

they shift from place to place in its quest, and may thus find an easy way of accounting for their uncertain appearance. The great band of Nutcrackers (*Nucifraga caryocatactes*) which in the autumn of 1844 pervaded Western and Central Europe¹ may also have been actuated by the same motive, but we can hardly explain the roaming of all other Birds so plausibly. The inroads of the Waxwing (*Ampelis garrulus*) have been the subject of interest for more than 300 years, and by persons prone to superstitious auguries were regarded as the forerunners of dire calamity. Sometimes years have passed without its being seen at all in Central, Western, or Southern Europe, and then perhaps for two or three seasons in succession vast flocks have suddenly appeared. Later observation has shown that this species is as inconstant in the choice of its summer-as of its winter-quarters, and though the cause of the irregularity may possibly be of much the same kind as that just suggested in the case of the Crossbill, the truth awaits further investigation.² One of the most extraordinary events known to ornithologists is the irruption into Europe in 1863 of Pallas's Sand-Grouse (*Syrhaptes paradoxus*). Of this Bird, hitherto known only as an inhabitant of the Tartar steppes, a single specimen was obtained at Sarepta on the Volga in the winter of 1848. In May 1859 a pair is said to have been killed in the Government of Vilna on the western borders of the Russian Empire, and a few weeks later five examples were procured, and a few others seen, in Western Europe—one in Jutland, one in Holland, two in England, and one in Wales. In 1860 another was obtained at Sarepta; but in May and June 1863 a horde computed to consist of at least 700 individuals overran Europe—reaching Sweden, Norway, the Feroes, and Ireland in the north-west, and in the south extending to Sicily and almost to the frontiers of Spain. On the sandhills of Jutland and Holland some of these birds bred, but war was too successfully waged against the nomades to allow of their establishing themselves, and a few survivors only were left to fall to the gun in the course of the following winter and spring.³ In the summer of 1872, another visitation to Great Britain was reported, but if it really took place it must have been that of a very small number of birds, and it was not observed on the Continent. Speculation has amused itself by assigning causes to these movements but the real reason remains in doubt.

We cannot quit the subject of Migration, however, without referring to the wonderful assemblages of Birds which have in various places been time and again noticed by night. Towards the close of summer, in dark, cloudy, and still weather, it not unfrequently happens that a vast and, to judge from their cries, heterogeneous concourse of Birds may be heard hovering over our large towns. The practical ornithologist will recognize the notes of Plover, Sandpiper, Tern, and Gull, now faint with distance and then apparently close overhead, while occasionally the stroke of a wing may catch his ear, but nothing is visible in the surrounding gloom. Sometimes but a few fitful wails are heard, of which only an expert listener will know the meaning. At others the continuous Babel of sounds will ensure the attention of the most incurious. It is supposed that these noises proceed from migrating birds, which, having lost their way, are attracted by the glare of the street-lamps, but far too little has been observed to remove the obscurity that in a double sense surrounds them and to enable us to come to any definite conclusion. It must be added also that such a concourse has been noticed where the fascina-

¹ Bull. de l'Acad. de Bruxelles, xi. p. 298.

² Cf. Yarrell, *Brit. Birds*, ed. 4, i. pp. 524-532.

³ *Ibis*, 1864, pp. 185-222. A few additional particulars which have since become known to the writer are inserted above.

tion of light did not exist, for Lord Lilford has recorded⁴ how that once at Corfu he was startled by an uproar as if all the feathered inhabitants of the great Acherusian Marsh had met in conflict overhead, but he could form no conception of what birds produced the greater part of it.

SONG.

Leaving then the subject of Migration, the next important part of the economy of Birds to be considered is perhaps their Song—a word, however, in a treatise of this kind to be used in a general sense, and not limited to the vocal sounds uttered by not more than a moiety of the feathered races which charm us by the strains they pour from their vibrating throat,—strains indeed denied by the scientific musician to come under cognizance as appertaining to his art, but strains which in all countries and in all ages have conveyed a feeling of true pleasure to the human hearer, and strains of which by common consent the Nightingale is the consummate master. It is necessary in a philosophical spirit to regard every sound made by a Bird under the all-powerful influence of love or lust as a "Song." It seems impossible to draw any but an arbitrary line between the deep booming of the Emeu, the harsh cry of the Guillemot (which, when proceeding from a hundred or a thousand throats, strikes the distant ear in a confused murmur like the roar of a tumultuous crowd), the plaintive wail of the Plover, the melodious whistle of the Widgeon, "the Cock's shrill clarion," the scream of the Eagle, the hoot of the Owl, the solemn chime of the Bell-bird, the whip-cracking of the Manakin, the Chaffinch's joyous burst, or the hoarse croak of the Raven, on the one hand, and the bleating of the Snipe⁵ or the drumming of the Ruffed Grouse, on the other. Innumerable are the forms which such utterances take. In many birds the sounds are due to a combination of vocal and instrumental powers, or, as in the cases last mentioned, to the latter only. But, however produced—and of the machinery whereby they are accomplished there is not room here to speak—all have the same cause and the same effect. The former has been already indicated, and the latter is its consummation. Almost contemporaneously with the hatching of the Nightingale's brood, the song of the sire is hushed, and the notes to which we have for weeks hearkened with rapt admiration are changed to a guttural croak, expressive of alarm and anxiety, inspiring a sentiment of the most opposite character. No greater contrast can be imagined, and no instance can be cited which more completely points out the purpose which "Song" fulfils in the economy of the bird, for if the Nightingale's nest at this early time be destroyed or its contents removed, the cock speedily recovers his voice, and his favourite haunts again resound to his bewitching strains. For them his mate is content again to undergo the wearisome round of nest-building and incubation. But should some days elapse before disaster befalls their callow care, his constitution undergoes a change and no second attempt to rear a family is made. It would seem as though a mild temperature, and the abundance of food by which it is generally accompanied, prompt the physiological alteration which inspires the males of most birds to indulge in the "Song" peculiar to them. Thus after the annual moult is accomplished, and this is believed to be the most critical epoch in the life of any bird, cock Thrushes, Skylarks, and others begin to sing, not indeed with the jubilant voice of spring but in an

