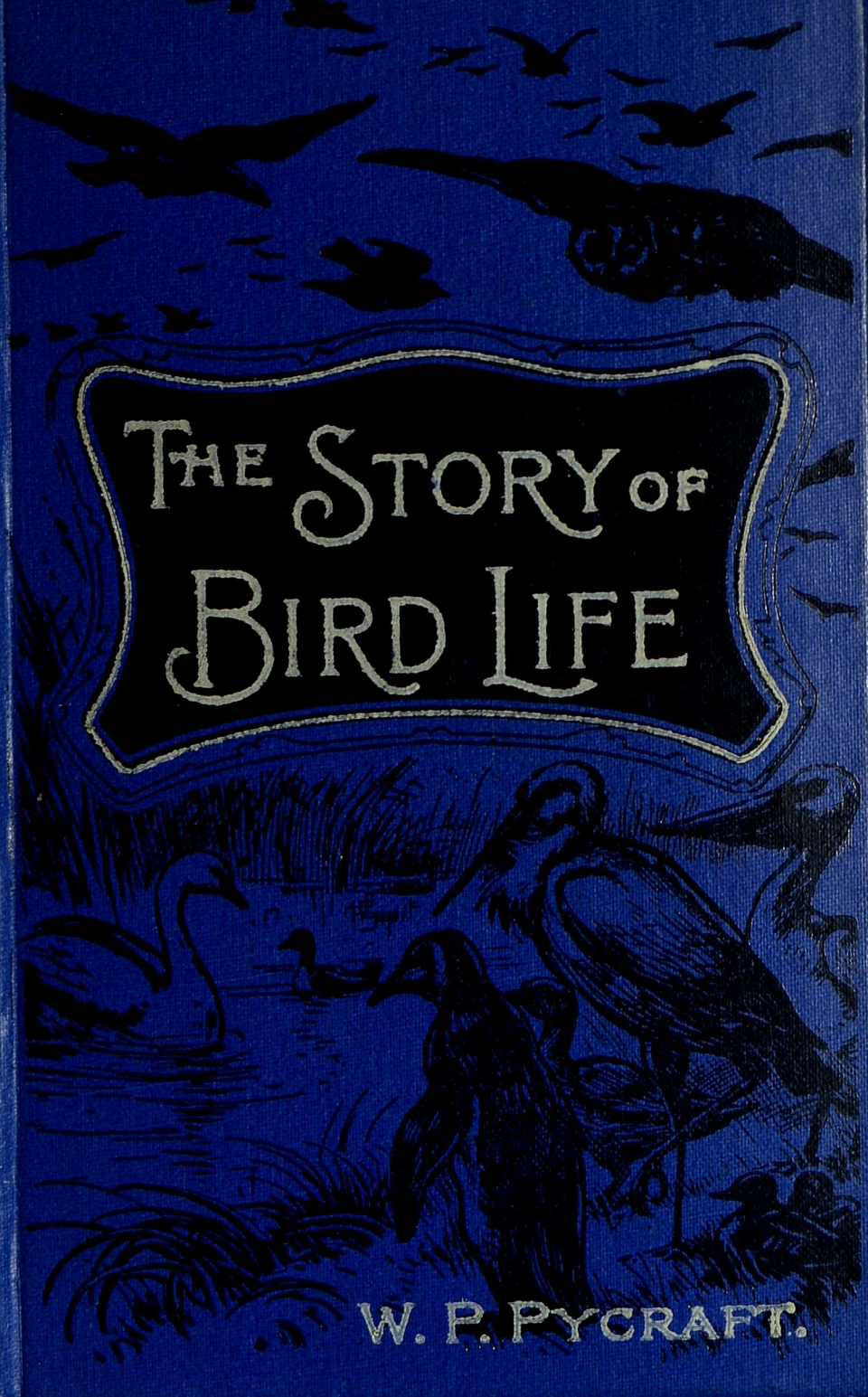
THE STORY OF BIRD LIFE



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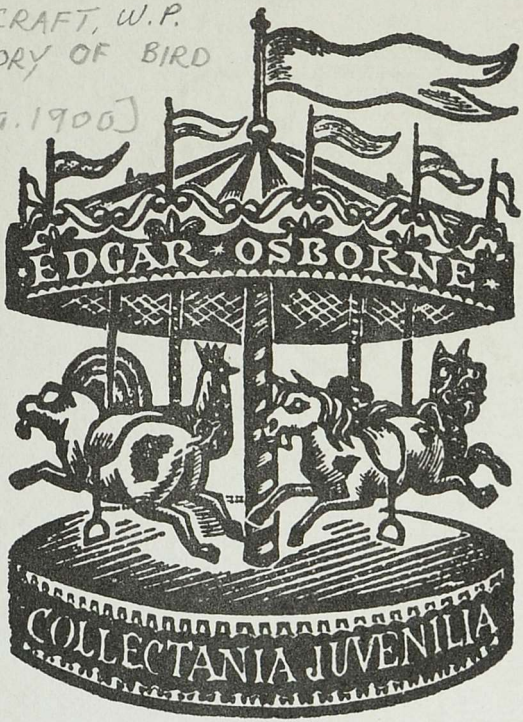

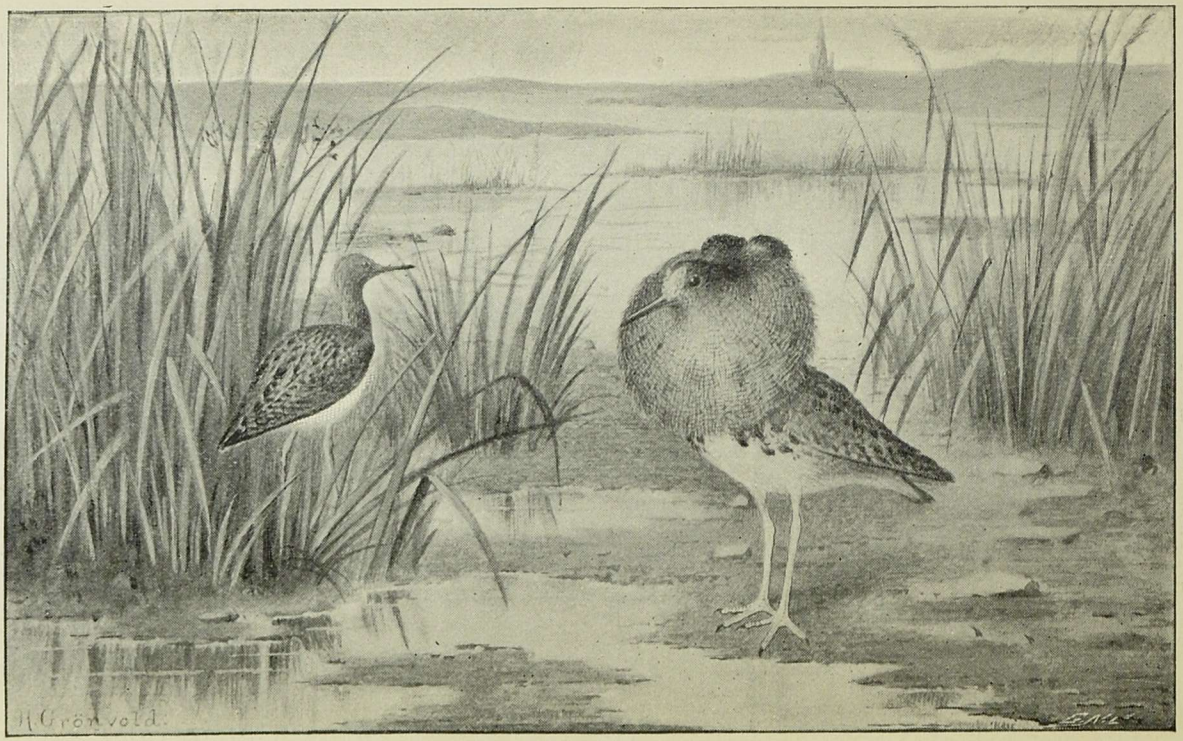

The summer home of the Ruff and Reeve.

THE STORY OF BIRD-LIFE

By W. P. PYCRAFT

LONDON: GEORGE NEWNES, LIMITED
SOUTHAMPTON STREET, STRAND, W.C.

PREFACE.

To compress the "Story of Bird-Life" within the limits of the present little work has been no easy task.

The object aimed at has been to present the main features of bird-life in a general way. Hence it is hoped this volume may prove of interest to bird-lovers the world over, not because it contains information about the birds of any particular neighbourhood or country; but rather, because it serves as a guide to what should be looked for, and recorded, of the life-history of birds wherever they may be met with. Even dwellers in the sordid city have some material upon which they may exercise their powers of observation.

Since there are no less than 13,000 known species of birds, it would have been courting failure, and wearisome in the extreme, to deal with individuals in detail! The present work then is a skeleton picture, which each can fill up as he may for himself.

To those who wish to pursue this subject further, by the aid of other and more costly works, I would recommend the following as especially helpful:—

The "Dictionary of Birds," by Prof. Newton; the "Elements of Ornithology," by Dr Mivart; "Birds," by Mr A. H. Evans; (Cambridge Natural History Series) The Royal Natural History, vols. III., IV.

These are a library in themselves, and should fill up whatever blanks the reader may discover in the present work.

The excellent full-page blocks representing the ruff, and bustard, and birds-of-paradise, have been drawn specially for this little book by Mr H. Grönvold.

W. P. PYCRAFT.

December 1899.

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THE STORY OF BIRD-LIFE.

CHAPTER I.

WHAT IS A BIRD?

WHAT is a bird? The text-books tell us that it is a warm-blooded, egg-laying, feathered biped, whose fore limbs take the form of wings, and whose jaws are encased in a horny sheath to form a beak.

Such a definition will suffice for most of us, but not for all. A few there be who would know more; who are curious concerning origins, and will not be satisfied by any such cut and dried definition; for a definition is not an explanation. To meet this curiosity in full is, however, beyond the scope of this little work.

As scraps by the wayside guide the pursuers in a paper chase, often through unknown country, so the fragments of rock, and bits of bone, left by time in the course of ages, serve to give us a clue as to the probable direction which our search must take. But here we have no clear view, only fragments of evidence which must be

laboriously fitted and pieced together, not once but many times. We have to work in this, much as detectives work, and many of our "clues" are about as useful!

From the evidence which we have collected so far, we gather that what we now know as a bird has reached its present form by a slow process of change from some other, which was probably, more or less, like what we designate to-day a reptile, *e.g.* lizard. We say more or less, advisedly; for the lizard, in its turn, has an equally mysterious origin. One reason then for thinking the bird in some way reptilian is because it shares many things in common with this group, things which occur nowhere else outside, things that are shared by both, probably by virtue of descent from a common stock.

The bird has risen in the world so as to rank, by common consent of men of science—who fill the part of Nature's Herald's Office—higher than the reptiles. These represent, to-day, its poor relations.

This gradual change of form, from a more or less like and uniform beginning, the ancestral stock, and the division of this stock into two great classes reptiles and birds, we call evolution. Exactly how this evolution has come about even those best qualified to speak do not entirely agree.

The hypothesis most generally in favour at the present day is that of Darwin and Wallace, and known as "Natural Selection." According to this hypothesis the interaction of living organisms, one upon another, involves a "struggle for

existence" in which the "fittest" survive, and the unfit are eliminated—the unfit representing those who cannot respond, or adapt themselves to changes in their surroundings or environment.

Although much abused, and generally misunderstood and misrepresented, this is nevertheless for the most part admitted to be the best and most satisfactory of any hypothesis yet offered us.

What answer will this give us to the question, How did the pigeons, ducks, geese, and songbirds, come to be?

Well, it would first of all draw our attention to the fact that "like begets like." That though the pigeon, the lizard and the snake all lay eggs, yet the pigeon's egg will never bring forth anything but another pigeon.

It will next point out the much less familiar fact that

> "No being on this earthly ball
> Is like another, all in all."

Now this is a most important observation. Just as all the children of a family differ one from another, so do all the birds of the same nest, though, perhaps, not so markedly to our eyes. Let us follow this up.

The children of this family intermarry with those of some other, and their children yet again with another, and so on. So that, if a census was taken of the population of, say a village, and careful measurements and observations taken as to the height, sight, and hearing, colour of the hair and eyes, freedom from disease, and so on, we

should find that half of the whole number would fall below, and half would rise above a common mean. The mean, of course, would be different for each test. Thus a large number of those who were included as above the average in height might find themselves bracketed as below the average in power of endurance, and so on.

In this tendency to vary we have the raw material used in Nature's workshop in the manufacture of new types.

Man long ago seized upon this fact and turned it to his own advantage, as witness our garden flowers and vegetables, and our domestic cattle. These have only reached their present form by slow degrees, each stage improving upon the last. The result of such a series of progressive changes must be to remove slowly from, and obliterate in, the individuals concerned, the traces of their ancestral likeness.

In the case of domestic animals we can constantly compare the latest variety with the original stock from which it was derived. For instance, all the domestic pigeons are descended from our common rock dove. Selective breeding—that is to say, breeding with a definite end in view—has resulted in numerous varieties so unlike one another, and the original, that did they exist in a wild state, we should regard each as a separate "species." When it was desired, for instance, to obtain birds with enormous fleshy lobes or wattles round the beak and eyes, those young, in which this feature was most developed were selected to breed from, the rest went to supply the table. The offspring of the selected

were similarly treated, in this way the character grew more and more marked till the present somewhat unsightly forms came in to being. The experience of many of my readers will supply a dozen such instances.

A similar process of selective breeding seems to be going on around us, amongst wild animals and wild plants. It has given us hare and rabbit, wolf and fox, lion and tiger, and so on. These are all different from what they once were; they are all modifications of some earlier form. More detailed explanations of these things must be sought in other and more learned treatises; they have no place here.

This development of species and races leads us to consider another very important factor in the making of a bird. This we call specialisation.

We find certain birds fitted apparently to live only upon certain spots on the earth's surface or upon certain food. We say these are highly *specialised.*

The little humming-birds afford us an admirable illustration of a specialised bird. They feed by hovering on the wing, under flowers, and thrusting up the beak into the long tubes to get at the insects and honey. For this purpose, the beak and tongue are of great length, often exceeding the length of the body of the bird itself. The tongue differs from that of all other birds, and is tube-like in form. Now the young birds, when just hatched, have tiny three-cornered beaks like those of a swift. We gather from this —those of us who study these things—that this long beak is a new kind of beak and that, once

on a time, it was like that of a swift. This gives us an inkling. We turn to the swifts and comparing their anatomy generally, with that of the humming-birds, we find some extraordinary resemblances. So much so that we feel justified in regarding the humming-birds as having got their characters from the same source; in other words, we conclude that the humming-bird and the swift are closely allied, and regard the former as a highly "specialised" form of the latter.

We shall often have to refer to specialisation in these pages, and we shall take up again this question of descent.

Specialisation may be carried to such a degree of perfection that any considerable change in the environment of an animal may cause its extinction. The sabre-toothed tiger, the moa, great auk, and dodo, are illustrations of this. Let us take another from ourselves. The labourer corresponds to what we call a generalised type. He can earn his living in many ways; the watchmaker, or woodcarver, or artist, only in one. If the latter are prevented from carrying on their trade, starvation and death stare them in the face—they are too specialised to turn to some new mode of earning a livelihood.

Briefly then, the creature which we know to-day as a "bird" is probably the specialised product of some reptilian form of ancestor, the particular direction of this specialisation being that of flight.

Moreover, the bird differs from all other creatures that fly in the method whereby this power of flight is brought about. Apart from

the *skeleton* of the wing, which will be considered later, there is an equally unique difference in the nature of the flying membranes which this skeleton supports. In bats, the only real flying members of the class mammalia, this membrane takes the form of a thin web of skin, stretched between the fingers, and running down the arm and side of the body; in certain so-called flying-squirrels this membrane is much smaller in area and does not extend between the fingers; the result is a form of parachute. In birds, the membrane plays a quite secondary part; instead, certain of the feathers clothing the hinder margin of the wing become enormously elongated and flattened out. These, by aid of strong ligaments at their base, and a peculiar method of over-lapping one another, form a broad surface which proves even more efficient for its work than does the skin folds of the bat. The bat's wing would resemble the bird's, if certain of the hairs along its hinder margin became elongated and flattened out so as to take the place of the membrane now existent. A reference to the figures should make this clear. Fig. 6, p. 227.

The sum of the whole of this process of evolution is a form specially adapted for rapid progression through the air. The leading characteristics of this form may be summed up in the long slender and mobile neck and pointed head, the perfectly rounded and somewhat elongated body of extreme lightness, raised and propelled by wings, and clothed in the lightest and strongest possible

materials, which we call feathers—such is a bird.

All of us know that a bird is clothed with feathers, but probably few know anything of the peculiar manner in which these are distributed over the body, or have ever taken the trouble to find this out; we content ourselves—if we ever trouble to think about it at all—with reasoning from analogy and the deductions drawn therefrom. The hairs of the silky coat of a well-groomed horse, or of a dog or cat, we remark, are set as close as close can be, one to another all over the body as are the hairs in our head. Surely therefore, we assume, the feathers would be similarly distributed.

Now, this is exactly what does not happen. One of the earliest to point this out was a German ornithologist named Nitzsch. Just upon sixty years ago he published a wonderful book on this very subject, in which he showed that although the whole of the bird's body save its beak and "legs" are concealed from view by the feathers, yet these need by no means occupy a very large area of the bird's skin. On the contrary, he found that they are always more or less restricted to certain definite areas, which he called "feather-forests" separated by tracts of skin, often perfectly naked. On this discovery he based a series of most important and far-reaching observations, which eventually, after his death, were published, and now form the foundation of what might almost be called the "science" of Pterylography. Perhaps we ought to regard his work as something more than a

foundation, for comparatively little has been added since his death. But this by the way. The study of Pterylography tells us then, not only that the feathers are restricted to certain areas of the bird's skin, but that the size and form of these areas vary. Thus we may have one strongly defined tract running down the backbone from the nape of the neck to the tail; this is called the spinal tract. Another runs from the throat down the front of the neck and dividing at its base, passes down on each side of the breast and abdomen to the inner side of the thighs quite to the end of the body; this is called the ventral tract. Then we have a pair of tracts running across the upper arm, these are the humeral tracts;—the feathers forming these tracts are known to the field ornithologist as the "Scapulars"—; and a pair of tracts over the thighs; these are the femoral tracts. Besides these we have the feathers covering the wings, the head, and the tail which are generally dealt with separately in special treatises, and called each by a special name. The form of these tracts is so constant that experts can tell at once to what group any particular bird belongs, and often even to what species.

A little reflection will carry us a step further, and suggest to us that, if the feathers are restricted in their distribution they must, to conceal the skin, be (1) very long and broad, and (2) directed so as to slope away from a line drawn through the middle of any given tract. And this actually obtains.

The reason for the existence of these tracts is not so obvious. It has been suggested that they represent the regions of the body where resistance during flight is least. That is to say, their restriction to certain areas, gives greater freedom of movement to the limbs. But this is not a very convincing explanation. Possibly we should be nearer the truth to regard it as an instance —one of many—of the economy of material so often practised by Dame Nature.

The number of feathers, or rather the size of the tracts bears some sort of relation (*a*) to the amount of specialisation which the bird has undergone generally; and (*b*) to the particular mode of life which the bird follows. Thus, the most highly specialised of all birds—the passeres, of which a crow may stand as the type, are the most scantily clothed of birds, the tracts being very narrow, and the spaces very wide, whereas the birds of the ostrich kind have the feather tracts of great breadth, so much so, as to make it difficult to find the spaces.

So far, the feathers of which we have been speaking have been those known as the contour-feathers; because, as their name implies, they form the contour or outline of the body. In many birds, as a duck, for instance, if we raise the contour-feathers, we find below a thick underclothing of down-feathers. These will need no lengthy description. They are familiar to all, either in the shape of eider-down or swan's-down. They are found to be closely interspersed amongst the bases of the contour-feathers, and over the spaces, so as to form a thick underclothing.

A very remarkable form of down-feathers is found in many birds, such as the common heron, the bittern, some hawks, parrots and tinamous. This is known as "Powder-down." The exact nature of this powder-down is not yet thoroughly understood. It is peculiar, in that it is constantly crumbling away into an exceedingly fine dust, which feels something like Fuller's Earth when rubbed between the fingers. In the herons, it grows from enormous patches on the body—a pair on the breast, and a pair over the thighs. These, when the bird is skinned, appear on the inner surface of the skin as large dark-coloured areas.

Filo-plumes would hardly be recognised as feathers at first sight. Exactly what is meant by a filo-plume can be seen at a glance by a visit to the kitchen, or the nearest poulterer's when a newly plucked fowl is undergoing preparation for its appearance later on in the dining-room. You will notice that, now that the feathers have been removed, the body appears to be sparsely covered with long delicate hairs. These are the filo-plumes. Their true feathery nature can only be fully made out by an examination under the microscope, before they have quite completed their growth.

Sometimes the filo-plumes attain great length, and are then quite conspicuous. In the cormorant, for instance, they form a large white patch on each side of the body during the nesting season of the year.

Another, and very greatly modified kind of feather occurs in the form of eyelashes, and what

are known as rictal bristles. These last are the long and coarse, or rather stiff hair-like structures which grow around the mouth of goat-suckers and fly-catchers, for instance. Eyelashes occur in many birds, such as hornbills and ostriches.

But we have not yet exhausted the list which must be examined before we can say that we know how a bird is clothed. Since in the majority of birds we find the legs, or to be quite correct, the *feet*, are encased in a covering of scales or scutes, of various forms, whilst the tips of the toes, and of the thumb and first finger at least are ensheathed in horny claws, which are sometimes of great length and strength. The beak, too, is encased in horn, but we shall have something further to say about this later.

