list includes wild-cats, several rodents, bats, and, most of all, monkeys. All these animals make regular explorations for *nests*, chiefly hoping to find young birds; and we may be sure that many more "adaptively colored" eggs fall to their share than are overlooked.

Another dangerous marauder is the snake; it is the especial dread of the troglodytes—birds that live in holes impenetrable to larger thieves. With us the blacksnake does most damage; but egg-eating serpents are common the world over, and Africa has a species that subsists almost wholly on this food, and has special arrangements in its throat for breaking the shells. Now a snake cannot see well at all, and seems to have no perception of color whatever. In its search for eggs or young birds the creature depends altogether on the senses of touch and taste that are combined with superlative delicacy in its forked tongue. It ascends bush after bush, climbs rocks, stumps, and trees, crawls through the grass, exploring blindly, touching everything as it goes, until a prevalence of bird-traces warns it to examine carefully every spot within reach, and at last it hits upon a nest. Of course in all these forays the alarm and fury of the poor owners and their friends assist the marauder to discover the object of his search, although they are often able to prevent him from securing the prize.

Substantially the same thing is true of the four-footed nest-hunters—the weasel, squirrel, skunk, and so on. They trust to their noses far more than to their eyes to discover birds' nests, as well as other prey; furthermore, it must be remembered that nearly all the mammals and many of the serpents are nocturnal, hunting in the dark, when color disappears as a factor in the question of safety. Moreover, none of these animals are strangers in the limited district where they work.

They live there as steadily as do the birds themselves—more continuously, as a rule. Day and night they are prowling about, and keeping themselves well informed of what is going on in their little world. Few birds' nests can be built and occupied without their being aware of it; and that all are not robbed as fast as they are filled is due principally to the facts that "the game is not worth the candle," and that the birds make many a successful battle in defence of their treasures. A friend of mine recently hatched out a brood of ducks in a remote locality where no fowls had ever lived before, and lost them all in a few days from wild animals whose presence he had not suspected, but who had kept well posted as to his doings.

Now I do not mean to say that the dull, assimilative colors of certain classes of eggs do not sometimes lead to their escaping hostile notice, and by so much contribute to the survival of the family; nor do I mean to deny that such adaptive and useful resemblances may be due in some cases partly or wholly to natural selection, with which I have no quarrel whatever; but I do fail to see that this is either sufficiently universal or sufficiently effective to establish a firm basis for any such theory as has been reviewed.

I have often wondered why Mr. Wallace never adduced birds' eggs as examples of recognition colors, where, it seems to me, he might have made a better case. It is a well-known fact that birds occasionally lay in one another's nests, and from what I know I am inclined to think that this most often happens between birds whose eggs are plain or closely similar in markings, so that a mistake might be excusable "as between friends." The supposition that the varied colorings are serviceable in enabling the owners to recognize their property would account for the whiteness of eggs laid in dark holes, where no markings could easily be noticed, and would give a reasonable explanation of the individual variety, within specific or tribal likeness, which characterizes all eggs. However near alike they may seem to our eyes, doubtless a mother-bird would be capable of selecting her own out of a hundred jumbled together, so that, on the whole, this theory seems to me much more tenable than the other one.

I do not believe, however, that the coloration of the eggs of birds is truly

explained by either of these hypotheses, however much nature may utilize the existing facts in the apparent direction of either, and even though I am willing to admit freely that the influences of natural selection may have been, here and there, instrumental in bringing out this or that color or pattern. I believe, on the contrary, that these colors and patterns are a by result of peculiarities of organization as intimate as is the microscopic structure of the shell, and that if natural selection is to get credit for it at all, it is only so far as protective colors in eggs may sometimes have followed, as a secondary, or accidentally correlated, "by product," the tendency to produce protectively colored plumage. In other words, there is a constant relation between the pigments that paint the feathers and those that paint the egg; sometimes they are suppressed altogether (but white birds often lay highly colored eggs, *e. g.*, gulls); sometimes they produce a similar effect, giving the eggs the general tone of the *mother's* plumage, as in the whippoorwill, shore-birds, and others; and sometimes they produce upon eggs a color effect entirely different from that of the parent's plumage. It must not be forgotten that the tint of a pigment applied to an egg-shell might be widely removed from that of the same pigment dyeing a feather; and it is also necessary to remember that many plumage colors are not pigmentary at all, but purely optical effects of interference of the light reflected. Such is the case with the burnished back of the turkey, the jewel-like brilliance of the humming-bird's throat, the glittering green of trogons, and so on, and it is noteworthy that perhaps all the birds thus gorgeously apparelled lay white eggs!

It is justly believed, indeed, that in the beginning all birds produced white, unspotted, soft-shelled eggs, following the rule of the reptilian class, from which birds have no doubt arisen. How the change toward a hard and differently shaped shell and the addition of colors came about we may never know. It is the great obstacle to this line of investigation that almost no historical evidence is in existence, or is ever likely to be; and yet in the past is hidden, no doubt, the key to the problem oölogy now presents when approached by the evolutionist.