⁴ *Ibis*, 1865, p. 176.

⁵ The true cause of this sound has been much discussed, but Herr Meves's explanation (*Proc. Zool. Soc.* 1858, p. 302), based on experiment, seems to be correct, though it is far from being generally accepted.

uncertain cadence which is quickly silenced by the super-vention of cold weather. Yet some birds we have which, except during the season of moult, hard frost, and time of snow, sing almost all the year round. Of these the Red-breast and the Wren are familiar examples, and the Chiff-chaff repeats its two-noted cry, almost to weariness, during the whole period of its residence in this country.¹

Akin to the "Song" of Birds, and undoubtedly proceeding from the same cause, are the peculiar gestures which the males of many perform under the influence of the approaching season of pairing, but these again are far too numerous here to describe with particularity. It must suffice to mention a few cases. The Ruff on his hillock in a marsh holds a war-dance. The Snipe and some of his allies mount aloft and wildly execute unlooked-for evolutions almost in the clouds. The Woodcock and many of the Goatsuckers beat evening after evening the same aerial path with its sudden and sharp turnings. The Ring-Dove rises above the neighbouring trees and then with motionless wings slides down to the leafy retreat they afford. The Capercally and Blackcock, perched on a commanding eminence, throw themselves into postures that defy the skill of the caricaturist—other species of the Grouse-tribe assume the strangest attitudes and run in circles till the turf is worn bare. The Peacock in pride spreads his train so as to shew how nearly akin are the majestic and the ludicrous. The Bower-bird, not content with his own splendour, builds an arcade, decked with bright feathers and shining shells, through and around which he paces with his gay companions. The Larks and Pipits never deliver their song so well as when seeking the upper air. Rooks rise one after the other to a great height and, turning on their back, wantonly precipitate themselves many yards towards the ground, while the solemn Raven does not scorn a similar feat, and, with the tenderest of croaks, glides supinely alongside or in front of his mate.²

NIDIFICATION.

Following or coincident with the actions just named, and countless more besides, comes the real work of the breeding-season, to which they are but the prelude or the accompaniment. Nidification is with most birds the beginning of this business; but with many it is a labour that is scamped if not shirked. Some of the Auk tribe place their single egg on a bare ledge of rock, where its peculiar conical shape is but a precarious safeguard when rocked by the wind or stirred by the thronging crowd of its parents' fellows. The Stone-Curlew and the Goatsucker deposit their eggs without the slightest preparation of the soil on which they rest; yet this is not done at haphazard, for no birds can be more constant in selecting, almost to an inch, the very same spot which year after year they choose for their procreant cradle. In marked contrast to such artless care stand the wonderful structures which others, such as the Tailor-bird, the Bottle-Titmouse, or the Fantail Warbler build for the comfort or safety of their young. But every

Varieties of nests.

¹ A curious question, which has as yet attracted but little attention, is whether the notes of the same species of Bird are in all countries alike. From his own observation the writer is inclined to think that it is not, and that there may exist "dialects," so to speak, of the song. (*Cf. Gloger, Jour. für Orn.* 1859, p. 398.)