The scaly covering of the "legs" and toes may be replaced by more or less extensive areas of smooth skin, or by a partial or complete investment of feathers, which may grow, as in some grouse even on the soles of the feet, like the fur on the sole of the rabbit's foot.

There are few objects with which we are more familiar perhaps than feathers. They enter largely into the comfort of our everyday life, they figure conspicuously in our personal and household decorations, they add splendour to our pageants, form the crest of the heir-apparent to the throne, head-dresses for our army, and constitute not seldom our standards of comparison for beauty and lightness; yet, there are few things probably about which we know less. Let us learn!

To begin with, a feather is an absolutely

unique structure, it never has been, nor is now, grown by any creature under heaven other than a bird, just as hairs, for instance, are found only within the class mammalia—animals that suckle their young. But the bird's covering is more peculiarly exclusive, since no bird is clothed, in any way other than with feathers, whereas mammals, or more popularly "animals" may have the skin covered with scales, as in the manis, or horny plates, as in the armadillo, or curious modifications of hairs in the shape of spines, as in the porcupine, or wool as in the sheep, or bristles as in the pig, or may even be entirely naked, as in the whales and porpoises.

What is a feather? Feathers are to the bird what scales are to the fish and reptile, and hairs to the mammal—a covering to protect the surface of the body, and to regulate its temperature. We cannot tell much about their structure without a microscope. We have seen already that there are different kinds of feathers. There are those outside that form the general contour of the body, some of which grow very large to form the "quills" with which the bird flies, and from which our pens and toothpicks are made, and there are those below the surface, the chief of which we call down, eider and swan's-down being familiar to most.

We can learn something about them however without a microscope. A "quill" feather will serve us best. Take one, and note first of all the strong central axis or shaft; along each side of this you will see hundreds of little straight branches set very close together, and held in

position, as you will discover, in some mysterious way, so that the branches, as a whole, combine to form what is called a "web." If you try to pull this "web" apart in any place, you will see that it gives way reluctantly. Hold it up to the light and you will get an inkling of the reason of this. Along each of the little branches you will find other little branches, arranged, much as were the larger branches on the main axis. The larger branches are called barbs, the smaller barbules. Now all the barbules turned towards the base of the feather, have their top edges inturned, whilst all the barbules turned towards the tip of the feather bear long and delicate little hooklets. These overlap the inturned edges of the hinder set, and the hooklets seize upon them and hold in like so many grappling-irons; thus you see how the web is formed. Now for some figures. On a piece of the web of about 15 in. long of a crane's quill feather there were counted no less than 650 of these barbs, each of which bore about 600 pairs of barbules—that is about 800,000 for the inner web alone, and more than a million for the whole feather! The accuracy of these figures can scarcely be doubted, for they are the result of a careful examination into the matter by Dr Gadow, one of our greatest authorities on bird anatomy.

The peculiar curling qualities of the ostrich feather are due to the fact that the feather is of a degenerate structure and has no hooklets, consequently it has lost the faculty of forming a "web." Hence the barbs are permanently disconnected.

Once a year at least every bird dons a new suit. This is done by a process known as moulting, during which the old feathers are cast off and replaced by new ones. In the lizards and snakes the external layer of the skin is thrown off more or less whole, much as is the shell of the lobster or crab, but in the bird it is done much more gradually. The feathers are cast separately, their places being immediately filled by new ones. These are at first enclosed in a thin blue sheath which breaks away in flakes near the tip, and slowly exposes the gradually unfolding feather within. Sometimes this sheath remains whole for a very considerable time, and thus gives the bird the appearance of having spines mixed up with its plumage.

As a rule the moult begins at the end of the breeding season so that the old dress, worn with the work entailed in rearing a family, may be discarded and gradually replaced. Some moulting however takes place, in the case of certain male birds, before the period of courtship begins. At this time they assume the purely decorative part of their plumage, and throw it off again after the serious business of life is over.

Swans, geese and ducks, moult all the quills at once, so that for a time they are flightless. During this time they remain in the strictest seclusion, sometimes even throwing off their characteristic male attire to don the more sombre garb of the female, and thus to render themselves less conspicuous. In the case of certain ducks, when both male and female, and young,

are more or less brilliantly and conspicuously coloured, no such change of dress is possible. Having so definitely "assumed the purple" and renounced the plainer garb, it is impossible to revert. As a rule, the quills are moulted in pairs, thus, even when moulting, escape by flight is possible.

Some birds there are who carry the process of moulting much further, and even periodically shed their claws as in certain grouse, or the sheath of the bill as in our common English puffin. Concerning the colours and coloration of feathers—for these are not the same—there is much to be said, but most of it is of too technical a character to be dealt with here.

Strange as it may seem it is yet true that the colour which a feather appears to be is often quite other than that which it *is*, at least the chances are one to three of its being so. The colours of feathers are classed under three heads. Under the first of these come, what are known as chemical or absorption colours. These are due to pigment, or colouring matter, either evenly distributed or diffused through the substance of the feather, or to little particles of colouring matter packed closely in between its fibres, if we may so term what would be scientifically known as the cells of the tissue, which combined, form the feather itself. Such colouring matter is not affected by changes of the position of the light by which it is illuminated. Thus, red, yellow, brown and black feathers always remain the same. Orange and yellow generally, green rarely, blue never, belong to this category.

Of these colours that which is known as turacin is the most remarkable. It is found in the red feathers of the turacou or plantain-eater of Africa. In addition to the colouring matter, these feathers contain from 5 to 8% of copper, which can be extracted, Mr Church tells us, by soaking in a little weak ammonia and acetic acid, and filtered off as a metallic red or blue powder. These birds lose the red colour when washed by the rain, but regain it when dry, moreover, this colour is said to tint the water in which they bathe, just as is said to be the case with the common heron.

The second kind of colouring is that produced by the combination of pigment or colouring matter, and certain structural peculiarities in the surface of the feather itself. Violet, blue and green, are colours produced in this way. Thus the deep blue feather of a parrot held against the light no longer appears blue, but grey or yellowish. The green feathers of the Amazon parrot, when wetted, appear brown. Blue colouring matter has never yet been found in birds. The blue colour of certain feathers is due solely to structural characters. The only colouring matter discoverable is either brown, black or orange, according to the particular tone of the blue.

To the third form of colouring belong the exquisitely beautiful metallic tones, such as occur in the common English starling, the humming-birds, many pheasants, the "tail" of the peacock, birds of paradise, and so on. These are all due to the structure of the sur-

face of certain parts of the feather which through the microscope are seen to be strangely and wonderfully carved into fine ridges and grooves, or covered with tiny dot-like papillæ; these act like so many prisms, and hence the marvellous play of colour which so fascinates us. Those who would like to know more of this subject should read Dr Gadow's lucid descriptions in the new "Dictionary of Birds," a book all bird-lovers should possess.

The beak sheath, to which we have already referred, constitutes the outer covering of the jaws, which form what is commonly known as the "bill" or "beak" of the bird. Sometimes this sheath, as in the petrels, is made up of a number of pieces; sometimes, and more generally, it consists of two simple cases only, one for the upper and one for the lower jaws. The various forms which the beak assumes are to be dealt with in our next chapter.

The claws are the "nails" of the bird's foot and vary in form, length and so on according to the need of the bird. In many birds, such as the heron, and night-jar, and some others the claw of the middle toe bears a curious little comb the purpose of which no one has yet been able to discover.

Many birds are armed with formidable spurs. Sometimes these grow on the legs and sometimes on the wings. The screamer, a South American bird, allied to the ducks and geese, has a most formidable spur on its wrist joint. The common barn-door fowl bears spurs upon its legs. In the olden time, when cock-fighting was a favourite

amusement, the length and offensiveness of these spurs was increased by the addition of long silver sheaths which were fastened on to the real spurs. The use of spurs to wild birds, whether on the wings or legs, is the same—for purposes of offence. The males, by whom they are almost exclusively borne, fight furiously with these, for the possession of such eligible females as may be in the neighbourhood. As the strongest almost invariably wins he hands on his more vigorous constitution and better weapons to his offspring and these again repeat the process, thus in course of time the size of these spurs has increased to the size we know them now.

CHAPTER II.

BIRD LIVERIES AND THEIR MEANING.

We have now completed a very brief survey of how a bird is clothed, at least from the point of view of the *way* in which this clothing is worn, so to speak. I propose now to carry my readers with me through a rapid survey into the domain of bird fashions, to try and contrast the sombre and the splendid, the useful and the ornamental. But we can do no more than peep.

The gorgeous plumes of the bird of paradise, the splendid "train" of the peacock, the brilliant hues of the humming-bird, the garish colours of the toucan or the macaw, have at times excited the wonder or the admiration of us all, but, few perhaps suspect the fascinating problems to

which these have given rise. What is *exactly* the meaning and interpretation thereof we do not as yet know; we feel, as yet, in the twilight. Certain rules or laws have been formulated which are generally admitted as satisfactory, and possibly the true explanation. But an analysis of these is outside the scope of the present work. We will sample the fruits resulting from the patient and laborious research of students of all nations in this field, foremost amongst whom stands our own countryman Charles Darwin.

Briefly then it is, I take it, a matter of common knowledge that when the colouration of the sexes of any given species differs the male birds are more brilliantly coloured than the females. The reason for this, we are told, is that if the female were as conspicuously coloured as the male she would be easily discoverable when sitting on her eggs by prowling enemies; a more sombre dress enhances the safety of both mother and offspring —a very important consideration if the species is to hold its own in the struggle for existence. Now, we have some really weighty evidence in favour of the truth of these interpretations, since it sometimes happens that the case is exactly reversed, and the female dons the gayer dress. Whenever this occurs it always happens that it is the *male* which undertakes the incubation of the eggs. The little phalarope, one of our British birds, affords us a case in point, as also do the little three-toed bustard quails of India, Africa, and Australia, and the painted snipes of India, Africa, Australia, and S. America. Darwin's explanation of why the

males are more beautifully coloured than the females, or rather, of how the males have acquired their superior beauty we shall consider in a later chapter.

We mentioned just now, that the plumage of the females was often of a sombre hue when that of the males was of a brilliant colouration : and remarked that this was for protective purposes. In the cases in point, however, this need for protection was only partial and requisite only during the breeding season. In some cases, however, as of desert-dwelling species the tone of colouration both of males and females is that of the surrounding country. Shelter being difficult, the birds are consequently always exposed to attack, and hence both sexes have come to assume a tint precisely similar to that of the sand and rocks by which they are at all times surrounded. From this fact they can more easily escape observation from their enemies. Desert wheat-ears, sand-grouse, and coursers, are the best known examples of this kind of protective colouration as it is called.

Sometimes we have a seasonal protective colouration. The British ptarmigan affords us a splendid illustration of this kind. In the summer and autumn both male and female are clothed in a dark plumage, a mixture of dark brown, black, buff and grey—according to the sex and time of the year. In winter, both don a white dress, so as, apparently, to harmonise with the snow-clad hills amongst which they roam, again to render themselves less conspicuous and so to escape from their ever present enemies

—which it must be mentioned, are in their turn obliged to adopt a similar change that they may creep up unawares. Thus under the spur of hunger is the evolution of the species involved in this competition, furthered; by means of this system of interaction one upon another, does each become more and more specialised, and at the same time nearer and nearer the day of its extinction, which must arrive so soon as one of the two competitors fails to respond to further stimuli. We have a similar object lesson in evolution enacted before us in the growth of modern warfare. Compare the modern battle-ship with the old three-decker. The iron vessel which may be likened to the defenceless prey, was the outgrowth of a need to resist more powerful guns—the type of the prowling carnivore—and ships and guns have been competing for the supremacy ever since, and the end is not yet.

Some birds, however, adopt protective colouration which is not seasonal, but permanent. Strange as it may seem, some of these are amongst what would appear to be, the most conspicuously coloured of birds. Take the case of the hoopoe. This is an occasional visitor to Britain—and would probably become resident were it not so ruthlessly shot down on its every appearance in this country. It is of a rich buff, or sand colour, with a very large and beautiful crest on the crown of the head, and the wings conspicuously barred with black and white. Yet, on the approach of a hawk or other enemy, it throws itself flat on the ground, drops its crest, and spreads out its wings and

—heigho, as if in obedience to the magician's wand our bird has vanished; what appears to be a bundle of rags remains in its place.

The colouration of some of the most sombre plumaged birds we are apt to regard as instances of the "dull but useful" order: and to reflect, with the eye of a careful house-wife, on its good wearing properties: and here we generally leave it. As a matter of fact, it is fraught with a deep significance. It certainly affords us some admirable illustrations of protective colouration. Take the case of the night-jar or goatsucker, the bird which shares with the bat and the owl, the charming twilight evening hours of our rural England. Its exquisitely mottled plumage of grey and brown so perfectly harmonises with the bough *along*, and not *across* which it rests, or when sitting on its eggs, with bits of bark and stone strewn about the ground, that it becomes invisible, and can only be detected by the merest accident. Again, in the "common" bittern of our Islands—alas! no longer common—we have a splendid instance of protective colouration, aided, as in other cases, by posturing on the part of the bird. The general tone of its plumage is buff, streaked with black in such a way as to simulate the colour of the dried stems of the reed-beds which it frequents, and the shadows between the stalks. On alarm, the bird straightens itself out so that the head, neck and spine form one vertical line, pointing skywards. Thus posed, it remains absolutely still till danger is past: the chances of detection amid such surroundings being infinitely remote. How

difficult this disguise is to detect, has been told of the little bittern of Argentina, by Mr Hudson, as only Mr Hudson can tell it. The story is too long to be reproduced here, but my readers may turn with profit to the original.

We have yet another kind of protective colouration which is truly remarkable. It is of the kind known as "mimicry." In cases of "mimicry" the bird does not resemble surrounding inanimate objects, but some other bird, and that bird either one that is much feared and dreaded, or regarded with indifference. It is not only a case of the wolf in sheep's clothing, but also of the sheep in the wolf's. The latter case, indeed, is a realisation of the ass in the lion's skin.

Let us take a few examples. In Central America there lives a bird of prey known as the caracara or curassow hawk, which so closely resembles a curassow, one of the game-birds of that region, as to deceive experienced sportsmen, who shoot the bird for the purpose of providing food, only to find it a carrion-eater. This resemblance is of a distinct advantage to the hawk. He is enabled thereby to capture his prey with ease, since the victim, mistaking its enemy for the guileless game-bird, allows the approach of the hawk to within easy striking distance, without entertaining a suspicion of danger so close at hand.

The hawk-cuckoos of India and Africa afford us an illustration of the opposite form of mimicry. These birds very closely resemble the sparrow-hawks of the locality; similarly, our English cuckoo resembles our native sparrow

hawk. In such cases again the advantage gained is quite apparent. Wherever the cuckoos go they are mobbed more or less violently by all the smaller birds in the neighbourhood in mistake for their hereditary enemy the hawk; the tribe has an evil name in the bird world, and not without some reason. Now, as we shall show later, the cuckoo is a parasitic bird, inasmuch as it leaves its offspring to the care of strangers. To do this, the egg must be deposited in the nest of strangers, a rather difficult task when both of the intended foster parents are busy near the nest. The male cuckoo, therefore, seeks to drive, or draw them from home, by hovering near the nest hawk-fashion, and at last inducing both parents to leave home in an endeavour to chase the intruder away. By the time they have returned, the fell purpose has been effected, the female having slipped at once to the nest, and deposited her egg therein, to be hatched by the unsuspecting dupes. The black cuckoo of India is an even more wonderful instance of mimicry. It has come to resemble the black drongo—a kind of shrike—of the same locality so perfectly as to make it difficult at first sight to distinguish the two. The most curious part is, that the drongo-shrike resents fiercely the approach of any intruder near its nest, and yet it is *in* this nest that the cuckoo lays its egg, and it is by the shrikes that the young cuckoo is reared. The resemblance of the cuckoo to the shrike is so close that the latter are quite deceived, and mistake the cuckoo, when seen near the nest,

either for one of its own species, or for its own mate. This ability to successfully mimic the shrike has certainly proved of the greatest value to the species.

In the earlier part of this chapter we spoke of the resemblance of certain birds to their normal surroundings. This is called "adaptation to environment." Concerning this we have a few more words to say.

A little reflection will call to the readers' mind the fact that most animals, *e.g.*: foxes, hares, rabbits, most birds, reptiles and fish, are of a darker colour above than below. The great advantage of this has recently been most successfully demonstrated at the British Museum (Natural History), by means of a couple of models prepared by Mr Thayer, of the United States of America. It was done in this wise: A large square box was lined with grey flannel, and in it were placed two bird models which were fastened to a rod running through the middle of the box. Both of these dummies were covered with flannel cut from the same material as that used to line the box. One, however, was painted dark above and white below, the other was left uncoloured. Strange to say, the uncoloured bird is most conspicuous; the painted bird, by counteracting the normal light and shade, becomes, at two yards' distance, almost absolutely invisible.

Thus, then, we must altogether cease to regard the colours of animals as due to mere chance. Whether gorgeous or plain, brilliant or dull, there is a meaning behind it. Of the truth of

this we shall have still more evidence in the course of these pages.

Sometimes, in addition to resplendent colours, we get wonderful developments of the feathers themselves. We have not space to do more than make the slightest references to such here, and to give one or two illustrations thereof.

In the Birds of Paradise alone we get some most marvellous illustrations of this, such as the superb Bird of Paradise and King of Saxony's Bird of Paradise. This last has been quite recently discovered. The long streamers from the head are horny in texture and like nothing else in the bird world. What these are like can be gathered from the accompanying pictures (fig. 1).

Let us here pause to consider some general rules which appear to govern the colouration of the plumage from infancy to adult life. To be brief, when the male plumage is conspicuously brighter than that of the female, the young in their first plumage after moulting the nestling down resemble the female. The females retain this form permanently; the young males after a longer or shorter period assume the characteristic male livery.

When the male and female are both alike and more or less brilliantly coloured, the young don a livery different from both, as is the case in the robin and starling; or the young may closely resemble both parents and lack only something of their brilliancy, as happens with the kingfishers, for instance.

The time which it takes for a bird to gain

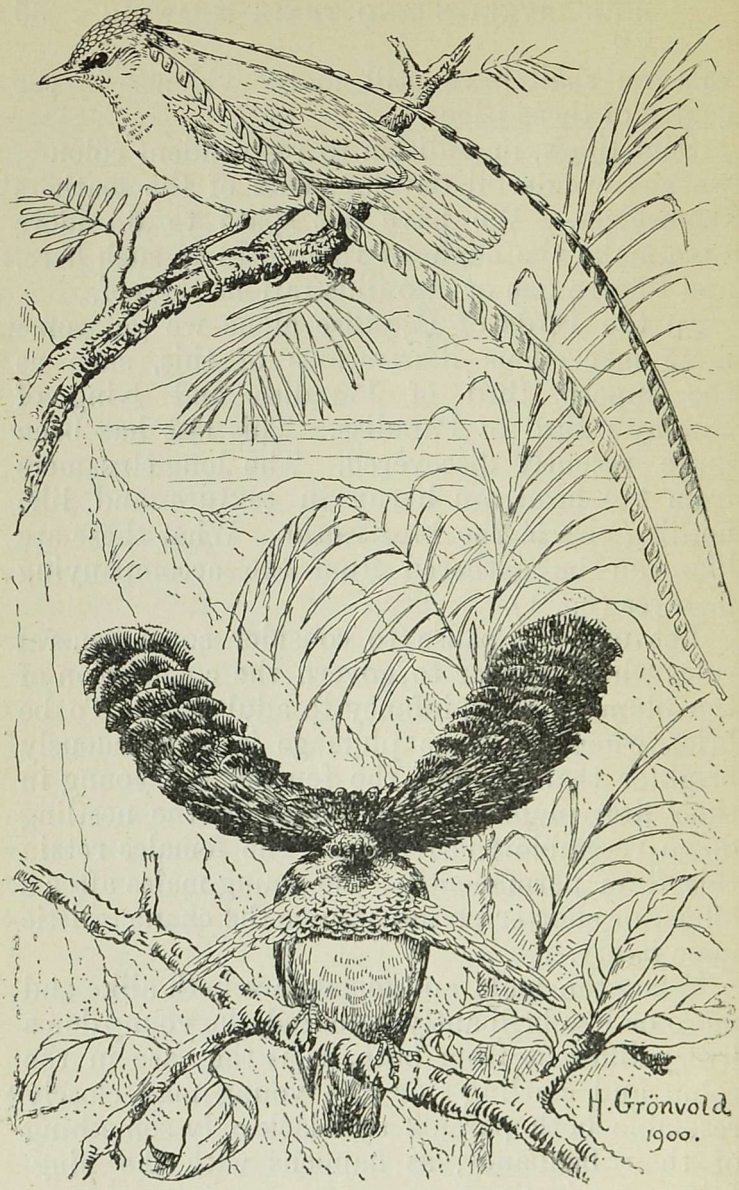

Fig 1.
The King of Saxony's Bird of Paradise (upper figure).
The Superb Bird of Paradise (lower figure).

the adult plumage varies from a few weeks to about three years or more. Those of my readers who reside in England can watch this process, through a most beautiful series of transitions, in the common starling: the whole process takes in this case but a week or two.

Changes of colour in plumage may be brought about either by replacing old feathers by new, or by wearing away of certain parts of an adult feather. There is yet a third way, according to some, and this is by an actual deposit of pigment in the feathers in position at the time the required change is made.

Sometimes colour-changes can be induced artificially, as witness cayenne-fed canaries and birds fed on hempseed. Bulfinches and other birds turn black on a diet of hempseed. The natives of the Amazonian region feed the common green parrot, says Darwin, with the fat of large siluroid fishes, and the birds thus treated become beautifully variegated with red and yellow feathers. In the Malay Archipelago the natives of Gilolo alter, in an analogous manner, the colours of another parrot; so great is the resultant change that the bird has been, after the change, described as a new species.

Mr Alfred Wallace records an even more remarkable fact. The native South Americans have a curious way of changing the coloration of the plumage of parrots and certain other birds. This they do by plucking out the feathers from the part to be operated upon, and innoculate the fresh wound with the milky secretion of a small toad. The feathers then grow of

a brilliant yellow colour, and on being plucked out, it is said, grow again of the same colour without any fresh innoculation.

It rarely happens that a bird having once donned a smart livery ever discards it for a dull one, yet this happens in the case of the wild duck. In the summer of every year he, as it has been described, "goes into eclipse" and assumes a plumage so like that of his mate as to be almost indistinguishable. As at this time of the year he has for the nonce lost his power of flight, it is probable that this sombre dress is a source of safety. In the autumn he re-assumes the splendid dress in which we know him.

As a rule, whatever bright colours or ornaments are developed follow late in life. There are one or two exceptions to this rule. The nestling Gouldian weaver finch of Australia for instance has at the angle of the mouth three small bead-like bodies of a brilliant opalescent emerald green and blue; the roof of the mouth itself is marked by five black spots perfectly symmetrically disposed. As the bird is quite blind at this time it is difficult to see what can be the reason or use of such ornaments. The nestling of the red-tailed weaver finch of Samoa again has a red wattle at the gape which disappears in the adult; and many of our British birds have yellow-gape-wattles.

The curiously striped nestling of the great crested grebe bears a heart-shaped, fleshy excrescence of a brilliant coral-red colour on the crown of the head. No trace of this is found in the adult. The nestling of the coot has the

head ornamented with curious tiny red wart-like bodies of a bright red colour, but these disappear as soon as the nestling period passes away. We fear that the explanation of these things is yet a long way off.

It is possible, of course, that they may be remnants of structures once more perfectly or extensively developed: they may be the last remaining record of a style of decoration now obsolete. Just as the young lion bears upon his coat distinct spots and stripes indicating his origin from a striped ancestor.

CHAPTER III.

HOW A BIRD FEEDS.

We may admit it grudgingly, we may never have realised it as a fact, but is nevertheless true that hunger, the imperative command to eat, has played a most powerful part in the drama of our evolution. Not less severe has been the struggle for daily bread on the part of every other living thing. The result of all this is writ large in Nature's records, and the beasts of the field, and the birds of the air, past and present, are so many witnesses, eloquently silent, testifying to the truth of this.

Let us now confine ourselves to birds, and see how this is borne out.

It is obvious that a given area of land will support a larger number of creatures of different habits, and requiring different food than would

be the case if all required the same kind of food. One eats what another leaves. A verification of the old adage "what is one man's meat is another man's poison." The outcome of this effort at adaptation to different localities, the struggle to hold unoccupied corners, is seen in the different modification of organs and forms of the body in the various animals and plants around us. In the case of birds we have numerous examples. We have birds that have become specially modified, so that they are enabled to seek their food beneath the surface of the waters, birds that obtain their food in mid-air, birds that delve beneath the ground, birds that tax our fields and orchards, birds that eat other birds, and a dozen intermediate stages of feeding and procuring food: some of which we shall discuss presently.

When we want to find out how an unknown animal feeds we look first of all at its mouth. The entrance to a bird's mouth is its beak. This is a part of the head which is produced forwards, more or less into a point. This point is divisible into two parts or jaws, an upper and a lower, both of which are encased in a horny sheath of more or less density. On the form and texture of this sheath much depends. Moreover, we shall soon see that it is not the beak that makes the bird, for we have beaks of similar form belonging to birds not at all related—the likeness has been brought about by the similar mode of feeding. At one time the shape of the beak was considered a very important character by which to judge of a bird's relationship. It was treated somewhat after the fashion

of armorial bearings, and a bird's pedigree was "read off" and its rank assigned according to the form of its beak.

The model of the strong, sharp-pointed, hooked beak of the birds of prey is closely followed by that of the parrots. In both cases we have an adaptation to the peculiar requirements of each group. In both it is needed for tearing up large portions of food into small pieces, albeit one is of flesh and another fruit. The parrot's beak, however, has proved itself readily convertible into the hawk's, inasmuch as a New Zealand parrot has, within recent years, changed its diet very largely from one of fruit to that of flesh. Since the introduction of sheep into that part of the world by the settlers, this bird seems to have found a diet of flesh more stimulating than one of fruit. Exactly how this came to be is not known. Two explanations have been advanced. The first has it that the birds settled on the skins of the sheep slaughtered for their wool, and picked off pieces of fat therefrom, as well as various tit-bits from the carcasses of the same, and thus found out how toothsome — or beaksome — mutton was. From this they went a step further and did the slaughtering for themselves. Parties of them now go a-hunting, worry a sheep till exhausted, then dig down through the back and so wound the intestines that death results. Another explanation is that the birds in the original instance mistook the sheeps' backs for the huge masses of lichen common to this region, and of which the birds are very fond. Not finding it to their taste at the top, they dug deep and soon came to the flesh

which, like the forbidden fruit, proved more palatable than that which was provided for them by a bountiful Nature. The result is, they have become a menace to sheep farmers, and are, on this account, in danger of extinction. It has, however, been denied recently that the damage inflicted is anything like so serious as this, and the latest evidence to hand has done much to clear the kea's character. Kea is the name bestowed by the Maories on this bird. Specimens of the kea, provided with mutton chops, can be seen at the Zoological Gardens in London every day.

The stork and plover tribe and the humming-birds furnish us with some admirable illustrations of the outcome of a gradual modification to suit the demands of a peculiar diet; and give to their possessors an advantage over their neighbours, a sort of monopoly over certain kinds of food.

In the avocet a nearly extinct British bird of the plover kind the beak is awl-shaped, being turned upwards, and produced into a point of extreme thinness. With this the bird is enabled to feed on minute aquatic animals, otherwise impossible of capture. The wry-bill plover has the bill turned sharply to one side, enabling the bird to pick out small crustacea, and the like, from under stones. The scissor-bill, a kind of tern found in the tropics has the upper and lower jaws compressed from side to side, to the thinness of a knife-blade, the lower being considerably longer than the upper. The bird flies just above the surface of the water, with the lower elongated portion of the beak thrust just below the surface.

By this means it is enabled to catch up small fish from the shoals which swim at the surface.

One of the storks and also a small plover have the bill flattened from above, and expanded at the tip from side to side to form a sort of flat spoon, hence the name of spoon-bill, and spoon-bill plover. These both obtain their food from pools of shallow water. Another of the storks, the flamingo, has the beak bent down upon itself in a most peculiar way, so that the bird has to feed with the crown of its head turned towards the surface of the water in which it wades and from which it obtains its food. Even a long description could not make this quite clear. My readers, if not fortunate enough to live in Spain or Africa where these birds are common, must go to the nearest Zoological Gardens where they will see these birds and much more concerning them that is curious.

The humming-birds have very long, slender beaks, which are thrust up the long tubes of honey-bearing flowers, in search of the insects which come to feast therein. Sometimes these beaks are of such length that they exceed that of the body itself! We might add dozens more of such instances, but this would be wearisome. Enough has been given to show that only birds with beaks specially adapted can obtain food from those special sources; and thus, while these sources continue open, their existence — other things being equal—is assured. *But*, existence depends upon this. Should, by any means, these particular sources of food-supply fail, the birds are doomed to death, and the race to extinction;

whereas birds with a more generalised kind of beak might possibly obtain food in some other way—as the kea-parrot has done.

That the form of the beak and tongue is due to the method of obtaining the food, is proved, if proof were needed, by the precisely analogous structures found amongst animals in no possible way related. Thus, the beak of the hawk is matched by the exactly similar beak of the octopus, a marine invertebrate. In both, the organ is used for tearing up living prey. Instances could easily be multiplied. That the most highly specialised form of beak is derived from a more generalised type is shown from the fact that, humming-birds, spoon-bills, scissor-bills and so on, do not develop their peculiarities till late in life.

There is at least one instance in which the form of the beak differs in the two sexes. This case is afforded by the Huia bird of New Zealand. That of the male is short and stout, that of the female long, slender and curved downwards. They feed on grubs obtained from more or less decaying wood. The male, with his stouter bill, breaks away the decayed wood and so unearths the concealed grub—this is not a pun! The female probes the sounder wood and drags out her food by force. Sometimes when the male having cleared away all the decayed wood is yet unable to reach his prey the female is enabled to do so, but, having done so, we are told she retains, perhaps by consent, what she has procured.

If the beak is important to some birds, the tongue is equally so to others.

The form and size of the tongue, like every

other organ of the body, is capable of being slowly but surely modified and changed like clay under the thumb of the potter. Sometimes this change is one of progression, the tongue becoming more and more complex and more and more perfectly fitted for its peculiar purpose: sometimes it is rather one of suppression as the tongue becomes less and less in size, in proportion as the need for its existence decreases, till at last, as in our cormorant and gannet, only a mere vestige of it is left. For it is a fact that so soon as an organ ceases to be useful, so soon as it ceases to work, its fate is sealed and slowly but surely it is removed from the body, or remains an insignificant vestige by which all men may measure the distance which it has fallen.

We cannot do more here than examine a few of the more remarkable tongues.

Take the common duck for instance, a bird familiar to us all. The tongue in this bird is very thick and fleshy, and provided on each side with little horny plates, and at its tip with a kind of horny spoon. The horny bristle-like plates at the side fit into similar horny plates which form a sort of fringe round the inner edge of the beak; the purpose of these plates is to form a sort of strainer, by which the bird is enabled to strain off the water which it takes in with its food. The arrangement of these plates suggests that of the whalebone in the mouth of the whale, and are used for a precisely similar purpose. These plates are best seen in one of our fairly common wild ducks, called the shoveller. In this bird they are of great size.

The honeyeaters of the New Zealand and Australian regions, the sun-birds of Africa, India, and Australia, and the humming-birds of America, have the most remarkable tongues of all birds. They are much too complicated to describe. Those who wish to know more about them should consult the various works on bird anatomy. Suffice it to say, that they resemble one another, in that the edges of the right and left sides of the tongue are of extreme thinness and rolled up in different ways to form more or less complicated tubes. The exact use of these tubes is even now a matter of dispute. Some hold they are for the purpose of sucking up honey or nectar—after the fashion of the proboscis of a butterfly which they rather closely resemble—and some, that their purpose is to "coax" insects from the flowers whose honey they have come to feast on. Certainly insects are always found in the stomachs of these birds. It may be that the birds really come for the honey, and that the insects are swallowed unintentionally, a sort of fortunate accident, the mixture rendering the diet a more nourishing one than would otherwise be the case.

Take the woodpeckers again, birds that can be seen in almost any of our English woods. Here the tongue has grown to an enormous length, so much so that it can be projected far beyond the head. The bird feeds on ants. After exposing the nest or otherwise disturbing the inmates, the long, worm-like tongue, covered with a sticky material secreted by glands at the sides of the head, is thrust in amongst the

frightened hosts, which, entangled in this substitute for bird-lime, are swiftly drawn back to be speedily swallowed. The skeleton which supports the tongue is of extreme delicacy and has to be stored away by being curled up round the head just under the skin.

A precisely similar method of feeding on ants has been developed by various mammals—the ant-eater for instance, and the echidna, or spiny ant-eater of New Zealand. Thus again we have more instances of exactly similar and independently acquired modifications of the same organs due to the need to perform the same functions. That is to say, the woodpecker and the New Zealand and South American ant-eaters are not even remotely related, yet, having adopted a similar diet, all have followed the same method of obtaining it.

There is a barbarous and old-time custom of splitting a bird's tongue to make it sing better; did those who practise this brutal custom but know it, they would be spared the excuse of performing this operation. The tongue does not improve the song, the organ of voice or song is at the lower end of the wind-pipe, concerning which we shall have something to say later. That it can have but little to do with the voice can be seen in the fact that the starling, the raven, the magpie, and others, all alike in having a hard horny tongue, can be taught to talk well, as distinctly as the most familiar example of all talking birds—the parrot, which has a large and

fleshy tongue, that might be well compared to our own.

But this chapter is to record how a bird feeds and digests its food. We have seen now, I think, fairly clearly, how important a place the beak and tongue fill in the matter of obtaining the food, and how these have been slowly modified so as to assume strange forms, in response to the need of obtaining food otherwise inaccessible. But some may ask, what is the evidence that these changes *have* taken place? This would take too long to discuss. But we have very good witnesses in the birds themselves: one can see that a long straight bill can become a long upturned one, or a long spoon-shaped one, for the change is enacted before our eyes in every avocet and every spoon-bill, and every cross-bill and every wry-bill-sand-piper and every humming-bird, and so on, that is born. In *none* of these birds are the bills of these peculiar shapes at birth. They assume these various forms later on in life; all begin with just ordinary beaks.

Just as the beak becomes changed from one form to another to enable it to do work of a certain kind more efficiently, so the stomach and intestines become also changed. The one *must* work in sympathy with the other, according to the need in each particular case.

The form and structure of the intestine or alimentary canal generally, however, do not vary as the beak, but rather as the need for adaptation to a new food. Thus the form of the digestive organs of the spoon-bill, the avoset,

and the plover is the same, as the nature of their food is the same; though differing in the form and way it is procured. The beak has changed to enable it to obtain the same kind of food in a form inaccessible except to a beak specially modified for its capture. But the digestive organs of the plover, the ostrich, and the hawk, are very different, because the food they have to digest is different.

A detailed discussion on the digestive apparatus of a bird would be out of place here. Suffice it to say that it may be divided into four parts—a mouth, a gullet, down which the food passes from the mouth; a gizzard or stomach in which the breaking-up and digestion of the food is begun, and the intestines in which the process of digestion is completed, and from which it is taken by the blood into the body to build up the tissues spent in work.

In many birds, such as the pigeon and common fowl, the gullet is provided with a large thin-walled bag, called the crop. Into this considerable quantities of food are taken, to be used later. No digestion takes place here, but the food is softened by admixture with saliva; it is mostly a storehouse used by birds that have to take in much food at a time, and then retire to assimilate it. During this process of gathering the daily bread the bird is exposed to many enemies; thus an advantage is gained if it is able to take in a large store rapidly, and then retire slowly to digest it. In the same way bullocks, antelopes and sheep, have developed a remarkable stomach, which enables them to lay in rapidly a large quantity of food,

and then to retire and quietly digest it by the process known as "rumination," or "chewing the cud."

The hard seeds and nuts devoured by the pigeon or the fowl are slowly passed on to the gizzard, where they are gradually broken up and again passed on to the intestine, to be finally absorbed as food — a beautiful instance of division of labour. The gizzard in these birds is a large, muscular (fleshy) organ, the walls of which are of great thickness, and the interior of which is armed with two horny pads. These are made to rub one against another, after the fashion of millstones; their work is further aided by small stones which the bird swallows on purpose, indeed without these it is doubtful if digestion could proceed. The gizzard and its stones serve the bird in the place of teeth for masticating its food.

There is a South American bird—the hoatzin—which has so far upset the order of things as to make its crop do the work of a gizzard. In the transformation, it has thickened its walls, and become hard and horny inside. Following on this another change has taken place. The weight of so much food, retained so long as it must be in the gizzard, has brought about a gradual decline in the form and size of the merry-thought, between the arms of which, in ordinary birds, the crop lies, and of the breast-bone, so much so that the bird's power of flight has become seriously hampered, why, we shall see later.

In the stomach (gizzard) of the great crested

grebe, one of our British birds which lives on fish, we never find stones, but only feathers. Why this should be so has never been explained.

The stomach of our common cuckoo appears to be lined with hairs when opened. Examination shows them to be the hairs of certain caterpillars, which only this bird can eat.

We have discussed the instruments by which the food is seized, and taken a peep into the mysteries of its digestion, let us, for a space, try and learn something of the means by which it is procured, and of the method by which it is discovered.

In the case of some birds, it is difficult to say whether sight or scent plays the more important part. The vulture in the past furnished material for much controversy on this point. Waterton, that most delightful of old-time naturalists, devoted much attention to this very subject. He held it proved beyond doubt that this bird discovered its food by *scent*, and not by *sight*. The vulture it must be remembered feeds only upon dead and more or less decaying animal matter, so that there would be no mistake about the smell as a feature of his diet! He argued out his case at some length. Most of us now are inclined to believe that Waterton, for once, was wrong. We hold with the view that he tried to oppose, that the bird depends entirely upon sight: a faculty which is developed to an extraordinary degree in these birds. Vultures, as is well-known, collect in large numbers in an incredibly short time on a spot where a few hours before not one was to be seen. For instance,

should a camel in a caravan fall out to die on its way through the burning desert, the fact seems to be communicated to every vulture in the country as if by magic, and lo ! in a short while they have gathered for the feast, and wait—ghoul-like—for the end. It is supposed that the prospective meal is discovered in the first instance by perhaps a single bird soaring, as they are wont, at an enormous altitude. The movements of the bird are watched by a second at an equal elevation but yet further off, and thus by a third, and so on, till one becomes a crowd. This has been beautifully expressed by Longfellow in "Hiawatha."

Some birds, like our common British snipe and woodcock, and the New Zealand apteryx, find their food by the sense of touch, or in the case of the apteryx perhaps by smell also. In both cases it is hidden from view, inasmuch as it has to be obtained by thrusting the beak down into soft ground in search of worms and such-like animals. But for the sense of touch it is obvious that feeding from such a source would be impossible. The beak of the snipe, if examined, will be found very soft and pliable; dissection shows it to be richly supplied with nerves.

Tradition has it that snipe and woodcock live on "suction." Consequently, they are cooked without the removal of the intestines or "trail." The cookery-books bid us "toast and butter a slice of bread, and put it under them for the trail to drop on." It is doubtful whether, if it were known that this trail was stuffed with more or less digested earthworms, this fashion of cooking would be so religiously followed !

To return for a moment to the sense of sight in procuring food. How keen must this sense be in the hawks and eagles. Take one of our commonest birds of prey, the little kestrel. Who has not admired its wondrous poise high in air with quivering wings, yet never moving from the same spot, till suddenly there is a downward plunge, swift as an arrow, and we know that a mouse has gone the way of all flesh: in one sense at any rate! Yes, though the bird is so high up as to appear little more than a speck in the sky, yet he has discerned, and secured, from that high altitude, a prey so small! This keenness of vision depends upon the beautiful power of compensation which the eye possesses: like a telescope, only infinitely easier, it can be focussed to suit near and distant objects at an instant of time.

The kingfisher of our river sides, the osprey of our lakes, and the gannet of our coasts, all discern their prey—fish large or small—from a distance, and seize it by a quick lightning-like plunge below the surface. The force with which this is done is well seen in the gannet, though by a cruel experiment. Sailors often tie a fish to a plank and set it adrift near these birds, suddenly there is a wild plunge, the fish is struck and the bird—is slain. The force with which it strikes the wood breaks its neck.

The cormorant, like the penguin and the darter, is a most deadly fisherman. The Chinese take advantage of its skill, turning it to their own profit. They train, and set it to catch fish. That it may not swallow what it catches,

a rubber ring is placed round the neck so that the bird is bound to come to the surface to disgorge it. Every now and then it is allowed to keep one as a reward.

Having now learnt something of the hunters that scour the face of the earth, and "of the waters under the earth," and of those who delve into the solid ground, we may profitably, in passing, take a brief survey of the domain of that lighter liquid that surrounds the earth—the air. The children of the air—the bird children—are not always the children of light, for some hunt only during the reign of twilight. And they are loved none the less on this account by those who know them. On the contrary, some of us love them more, they fill a place in our affections which the others cannot share. They are a part of some of the best and most restful moments of our lives. When the heat and glare of the long summer day has passed, and all is quiet and hushed, they break in upon the stillness and give it life. Who does not love to remember, having known them, the "churring" of the night-jar taking toll from amongst the ranks of the lazy, humming, helpless dor-beetles and cockchafers; or the delirious scream of the bow-winged swift, as he rushes with a score companions down the village street, and round the ivy-clad church-tower, snapping up as he goes along, flies, gnats, and other winged things too tiny for our eyes to see. They have burnt themselves in upon our memories, and rise at our bidding fresh as ever.

Amongst the "children of light" we have

many friends: the swallow, and martin, sand-martin and fly-catcher. Not one of these will deign to touch the earth to take from it one morsel of food, but captures it in passing through the air.

We referred, in an earlier part of this chapter, to the butcher-bird or shrike as it is more properly called. This, like the nut-hatch, is peculiar in that it often has to resort to a mechanical device to enable it to attack and demolish its food. The shrike, which feeds largely upon small birds, mice, frogs and beetles, transfixes these upon sharp thorns, then proceeds to tear pieces from them, leaving the remains to rot in the sun. Usually it keeps to one bush, at least for some time, for this purpose, and consequently the effect is rather ghastly after a while. The hawk, which feeds upon similar food, holds it by both feet; but the feet of the shrike are perhaps not strong enough for this purpose.

The nut-hatch, one of our woodland, as the shrike is one of our hedgerow birds, seems only to have recourse to artifice when feeding on nuts or hard seeds. Its chief diet is of insects. Nuts it breaks open by thrusting them into chinks and crevices in the bark of trees, and then, taking firm hold of the bark with both feet, it uses its beak as a sort of pick-axe, hammering away until the shell breaks and the coveted kernel is exposed. The noise made during this operation is considerable. The nut-hatch seems to know instinctively a sound nut from an empty shell without breaking it. Out of a liberal supply

of nuts which were placed in a tray that was fixed outside the window of the rooms of a friend of the writer in Merton College, Oxford, for the special benefit of these birds, several were always rejected, and these when opened were found to be empty, without exception.

In noting of these habits, we must not forget that gradations leading up to them are not wanting. Thus, the thrush brings snails to some large stone whereon to beat them till the shell is broken. Many birds are in the habit of softening food with water before swallowing. Crows will carry shell-fish high into the air then drop them on to the rocks below to break the shell.