² No comprehensive account of the Song of Birds seems ever to have been written. The following may be cited as the principal treatises on the subject:—Barrington, *Phil. Trans.* 1773, pp. 249-291; Kennedy, *N. Abhandl. baier. Akad. (Phil. Abhandl.)* 1797, p. 169; Blackwall, *Mem. Lit. and Phil. Soc. Manch.* 1824, pp. 239-323; Savart, (*Froriep's Notizen u. s. w.*, 1826, pp. 1-10, 20-25; Brehm and Hansmann, *Naumannia*, 1855, pp. 54-59, 96-101, 181-195, and *Journ. für Orn.* 1855, pp. 348-351, 1856, pp. 250-255. The notes of many of our common Birds are musically expressed by Mr Harting, *Birds of Middlesex* (London: 1866).

variety of disposition may be found in the Class. The Apteryx seems to entrust its abnormally big egg to an excavation among the roots of a tree-fern; while a band of female Ostriches scrape holes in the desert-sand and therein promiscuously dropping their eggs cover them with earth and leave the task of incubation to the male, who discharges the duty thus imposed upon him by night only, and trusts by day to the sun's rays for keeping up the needful, fostering warmth. The Megapodes raise a huge hotbed of dead leaves wherein they deposit their eggs and the young are hatched without further care on the part of either parent. Some of the Grebes and Rails seem to avail themselves in a less degree of the heat generated by vegetable decay, and dragging from the bottom or sides of the waters they frequent fragments of aquatic plants form of them a rude half-floating mass which is piled on some growing water-weed—but these birds do not spurn the duties of maternity. Many of the Gulls, Sandpipers, and Plovers lay their eggs in a shallow pit which they hollow out in the soil, and then as incubation proceeds add thereto a low breastwork of haulm. The Ringed Plover commonly places its eggs on shingle, which they so much resemble in colour, but when breeding on grassy uplands it paves the nest-hole with small stones. Pigeons mostly make an artless platform of sticks so loosely laid together that their peary treasures may be perceived from beneath by the inquisitive observer. The Magpie, as though self-conscious that its own thieving habits may be imitated by its neighbours, surrounds its nest with a hedge of thorns. Very many birds of almost every group bore holes in some sandy cliff, and at the end of their tunnel deposit their eggs with or without bedding. Such bedding, too, is very various in character; thus, while the Shelduck and the Sand-Martin supply the softest of materials, the one of down from her own body, the other of feathers collected by dint of diligent search,—the Kingfisher forms a couch of the undigested spiny fish-bones which she ejects in pellets from her own stomach. Other birds, as the Woodpeckers, hew holes in living trees, even when the timber is of considerable hardness, and therein establish their nursery. Some of the Swifts secrete from their salivary glands a fluid which rapidly hardens as it dries on exposure to the air into a substance resembling isinglass, and thus furnish the "edible birds' nests" that are the delight of Chinese epicures. In the architecture of nearly all the Passerine birds, too, some salivary secretion seems to play an important part. By its aid they are enabled to moisten and bend the otherwise refractory twigs and straws and glue them to their place. Spiders' webs also are employed with great advantage for the purpose last mentioned, but perhaps chiefly to attach fragments of moss and lichen so as to render the whole structure less obvious to the eye of the spoiler. The Tailor-bird deliberately spins a thread of cotton and therewith stitches together the edges of a pair of leaves to make a receptacle for its nest. Beautiful too is the felt fabricated of fur or hairs by the various species of Titmouse, while many birds ingeniously weave into a compact mass both animal and vegetable fibres, forming an admirable non-conducting medium which guards the eggs from the extremes of temperature outside. Such a structure may be open and cup-shaped, supported from below as that of the Chaffinch and Goldfinch, domed like that of the Wren and Bottle-Titmouse, slung hammock-wise as in the case of the Golden-crested Wren and the Orioles, or suspended by a single cord as with certain Grosbeaks and Humming-birds. Under such circumstances it is even sometimes needful to balance the nest lest the weight of the growing young should destroy the equipoise and, precipitating them on the ground, dash the hopes of the parents, and compensation in such cases is applied by loading the opposite

side of the structure with lumps of earth. Certain Warblers (*Aedon* and *Thamnobia*) for some unascertained reason invariably lay a piece of snake's slough in their nests—to repel, it has been suggested, marauding lizards who may thereby fear the neighbourhood of a deadly enemy. The clay-built edifices of the Swallow and Martin are known to everybody, and the Nuthatch plasters up the gaping mouth of its nest-hole till only a postern large enough for entrance and exit, but easy of defence, is left. In South America we have a family of birds (*Furnariidae*) which construct on the branching roots of the mangrove globular ovens, so to speak, of mud, wherein the eggs are laid and the young hatched. The Flamingo erects in the marshes it frequents a mound of earth some two feet in height, with a cavity atop, on which the hen, having oviposited, sits astride with dangling legs, and in that remarkable attitude is said to perform the duty of incubation: The females of the Hornbills, and perhaps of the Hoopoes, submit to incarceration during this interesting period, the males immuring them by a barrier of mud, leaving only a small window to admit air and food, which latter is assiduously brought to the prisoners.