Some birds live largely by the exertions of their weaker neighbours. The skua-gull, for instance, is one of the most persistent of these pirates. Powerful and bold, he waylays his cousin the sea-gull when returning from a heavy meal, and the latter, to escape, lightens his weight by disgorging his too recently swallowed dinner. Swift as light, the skua descends, and catches it before it has reached the sea.

CHAPTER IV.

BIRDS' FLIGHT, AND BIRDS' WINGS.

We are wont to regard ourselves as the "Lords of Creation," and to speak of all other living things as the inferior animals. Yet a few of these, in one respect, are a constant source of

humiliation to us. For many generations man has been sighing, with David, for the wings of the dove—or some other bird—that he too might rise as they rise, and soar as they soar, at will from one new sphere to another; that he might at will change the fog-laden atmosphere of a crowded city for the bright blue skies and sunshine of the open country. But he has sighed in vain. Many have been the attempts and as many the failures to accomplish this and success seems almost as far off as ever.

The power of flight, as a moment's reflection will remind us, is by no means confined to the birds. The butterflies and moths, flies and beetles, and the bats, in our own class—the mammalia—are all superb fliers. All fly by means of wings, but—and this has probably never before occurred to many of my readers—these wings are not in all cases of precisely the same nature and origin. The wing of the butterfly or of the bee, when compared with that of the bird or the bat, is said to be an "analogous structure"; but the wings of the bird and bat homologous structures. To put it more plainly, when we say that the wing of the butterfly is analogous to, or is the analogue of, the wing of the bird, we mean that the two organs perform the same function—of sustaining the body in the air, but that they are of different origin; whilst the wing of the bat and bird are of the same origin, or are homologous. For instance, the bat and the bird, like the horse or the dog, or ourselves, have each four limbs,

which we call—the fore- and hind-limbs of the horse and dog, the arms and legs of the man, the wings and legs of the bird or bat. The wings then are homologous with our arms, and the horse's fore-limbs; they are developed from the same parts in the unborn young or embryo. The butterfly and the bee have six legs, which cannot be compared with our legs, except in so far as they perform the same function of supporting the body. The wings certainly then cannot correspond to our fore-limbs. Moreover, there is some evidence tending to show that the wing in these last is a highly specialised and modified *gill.*

The plan upon which the bird's wing is built is quite different. Let us compare it with our own arm and hand. The wing of a bird then and the "arm" of a man are precisely similar in kind, but the former has become much more highly specialised or modified, so as to perform the office of a wing. To this end, as we shall see, certain fingers have been lopped off, and the remainder so altered as to be scarcely recognisable. The wing and the arm are both divisible into three main divisions: (1) the long single bone from the shoulder to the elbow called the "arm"; (2) the two long bones from the elbow to the wrist called the "fore-arm"; and (3) the series of bones from the wrist to the fingers which make up the hand! It is in the form of the wrist and hand that the bird differs from ourselves. The bird has retained but three of his original five fingers. One of these forms the tiny thumb; the second or index finger, and the

third or medius, have become immovably joined together; whilst the lower end of the third finger has become reduced to a single tiny bone buried beneath the skin; so that at first sight there appears to be but a thumb and one finger on the hand.

Along the hinder border of this hand, and along the same region of the fore-arm, run a number of large feathers—the quill or flight feathers. These are divided into two series, those of the hand being called the primaries, those of the fore-arm, secondaries. On the form and length of these quills depends largely the nature and the power of the flight.

Those of my readers who happen to be sportsmen or dwellers in the country will readily call to mind some four quite distinct forms of flight. The 12th of August or the 1st of September or October will furnish them with many a vision of the first kind—that of birds with heavy bodies and short rounded wings. The whirr of wings of a covey of partridges in full career is not easily forgotten. One has but to shut one's eyes and touch the spring of the proper compartment of one's mental picture stores to revive, with a vividness that cannot be equalled by the cinematograph, a whole series of scenes. Turnip-fields and stubbles, dogs and beaters, the flash and report of guns, and the call of frightened birds that have just alighted into fresh cover. And in this we have a lesson not easily effaced, a lesson from which we derive two important deductions: (1) That birds with short rounded wings and heavy bodies fly rapidly; (2) drive

the wings with great velocity and power; and do not fly far.

Those who know the partridge should know also the lapwing and the owl, the heron and the gull. These are all birds having a relatively small light body and large wings. They will be able to picture the slow majestic long-sustained flight of the heron, or the fairy-like movements of gull or tern now skimming over the shiny waters of the sea or lake, and now mounted high in air and wheeling round and round, as if for the mere delight of moving. We find in these an object lesson in the second form of flight.

To see the third form we shall have to move further afield than our own shores. We must seek out the albatross and the pelican, birds whose bodies are heavy and whose wings are long—in the case of the albatross, ribbon-like—and moved with a decidedly slow and rhythmical beat. Concerning the prowess of these on the wing we shall have something to say presently.

This classification by no means covers all the varied forms of flight. It is rather meant to be an indication of the fact that the nature of flight varies much in different groups of birds.

So far, that of which we have spoken has had reference to direct movement with a purpose, so to speak, to a deliberate passage from one point to another. But there is yet another form of flight quite different, and this is known as "soaring."

The masters of this art are, by common consent, the vultures, pelicans, and the storks; the ranks of the last claiming the finest performer of them

all in the adjutant stork. These birds are said to rise at first from 100 to 200 feet by the movement of the wings; and then, without the smallest perceptible movement of the wings, sweep round and round in elegant spirals with the wings and tail fully spread. During the first part of each turn of the spiral they sail with the wind, and in a slightly downward direction; at the end of this fall they sweep round and face the wind which bears them upward. They gain from ten to twenty feet at each turn. When the course is towards the left we are told the left wing is downward and the right upward, but the two wings always form one rigid rod, moving only as the body moves.

Thus they attain an elevation of from one to two miles—the condor, one of the vultures, sometimes rises six miles — and so restful does this exercise appear to be that the birds are believed by some to go aloft to doze. The soaring of the albatross has been most graphically described by Captain Hutton. He says, "I have sometimes watched narrowly one of these birds sailing and wheeling about in all directions for more than an hour without the slightest movement of the wings, and have never witnessed anything equal to the ease and grace of this bird as he sweeps past, often within a few yards, every part of his body perfectly motionless except the head and eyes, which turn slowly and seem to take notice of everything."

Soaring birds in this country are now rare indeed. Only where the buzzard still holds his own can we occasionally watch this beautiful

flight. One quite peculiar type of soaring, if it can really be accounted soaring, is that of the skylark: and this is performed to the accompaniment of the sweetest music that can be heard, even in this world of songsters, as the bird world is. Who has not watched, with upturned eyes, its spiral ascent till it becomes a mere speck; and often even this is lost, and the songster vanishes, naught but those exquisite notes sinking down from heaven to earth serving to indicate its whereabouts.

There yet remains one other form of flight about which we must say a few words. This is known as hovering. It is the very antithesis of soaring, though sometimes it is performed at great altitudes.

In soaring the wings are held more or less motionless, and the effect is to carry the body higher and yet higher. In hovering the wings are driven at enormous speed, yet the bird remains poised over a given spot. The wings of the humming-bird when feeding, suspended as it were beneath the mouth of some honey-laden flower-tube, dropping honey as the cloud's fatness, move so rapidly that it is impossible for the eye to follow each stroke, and a hazy circle of indistinctness on each side of the bird is all that is perceptible.

In our common kestrel hawk again we have a superb exponent of this feat. So well known is he on this account that he is popularly known as the "wind-hover."

Hovering however differs from soaring in this —it is always done in order to find food; soar-

ing is often performed—always perhaps except in the case of the vulture—for the sake of rest, or the mere pleasure and joy of living.

Concerning the speed of a bird in full flight we know but little.

We have records however of the feats of homing-pigeons and of swallows, many of which have been ridiculously exaggerated. Thus, Pliny tells of a certain Roman knight who wished to convey to his friends at Volterra, in Tuscany, the result of the chariot races in Rome, and for this purpose took swallows with him. A swallow sent from Roubaix to Paris—160 miles—is said to have covered the distance in 90 minutes, a speed of 106 miles per hour! It is stated that one of the racing homing-pigeons in 1892 accomplished a flight of 114 miles at a rate of 80 miles per hour. In the same year a flight of 82 miles is recorded, the rate of the speed attained being 71 miles per hour. Thirty-six to fifty-six miles per hour for a course of 208 miles was the average of the winning birds of the United Counties Flying Club in 1883. High up in the air it is probable that a bird can attain greater speed than near the ground, and that this moreover can be sustained for long periods. Thus the American golden plover on migration is said to cover over 1700 miles in a single night!! As Mr Headley an authority on this subject says, "Even if we assume an average of 60 miles per hour, the birds would be over 28 hours on the wing."

Gätke, a great German ornithologist, who spent

a lifetime in observing bird-life in Heligoland, believed that the Arctic blue-throat can leave Africa at dusk one evening, and arrive in Heligoland nine hours after, travelling 1600 miles during the night, which gives, as Dr Sharpe mildly comments, "the almost miraculous velocity of 180 miles per hour." This is a prodigious performance to assign to little birds of the size of our robin.

This same authority (Gätke), by the way, in estimating the time taken by plovers and curlews in the flight from Heligoland to oyster-beds, some four English miles distant, calculated that they accomplished this distance in one minute, or at the rate of 240 miles an hour!!

The speed and power of the flight depend upon the size of the muscles which move the wings. These muscles are of great size, and familiar to us all in the shape of the breast of the fowl or duck, for instance. The weight of these in relation to all the rest of the muscles put together varies. Mr Headley found that in pigeons they represented just about one-fifth of the total weight. For the purpose of attachment of these muscles, the breast-bone in these, and in all birds that fly, has developed an enormous plate of bone called a keel, from its resemblance to the keel of a ship, the hull being represented by the body of the breast-bone.

There are one or two points concerning the wings of nestling birds that are well worth noting.

In South America there lives a bird called the hoatzin, about which we are still puzzled. Its

nestling is remarkable in one or two respects. When newly hatched the thumb and first finger are armed with long claws, by the aid of which it climbs out of its nest,—which is built in dense shrubs and trees overhanging the water,—to meet its parents coming with food. Day by day certain of the quill or flight-feathers of the wing grow longer and longer, but only about half of the proper number are represented in the hand. The development of those near the tip of the finger is held in abeyance for a very considerable time, until the inner ones have grown long enough to break the force of a fall should such an accident take place. So soon as this assurance against accident has come about the outer quills grow rapidly, and the claw of this finger drops off, there being no further use for it. The benefit of this law of growth is obvious. If the outer quills grew at the same rate as the inner ones, the wing would in a few hours be useful neither as an organ of flight, nor as an organ of prehension, for the wing area would not be large enough to support the body, nor would the claw, on account of the premature development of the quills, be enabled to grasp objects. Yet another change follows the loss of this claw. In the nestling the hand is longer than the forearm, in the adult the hand is shorter than the forearm. The whole wing, in short, in the adult bird, is of a degenerate character.

The hoatzin builds in trees, and passes its whole life therein. One has never been known to alight on the ground. If a nestling should happen by any chance to fall into the water,

it escapes by diving or swimming, which it does to perfection. So far as is known, it should be remarked, the adult does not swim.

The wing of the nestling chicken furnishes us with an admirable lesson in deductive zoology.

As in the hoatzin, the outermost quill feathers of the hand are not developed till a comparatively late date, the inner ones meanwhile growing rapidly; and just as in the hoatzin, so soon as these are long enough to enable the bird to take a short flight, so soon do the outer quills begin to grow. But the hand is relatively shorter, and the finger has no claw. The first point would suggest that the reason for this arrested development of quills was due to the same cause in both cases, the need to have the finger-tip free for the purpose of grasping objects. The second—the absence of the claw on the first finger—would appear to contradict this, or at least to be an obstacle. If we turn to the embryo, however, we get confirmation of our original hypothesis—that the wing in the chick was at one time used, like that of the hoatzin, for the purpose of climbing before it was used as a wing, inasmuch as the missing claw in the first finger is now present. It disappears before the bird is hatched, there being no use for it during the nestling period. In course of time, a very long time, it will probably be entirely suppressed, so that no record whatever will remain.

Not only in the chick does this happen, but also in the pheasants and partridges and their allies. From this we infer that once upon a time

the ancestors of these birds were strictly dwellers in trees, and that the existing representatives of these have since become dwellers on terra-firma. Thus then we get from those two small points a whole flood of light illuminating the past history and the evolution of the whole group.

We shall find even more convincing evidence of this later on in these pages.

There is one other point in connection with birds' wings which should certainly receive mention here. It has puzzled and baffled all attempts at explaining it for the past twenty years.

Exactly so many years ago, one Gerbe, a Frenchman, discovered that in certain birds, such as pigeons, gulls and parrots, for instance, one of the quill-feathers of the forearm appeared to be missing—No. 5. Ten years later, this same fact was re-discovered and this time by an Englishman named Wray. Like Gerbe, he held that the particular quill in question was actually missing, and sought amongst all orders of birds hoping to find some sort of a vestige of it, but in vain. The reason for assuming a lost quill lay in the fact that in these wings every pair of greater coverts of the wing embraced a quill between them save the fifth pair, between which was no quill.

The word diastataxic has been coined to signify the absence, and eutaxic the presence, of this quill.

It has since been shown that there really is no quill missing, but that it has changed its relations with the neighbouring feathers. Exactly how this is done would be too long and too

technical to explain here. The mystery, however, is even yet not quite cleared up. The subject is one well worth the attention of those fond of puzzles.

Most of us probably regard a bird's wings as the only parts of its body concerned in its flight. As a matter of fact, flight has two powerful auxiliaries in the shape of its lungs and air-sacs.

The former, which are very large, are peculiar in more ways than one. In the first place, they are not more or less freely suspended in the body cavity, as in other animals, but fitted closely to the back. So much so, that when dissected and taken out of the body they are found to be marked by deep grooves or tunnels indicating the shape of the ribs, in between which they had forced themselves. In the second they are traversed by numerous tubes which open eventually into large thin-walled bags placed along each side of the body, and called air-sacs. These air-sacs were believed at one time to be for the purpose of making the bird lighter when in the air; but the amount of difference which they make in this direction would be inappreciable.

They probably serve as a reservoir upon which the bird can draw during the violent exertions of flight, or singing, and for regulating the body temperature.

In many birds even the bones of the skeleton are hollow and filled with air from the air-sacs. This again was supposed to be a powerful auxiliary to flight; but, when we recollect that some of the most powerful fliers, like the swift, the swallow, and the albatross, have marrow in

the place of air, like ourselves, we see that this cannot be the true explanation.

Sometimes the whole body is thoroughly permeated with air. It runs in little bags between the muscles of the body, and between the skin and the body to a most extraordinary degree. The common gannet of our shores, the pelican, and the South American "screamer" are good examples of this.

CHAPTER V.

FLIGHTLESS BIRDS AND THEIR FATE.

To appreciate fully the significance of the fact that there are birds to whom the power of flight is impossible, that have never known what it is to soar above the clouds, but who have been confined, as were their ancestors, for countless generations to Mother Earth, we must imagine a race of men, or a family of men, who have never walked. Yet there are such birds, and it is of them that we are going to speak now.

We have seen in the previous chapters how different organs, or parts of the body, change their shape, taking on new forms to adapt themselves, as the need arises, to new surroundings or new food. In all these cases the result of this adaptation has been an increase in the complexity of the organ.

With every part of the body in the same way, so long as each particular organ continues to be useful, so long as the organism has need of it,

so long as it gets its proper amount of exercise and nourishment—and the latter largely depends upon the former—just so long will it remain vigorous. More than this, it will respond within certain limits to new demands upon it, and change its form or function accordingly. But, so soon as its usefulness becomes lessened, and its exercise diminishes, its nourishment is slowly withdrawn, and it gradually but surely starts on its downward path. Growing smaller and weaker, and losing more and more its characteristic shape and beauty in each generation, it soon is reduced to a mere vestige, and even this is sometimes lost. We may then remain in entire ignorance of its ever having existed, or may have our attention directed to its loss by reason of its presence in its nearly allied species.

The following brief review of flightless birds will afford us an excellent study of the results, more or less direct, of use and disuse.

The power of a bird's flight is probably in proportion to its need in procuring food and escaping enemies. The one plentiful and near at hand, and the other removed, it would seem that each of the birds, about which we are to speak presently, insensibly settled down to a comfortable, easy existence, seldom or never exercising its wings. The flight necessary to procure the daily bread was also often a means of enjoyment pure and simple, without any such gross motives. But this source of pleasure was smothered for ever in that evil day which placed food within too easy reach and banished enemies to the land of oblivion. As a result, the children of the

third and fourth generation have been called upon to suffer, flight to them being impossible.

In the course of the next few pages we shall see how gradually changes of this kind come about. In the domain of flight we have every gradation of power and speed, from the arrow-like velocity and skilled performance of the swallow to the feeble flutter of the hoatzin, the South American bird, whose whole life is spent on low trees by the water-side. So far as is known, this bird never descends to the ground, and never takes a journey of more than 100 yards on the wing at a time. It is said to jump from the highest point available, and then gradually to descend until he alights upon the desired bough, beyond and below.

In that other bird world where wings are, or have been, but flight is not, we shall see similar gradations, but this time they will be gradations of *im*perfection. We shall see the wing growing smaller and smaller, and one by one its bones fading away and its feathers vanishing, till finally it will altogether cease to be. We shall in some cases be able to determine approximately the date at which this phase of degeneracy began.

It will be necessary here to refer once again to certain points in the structure of the skeleton of these flightless birds, and to compare these points with similar others in those birds in which the power of flight yet remains unimpaired.

In the last, as already mentioned (p. 64), the power of flight is largely commensurate with the development of the breast muscles,

and the bones of the skeleton which support them.

These comprise a breast-bone, a pair of long bones which are fastened on to its front end, a pair of shoulder-blades fastened on to the ends of these, and a merry-thought.

In birds that fly well there is a deep thin keel running down the breast-bone. This keel is familiar to us all in the fowl or duck as the bony partition which divides the flesh of the left and right sides of the breast. In birds that have lost the power of flight, this keel, if the loss is recent, is small, if of long standing it is absent altogether. The merry-thought again is absent, or feebly developed in birds which do not fly much or well, or which are quite flightless. The long bone which we referred to as being fastened on to the end of the sternum, is called the coracoid. We shall have occasion to refer to it again later. This in flightless birds may become immovably fixed to the blade-bone, and the angle which the two form one with another is also a point of some significance.

Just as the bones supporting the breast-muscles shrink away, so to speak, though lack of use, so also do the bones of the hands and arm.

As examples of birds that have but recently, comparatively recently, lost the power of flight, let us take, first of all, the New Zealand kakapo or owl-parrot.

This is a fairly large bird for a parrot, and one of great and increasing rarity. There can be no doubt that it once lived in trees, like other parrots, and probably like them needed well developed

wings to escape its enemies, and get from one feeding-ground to another. In an evil hour, misfortune in the guise of blessing overshadowed the kakapo, and removed these two stimuli to healthy exercise, with the result that indolent habits formed themselves, and slowly stole away Nature's wondrous gift of flight. At the time the kakapo settled in the island, there were no flesh-eating mammals, the bird's natural enemies, whom they can only successfully resist by taking to themselves wings. But for the mammals we should have many more birds in the same plight as those discussed in this chapter. Food is generally procurable from the ground even by birds which feed in trees. To avoid prowling beasts they ascend the trees and pluck their food from the branches—nuts, fruit or whatnot—as the case may be. In the absence of such terrors they can obtain it in plenty when it falls. This has been the undoing of the kakapo. The hole in the ground or the cleft in the rock now serves this parrot for the hole in the tree. He can ascend these if he will, but with labour, for he must climb them. It is probable that some enemy, some danger, has threatened him since he became thus helpless, for now he has turned night into day, and feeds during the hours in which he once slept. In this way he has managed to hold his own. Recently, since the advent of Europeans into his domain, things have gone hard indeed, for new enemies, in the shape of pigs, dogs, and so on, have been imported, and from them there is no escape. They devour the eggs and young. His doom is sealed.

In Australia there are kinsmen on the way towards the same doom. These are little ground-parrots, whose power of flight, for reasons similar to those just recited, is slowly decreasing.

There is a point which is well worth noting here, concerning what we may call compensation for this loss of flight, but a sadly disproportionate one. To wit, in all markedly arboreal or tree-haunting birds the legs are very short indeed. Take the pigeons, the parrots, the cuckoos, and the hornbills as instances. In all of these certain of their members have fallen away and lost their first estate, and now walk the earth wearily instead of winging their way above it as fancy led them. In just so many instances have the legs become conspicuously longer; and from this fact only we could tell that they were to be written off as representing the poor relatives of the family—the failures and the fallen ones. Many of these fly no more, the remainder but indifferently.

The wood-hen, or weka rail of New Zealand, is another of these flightless forms; its wings, though moderately large, are of no use as organs of flight. Yet another of these forlorn ones who seem "to live, desiring without hope," is the large gallinule or water-hen *Notornis*. This bird is further remarkable in that it was first described as an extinct fossil bird, probably flightless. Years after a living specimen was captured, and within the last year yet another has been captured. It is probable, however, that it is now almost or quite extinct.

The dodo, the solitaire, and the great auk,

are all instances of flightless birds which have suffered extinction within the memory of man, in the case of the last-named, within the present century.