But though in a general way the dictates of hereditary instinct are rigidly observed by birds, in many species a remarkable degree of elasticity is exhibited or the rule of habit is rudely broken. Thus the noble Falcon, whose ordinary eyry is on the beetling cliff, will for the convenience of procuring prey condescend to lay its eggs on the ground in a marsh, or appropriate the nest of some other bird in a tree. The Golden Eagle, too, remarkably adapts itself to circumstances, now rearing its young on a precipitous ledge, now on the arm of an ancient monarch of the forest and again on a treeless plain, making a humble home amid grass and herbage. Herons also shew the same versatility and will breed according to circumstances in an open fen, on sea-banks or (as is most usual) on lofty trees. Such changes are easy to understand. The instinct of finding food for the family is predominant, and where most food is there will the feeders be gathered together. This explains, in all likelihood, the associated bands of Ospreys or Fish-Hawks, which in North America breed (or used to breed) in large companies where sustenance is plentiful, though in the Old World the same species brooks not the society of aught but its mate. Birds there are of eminently social predilections. In Europe, excepting Sea-fowls—whose congregations are universal and known to all—we have perhaps but the Heron, the Fieldfare, and the Rook, which habitually flock during the breeding-season; but in other parts of the world many birds unite in company at that time, and in none possibly is this habit so strongly developed as in the Anis of the Neotropical Region, the Republican Swallow of North America, and the Sociable Grosbeak of South Africa, which last joins nest to nest until the tree is said to break down under the accumulated weight of the common edifice.

In the strongest contrast to these amiable qualities is the parasitic nature of the Cuckows of the Old World and the Cow-birds of the New, but this peculiarity of theirs is so well known that to dwell upon it would be needless. Enough to say that the egg of the parasite is introduced

¹ There are not many works on nidification, for "Calology" or the study of nests has hardly been deemed a distinct branch of the science. A good deal of instructive matter (not altogether free from error) will be found in Rennie's *Architecture of Birds* (London: 1831), and there is Mr Wallace's most interesting dissertation, "A Theory of Birds' Nests," originally published in the *Journal of Travel and Natural History* (1868, p. 73), and reprinted in his *Contributions to the Theory of Natural Selection* (London: 1870). Mr Andrew Murray's and the Duke of Argyll's remarks on this essay are contained in the same volume of the *Journal* named (pp. 137 and 276).

into the nest of the dupe, and after the necessary incubation by the fond fool of a foster-mother the interloper successfully counterfeits the heirs, who perish miserably, victims of his superior strength. The whole process has been often watched, but the reflective naturalist will pause to ask how such a state of things came about, and there is not much to satisfy his enquiry. Certain it is that some birds whether by mistake or stupidity do not unfrequently lay their eggs in the nests of others. It is within the knowledge of many that Pheasants' eggs and Partridges' eggs are often laid in the same nest, and it is within the knowledge of the writer that Gulls' eggs have been found in the nests of Eider-Ducks, and *vice versa*; that a Redstart and a Pied Flycatcher will lay their eggs in the same convenient hole—the forest being rather deficient in such accommodation; that an Owl and a Duck will resort to the same nest-box, set up by a scheming woodsman for his own advantage; and that the Starling, which constantly dispossesses the Green Woodpecker, sometimes discovers that the rightful heir of the domicile has to be brought up by the intruding tenant. In all such cases it is not possible to say which species is so constituted as to obtain the mastery, but it is not difficult to conceive that in the course of ages that which was driven from its home might thrive through the fostering of its young by the invader, and thus the abandonment of domestic habits and duties might become a direct gain to the evicted householder. This much granted, all the rest will follow easily enough, but it must be confessed that this is only a presumption, though a presumption which seems plausible if not likely.

EGGS.

The pains bestowed by such Birds (incomparably the most numerous of the Class), as build elaborate nests and the devices employed by those that, not doing so, display no little skill in providing for the preservation of their produce, invite some attention to the eggs which they lay. This attention will perhaps be more cheerfully given when we think how many naturalists, not merely ornithologists, have been first directed to the study of the animal kingdom by the spoils they have won in their early days of birds' nesting. With some such men the fascination of this boyish pursuit has maintained its full force even in old age—a fact not so much to be wondered at when it is considered that hardly any branch of the practical study of Natural History brings the enquirer so closely in contact with many of its secrets. It is therefore eminently pardonable for the victims of this devotion to dignify their passion by the learned name of "Oology," and to bespeak for it the claims of a science. Yet the present writer—once an ardent follower of the practice of birds'-nesting, and still on occasion warming to its pleasures—must confess to a certain amount of disappointment as to the benefits it was expected to confer on Systematic Ornithology, though he yields to none in his high estimate of its utility in acquainting the learner with the most interesting details of bird-life—without a knowledge of which nearly all systematic study is but work that may as well be done in a library, a museum, or a dissecting-room, and is incapable of conveying information to the learner concerning the why and the wherefore of such or such modifications and adaptations of structure. To some—and especially to those who are only anatomists—this statement may seem preposterous, but it is in truth no such thing. What engineer can be said to understand his business if he knows not the purpose to which the machines he makes are to be applied and is unacquainted with their mode of working? We may investigate thoroughly the organs of any animal, we may trace them from the earliest moment in which they become defined, and

watch them as they develop to maturity, we may comprehend the way in which every part of a complicated structure is successively built up, but if we take not the trouble to know their effect on the economy of the creature we as naturalists have done but half our task and abandon our labour when the fulness of reward is coming upon us. The field-naturalist, properly instructed, crowns the work of the comparative anatomist and the physiologist, though without the necessary education he is little more than an empiric, even should he possess the trained cunning of the savage on whose knowledge of the habits of wild animals depends his chance of procuring a meal.

Perhaps the greatest scientific triumph of oologists lies in their having fully appreciated the intimate alliance of the *Limicolae* (the great group of Snipes and Plovers) with the *Gaviee* (the Gulls, Terns, and other birds more distantly connected with them) before it was recognized by any professed taxonomist,—L'Herminier, whose researches have been much overlooked, excepted; though to such an one was given the privilege of placing that affinity beyond cavil (Huxley, *Proc. Zool. Soc.* 1867, pp. 426, 456–458; *cf. Ibis*, 1868, p. 92). In like manner it is believed that oologists first saw the need of separating from the true *Passeres* several groups of birds that had for many years been unhesitatingly associated with that very uniform assemblage. Diffidence as to their own capacity for meddling with matters of systematic arrangement may possibly have been the cause which deterred the men who were content to brood over birds' eggs from sooner asserting the validity of the views they held. Following the example furnished by the objects of their study, they seem to have chiefly sought to hide their offspring from the curious eye—and if such was their design it must be allowed to have been admirably successful. In enthusiastic zeal for the prosecution of their favourite researches, however, they have never yielded to, if they have not surpassed, any other class of naturalists. If a storm-swept island, only to be reached at the risk of life, held out the hope of some oological novelty there was the egg-collector (Faber, *Isis*, xx. pp. 633–688; Proctor, *Naturalist*, 1838, pp. 411, 412). Did another treasure demand his traversing a burning desert (Tristram, *Ibis*, 1859, p. 79) or sojourning for several winters within the wildest wastes of the Arctic Circle (Wolley, *Ibis*, 1859, pp. 69–76; 1861, pp. 92–106; Kennicott, *Rep. Smithsonian Inst.* 1862, pp. 39, 40), he endured the necessary hardships to accomplish his end, and the possession to him of an empty shell of carbonate of lime,¹ stained or not (as the case might be) by a secretion of the villous membrane of the parent's uterus, was to him a sufficient reward. Taxonomers, however, have probably been right in not attaching too great an importance to such systematic characters as can be deduced from the eggs of birds, but it would have been better had they not insisted so strongly as they have done on the infallibility of one or another set of characters, chosen by themselves. Oology taken alone proves to be a guide as misleading as any other arbitrary method of classification, but combined with the evidence afforded by due study of other particularities, whether superficial or deep-seated, it can scarcely fail in time to conduct us to an ornithological arrangement as nearly true to Nature as we may expect to achieve.

The first man of science who seems to have given any special thought to oology, was the celebrated Sir Thomas Browne, of Norwich, who already in 1681, when visited by John Evelyn (from whose diary we learn the fact), had assigned a place in his cabinet of rarities to a collection of birds' eggs. The next we hear of is that Count of Marsigli

¹ A small proportion of carbonate of magnesia and phosphate of lime and magnesia also enters into its composition.

who early in the eighteenth century explored, chiefly for this kind of investigation, the valley of the Danube—a region at that time, it is almost unnecessary to remark, utterly unknown to naturalists. But there is no need to catalogue the worthies of this study. As they approach our own day their number becomes far too great to tell, and if very recently it has seemed to dwindle the reason is probably at hand in the reflection that most of the greatest prizes have been won, while those that remain to reward the aspiring appear to be just now from one cause or another almost out of reach. Perhaps at the present time the Birds-of-Paradise and their allies form the only group of any recognized distinctiveness and extent of whose eggs we know absolutely nothing—though there are important isolated forms, such as *Atrichia*, *Heterolocha*, and others, concerning the eggs as well as the breeding habits of which our ignorance is absolute, and the species of many families that have hitherto defied the zeal of oologists are very numerous. These last, however, though including some common and some not very uncommon British birds, possess in a general way comparatively little interest, since, the eggs of their nearest allies being well known, we cannot expect much to follow from the discovery of the recluses, and it is only to the impassioned collector that the obtaining of such desiderata will afford much satisfaction.