"As extinct as the dodo" is a very familiar simile, but probably few know what manner of bird — or if indeed it is a bird — they speak of. This remarkable bird was an inhabitant of Mauritius—an island in the Indian Ocean to the east of Madagascar. It was, the old travellers tell us, of about the size of a swan and of great stupidity. Our best descriptions of the bird in a living state come from the Dutch. Specimens undoubtedly were brought over to Europe and exhibited as curiosities, and one or more of them sat for its portrait not once but many times. One of these pictures, and of the birds at least two, were brought to this country. One of the birds seems to have found its way into the dissecting room, and another was exhibited alive in London in 1638. Sir Hamon Lestrange —to quote an article on this subject by Professor Newton—says, that as he walked London streets he saw a picture of a strange fowl hung out on a cloth canvas, and on going in to see it found a great bird kept in a chamber, "somewhat bigger than the largest turkey cock and so legged and footed, but shorter and thicker." The keeper called it a dodo, and showed visitors how it would swallow "large pebble stones . . . as big as nutmegs." It is probable that this found its way eventually to Oxford among a collection of stuffed birds. In 1755 its remains were seriously threatened

for it was ordered to be destroyed. Fortunately its head and right foot were preserved and these now adorn the University Museum, together with a picture by Roelandt Savery.

The extinction of the dodo is said to be due to the importation of pigs which overran the island and devoured its eggs and young.

To get an idea of how greatly the wing has degenerated it is necessary to compare it with its leg or with the wing of some existing pigeon. One can see at a glance how disproportionate the one is to the other, and thus gain a standard of measurement absolutely reliable. The dodo was really a gigantic pigeon. So also was its kinsman and near neighbour the solitaire.

Strangely enough, although the name of the solitaire is almost unknown outside scientific circles, whilst that of the dodo is almost a household word, yet we know far more about the former than the latter. We owe much of this information to the traveller Leguat who published an account of his travels in 1708. "Of all the birds in the island," he says, "the most remarkable is that which goes by the name of the 'Solitary,' because 'tis very seldom seen in company. . . . The feathers of the males are of a brown-grey colour; the feet and beak are like a turkey's but a little more crooked; they have scarce any tail, but their hindpart covered with feathers is roundish like the crupper of a horse; they are taller than turkeys. . . . They never fly, their wings are too little to support the weight of their bodies. . . . Though these birds will sometimes very familiarly come up near enough

to one, when we do not run after them, yet they will never grow tame. As soon as they are caught they shed tears without crying, and refuse all manner of sustenance till they die."

"We find in the gizards of both male and female a brown stone of the bigness of a hen's egg. . . . We believe this stone was there when they were hatch'd, for let them be never so young you meet with it always. They have never but one of 'em, and besides the Passage from the Craw to the Gizard is so narrow that a like Mass of half the bigness could not pass. It served to whet our knives better than any other Stone whatsoever. . . ."

"All the while they are . . . bringing up their young one, which is not able to provide for itself in several Months, they will not suffer any other Bird of their Species to come within two hundred yards round the Place: But what is very singular is, The Males will never drive away the Females; only when he perceives one he makes a noise with his Wings to call the Female, and she drives the unwelcome Stranger away, not leaving it till 'tis without her Bounds. The Females do's the same as to the Males, whom she leaves to the Male, and he drives them away. We have observed this several times, and I affirm it to be true!

" . . . We have often remark'd that some days after the young one leaves the Nest, a Company of thirty or forty brings another young one to it; and the new fledg'd Bird with its Father and Mother joining with the Band march to some Bye Place. We frequently follow'd them,

and found that afterwards the old ones went each their way alone, or in Couples, and left the two young ones together, which we call'd a Marriage."

Another very remarkable flightless bird is the steamer-duck (*Tachyeres cinereus*), of the Straits of Magellan. Captain King who has given us a very vivid description of its habits, writes ". . . before steamboats were in general use, this bird was denominated, from its swiftness in skimming over the surface of the water, the 'race-horse.' . . . It is a gigantic duck, the largest I have met with. . . . The principal peculiarity of this bird is the shortness and remarkably small size of the wings, which not having sufficient power to raise the body, serve only to propel it along, rather than through, the water, and are used like the paddles of a steam-vessel. Aided by these and its strong broad-webbed feet, it moves with astonishing velocity. It would not be an exaggeration to state its speed at from twelve to fifteen miles an hour. The peculiar form of the wing, and the short rigid feathers which cover it, together with the power this bird possesses of remaining a considerable time under water, constitutes a strong link between the ducks and the penguins. . . . When alarmed, they lose no time in getting up steam, paddling through the water at a marvellous rate by dint of flapping their little wings, the motion of which is so excessively rapid that it is difficult to convince one's self that they are not revolving, leaving a long wake of foam like that produced by a miniature steamer behind them. . . ."

Mr Darwin believed that in this paddling

exercise the wings were moved alternately and not both together as in other birds. The maximum weight of a steamer-duck he estimates at 12 lbs.

There is one really very curious feature about this bird. The young are able to fly till after their first moult, when the power is lost for ever.

The great auk, like the dodo, the solitaire, and a dozen more, is but a memory: stuffed skins and skeletons scattered throughout the museums of the world, and fewer eggs, being all that remain of what was once a numerous people. The great auk it should be said is a near relative of the razor-bill (*Alca torda*) and the guillemot (*Uria troile*), such as swarm now on our coasts, and whose eggs are gathered by the bushel every year. These fly well, but in the great auk the wings were so much reduced in size as to be useless for flight.

The great stronghold of this ill-fated bird was Newfoundland. Our first account of them in these regions dates from 1536. In those days there were no condensed foods and tinned meats, so that sailors were perforce obliged to lay in large quantities of such food as could be depended upon, more or less certainly, to remain wholesome for a considerable time. Meat had to be salted, and for months at a time only this form of flesh food was available. How soon such a diet would begin to pall, we, who live in these favoured times, can readily guess. But anything seems to have been preferable to the everlasting diet of salt meat and weevil-bitten biscuits. Moreover, their complaint was surely justified,

for this diet brought more than monotony with it; it came, accompanied by that great scourge of all who have to subsist long on salt food—scurvy. Consequently, at every port of call fresh meat and vegetables were eagerly sought for. Sometimes these were to be purchased of the natives, civilised or otherwise, of the particular port. Sometimes they helped themselves freely at the expense of Nature's children. These were often so guileless, so unused to the presence of man that they felt no fear of him, and he went in and out amongst them and slaughtered at his will. It is to be feared that this freedom more often than not stirred up the brute within him, and he got the lust of killing for killing's sake.

But this is a digression. The extinction of the great auk is one of the very few cases which can in a measure claim our forbearance. But even here greed was present, more were slain than need have been. In a work published in 1620, entitled "A Discourse and Discovery of Newfoundland," we read that "among the water-fowl, which are very plentiful, are 'penguins' (the name by which the great auk was generally known) which are as bigge as geese and flye not, for they have but a little short wing, and they multiply so infinitely, upon a certain flat island, that men drive them from thence upon a board, into their boates by hundreds at a time, as if God had made the innocency of so poore a creature, to become such an admirable instrument for the sustentation of man."

On Funk Island these birds were discovered in 1534, and could then be reckoned by thousands.

For more than two hundred years they were subjected to a ceaseless persecution, till at last they were exterminated. On this island, it is said, it was the custom for the crews of several vessels to spend the summer for the sole purpose of killing "gare-fowl" (another alias of the great auk) for the sake of their feathers. Stone-pens were erected into which the birds were driven like sheep, to be slain by millions, and their bodies left to rot where they lay.

Two motives thus seem to have been at work, bringing about the destruction of these poor helpless fowl. Let us hope the need of food predominated; the evidence so far seems to point this way.

The great auk appears to have been exterminated in this quarter of the world before the beginning of the present century.

As a British bird it was nowhere plentiful, the last seems to have been captured alive in Waterford Harbour in 1834. It was kept a prisoner for some time, and on its death became one of the chief ornaments and treasures of the museum of Trinity College, Dublin.

The ostrich and the rhea, the emu, the apteryx and the moa, serve us with more instances of flightless birds.

The wings of the ostrich have not yet ceased to be useful though they no longer serve as organs of flight. They are used now as balancers in running. For this they seem to be no mean aids. Job's description of this terrestrial flight is vivid: "What time she lifteth up herself on high she scorneth the horse and his rider."

The wings of the rhea again seem to be quite large—until we realise how great is the size of the body requiring to be lifted, and examine the skeleton of the wing, when it at once becomes plain what a falling off has taken place.

In the emu and the apteryx we have an obviously degenerate wing. In these it is so tiny as to require the most careful search in the living bird to find it. But even here, small though they are, they are *bird's* wings, and modelled on the same plan as the eagle's. They have descended to greater depths than the wings of the ostrich, or the rhea, for they have lost the thumb and shortened up the hand till there is practically none left. In the old fossil diver *Hesperornis* (see page 186) not only the hand but the forearm was lost, leaving nothing but the humerus or upper wing-bone. In the moa's wing even this was lost.

We now come to our last flightless bird—the penguin—and this is one of peculiar interest.

It affords an admirable illustration of how an organ gradually modified for some particular purpose — such as flight — may as gradually assume other functions and take on quite new characters.

It is certain that the wing of the penguin was used once on a time for the purpose of flight, for it is built upon exactly the same plan as that of all other birds. Whatever points of difference there may be now, are obviously the result of a modification of the original structure, to enable it to perform more efficiently its new duty — that of a paddle. Again, the wing serves as an admirable model of

the results of the modification of the same organ in different animals for the same purpose. Or to put it in another way, it shows us how the need to overcome certain mechanical obstacles demands that every organism or part of an organism shall adopt one common plan of a nature demanded by the particular obstacle to be overcome. The superficial appearance in all, is as a result, the same, however different may be the underlying structures.

Let us take, first of all, one or two illustrations of the adaptation of animals originally very different one from another but now very similar.

Once upon a time, ages and ages ago, certain reptiles or lizard-like animals found life more tolerable and food easier to procure near the sea-shore, and occasionally in the sea itself. Of these some were more expert in catching food in the water than others. Some slight difference in their power of keeping out the water from the lungs, a broader hand, greater power of remaining for a long time submerged, and so on, gave them an advantage over their fellows which their offspring shared, and not only shared, but possessed in greater perfection. Exactly in so far as they became more successful in these respects, so in exactly the same proportion did they become more unlike their unsuccessful friends, and more unlike their own parents and grandparents. Eventually, after many generations, all obvious relationship was lost. This process of transformation was aided and hastened, by a weeding out, which worked by the gradual killing off of

all the less perfectly adapted. Some would die, because they could not manage to breathe so well, or catch food, or dive so well as their neighbours, and so on. These defects did not necessarily actually kill them before the normal limit of life was attained, but it would tend to make them less productive. Being weaker they could not so readily procure mates and would die without offspring, leaving their more vigorous and less conservative brethren to carry on the race.

The final result of all these changes was a long whale-like animal with smooth, naked skin, large flukes or blades on its tail, a large fin or fins down the middle of its back, and four big paddles representing four legs. If we dissected one of these paddles we should find it was like a huge thumb and fingerless glove, for inside would be several separate fingers; this glove moreover would be found to enclose more than the hand; all the arm would be found inside it.

If we could trace the history of such a queer beast back by a series of portraits, as some of us are able to do our ancestors, we should find just as many surprises in the fashions of their old times as in ours. If we could get back to the founder of the House we should find something very very different from the last of the line. Thus we should find the body covered with scales, the fingers quite separate, a distinct arm and forearm, and a long and thin tail.

The name and all particulars of this founder are lost in the mists of Time; the last of the line has long since followed him to the grave. His

remains we dig up occasionally in the rocks in the form of fossils, and we call them the remains of the ichthyosaurus—which means fish-lizard.

Later in the world's history, long after the ichthyosaurus had passed away, this same set of changes and transformations was re-enacted. Certain members of another house, also of ancient lineage, but of "bluer blood," played and fed, and brought up their children, and died upon the shores of ancient seas, till they grew more and more fond of it, and more and more dependent upon it; at last, their very existence hung upon it; they could live nowhere else. Like the sirens of old the sea-mother wooed and wooed and won them for her own. She grew more and more persuasive, her blandishments more and more telling, so that one after another of their family traditions were relinquished—quite unconsciously—and one after another new features were substituted, each one of which bound them to her more and more closely. Till eventually, they forgot they ever lived on land, and with this memory passed away all desire for any life other than that which they now lead.

The creatures in question, which we know as whales, and porpoises, and dolphins, in external appearance hardly differ from the old ichthyosaurus. The founder of their house had four limbs, a body clothed in hair, a long thin tail, and long ears. The hair has now been lost completely; of the four limbs, each with separate fingers, only two remain, corresponding to our arms. The separate fingers have been thrust again into the fingerless glove, the tail has de-

veloped a huge fin, as also has the back, and the ears have been cut off. The transformation is complete. The proud mammal has been brought to the level of the lowly fish-lizard, the conger eel and the shark.

Some other animals there are which have been more fortunate. The old sea-mother has succeeded in binding them to herself, but yet allows them to spend a part of their time on land, wherein the duties of the nursery may be attended to; for food they remain absolutely dependent upon her. These, too, have had to surrender more or less of their original characters and take upon themselves in exchange others more in harmony with their changed habits.

We have three such cases. One of these is furnished by the lowly reptiles, another by the more well-to-do birds, and a third by the aristocratic mammals.

The reptiles have given us the turtles; the birds, the penguins; the mammals, the seals, sea-lions, and walruses.

In the first mentioned, all four limbs have been thrust into fingerless gloves; in the second, only the fore-limbs or wings. In the mammals the hands and feet are gloved, so to speak, but the fingers remain distinct—not *separate*. They are united one to another by a sort of web.

These flightless birds then have much to tell us if we only read Nature's lessons aright. They make us think, and look about, and tell us much of the world around us that we had previously never suspected. They teach us to

be careful in drawing conclusions. We realise, indeed, that things are not always what they seem. That things which appear to be very much alike may in reality be very unlike. Thus a whale is not a fish because it lives in the sea, nor is a snake an eel, though the one may be hardly distinguishable from the other, and both may conceivably be caught in the same haul of the net.

The wing of the penguin is now, in consequence of this transformation to perform other duties, no longer a wing in function, but a paddle. If it were compared with a wing such as that of a pigeon or a duck, we should notice many superficial differences. First of all would be its great breadth, secondly we should find that we could not open and close it like other wings, but that it remained always open. Again, we should see it had no thumb, and lastly, we should miss the long distinct covert and quill feathers. Instead, we should find tiny feathers with very broad shafts, and very little of the vane or web which is found in all other birds. But, after all, these changes are but slight. The paddle is still a wing at bottom. It has only undergone a few comparatively slight and superficial changes to transform it into an efficient instrument for its new duties. Just as, by a few slight alterations, we can make some existing piece of machinery undertake new work without throwing the whole into the furnace to be recast.

Those who can visit the London Zoological Gardens should make their way to the fish-house at about the penguin's feeding-time. They will

then see what an admirable paddle his modified wing has become, having entirely supplanted the feet for the purpose of propulsion in the water. In the penguin, the feet are stretched out behind quite straight and held motionless, whilst the wings work as rapidly as if the bird were flying through the air.

Thus the loss of flight may be followed by the entire loss of the whole wing; or this organ, whilst undergoing a certain amount of degeneration, may be saved, as it were, to perform some new function—such as that of swimming. The loss of the whole wing cannot be regarded as a dead loss to a flightless bird. The amount of nourishment which would be expended in its sustenance is put to the credit of the sustenance of the rest of the body.

CHAPTER VI.

COURTSHIP.

To tell the story of the courtship and lovemaking of the birds, in anything like fulness, would be to undertake a task far too large to be compressed within the limits of these pages. But we can and will take a brief survey of some of its more important features. We venture to think that these will form a surprise, as pleasing as it is great. That they will prove quite a revelation of the hidden life of the bird world.

With the birds, as with ourselves, there comes, with the period of maturity, that strange indefin-

able conviction, that it is not good to live alone, and all the energies become centred upon one object—the finding of a mate and the founding of a home.

The fashions, customs and traditions requisite, to be observed in bird society in securing this mate are as varied as in our own species. We may roughly divide the methods into conquest by blandishments, and conquest by battle.

Let us take conquest by blandishments first. These are of several kinds, though by no means sharply divided one from another. They may be classed under the heads of vocal and instrumental music, dances, antics and display of decorative or brilliantly-coloured plumage. In one or two cases it is hard to say whether we are dealing with a display of plumage, or an instance of battle.

The vocal and instrumental music of birds can be studied in Great Britain perhaps to better advantage than anywhere else in the world.

The glades and meadow-lanes of rural England teem with instances, as our literature, both poetry and prose, bears witness. Perhaps the skylark and the nightingale have secured the largest share of attention. Those who only know that divine songster, the skylark, as a prisoner, beating out its life against the bars of a tiny cage, can scarcely claim to have heard its song! Who does not feel raised to the seventh heaven of delight in listing to the nightingale trying, as it would seem, to "satiate the hungry dark with melody"?

The skylark, the nightingale, the black-cap,

and the thrush occupy undoubtedly the foremost place amongst our English songsters. But they are by no means the only minstrels we possess. Of songsters of lesser mark we have a crowd. By describing them as of lesser mark we do not, however, wish to seem to despise them. On the contrary, we prize them scarcely less than their more gifted brethren. They are the life and soul of some of the fairest spots of our riversides and hedgerows.

Our cousins beyond the seas are scarcely less fortunate than ourselves. For our nightingale, they have the mocking-bird, the cat-bird, and many more. How greatly, and how justly they are esteemed, let their own poets—Walt Whitman, Burroughs, Emerson and Longfellow — bear witness.

I would here say a few words with regard to the relation of the song of birds to our music, which latter, as that great bird-lover, Mr Warde Fowler, remarks, "is a highly-developed product of science and art combined: that you cannot write down on our musical scale without depriving them of all that freedom and wildness in which their very life and beauty consist; and that they cannot be played upon a highly artistic instrument of man's making, though they can be rudely imitated on a rude one. If they are to be compared with anything human, it should rather be with that rude music of primitive man out of which our own has gradually been evolved —with cries of victory, the wailing of women, the weird chant of the prophetess, or even the "hwyl" that may still occasionally be heard in

the Welsh pulpits." Nevertheless, our music has been and doubtless often is inspired by that of the birds. Thus, to quote Mr Warde Fowler again, "the song of the yellow hammer is said to have suggested the famous opening notes in Beethoven's symphony in C minor." Again, he tells us in the "andante of Beethoven's Pastoral Symphony, the voices of birds are consciously imitated." About the musical quality of these notes he asks, "In what sense can we truly call them music? what is their relation to our modern musical art?" The singing apparatus of a bird, he continues, "where it is perfect . . . is a legitimate musical instrument, consisting of a long tube and a tiny membrane which vibrates under the transmission of air from the lungs, and it is played upon, or modulated, by the muscles which tighten and relax like the lips of a performer on a reed instrument. The method of producing the sound is, in fact, very much the same in the bird and in a reed instrument, and this may account for what I may call the reedy quality of the voices of most birds."

In the oboe "the sound is produced by the reed affixed to the small end of the instrument, which vibrates between the lips of the player as he breathes air into it from his lungs." The vibration of the reed is "communicated to the column of air in the pipe of the oboe." The result is a true musical sound. The sound is produced in a similar way, by all songsters, and on the same principle as in the oboe. "The bird breathes from its lungs into two bronchial tubes ; at the point where these two tubes com-

bine into one there is fixed a tiny elastic membrane, which serves the same purpose as a reed, and sets the air vibrating in the pipe which corresponds to the pipe in the oboe, *i.e.*, the bird's windpipe. We are apt to fancy that the bird sings with his bill or his tongue, but this is altogether a mistake. . . . These may have some kind of influence upon the sound, but that sound is produced far down in the bird's throat, at the thin end of the tube, just as it is in the oboe."

"In the oboe the tube is of wood, and therefore hard and inelastic; of itself it cannot alter the pitch of the sound produced by it, but, in order to alter the pitch, holes have been punched in the tube by stopping which with the fingers you can make the vibrating column of air in the tube longer or shorter at will, and thereby alter the pitch of the sound; just as in the trombone the same thing is effected by moving one tube up and down within the other."

"In the bird's instrument the tube is not hard or stiff. . . . It can be lengthened and shortened, squeezed and relaxed, by many strong muscles which are attached to it; and these give the bird a capacity . . . of producing an almost endless variety of pitch. . . ."

Many birds have exquisitely beautiful notes, but they are nevertheless not to be confounded with song. Our English cuckoo, for instance, has no song. The well-known notes so dear to us all are to be regarded as call-notes intended to give notice of his whereabouts to his mate. So again the piping of the curlew and many other water-birds are not songs, but call-notes.

Some others have deep trumpet-like notes which are used for a similar purpose. In some of these, as in certain swans and cranes, the keel of the breast-bone forms a hollow tunnel into which a part of the windpipe coils itself on its way to the lungs. In the painted snipe, curassows, the manucode, and some other birds, the windpipe is coiled many times between the skin and the muscles of the breast. In many ducks at the base of the windpipe there is a curious enlargement, forming a hollow chamber. It is generally supposed in such cases, that birds so modified have very powerful voices, or voices in some way peculiar. This does not however seem to be borne out by facts. In ducks, for instance, it is the female which has the loudest voice. The boom of the bittern again is a loud enough note yet the windpipe is in no way specially modified. In the female emu, the front of the windpipe, about half-way down the neck, opens into a curious bag, which, when filled with air, can be made to produce the curious drumming sound which this bird makes.

Certain other cries express danger signals, or it may be are intended as notes of defiance or challenges to battle.

Some birds sing in concert. Mr Hudson has vividly pictured for us such a concert, the performers being the crested screamer of South America. These birds, he tells us, often sing together in vast flocks at intervals during the night. He tells us how that on one occasion he was surprised by "an awful and overpowering burst of 'melody' which saluted him from half a

million of voices at an out-of-the-way spot in the pampas one evening at nine o'clock; and again how once at noon he heard flock after flock take up their song round the entire circuit of a certain lake, each flock waiting its turn to sing, and only stopping when the duty had been performed."

The bird's voice then may express anger, recognition or mate-hunting calls, or may breathe forth furious challenges, or soft-assurances of love, but none of these need be included under the category of true song. This brings us to the question, what does the genuine songster mean, why does he sing? Opinions on this point are by no means in strict harmony.

The most probable interpretation seems to be that the song, like that of the nightingale for instance, is primarily for the purpose of winning a mate, and for her delectation during the period of incubation. It seems certain that there exists a great deal of rivalry amongst the males of each particular species in the neighbourhood as to which shall sing best, the judges being the females of the same species settled near the trial courts. These select the finest performers and leave the rest to rise to greater proficiency —or remain bachelors. The fact that they sing before the pairing season actually begins, as well as later in the year, need *not*, as some suppose, militate against this view. Neither does the fact that a bird will sing immediately after its nest has been plundered serve as hostile evidence. It may pour forth its soul in anguish as well as in joy. We may not detect the difference in the two cases, but it may nevertheless be there.

We would not rob our feathered friends of the credit of doing their best to show the world "how to be happy though married." When we find some songster, perched high above his mate, sitting on the eggs below, we can but feel that he is trying to charm the dull hours of waiting with his sweet-toned melodies. He is telling how that

> "The blue eggs in the robin's nest
> Will soon have wings, and beak, and breast,
> And flutter and fly away."

Some hold that singing is merely the expression of superabundant energy: that a bird sings from the pure enjoyment of life, and that the song is the measure of his superfluous vitality. They point to the fact that nearly all songsters are dull coloured, and that brilliantly-coloured birds rarely sing well. This may be true, but it need not affect the truth of the first hypothesis. According to this, brilliantly-coloured birds or great songsters represent those who have been so successful in the struggle for life, that they have something over of their vitality to spend in this way—the luxury of music, or fine feathers—but let it be noted, never both.

True song, then, is probably to be regarded as Darwin regarded it, primarily as a method of courtship. There is certainly great rivalry amongst the males as to who shall sing best, and it is probable that the female always chooses the finest performer as her mate. Call-notes, musical or otherwise, songs in concert, challenges and so forth, simply represent the language of the bird-world generally, and have

little or nothing to do with courting. It will be found that the birds which have no song for the most part have adopted other means for the purposes of courtship; it may be by antics, it may be battle. This is what is meant by sexual selection. The preference of the female for the finest performers gradually raises the standard of the performance, in-as-much as the offspring being begotten of parents with a higher æsthetic taste and degree of skill than the unsuccessful suitors, would cause each generation to slowly improve upon the last. The excellence of their performance to-day is the measure of the distance they have traversed from the dead level of mediocrity.

Of instrumental music we have not so many instances, nor are they so varied.

Our common British snipe (*Gallinago coelestis*) affords us one of the best instances. In the pairing season, and at this time only, it gives rise to a most remarkable kind of noise, which has been variously described as bleating, drumming, neighing or thundering, according to the ear of the listener. To the present writer it sounds rather like humming, like the noise often made by wind. Mr Darwin says, "This bird, during the pairing-season, flies to 'perhaps a thousand feet in height,' and after zig-zagging about for a time, descends to the earth in a curved line with outspread tail and quivering pinions and surprising velocity. The sound is emitted only during this rapid descent. No one was able to explain the cause, until Herr Meeves observed that on each side of the tail the outer feathers are peculiarly

formed, having a stiff, sabre-shaped shaft with the oblique barbs of unusual length, the outer webs being strongly bound together. He found that by blowing on these feathers, or by fastening them to a long thin stick and waving them rapidly through the air, he could reproduce the drumming noise made by the living bird. . . ." In some species four feathers and in others no less than eight on each side of the tail are greatly modified. The variation in the number and shape of these feathers give rise to a corresponding variation in the tone of the sound produced.

The guan, a South American game-bird, produces a similar sound with its wings. The late Mr Salvin says of it, "I well remember being startled by a strange sound when shooting in one of the ravines in the Volcan de Aqua in Guatemala. Not at first perceiving whence it arose, I walked on, when the noise was again repeated. I then set about discovering the cause and soon found that it was produced by a male *Penelopina nigra* (the black penelope) which, when flying in a downward direction with outstretched wings, gave forth a kind of crashing, rushing noise, which I likened at the time to the falling of a tree."

The manakins—small perching birds of South America—have the shafts of the secondaries, or quill-feathers of the forearm curiously "thickened to an extraordinary degree, forming a solid, horny lump." . . . These little birds make an extraordinary noise, the first "sharp note being not unlike the crack of a whip."

A very remarkable form of drumming is

practised by the kalij pheasant. Captain J. H. Baldwin thus describes it: "We had been sitting motionless for, I suppose, half-an-hour, when I was startled, all of a sudden, by the loud, drumming noise . . . close at hand. The sound came from behind, and on looking over my shoulder my companion, with a smile, pointed out the drummer. An old cock kalij was squatting on the stump of a fallen tree and, with all its feathers ruffled and tail spread, was causing this extraordinary sound by rapidly beating its wings against its body."

We will pass on now to the dances, antics and display of decorative plumage, and bare patches of coloured skin. Instances of this kind are very numerous, but a few of the more important will suffice us here.

In the British Islands we have, or rather had, one magnificent example of these "love-antics," or what is generally known as "showing-off." Once upon a time, say two generations ago, there roamed on heaths and plains of England a large bird—the largest of our British fauna—called the great bustard (*Otis tarda*). Cultivation of waste land and improved fire-arms have, between them, wiped out the bird from the list of our fauna. The last of the old British stock was killed in Norfolk.

"When the male wishes to attract the attention of the female bird," writes Dr Sharpe, "he first approaches her with short steps, lifting his feet from the ground and rustling his wings. His next proceeding is to throw his tail flat over on to his back, and to spread his shoulders out,

so that, by crossing the ends of the long primary quills, he is enabled to keep the tail down, and he then ruffles up all his back feathers and scapulars, so as to completely hide the wings and the tail together. The white under-tail coverts are then brought up so as to form a kind of fringe or 'halo' at the back of the bird, who next proceeds to make an attempt to turn the feathers of the wing inside out. The white inner secondaries which lie nearest to the back are raised and thrown over the latter, and in order that there may be no mistake about these being seen, the bird flings down the long parapteral feathers which lie between the shoulders and the wing-coverts, and thus the wife is enabled to admire the show of white feathers which are elevated across the back. The wing-coverts are also treated in a similar fashion, but not quite to the same extent. Having accomplished this extraordinary contribution to the study of the love-making, the bustard then proceeds to inflate his chest, which he does by blowing out his pouch to an enormous extent; and then, burying his head in his neck so that his whiskers become upturned on each side of the head, he adds the final touch to one of the most wonderful exhibitions in nature. That *white* is an attractive colour in this display must be gathered from the extraordinary efforts put forth by the bird to show all his white plumage to the best advantage." What this display looks like is admirably shown on page 102.

The pouch referred to, and shown in the accompanying illustration (fig. 3), is a suffi-

ciently extraordinary structure to deserve a brief description here. It is a long thin-walled bag running all the way down the neck, just under the skin. Its upper end opens in front of, and below the tongue, its lower end is often flask-shaped enabling it the more easily, at the constricted portion, to pass between the merry-thought. When the bird is "showing-off" this pouch is filled with air, and thus increases the size of the neck enormously. This pouch was believed by the older ornithologists to be for the purpose of holding water, owing to the difficulty of procuring this in the arid localities in which the birds lived. But as the pouch is only present in the male the force of this argument was hard to see.

The display of the pinnated grouse (*Tympanuchus Americanus*) has been vividly described as follows by Captain Bendire: "Early in the morning you may see them assemble in parties, from a dozen to fifty together, on some high dry knolls where the grass is short, and their goings-on would make you laugh. The cock birds have a loose patch of naked yellow skin on each side of the neck just below the head, and above these on either side, just where the head joins the neck, are a few long black feathers which ordinarily lay backward on the neck, but which, when excited, they can pitch straight forward. Those naked yellow patches . . . cover sacs which they can blow up like a bladder whenever they choose. These are their ornaments, which they display to the best advantage before the gentler sex at these love-feasts. This they do by blowing

up these air-sacs till they both look like two ripe oranges on each side of the neck, projecting their long black ears right forward, ruffling up all the feathers of the body till they stand out straight, and dropping their wings on the ground like a turkey cock."

"Then it is that the proud cock, in order to complete his triumph, will rush forward at its best speed for two or three rods through the midst of the love-sick damsels, pouring out as he goes a booming noise, almost a hoarse roar, only more subdued, which may be heard for at least two miles in the still morning air. This heavy booming sound is by no means harsh or unpleasant, on the contrary it is soft and even harmonious. When standing in the open prairie at early dawn listening to hundreds of different voices, pitched on different keys, coming from every direction and from various distances, the listener is rather soothed than excited. If this sound is heavier than the deep keynotes of a large organ it is much softer, though vastly more powerful, and may be heard at a much greater distance. One who has heard such a concert can never mistake or forget it.

"Every few minutes this display is repeated. I have seen not only one, but more than twenty cocks going through this funny operation at once, but then they seem careful not to run against each other, for they have not yet got to the fighting-point. After a little while, the lady-birds begin to show an interest in the proceedings by moving about quickly a few yards at a time, and then standing still a short time."

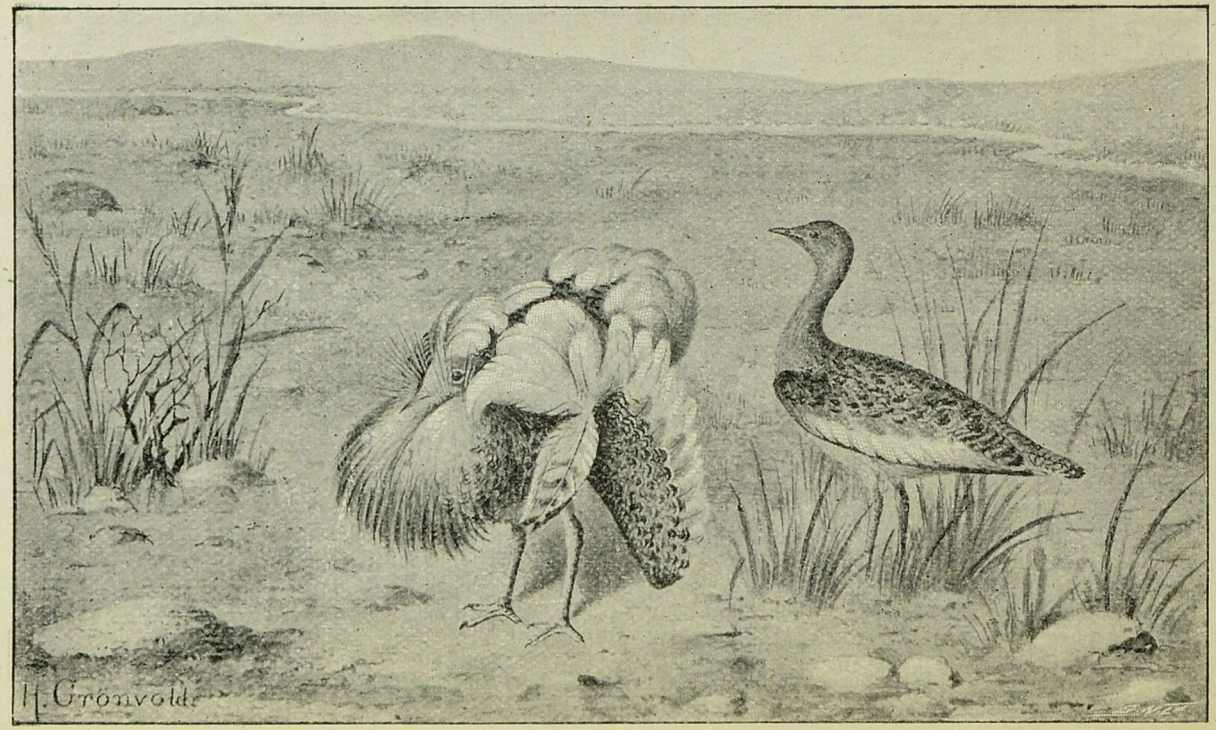

FIG. 2.—The love-display or "showing-off" of the great bustard, *Otis tarda*.

"The party breaks up when the sun is half-an-hour high to be repeated the next morning and every morning for a week or two before all make

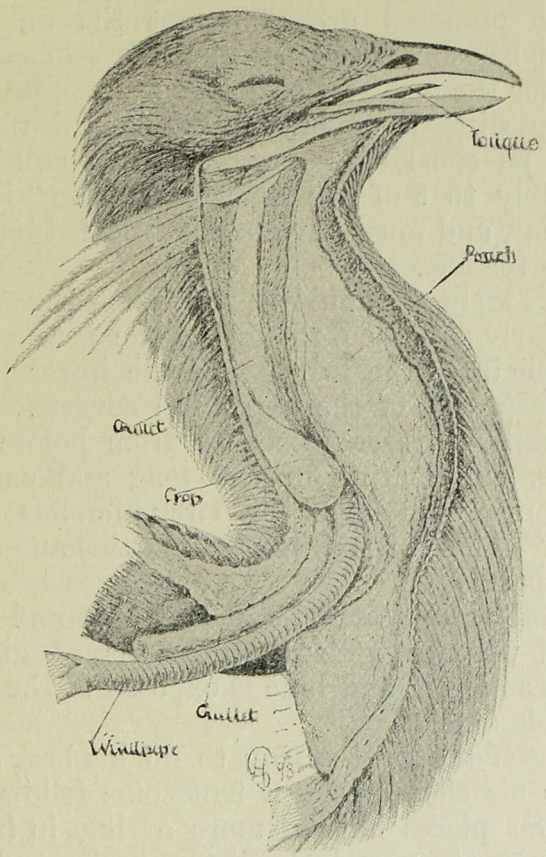

FIG. 3.—Dissection of the head and neck of a great bustard, *Otis tarda*, to show the curious wind-bag or pouch (p. 100) used in the love-display.

satisfactory matches. It is toward the latter part of the love-season that the fighting takes place among the cocks, probably by two who

have fallen in love with the same sweetheart, whose modesty prevents her from selecting between them."

The pinnated grouse is not the only bird which has developed naked patches of coloured skin for the purposes of display.

The display of brilliantly-coloured plumage must be considered now. Of such exhibitions probably that of the peacock's "train" is most familiar, and must have been witnessed by many of my readers.

This train, it should be remarked, is *not*, as is popularly supposed, the *tail* of the peacock. It is made up of the feathers of the lower part of the back, and of the upper tail coverts. These gradually increase in length from before backwards, culminating in the long and exquisite feathers which form the circumference of the train. The real tail lies behind this and acts as a support.

These train feathers can be slowly and gently raised till the well-known fan-shaped glory of green and gold and blue is exposed to the fullest possible extent.

Watch the bird trying to do his best to persuade his chosen what a handsome fellow he is. He first places himself more or less in front of her, but at some little distance off; and then, watching his opportunity, walks rapidly backwards, going faster and faster and faster till, arrived within a foot, he suddenly, like a flash, turns round and displays to the full his truly gorgeous vestments. This turning movement is accompanied by a violent shaking of the train,

the quills of which rattle like the pattering of rain upon leaves. Often this movement is followed by a loud scream.

When the train is fully erect it will be noticed that it lies so far forward that the bird's head and neck appears as if rising from its base. In a side view the whole body, from the front of the wings backwards, appears to lie behind the train.

The curious part of it is, as in the case of the bustard and of the ruffs, the female appears to be supremely indifferent to all this fuss. Perhaps it is etiquette to behave thus—to affect an indifference they do not feel.

The argus-pheasant, writes Mr Darwin, " . . . affords a much more remarkable case. The immensely developed secondary wing-feathers are confined to the male, and each is ornamented with a row of from twenty to twenty-three ocelli above an inch in diameter. These feathers are also elegantly marked with oblique stripes and rows of spots of a dark colour, like those on the skin of a tiger and leopard combined. These beautiful ornaments are hidden until the male shows himself off before the female. He then erects his tail, and expands his wing-feathers into a great, almost upright, circular fan or shield, which is carried in front of the body. The neck and head are held on one side so that they are concealed by the fan ; but the bird, in order to see the female, before whom he is displaying himself, sometimes pushes his head between two of the long wing-feathers . . . and then presents a grotesque appearance. This must be a frequent habit with the bird in a state

of nature, for . . . on examining some perfect skins sent from the east [there was] found a place between two of the feathers which was much frayed, as if the head had here frequently been pushed through.

"The ocelli on the wing-feathers are wonderful objects, for they are so shaded that, as the Duke of Argyll remarks, they stand out like balls lying loosely within sockets. When I looked at the specimen in the British Museum, which is mounted with the wings expanded and trailing downwards, I was, however, greatly disappointed for the ocelli appeared flat, or even concave. But Mr Gould soon made the case clear to me, for he held the feathers erect, in the position in which they would naturally be displayed; and now, from the light shining on them from above, each ocellus at once resembled the ornament called a ball and socket."

"The foregoing remarks relate to the secondary wing-feathers, but the primary wing feathers, which in most gallinaceous birds are uniformly coloured, are in the argus-pheasant equally wonderful. They are of a soft brown tint, with numerous dark spots, each of which consists of two or three black dots, with a surrounding dark zone. But the chief ornament is a space parallel to the dark-blue shaft, which in outline forms a perfect second feather lying within the true feather. This inner part is coloured of a lighter chestnut, and is thickly dotted with minute white points. . . . Now, these feathers are quite hidden on all ordinary occasions, but are fully displayed, together with

the long secondary feathers, when they are all expanded together, so as to form the great fan or shield. The case of the male argus-pheasant is eminently interesting, because it affords good evidence that the most refined beauty may serve as a sexual charm, and for no other purpose. We must conclude that this is the case, as the secondary and primary wing-feathers are not at all displayed, and the ball-and-socket ornaments are not exhibited in full perfection until the male assumes the attitude of courtship. The argus-pheasant does not possess brilliant colours, so that his success in love appears to depend on the great size of his plumes, and on the elaboration of the most elegant patterns. Many will declare that it is utterly incredible that a female bird should be able to appreciate fine shading and exquisite patterns. It is undoubtedly a marvellous fact that she should possess this almost human degree of taste. He who thinks he can safely gauge the discriminations and taste of the lower animals may deny that the female argus-pheasant can appreciate such refined beauty; but he will then be compelled to admit that the extraordinary attitude assumed by the male during the act of courtship, by which the wonderful beauty of his plumage is fully displayed, are purposeless; and this is a conclusion which I for one will never admit."

The birds of paradise again afford us striking instances of the recognition by birds of their own beauty.

Dr A. R. Wallace, during his stay in the Aru Islands, was so fortunate as to witness one of the

"dancing-parties" of these birds. He says: "The birds had now commenced what the people here call their 'sácaleli,' or dancing-parties, in certain trees in the forest . . . which had an immense head of spreading branches and large but scattered leaves, giving a clear space for the birds to play and exhibit their plumes. On one of these trees a dozen or twenty full-plumaged male birds assemble together, raise up their wings, stretch out their necks, and elevate their exquisite plumes, keeping them in a continual vibration. . . . Between whiles they fly across from branch to branch in great excitement, so that the whole tree is filled with waving plumes in every variety of attitude and motion . . . the wings are raised vertically over the back, the head is bent down and stretched out, and the long plumes are raised up and expanded till they form two magnificent golden fans striped with deep red at the base, and fading off into the pale brown tint of the finely divided and softly waving points. The whole bird is then overshadowed by them, the crouching body, yellow head, and emerald-green throat forming but the foundation and setting to the golden glory which waves above. When seen in this attitude, the bird of paradise really deserves its name, and must be ranked as one of the most beautiful and most wonderful of living things."

We might quote many another instance of the display of brilliant or decorative plumage, but space forbids.

We must now pass on to consider dances and playing-grounds.

The account of the display of the bird of paradise just related is regarded by the natives as a dancing-display; we prefer to consider it rather as a dress-display.

The jacana of South America is an expert dancer. "Mr Hudson," writes Dr Sharpe, "says that in the Argentine Republic he has seen these birds leave their feeding all in a moment, and with quick excited notes cluster together in a close group, and go through a singular and pretty performance, all together holding their wings outstretched and agitated, some with a rapid fluttering, others with a slow-moving, leisurely motion, like that of a butterfly sunning itself. The performance over, the birds peaceably scatter again. . . ."

One, at least, of the manakins—small South American birds—practises the noble sport of dancing. Mr Nutting, in relating his travels in Nicaragua, writes: "The natives call this bird the 'bailador' or 'dancer,' but it was not until I had been in the region for some time that I understood why it was called by that name. One day when hunting through the dense forest, the profound silence was suddenly broken by the regularly repeated note of 'El Bailador,' and softly making my way to the spot, I witnessed one of the most remarkable performances it has ever been my lot to see. Upon a bare twig which overhung the trail at a distance of about four feet from the ground, two male 'bailadors' were engaged in a 'song and dance' act that simply astonished me. The two birds were about a foot and a half apart,

and were alternately jumping about two feet in the air, and alighting exactly upon the spot whence they jumped. The tune was as regular as clockwork, one bird jumping up the instant the other alighted, each bird accompanying himself to the tune of *To-lé-do—to-lé-do—to-lé-do*, sounding the syllable *to* as he crouched to spring, *lé* while in the air, and *do* as he alighted. This performance was kept up without intermission for more than a minute, when the birds suddenly discovered that they had an audience, and made off."

In the Hon. Walter Rothschild's "Avifauna of Laysan," there is a vivid word-picture of similar antics of the stately albatross. "First, they stand face to face, then they begin nodding and bowing vigorously, then rub their bills together with a whistling cry. After this they begin shaking their heads and snapping their bills with marvellous rapidity, occasionally lifting one wing, straightening themselves out, and blowing out their breasts; then they put their bill under the wing or toss it in the air with a groaning scream, and walk round each other often for fifteen minutes at a time."