The first thing which strikes the eye of one who be- Varied holds a large collection of egg-shells is the varied hues of hues of the specimens. Hardly a shade known to the colourist is eggs. not exhibited by one or more, and some of these tints are their beauty enhanced by the glossy surface on which they are displayed, by their harmonious blending, or by the pleasing contrast of the pigments which form markings as often of the most irregular as of regular shape. But it would seem as though such markings, which a very small amount of observation will shew to have been deposited on the shell a short time before its exclusion, are primarily and normally circular, for hardly any egg that bears markings at all does not exhibit some spots of that form, but that in the progress of the eggs through that part of the oviduct in which the colouring matter is laid on many of them become smeared, blotched, or protracted in some particular direction. The circular spots thus betoken the deposition of the pigment while the egg is at rest, the blurred markings show its deposition while the egg is in motion, and this motion would seem often to be at once onward and rotatory, as indicated by the spiral markings not uncommonly observable in the eggs of some Birds-of-prey and others—the larger end of the egg (when the ends differ in form) making way for the smaller.² At the same time the eggs of a great number of birds bear, beside these last and superimposed markings, more deeply-seated stains, generally of a paler and often of an altogether different hue, and these are evidently due to some earlier dyeing process. The peculiar tint of the ground-colour, though Ground commonly superficial, if not actually congenital with the colour. formation of the shell, would appear to be suffused soon after. The depth of colouring whether original or super-vening is obviously dependent in a great measure on the constitution or bodily condition of the parent. If a bird, bearing in its oviduct a fully-formed egg, be captured, that egg will speedily be laid under any circumstances of inconvenience to which its producer shall be subjected, but such an egg is usually deficient in coloration—fright and

² That the larger end is protruded first was found on actual experiment by Mr Bartlett, Superintendent of the Gardens of the Zoological Society, to be the case commonly, but as an accident the position may be sometimes reversed, and this will most likely account for the occasional deposition of markings on the smaller instead of the larger end as not unfrequently shown in eggs of the Sparrow-hawk (*Accipiter, nisus*). The head of the chick is always formed at the larger end.

captivity having arrested the natural secretions. In like manner over excitement or debility of the organs, the consequence of ill health, give rise to much and often very curious abnormality. It is commonly believed that the older a bird is the more intensely coloured will be its eggs, and to some extent this belief appears to be true. Certain *Falconidae*, which ordinarily lay very brilliantly-tinted eggs, and are therefore good tests, seem when young unable to secrete so much colouring-matter as they do when older, and season after season the dyes become deeper, but there is reason to think that when the bird has attained its full vigour improvement stops, and a few years later the intensity of hue begins to decline. It would be well if we had more evidence, however, in support of this opinion, which is chiefly based on a series of eggs of one species—the Golden Eagle (*Aquila chrysaetus*), in the writer's possession, among which are some believed on good grounds to have been the produce in the course of about twelve years of one and the same female. The amount of colouring-matter secreted and deposited seems notwithstanding to be generally a pretty constant quantity—allowance being made for individual constitution; but it often happens—especially in birds that lay only two eggs—that nearly all the dye will be deposited on one of these, leaving the other colourless; it seems, however, to be a matter of inconstancy which of the two is first developed. Thus of two pairs of Golden Eagles' eggs also in the possession of the writer, one specimen of each pair is nearly white while the other is deeply coloured, and it is known that in one case the white egg was laid first and in the other the coloured one. When birds lay many mottled, and *a fortiori* plain, eggs, there is generally less difference in their colouring, and though no two can hardly ever be said to be really alike, yet the family resemblance between them all is obvious to the practised eye. It would seem however to be a peculiarity with some species—and the Tree-Sparrow (*Passer montanus*) which lays five or six eggs may be taken as a striking example—that one egg should always differ remarkably from the rest of the clutch. In addition to what has been said above as to the deposition of colour in circular spots indicating a pause in the progress of the egg through one part of the oviduct, it may be observed that the cessation of motion at that time is equally shewn by the clearly defined hair-lines or vermiculations seen in many eggs, and in none more commonly met with than in those of the Buntings (*Emberizidae*). Such markings must not only have been deposited while the egg was at rest, but it must have remained motionless until the pigment was completely set, or blurred instead of sharp edges would have been the result.¹

The composition of this pigment has long excited much curiosity, and it has been commonly and rather crudely ascribed to secretions of the blood or bile,² but very recently unexpected light has been shed upon the subject by the researches of Mr Sorby (*Proc. Zool. Soc.* 1875, p. 351), who, using the method of spectrum-analysis, has now ascertained the existence of seven well-marked substances in the colouring-matter of eggs, to the admixture of which in certain proportions all their tints are due. These he names

¹ The principal oological works with coloured figures are the following:—Thienemann, *Fortpflanzungsgeschichte der gesammten Vögel* (4to, Leipzig: 1845); Lefèvre, *Atlas des œufs des oiseaux d'Europe* (8vo, Paris: 1845); Hewitson, *Coloured Illustrations of the Eggs of British Birds* (8vo, Ed. 3, London: 1856); Brewer, *North American Oology* (4to, Washington: 1859); Taczanowski, *Oologia Ptaków Polskich* (8vo, Warszawa: 1862); Bädcker, *Die Eier der Europäischen Vögel* (fol. Leipzig: 1863); Wolley, *Ootheca Wollayana* (8vo, London: 1864)—some of which have never been completed; but a great number of rare eggs are also figured in various journals, as the *Proceedings of the Zoological Society*, *Naumannia*, the *Journal für Ornithologie*, and *The Ibis*.
² Cf. Wilke, *Naumannia*, 1858, pp. 393-397, and C. Leconte, *Revue Magasin de Zoologie*, 1860, pp. 199-205.