Dr Sharpe, in his "Wonders of the Bird World," gives the following extract from Mr Nelson's Report on the Birds of Alaska, illustrative of the curious dancing habits of the cranes. "On May 18, I lay in a hunting blind and was much amused by the performances of two cranes which alighted near by. The first-comer remained alone but a short time, when a second bird came along, uttering his loud note at short

intervals, until he espied the bird on the ground, when he made a slight circuit, and dropped close by. Both birds then joined in a series of loud rolling cries in quick succession. Suddenly the new-comer, which appeared to be a male, wheeled his back towards the female and made a low bow, his head nearly touching the ground, and ending by a quick leap into the air. Another pirouette brought him facing his charmer, whom he greeted with a still deeper bow, his wings meanwhile hanging loosely by his side. She replied by an answering bow and hop, and then each tried to outdo the other in a series of spasmodic hops and starts, mixed with a set of comically grave and ceremonious bows. The pair stood for some moments bowing right and left, when their legs appeared to become envious of the large share taken in the performance by the neck, and then would ensue a series of skilled hops and skips, which are more like the steps of a burlesque minuet than anything else I can think of. Frequently others join, and the dance keeps up until all are exhausted."

Perhaps one of the most curious of all these instances of dancing is that of the Cayenne lapwing.

"These birds, which are known in the pampas by the name of teru-teru, generally live in pairs, and have a curious habit of indulging frequently in a kind of dance or march, which is described by Mr W. H. Hudson. "This observer writes that anyone watching a pair of these birds will see an individual from another pair rise and fly to them. Advancing to receive their visitor, the

pair place themselves behind it; then all three, keeping step, begin a rapid, uttering resonant drumming note, in time with their movements; the notes of the pair behind being emitted in a stream, like a drum-roll, while the leader utters loud single notes at regular intervals. The march ceases; the leader elevates his wings and stands erect and motionless, still uttering loud notes; while the other two, with puffed-out plumage and standing exactly abreast, stoop forward and downward until the tips of their beaks touch the ground, and sinking their rhythmical voices to a murmur, remain for some time in this posture. The performance is then over, and the visitor goes back to his own ground and mate to receive a visitor himself later on."

The playing-grounds and gardens of some birds are perhaps even more remarkable than these instances of dancing. Those of the bower-birds are the most remarkable and have been graphicly described by Gould, the greatest of authorities on Australian birds.

One of the most remarkable is the bower of the "Gardener" bower-bird. This, says Prof. Newton, shows an "appreciation of beauty perhaps unparalleled in the animal world." It builds, to quote the same author, "at the foot of a small tree a kind of hut or cabin . . . some two feet in height, roofed with orchid-stems that slope to the ground, regularly radiating from the central support, which is covered with a conical mass of moss, and sheltering a gallery round it. One side of this hut is left open, and in front of it is arranged a bed of verdant

moss, bedecked with blossoms and berries of the brightest colours. As these ornaments wither they are removed to a heap behind the hut, and replaced by others that are fresh. The hut is circular, and some three feet in diameter, and the mossy lawn in front of it nearly twice that expanse. Each hut and garden are, it is believed, though not known, the work of a single pair of birds, or perhaps of the male only."

We have now come to the concluding section of this chapter—conquest by battle. In this form of courtship the male birds meet, sometimes in mortal combat, often, however, these battles seem to be rather like the tournaments of olden times wherein the "sterner" gather together to a mimic warfare in the presence of the "gentler sex" to win therefrom not only admiration, but a mate. In the real battle, the female is seized by the victor, in the mimic the male who wins most favour is chosen by the female. "Almost all male birds," writes Darwin, "are extremely pugnacious, using their beaks, wings and legs for fighting together." We see this every spring, with our robins and sparrows. The smallest of all birds, namely the humming-bird, is one of the most quarrelsome. Mr Gosse describes a battle in which a pair seized hold of each other's beaks, and whirled round and round till they almost fell to the ground; and M. Monte de Oca, in speaking of another genus of humming-bird, says, "that two males rarely meet without a fierce aërial encounter: when kept in cages 'their fighting has mostly ended in the splitting of the tongue of one of the two,

which then surely dies from being unable to feed.' With waders, the males of the common water-hen (*Gallinula chloropus*) 'when pairing, fight violently for the females; they stand nearly upright in the water and strike with their feet.' Two were seen to be thus engaged for half-an-hour, until one got hold of the head of the other, which would have been killed, had not the observer interfered; the female all the time looking on as a quiet spectator." An allied bird (*Gallicrex cristatus*) is so "pugnacious during the breeding season that they are kept by the natives of Eastern Bengal for the sake of fighting."

We in England can, or rather could, furnish a splendid illustration of these battles, in the "ruff" of our Fenlands. But, partly on account of the drainage of the ground which furnished it shelter and partly by reason of "its wholesale capture in spring, for the tables of the rich, when 'game' is out of season," it must now be regarded as extinct.

This bird is so called, writes Prof. Newton, "from the very beautiful and remarkable frill of elongated feathers that, just before the breeding-season, grow thickly round the neck of the male, who is considerably larger than the female known as the reeve. In many respects this species . . . is one of the most singular in existence. . . . The cock-bird, when out of his nuptial attire, or, to use the fen-man's expression, when he has not his 'show on,' and the hen at all seasons offer no very remarkable deviation from ordinary sand-pipers. . . . But when spring comes all is changed. In a surprisingly

short time the feathers clothing the face of the male are shed, and their place is taken by *papillæ* or small caruncles of bright yellow or pale pink. From each side of his head sprouts a tuft of stiff curled feathers (see frontispiece), giving the appearance of long ears; while the feathers of the throat change colour, and beneath and around it sprouts the frill or ruff already mentioned. The feathers which form this remarkable adornment, almost unique among birds, are like those of the 'ear tufts,' stiff and incurved at the end, but much longer—measuring more than two inches. They are closely arrayed, capable of depression or elevation, and form a shield to the front of the breast impenetrable by the bill of a rival. More extraordinary than this, from one point of view, is the great variety of colouration that obtains in these temporary outgrowths. It has often been said that no one ever saw two ruffs alike. That is perhaps an overstatement; but considering the really few colours that the birds exhibit, the variation is something marvellous, so that fifty examples or more may be compared without finding a very close resemblance between any two of them, while the individual variation is increased by the 'ear-tufts,' which generally differ in colour from the frill, and thus produce a combination of diversity. The colours range from deep black to pure white, passing through chestnut or bay, and many tints of brown or ash-grey, while the feathers are more or less closely barred with some darker shade, and the back is very frequently glossed with violet, blue or green—or, in addition,

spangled with white, grey, or gold colour . . . every ruff in each successive year assumes tufts and frill exactly the same in colour and markings as those he wore in the preceding season; and thus, polymorphic as is the male, as a species, as an individual, he is unchangeable in his wedding-garment."

"That all this wonderful 'show' is the consequence of the polygamous habit of the ruff can scarcely be doubted." Our really beautiful frontispiece gives a good idea of what this 'ruff' is like.

Their actions in fighting are said to be similar to those of the game-cock: the head is lowered and the beak held straight out; each particular feather is made to stand on end, the "ruff" and tail are extended to the full, so that the general effect is one of great ferocity. Then a swift movement is made by one or other of the combatants, the beak of the less active is seized, and a leap made into the air, followed simultaneously by a stroke of the wing—generally a harmless one.

These combats take place on some slight eminence near the spot where the eggs are laid, the males meeting here for the purpose of contending for the females. This habit helped largely to bring about their extinction in this country. For the fowler, having discovered one of these spots of "hilling places" by the birds having trodden the spot bare, managed, by cunningly laid nets, to capture every bird then on the "hill."

Fighting would seem, however, to be only

a part of the methods of conquest practised by the ruff. He is also an adept in the art of "showing off." This, probably, is his plan of making himself agreeable to the ladies of his harem, or perhaps is intended to impress them with his beauty, and follows upon his conquest. That both "battle" and display or "showing off" are practised there can be no doubt, but there seems to be no record to show whether the fighting precedes or follows the "showing off."

Wolley, a well-known "light," in the ornithological word, now unhappily deceased, writes of the habits, or as Prof. Newton happily puts it the "moral characteristics" of the ruff:—

"The ruff, like other fine gentlemen, takes much more trouble with his courtship than with his duties as a husband. Whilst the reeves are sitting on their eggs, scattered about the swamps, he is to be seen far away flitting about in flocks, and on the ground dancing and sparring with his companions. Before they are confined to their nests, it is wonderful with what devotion the females are attended by their gay followers, who seem to be each trying to be more attentive than the rest. Nothing can be more expressive of humility and ardent love than some of the actions of the ruff. He throws himself prostrate on the ground, with every feather in his body standing up and quivering; but he seems as if he were afraid of coming too near his mistress. If she flies off, he starts up in an instant to arrive before her at the next place of alighting, and all his actions are full of life and spirit. But none

of his spirit is expended in care for his family. He never comes to see after an enemy."

"The males of almost all gallinaceous birds, even those which are not furnished with spurs, engage during the breeding-season in fierce conflicts. The capercailzie and black-cock . . . which are both polygamists, have regular appointed places, where during many weeks they congregate in numbers to fight together and to display their charms before the females. Dr W. Kovalevsky informs me that in Russia he has seen the snow all bloody on the Orenas where the capercailzie have fought; and the black-cocks 'make the feathers fly in every direction' when several 'engage in a battle royal.' The elder Brehm gives a curious account of the balz, as the love-dances and love-songs of the black-cock are called in Germany. The bird utters almost continuously the strangest noises: 'he holds his tail up and spreads it out like a fan, he lifts up his head and neck with all the feathers erect, and stretches his wings from the body. Then he takes a few jumps in different directions, sometimes in a circle, and presses the under part of his beak so hard against the ground that the chin feathers are rubbed off. During these movements he beats his wings and turns round and round. The more ardent he grows, the more lively he becomes, until at last the bird appears like a frantic creature. At such times the black-cocks are so absorbed that they become almost blind and deaf, but less so than the capercailzie: hence, bird after bird may be shot on the same spot, or even caught by the

hand. After performing these antics the males begin to fight, and the same black-cock, in order to prove his strength over several antagonists, will visit in the course of one morning several balz places, which remain the same during successive years."

Many of the game-birds have the legs armed with powerful spurs. These are capable of inflicting terrible damage; as witness the records of the old days of cock-fighting. In these cases, however, their power as weapons of offence was increased by fastening silver sheaths on to the natural spurs. The blood-pheasants are the most heavily armed, having from four to five pairs of spurs on each leg. So pugnacious is the disposition of this group of birds, that they fight not only for the possession of the females, but on the slightest provocation, and frequently on none at all. Thus, Mr Frederic Wilson writes of the kalij-pheasant that "it is very pugnacious, and the males have frequent battles. On one occasion I had shot a male, which lay fluttering on the ground in its death struggles, when another rushed out of the jungle and attacked it with the greatest fury. . . ."

Some birds there are which have the spurs upon the wings instead of the legs. Many of the plovers, *Hoplopterus*, the Egyptian spur-winged plover for instance, has large and very sharp spurs. In Egypt these birds have been seen to fight, after the manner of our common English peewit, by turning suddenly in the air and striking with the wings. In the case of the Egyptian bird the result is often fatal. With

our plover this is rarely or never the case, there being only swollen knobs in the place of spurs. Two very rare and ancient forms of geese, known as the chauna, and the horned screamer of South America, have the wings armed with huge spurs. So also does the African spur-winged goose, *Plectropterus*. These spurs, it should be mentioned, are bony outgrowths capped with horn, seated on the wrist bones, or the metacarpal bones, and are quite distinct from claws with which they are often confounded.

CHAPTER VII.

FAMILY CARES—BUILDING THE HOME.

With the birds, as with ourselves, during the period of courtship, more or less public protestations of affection, undying devotion, and fidelity are freely made, but like cheques we can only prove their genuineness at a later date.

The pure, sweet, full-throated songster proves himself, when the time of trial comes, to be in every way equal to the highest that could be expected of him. Of one who sings so sweetly, we look for great things. With silver-tongued melody he wins his mate, and with the same charm he soothes her during the period of incubation; but when called upon to face the sterner work of life in providing food for some five or six ever-hungry mouths he puts away his music and joins his mate in satisfying their

wants. How considerable these are, we shall see later. How different is the case with the buffoonery, and bluster, or brute force of the ruffs, the bustards and the game-birds. Here, no sooner has their wooing proved successful, than they turn their backs upon the females and leave them to fend as best they may, roaming the country it may be in parties as in bachelor days, or flitting indolently about the neighbourhood in wanton idleness. Fortunately, there is not much need of their help, for the young are able almost at once to run and feed themselves. But of this anon.

We have seen something of our feathered friends during the period of courtship, we are now going to take a peep at them in the homes which they have newly founded. The choice of a mate having been made the next step is to select a site on which to build a home. This home we call a "nest." The form which this nest may take, and the situation of the site, are exceedingly variable, though always constant in each kind of bird.

The object of a nest is to contain the eggs, and often the young, so that such a structure need not possess great durability, being required only for a few weeks in the year. It is not used, as is sometimes supposed, for the nightly shelter throughout the year.

The range of variation in the site chosen and in the form of the nest, is, as we shall see, a very wide one. We shall find it, in its rudest form, as a simple hole scraped in the ground, and in its highest, amongst the most elaborate and

beautiful structures in the animal world. We shall find it placed on the ground, in burrows, in hollow trees and in caverns, on the water, in our hedgerows and bushes, in lofty trees, and on ledges of the most precipitous cliffs. Whenever and wherever the nest is found its every detail should be carefully studied, for much mystery still enwraps it.

Of the most primitive are the ground-builders, such as the little ringed plovers and terns of the flat sandy beaches of our islands. Mere hollows in the sand, these "nests" would most certainly escape detection but for the chance discovery of the treasures they contain—the eggs. We say chance discovery advisedly for these eggs so closely resemble the surrounding shingle that they are almost impossible of detection save by the most experienced.

The ostriches and coursers of Africa and India, and the pratincoles of South Europe, India and Australia, likewise deposit the eggs in a slight depression in the ground.

The tinamous of South America, the penguins, many plovers and gulls make a slight depression in the ground and give it a scanty lining of grass. The ducks line a similar depression with down plucked from their own breasts, and so on.

Many birds seem to have found the preparation of making even a slight hollow too much trouble, or perhaps, unnecessary, and deposit their eggs on the bare ground without any further preparation whatsoever. The divers thick-knees, sand-grouse and night-jars, are instances of this. The auks and guillemots again

build no nest but deposit their eggs on the bare ledges of rocks which go to make the cliffs around our coasts. In these birds the form of the egg is specially modified on account of this habit. Their shape is roughly pear-shaped, so that, when blown by the wind, the egg revolves round on its small end, instead of rolling off into the sea below. As it is, many thousands *do* meet this fate every year. It used to be a favourite sport of wretches armed with guns to fire a shot from the top of the cliffs on which these birds nested, so as to startle the sitting-birds, and cause them, as they hurriedly left their eggs, to knock them off their ledges *in thousands* into the sea, in order that they might afford sport, or gratify the hideously morbid curiosity of tourists.

In all the cases which we have considered, in which birds make little or no provision for their eggs in the shape of a nest, but leave them fully exposed to view, it will be noted that these, for the most part, so closely resemble surrounding objects as to make further attempt at concealment unnecessary. It is almost certain that originally all birds laid white eggs, as do their cousins germane the reptiles. But as there is at least one reptile in which there is a distinct tendency to produce a coloured, rust-spotted shell, viz., the Tautera-lizard of New Zealand, so there may have been many birds in which the same tendency developed itself. Of these many would produce eggs much more strongly marked or spotted than their neighbour's. If a number of such birds migrated, say, from the forest-land of their ancestors to the plains or meadows, a process of

weeding out would quickly begin. For they would probably at once come in contact with new creatures, who would rapidly discover how good eggs were. Thus, those which were even slightly coloured would be in so far disguised. Having a taste for *white* eggs their enemies would pass the coloured so long as white were to be had. In this way white eggs would become more and more rare, for in course of time the birds which produced these would die, and die without leaving offspring, or so few that they would be swamped by inter-crossing with the newer and more vigorous race who had succeeded in laying coloured eggs. Some of these, unsuccessful in producing coloured eggs, learnt the lesson of repeated robberies, and sought crevices in rocks, or unoccupied burrows in the ground—themselves undertaking the work of excavating when necessary—and they have survived, and their children make their homes in holes in rocks and burrows in the ground to this day. A process precisely similar to that just sketched out was going on at the same time in the forests. Eggs here would soon have become a delicacy, and the same mode of disguise almost certainly occurring, the resultant protection would soon follow. Those who failed to produce coloured eggs, and yet survived, were those who sought safety in the hollow trees always at hand.

First of all, let us take a few cases of those birds who lay their eggs in burrows and holes in the ground, making little or no provision for them in the shape of a nest.

In the British Islands to begin with we have

some excellent examples. One of the most familiar must be the tiny tunnels driven by the score into the faces of sandy railway banks and cliffs by the Sand Martin. It seems almost impossible that these can have been tunnelled out by so small a bird, and when we examine the frailty of its beak and feet the mystery is deepened. The tunnels which they bore are of considerable length; at the end they expand slightly and herein is placed an apology for a nest, consisting of a few roots and feathers pressed closely together.

The sheldrake, one of the most beautiful of our ducks, builds its nest in burrows, usually those deserted by rabbits. The nest is sometimes as much as ten feet from the entrance and formed of bents of grass and gradually lined with down plucked from its own breast; the quality of this down is said to be but little inferior to eider-down. The puffin (*Fratercula arctica*) breeds in burrows, which it sometimes excavates for itself. If empty rabbit-burrows are to be had, the birds take these and save themselves further trouble; if still occupied by rabbits the latter are promptly evicted. Many of the petrels lay their eggs in rabbit-burrows. The kingfisher (*Alcedo ispida*) also breeds in burrows, generally those deserted by the water-vole. At the far end of the burrow an enlargement is made, the floor of which is quickly covered with a mass of fish-bones, and the hard parts of the external skeletons of such crustacea as may have been captured in the neighbouring streams and pools. These fish-bones and other materials are the undigested

parts of the bird's food which are ejected again through the mouth, exactly as are the pellets of the owls and hawks. On this mass of bones the eggs are laid. There is a tradition still extant that the authorities of the British Museum were so anxious to secure a perfect example of this peculiar nest that they were willing to pay as much as £100 for a specimen. Offers of such imaginary treasures are constantly being made to this institution.

From burrowers in the ground we pass to burrowers in the trees.

The most notable of these is the woodpecker. The British Islands possess several different species, but the great stronghold of these birds is America.

The woodpecker is a much maligned bird, being accused of destroying forest-trees by driving tunnels or burrows into the trunk and so admitting the wet. As a matter of fact this is a perfectly unjust accusation. The birds always choose a weak spot upon which to operate, one from which the life has already been sapped by fungi. Wherever such parasites grow, they kill the wood. The mischief, however, is not apparent to any but the trained eye of this master of forestry—the woodpecker. He seizes upon these weak spots as "desirable sites for building purposes," the wood being soft, and yielding readily to the blows of his powerful beak. No nest is made, the eggs being laid upon the smaller chips which fall to the bottom of the hole during the process of excavation.

It might be mentioned here that in the wood-

pecker we have another example of the adaptation and specialisation of parts. We have seen already how peculiarly the tongue has changed, we turn now to the tail-feathers. These differ from those of all other birds in their peculiar stiffness. They have been modified to form long sharp-pointed supporting rods, the tips of which the bird forces against the trunk of the tree to serve as a lever when driving his powerful pick-axe into the bark, or as an additional support in making vertical ascents. They may be regarded in short as climbing-spurs.

The little nut-hatches of our woodlands are also breeders in holes in trees. If the aperture is too large they plaster it up with mud till it is reduced to the required size: generally this is so small that the birds have to wriggle themselves in and out.

The hornbills of Africa, India, and the Malay Archipelago, are amongst the most remarkable of birds in their nesting habits. Having selected a hollow tree, the female takes up her station therein and remains incarcerated for many weeks. The following account of the nesting habits of the Bornean rhinoceros hornbill has been recently given by Mr Hose. "The nest," he says, "is always built in the hollow of a large tree—the hollow, be it noted, being always due to disease of the tree or to the ravages of termites, not to the personal labours of the birds. The bottom of this cavity is often plugged by a termite-nest and accumulation of decayed wood, and on the upper surface of this is made the nest, a very rough-and-ready struc-

ture, composed simply of the feathers of the female. The hollow of the tree communicates with the exterior air by means of a long aperture, which, just before the period of incubation, is closed up almost entirely by the male, simply leaving a long slit open, up and down which the beak of the enclosed female can move. The substance used in thus closing the aperture closely resembles some vegetable resin, and is probably composed of a gastric secretion combined with the woody fragments of fruit. It should be noted that this slit is always in close proximity to the nest, so that the female can easily protude her beak for food without moving from her sitting-position. During incubation the male bird supplies the female with food in the form of pellets of fruit, seeds, insects, portions of reptiles, etc., the pellets being enclosed each in a skin of rubber-like consistency. While feeding the female, the male clings to the bark of the tree, or sits on a branch if conveniently near, and jerks these pellets into the gaping beak of the hen, two to four pellets forming a meal. During mastication (for it is a mistake to suppose that the hornbills always bolt their food entire) some fragments of the pellet fall to the ground; any seeds which these fragments may contain take root, germinate, and sprout, and the natives can judge approximately of the date of incubation by the age of the seedlings. When these are four-leaved, the eggs have been hatched out for two or three weeks. At this stage, though not always so early, the mother-bird leaves the nest, breaking down the gluey

substance with her beak to effect an exit; having left the nest, the aperture through which she left is carefully closed up again, leaving the slit as before, and now both male and female devote their energies to feeding the young birds, who in course of time follow the example of their mother and leave their place of imprisonment. It is more than probable that this glueing up first of the mother-bird and her eggs and afterwards of the nestlings alone is solely a means of protection against predaceous carnivora. . . ."