Oorhodeine, Oocyan, Banded Oocyan, Yellow Ooxanthine, Rufous Ooxanthine, a substance, giving narrow absorption-bands in the red, the true colour of which he has not yet been able to decide, and lastly Lichenoxanthine. It would be out of place here to particularize their chemical properties, and it is enough to say that they are closely connected either with hæmoglobin or bile-pigments, and in many respects resemble the latter more than do any other group of colouring-matters, but do not actually agree with them. The first is perhaps the most important of all the seven, because it occurs more or less in the shells of so great a number of eggs that its entire absence is exceptional, and it is of a very permanent character, its general colour being of a peculiar brown-red. The second and third seem when pure to be of a very fine blue, but the spectrum of the former shows no detached bands, while that of the latter has a well-marked detached absorbent-band near the red end, though the two are closely related since they yield the same product when oxidized. The fourth and fifth substances supply a bright yellow or reddish-yellow hue, and the former is particularly characteristic of eggs of the Emeus (*Dromæus*), giving rise when mixed with oocyan to the fine malachite-green which they possess, while the latter has only been met with in those of the Tinamous (*Tinamidae*), in which it should be mentioned that oorhodeine has not been found, or perhaps in those of a Cassowary (*Casuaris*), and when mixed with oocyan produces a peculiar lead-colour. The sixth substance, as before stated, has not yet been sufficiently determined, but it would seem in combination with others to give them an abnormally browner tint; and the seventh appears to be identical with one which occurs in greater or less amount in almost all classes of plants, but is more especially abundant in and characteristic of lichens and fungi. There is a possibility however of this last being in part if not wholly due to the growth of minute fungi, though Mr Sorby believes that some such substance really is a normal constituent of the shell of eggs having a peculiar brick-red colour. That gentleman is further inclined to think that oorhodeine is in some way or other closely related to cruentine, being probably derived from the red colouring-matter of the blood by some unknown process of secretion, and likewise that there is some chemical relation between the oocyan and the bile.

The grain of the egg-shell offers characters that deserve far more consideration than they have received until lately, when the attention of Herr von Nathusius having been directed to the subject by some investigations carried on by Dr Landois³ and Herr Rudolf Blasius,⁴ he has brought out a series of remarkable papers⁵ in which he has arrived at the conclusion that a well-defined type of shell-structure belongs to certain families of birds, and is easily recognized under the microscope. In some cases, as in the eggs of certain Swans and Geese (*Cygnus olor* and *C. musicus*, *Anser cinereus* and *A. segetum*) even specific differences are apparent. The bearing of these researches on classification generally is of considerable importance and must be taken into account by all future taxonomers. Here we cannot enter into details, it must suffice to remark that the grain of the shell is sometimes so fine that the surface is glossy, and this is the case with a large number of *Picariæ*, where it is also quite colourless and the contents of their eggs seen through the semi-transparent shell give an

³ *Zeitschr. für wissensch. Zoologie*, xv. pp. 1-31.

⁴ *Op. cit.* xvii. pp. 480-524.

⁵ *Op. cit.* xviii. pp. 19-21, pp. 225-270, xix. pp. 322-343, xx. pp. 106-130, xxi. pp. 330-335. A summary of these will be found in *Journ. für Ornith.* 1871, pp. 241-260, and the subject has been continued in the same periodical for 1872, pp. 321-332, and 1874, pp. 1-28.

opalescence of great beauty; but among the Tinamous (*Tinamidae*) colour is invariably present and their opaque eggs present the appearance of more or less globular balls of highly-burnished metal or glazed porcelain. Most birds lay eggs with a smooth shell, such as nearly all the *Gaviæ*, *Limicolæ*, and *Passeres*, and in some groups, as with the normal *Gallinæ*, this seems to be enamelled or much polished, but it is still very different from the brilliant surface of those just mentioned, and nothing like a definite line can be drawn between their structure and that in which the substance is dull and uniform, as among the *Alcidæ* and the *Accipitres*. In many of the *Ratitæ* the surface is granulated and pitted in an extraordinary manner,¹ and in a less degree the same feature is observable in the eggs of some other birds, as the Storks (*Ciconiidae*). Many Water-fowls, and particularly the Ducks (*Anatidae*), lay eggs with a greasy or oleaginous exterior, as the collector who wishes to inscribe his specimens with marks of their identity often finds to his inconvenience; but there are other eggs, as those of the Anis (*Crotophaga*), the Grebes (*Podicipedidae*), and all of the *Steganopodes*, except *Phaeton*, which are more or less covered with a cretaceous film, often of considerable thickness and varied by calcareous protuberances.

Form of eggs.

In form eggs vary very much, and this is sometimes observable in examples not only of the same species but even from the same mother, yet a certain amount of resemblance is usually to be traced according to the natural group to which the parents belong. Those of the Owls (*Strigidae*) and of some of the *Picariæ*—especially those which lay the glossy eggs above spoken of—are often apparently spherical, though it is probable that if tested mathematically none would be found truly so—indeed it may be asserted that few eggs are strictly symmetrical, however nearly they may seem so, one side bulging out, though very slightly, more than the other. The really oval form, with which we are most familiar, needs no remark, but this is capable of infinite variety caused by the relative position and proportion of the major and minor axes. In nearly all the *Limicolæ* and some of the *Alcidæ* the egg attenuates very rapidly towards the smaller end, sometimes in a slightly convex curve, sometimes without perceptible curvature, and occasionally in a sensibly concave curve.² The eggs having this pyriform shape are mostly those of birds which invariably lay four in a nest, and therein they lie with their points almost meeting in the centre and thus occupying as little space as possible and more easily covered by the brooding parent. Other eggs as those of the Sand-Grouse (*Pteroclidæ*) are elongated and almost cylindrical for a considerable part of their length terminating at each end obtusely, while eggs of the Grebes (*Podicipedidae*) which also have both ends nearly alike but pointed, are so wide in the middle as to present a biconical appearance.³

Size of eggs.

The size of eggs is generally but not at all constantly in proportion to that of the parent. The Guillemot (*Alca troule*) and the Raven (*Corvus corax*) are themselves of about equal size; their eggs vary as ten to one. The Snipe (*Scolopax gallinago*) and the Blackbird (*Turdus merula*) differ but slightly in weight, their eggs remarkably. The eggs of the Guillemot are as big as those of an Eagle; and those of the Snipe equal in size the eggs of a Partridge (*Perdix cinerea*). Mr Hewitson, from whom these instances

¹ It is curious that Ostriches' eggs from North Africa are to be readily distinguished from those from the Cape of Good Hope by their smooth ivory-like surface, without any punctures, whereas southern specimens are rough as though peck-marked (*Ibis*, 1860, p. 74), yet no difference that can be deemed specific has as yet been established between the birds of the north and of the south.

² A great deal of valuable information on this and other kindred subjects is given by Des Murs, *Traité général d'Oologie ornithologique* (8vo, Paris: 1800).

are taken, remarks:—"The reason of this great disparity is, however, obvious; the eggs of all those birds which quit the nest soon after they are hatched, and which are consequently more fully developed at their birth, are very large." It must be added, though, that the number of eggs to be covered at one time seems also to have some relation to their size, and this offers a further explanation of the fact just mentioned with regard to the Snipe and the Partridge—the former being one of those birds which are constant in producing four, and the latter often laying as many as a dozen—for the chicks of each run as soon as they release themselves from the shell.

Incubation is performed, as is well known, by the female of nearly all Birds, but with most of the *Passeres* and many others the male seems to share her tedious duties, and among the *Ratitæ*, apparently without exception, the cock takes that office wholly on himself. There are a few groups or perhaps species in which the same practice is suspected to obtain—certain of the *Limicolæ* for instance, the Godwits (*Limosa*), the Phalaropes (*Phalaropus*), and the Dotterel (*Eudromias morinellus*)—and in these it is to be remarked that the hen is larger and more brightly coloured than her mate. Owing to the unfortunate neglect of those who have the opportunity of making the needful observations the period of Incubation has been ascertained in comparatively few birds, and it is here possible to deal with that subject only in the most vague and general language. It may be asserted that most of the smaller *Passeres* of Europe hatch their young in about thirteen days, but in a few species the term is believed to be shortened to ten or eleven days, while in the largest of that Order, the Raven, it is lengthened to some twenty-one days. This also is the period which the Barndoor-fowl ordinarily takes, but the Pheasant, though so very nearly allied, takes about twenty-eight. Most Water-birds, so far as is known, and the smaller Birds-of-prey seem to require as long a time, but in the Swan incubation is protracted to six weeks. The temperature of the air is commonly credited with having something to do either in hastening or retarding exclusion from the egg, but to what extent, or even whether justly so or not, seems in the absence of precise experiments to be doubtful. Certain birds occasionally begin brooding as soon as the first egg is laid,⁴ and this plan unquestionably has its advantages, since the offspring being of different ages thereby become less of a burthen on the parents which have to minister to their wants, while the fostering warmth of the earlier chicks can hardly fail to aid the development of those which are unhatched, during the absence of father and mother in search of food; but most birds, and it need scarcely be said, all those the young of which run from their birth, await the completion of the clutch before sitting is begun. The care bestowed, by almost every species, on the infant-brood, is proverbial, and there is hardly any extremity of danger which one at least of the anxious parents will not incur to ward off injury from their progeny.

MOULT.

The more or less protracted business of reproduction being ended there forthwith follows in the case of nearly all Birds a process of the most vital consequence to them. This is the Moulting or shedding of their old and often weather-beaten feathers to be replaced by an entirely new suit. It is probably the severest strain to which bird-life is exposed, and, to judge from its effects on our domesticated pets, produces a greater mortality than an occasional want

³ Hewitson, *op. cit.* Introd. p. x.

⁴ This seems to be very often the case with the Owls, but if the writer's observation is not mistaken the habit is not constant even with the same individual bird.