"The nesting season is during May and June, and it is noteworthy that the birds, if undisturbed, return to the same nesting-place every year. The saplings at the foot of the tree, sprung from seeds dropped in the first year of pairing, afford signs to the natives of the number of years during which the tree has been occupied. If during pairing or incubation the female, or female and young are destroyed, the male takes to himself another mate, and repairs to the same nesting-place; if, however, the male and female are destroyed, the nest is never re-occupied by other pairs. An interesting incident was observed while on Mount Dulit. Espying on a tree the external signs of a hornbill's nest, and a male *Buceros rhinoceros* perched close by, I shot the male, and while waiting for my Dyak collectors to make a ladder up the tree to secure the female, I observed several young male birds fly to the nest, and assiduously ply the bereaved widow with food, a fact which seems to indicate a competition in the matrimonial market of the bird-world as severe as that among human beings. It is no

easy matter to procure embryos or nestlings of hornbills, for the natives are inordinately fond of both as articles of diet; and, further, are always anxious to secure the tail-feathers of the adults to adorn their war-coats and hats. The native method of catching the female during incubation is ingenious, though decidedly brutal. The tree is scaled, the resin-like substance is broken away, and the frightened bird flies from her nest up the hollow trunk of the tree, but is ignominiously brought down by means of a thorny stick (the thorns point downwards), which is thrust after and twisted about until a firm grip in her plumage and flesh is obtained. The Dyaks, never very faithful observers of nature, believe that the female is shut up by the male, so that after hatching out her eggs, she may die, the maggots in her putrefying body affording food for the young. One very curious habit of *Buceros rhinoceros*, which I have not hitherto seen noted, is the rapid jumping up and down on a branch with both feet together. This jumping motion is imitated by the Kyans and Dyaks in their dances, the figure being known to the Kyans as 'wan blingong.'"

The reason for this strange incarceration is perhaps traceable to the fact that it occurs during the period of greatest helplessness: when the bird is moulting, and it would seem incapable of flight. Walled-in on every side, with only a small aperture for the beak, she is securely protected from enemies of all kinds — except man.

The bag enclosing the food brought by the

male is, strange to say, the lining membrane of his own gizzard which is ejected together with its contents!

As Dr Sharpe remarks, "between providing material for the effectual imprisonment of his wife, and shedding the lining of his gizzard for her future sustenance, to say nothing of that of the baby, the male hornhill must have rather a bad time of it. No wonder then that Livingstone says that the prisoner becomes quite fat, and is esteemed a dainty morsel by the natives; while the poor slave of a husband gets so lean, that in the sudden lowering of the temperature, which often happens after a fall of rain, he is benumbed, falls down, and dies."

We will next turn to birds which build nests of mud, mixing a certain amount of saliva therewith to ensure durability. We have two very perfect examples of such mud-built nests, amongst those of our British birds. The house-martin (*Chelidon urbica*) and the swallow (*Hirundo rustica*).

The beautiful cup-shaped nest of the house-martin must be familiar to most of us. It is made of mud gathered from rain-pools by the roadside or the riverside, and carried bit by bit in, and ejected from the mouth of the little architect, on to the surface of the selected site. As soon as a sufficient foothold can be obtained on the foundation of the new house, one or other of the little builders works continually from the inside to direct its shape. The pertinacity with which these poor birds will adhere to any spot they have selected is amazing. The writer well

remembers two misguided pairs who decided to throw themselves on the generosity and mercy of the powers that were, for the time being, and that was some four years ago, at a certain College in Oxford. They elected to build under the archway of the main entrance. No sooner had they completed their nest than it was ruthlessly swept away by the College servants. Again they tried with the same result; nothing daunted, they tried yet a third time with the same result; before the fourth nest was completed, the writer sought out one of the dons and pleaded for his feathered friends. But, alas! in spite of every argument, and every suggestion for lessening any possible inconvenience which might accrue from their presence, he was told that it was in vain to plead. "We cannot have swallows' nests under a College Archway," was the final pronouncement. For three consecutive years these birds, or apparently the same, returned to this much coveted spot, and spent the summer fretting out their little lives in a vain appeal for mercy where mercy was not.

In Lapland, these birds are always welcome. In Muonioniska in 1853, Wolley, the great naturalist, counted nearly one hundred and seventy nests round the courtyard of one house. "In Lapland the people almost everywhere multiply their eaves by nailing narrow planks to the walls at such a distance that there is just room between them for the nests, which thus appear row under row." . . . The cause of the bird's abundance in the country, and of the accommodation so gladly given to it, can be readily

understood when one sees and feels the innumerable gnats.

The saucer-shaped nest of the swallow is as familiar an object in our rural homesteads as the cup-shaped structure of the martin. Like these, it is built of little pellets of mud, tempered with saliva. But, whilst the martin's nest is self-supported, the swallow's is always deposited on a beam or rafter, and has small pieces of straw and grass intermixed with the mud. The Indian fairy-martin builds a very beautiful retort-shaped mud-nest; it is like a flask, fixed by its base to the wall, with a long neck forming the mouth of the nest, projecting some eight or nine inches outwards. These curious nests are found in India, Africa, North America and Australia. The nest of the Australian cliff-swallow, or fairy-martin, is said to be made by the united efforts of several birds, one remaining inside the nest and receiving the pellets as they are brought by its companions.

Some of the strangest nests are those of the edible swiftlets. These birds have increased the power of secreting saliva to so great an extent that mud and other foreign matter is almost or even entirely suppressed, the nest being made of the pure secretion. Such are in great demand amongst the Chinese, for conversion into "bird's-nest soup."

"With these nests," writes Dr Sharpe, "a large trade is done with China from many of the Malayan Islands, over three and a half million nests having been known to be exported in a single year from Borneo to the latter country, where bird's-nest soup is considered a delicacy.

In Borneo and other places the caves in which the swiftlets build are leased to the collectors for a considerable sum, but it is only the white nests made of the pure secretion derived from the salivary glands of the birds which are of any real value. Quantities of guano are also found in some of the caves, formed by the *débris* from the nests. The bodies of young birds which have perished, and the droppings of hundreds of occupants, form together a loathsome mass of putrid water, reaching in a cave visited by Colonel Legge in Ceylon to a depth of 30 feet. Mr Harry Pryer found that in one of the great caves of northern Borneo a pole thrust into the guano to a distance of 18 feet did not reach the bottom, and there was over the floor an average accumulation varying from 5 to 15 feet, so that it is evident that the caves inhabited by the swiftlets must have been tenanted by these birds for a very long period."

Yet another swift's nest must be noticed here. "One of the most curious nests in the world," writes Dr Sharpe, in his oft-quoted "Wonders of the Bird-World," "is to be seen in the bird-gallery at the Natural History Museum, and is the work of Salvin's Swift (*Panytila sancti-hieronymi*) from Guatemala. It is entirely composed of seeds, but whether the bird gathers these from the plants or catches them in the air as they are blown by the wind, has not been observed. In this way the scanty material for the nest of our European swifts (*Apus apus* and *A. melba*) are obtained, but in the Guatemalan species the nest is of such huge size that it would take a very

long time or the co-operation of many pairs of birds to collect the seeds in full flight. The nest was found by Mr Osbert Salvin in 1858, hanging under a shelf of rock, to which it was attached by means of the bird's own saliva, which is also employed throughout the building of the nest, to cement the seeds together. As with the penduline-tits . . . the nest of this swift also had a false entrance at the side, which Mr Salvin considered might 'be placed there to deceive some enemy, such as snake or lizard, to the attacks of which the parent-bird and its offspring would, during the time of incubation, be more exposed.'"

We have yet three more mud-nests which must be briefly noticed here—the nests of the flamingo, the oil-bird and the oven-bird.

The flamingo is an aberrant stork: the only one of all his house who builds a mud-nest. This is but a huge pile of mud raised a few inches above the water, by which it is generally surrounded. The long legs of this bird, like those of the heron, are doubled up under the body when sitting. There was an old idea that both these birds sat "straddle-legs" across the nest. Needless to say such a notion is ridiculous, for the birds can as easily fold up their legs as can the sparrow for instance.

The oil-bird, or guacharo, is a kind of night-jar common in Peru. It builds a mud-nest in a cave. The hard indigestible seeds investing the fruit upon which this bird feeds "are found," says Prof. Newton, "in quantities on the floor and the ledges of the caverns it frequents, where many of them for a time vegetate, the plants thus

growing being etiolated from want of light . . . forming a singular feature of the gloomy scene which these places present. . . . The young [guachoros] soon after they are hatched become a perfect mass of fat, and while yet in the nest are sought by the Indians, who, at Caripé . . . make a special business of taking them and extracting the oil they contain. This is done about mid-summer, when by the aid of torches and long poles many thousands of the young birds are slaughtered, while the parents in alarm and rage hover over the destroyers' heads, uttering harsh and deafening cries. The grease is melted over fires kindled at the cavern's mouth, run into earthen pots, and preserved for use in working as well as for the lighting of lamps. It is said to be pure and limpid, free from any disagreeable taste or smell, and capable of being kept for a year without turning rancid. In Trinidad the young are esteemed a great delicacy for the table by many, though some persons object to their peculiar scent, which . . . resembles that of a cockroach. . . ." For a tale of horror and satanic treatment, this slaughter of the innocents accompanied by the helpless wailing of the bereaved parents would be hard to beat.

The last of our mud-builders is that of the oven-bird of South America. The nest of this bird certainly merits the term "wonderful," which has often been accorded it. Placed in a most conspicuous position—the tip of a post or bare bough of a tree,—it is a very massive structure,—weighing as much as eight or nine pounds, and is composed of mud and

pieces of sticks and straw. In shape it somewhat resembles a squat bee-hive, or, as some say, an oven. The opening into this hive is large; inside, it is divided by a partition reaching nearly to the roof, and forming a passage or ante-chamber to the large chamber containing the eggs which are laid upon a bed of soft dry grass. We cannot but be struck with the industry and labour which must be expended in the construction of so large a nest, by so small a bird. The collection of the mud alone must impress us, when we recollect that the workman has nothing but a tiny beak to carry it in, so that it must be carried a pellet at a time, and a small pellet too!

We must now turn our attention to nests of a more complex character than any yet examined. They are made up of small blades of grass, roots, leaves, or sticks, they are sometimes objects of rare beauty, sometimes little more than slovenly piles of sticks, etc. The sites chosen for these vary as greatly as do the nests themselves. They occur on the ground, in thickets, or on the tops of the highest trees. Some rest upon branches, some are swung in the most perfect manner, hammock-wise *beneath* the boughs. Some are gems of the most exquisite beauty, some loosely made and untidy in the extreme; some are open to the sky; some domed; some hang like retorts, mouth downwards. It will be impossible to do more than take a hasty survey of some of the most important of them in this little work.

These nests are of the same kind as those

which we considered in the opening part of this chapter, only much more perfectly made. We have now something more than a mere collection of bits of grass, and roots, and so forth, used as a lining to some slight hollow in the ground, or for the floor of the terminal chamber of some tunnel or burrow. These which we are now about to examine are deftly interwoven structures capable of standing a considerable amount of wear and tear.

Among the simplest are those of the doves and pigeons, made of small branches and twigs of trees. The nest of one of these—the wood-pigeon for instance—is nothing more than a platform of sticks, so loosely put together that the eggs can be seen through it against the sky when the nest is viewed from below. The rooks and herons are British birds which build comparatively simple nests: an advance, however, upon those of the doves, as the centre of the structure is more or less carefully lined with fine grass, fibre, wool, and so on, for the reception of the eggs.

In strong contrast to these harsh nests of sticks stand the exquisitely beautiful nests of the goldfinch and chaffinch. The latter is constructed for the most part of wool and hair, matted together so as to form a very perfect "felt." On the outside of this are fastened, or rather woven, mosses, lichens, and spider-webs. The whole so completely harmonizes with its general surroundings as to make it very difficult of detection.

The nest of the British reed-warbler is one

of very great beauty. It must be sought for in our reed-beds, or the banks of such of our rivers as are liberally fringed with reeds. The stems of some three or four reeds are utilised as supporting pillars, and between them the nest is built so that, when finished it looks as though the reed-stems had been driven through its sides. The materials of which the nest is constructed are the seed-tufts, long grasses, moss, and portions of reed-leaves. It is lined with cow's hair. The cavity of the nest is very deep, so that even when the pliant reeds are bent nearly level with the water the eggs yet remain safe inside.

Whilst the nest of the reed-warbler is supported by branches passing *vertically* through it, that of the golden oriole is peculiar in that the supporting branches pass *horizontally* through its sides. It is composed of sheeps' wool, fibres of roots, slender grasses, and so on; all perfectly interwoven. All these are cup- or saucer-shaped nests.

That of the dipper is peculiar, as much on account of the site which is chosen as for its shape. The nest is a large mass of finely felted moss, in the middle of which the eggs are deposited. It is built, almost invariably *behind* some cascade, so that the birds have to pass *through* this torrent of water every time they enter or leave the nest. ". . . in some places, particularly in Scotland, where this bird is known as the water-cow, water-pyet, and king-fisher, it is foolishly destroyed by every possible device under the mistaken idea that it haunts

the spawning-beds to feed on the ova of the salmon and trout, while examination of its gizzard proves it to be one of the best guardians of the fishery." Alas! another victim to be added to the already long list of slaughtered innocents.

So far, the nests we have considered, when built above the ground, have all rested *upon* some support, and have been more or less cup-shaped; or have been formed of sticks into a platform more or less hollowed in the middle. That of the dipper was an exception, being domed, concerning which form more has to be said. We come now to pensile nests, nests slung or suspended *beneath* instead of *above* the bough, or other support, and will take a glance at one or two of the more important.

The first, and one of the most wonderful of them is that of the tailor-bird. Choosing two long leaves at the end of a twig, it bores a series of holes down the outer side of each, then with some long thread of vegetable fibre proceeds to seam the two leaves together by passing the thread through and through with its beak, much as we should do with a needle. In this, it is probably assisted by its mate who would look from the inside and push out the threads as they came through. The cavity of the nest is lined with a kind of cotton-wool, and in this are deposited the eggs.

The smallest of our British birds, the golden-crested wren, builds a most elegant pensile but cup-shaped nest. It is built of the "softest moss, thickly felted with wool and spiders' webs, intermixed with a few grasses and dead leaves,

and is lined with a quantity of small feathers." Macgillivray, the great ornithologist, by the way, once took the trouble to count up the feathers in the nest of a long-tailed tit, and found more than 2000. One can best appreciate the amount of labour this represents by recollecting that probably every one of these feathers was captured and brought in singly.

The nests of the baya-sparrow of India, and of the penduline-tits differ markedly from the normal form of cup-shaped nests so familiar to us all.

That of the baya-sparrow is suspended from the branch of a date palm, or cocoa-nut tree, or, it would seem in Burma, from the eaves of bungalows. "Its shape," says Prof. Newton, "can best be likened to a stocking hung up by the toe with the 'heel' enlarged to receive the eggs, while access and exit are obtained through the leg." In constructing the nest, the male and female are both engaged. The male, seizing a long piece of grass, thrusts it into the fabric already made; the female inside pulls it through, and then passes it out to him again, so that a very strongly plaited structure is the result.

The male bird, it seems, cuts his own grass, and this he does from the long blades of the seenta grass in the following manner. Alighting on the leaf head-downwards, "he bites through the edge to the exact thickness which it requires. He then goes higher up on the same blade of grass, and, having considered the length needed, bites through it again. He then seizes it firmly at the first notch and flies away. Of course the

strip of grass tears off and stops at the notch. He then flies away with the grass streaming behind him. As the edge of the grass is much serrated, the bird has to consider and pass it through the right way."

The nests of the penduline-tit or cotton-bird of South Africa, Dr Sharpe remarks, "are so extraordinary that they could hardly be believed to be the work of a bird at all. On handling one of their nests it feels as if it were made of the finest felt carpet, and how the birds contrive to weave it out of cotton and seed-down is a mystery. Towards the upper end of the nest is a funnel-shaped opening, and below this is a distinct little pocket, the use of which is not clearly understood, though . . . it is supposed to be a roosting-place for the male, for whom, as the nestlings grow larger, there would be no room in the nest itself. The little birds are said to draw in the tubular entrance of the nest before they finally go to sleep, and they then fasten it up tightly, so that any enemy, snake or otherwise, on attacking the nest, fumbles about at the pocket or false entrance, while the little birds peck a hole in the back part and escape."

Birds, for the most part, become very secretive concerning their nests. When not altogether hidden from view these are placed high up out of reach, or on the faces of precipitous cliffs, and so are inaccessible. Sometimes, however, no attempt at isolation or concealment is made, and the birds breed in colonies. Examples of such are furnished amongst British birds by

our "rookeries" and heronries, for instance; and by the wonderful gull colony at Scoulton Mere, Norfolk, where the black-headed gull breeds in thousands; as also by the guillemots and gannets along our coast-line, and so on. The penguins, albatrosses and terns, swifts, swallows and martins, are other, and well-known cases. In all these, however, the nests are separate one from another.

The nesting-colonies of the sooty terns or "wide-awakes" are peculiarly interesting. Dr Sharpe tells us that this bird "herds in countless numbers on Ascension Island," and "wide-awake fair," as the nesting-place is called, has often been alluded to in works on ornithology. One of the best accounts is that given by the late Commander Sperling, who found the "fair" to consist of a plain about fifteen acres in extent, in the interior of this most desolate of islands. He says that no words can give an adequate idea of the effect produced by thousands upon thousands of these wild sea-birds soaring and screaming over the arid cinder-bed, the eggs and young being scattered so thickly on the ground that it was often impossible to avoid treading on them. Only a single egg is laid, and the bird defends its treasure most courageously.

Although terns are birds which usually lay their eggs on the sand, or on the grassy flat of an island, there are some remarkable exceptions in the noddy terns of the genus *Anous* and *Gygis*.

The latter genus contains two snowy-white species, and no nest is made by them. The

single egg is often deposited on the leaf of a cocoa-nut-palm in a position, one would think, of great danger, but it swings in the wind apparently without risk of being broken.

The sociable weaver-birds (*Philhataerus socius*) of Africa furnish us with, I believe, the only instance of a colony, all, as it were, under a common roof. The colony seems to be originally founded by a single pair of birds, another joins their nest to that of the first pair, then a third, a fourth and so on, up to as many as three hundred and twenty pairs sometimes. The size of such a mass of nests is so great as to cause it to be occasionally mistaken for a native hut. At last, by the accumulated weight, the branch gives way and the whole comes to the ground. This generally happens during the rainy season when the dry grass soaking up the wet becomes too heavy to be borne longer.

The *ani* or "black witch," one of the American cuckoos, may also be considered as a colony-breeding bird. The difference however between it, and that of the weaver-bird just described, lies in the fact that several females lay their eggs in one and the same nest and bear the duties of incubation between them.

Colonies, such as these, are only possible where the birds' mutual interests do not clash: where there is enongh food in the immediate neighbourhood for all, and some to spare.

Colonies of fish-eating sea-birds for instance, are possible, because the food-supply is almost inexhaustible. Colonies of birds of prey are as a rule impossible, because the food-supply is

limited. On rare occasions, as on that of the great vole plague in Scotland a few years since, owls congregated and bred so plentifully in the locality where the voles were most numerous that they might almost be described as forming owl colonies.

Our next and last phase of this subject would seem, at first sight, to show a tendency more or less real, to shift the burden and responsibility of family cares, either upon other birds or upon inanimate incubators. Could we trace back these cases to their origin we should probably find that indifference to the welfare and fortunes of the offspring followed upon a slow process of weaning, and that the parental affection had become smothered as a consequence of "circumstances over which they had no control."

The beginnings of this curious phenomenon are indicated in the nesting of our grebes and rails. These seem to endeavour to lessen the labours of incubation by resorting to the heat generated by decaying vegetable matter dragged from the weeds in the vicinity of the nest. This is carefully deposited upon the eggs whenever the sitting bird leaves the nest.

Cowper was a little hard upon the ostrich, and cast rather a reflection upon its Maker, when he wrote :—

> "The ostrich, silliest of the feathered kind,
> And form'd of God without a parent's mind,
> Commits her eggs incautious to the dust,
> Forgetful that the foot may crush the trust."

yet there was truth in what he said.

The facts which have been lucidly summed

up as follows by Prof. Newton appear to be these: "Ostriches commonly, and especially in the breeding-season, live in companies of not more than four or five, one of which is a cock and the rest are hens. All the latter lay their eggs in one and the same nest—a shallow pit scraped out by their feet, with the earth heaped around to form a kind of wall against which the outermost circle of eggs rests. As soon as ten or a dozen eggs are laid, the cock begins to brood, always taking his place on them at nightfall surrounded by his wives, while by day they relieve one another, more it would seem to guard their common treasure from jackals and small beasts-of-prey than directly to forward the process of hatching, for that is often left wholly to the sun. . . ."

This hatching by artificial heat is carried to its farthest by the curious Australasian mound-builders or megapodes, allies of the game-birds.

These build no nest, neither do they brood over the eggs to hatch them out like other birds, but leave this to the heat of the sun, as is done by reptiles. The megapodes of the Solomon Islands and of Celebes scratch out a hole about two feet deep in the hot sand, deposit an egg, cover it up, and leave it to the genial warmth of the sun to bring it to life.

In Celebes, much of the sand is of volcanic origin, and black, and is chosen on this account by the megapodes in preference to the white sand. Therein they show great sagacity, inasmuch as this absorbs much heat during the day, and loses comparatively little at night.

White sand reflects heat. In the highlands of the island there are hot springs dispersed throughout the black sand, and it was discovered by the Sarasins, that the birds always choose the neighbourhood of a spring in which to lay their eggs. They write, "With regard to the breeding of the moleos, therefore, we are able to maintain our opinion that the bird indeed lays its eggs in the sand on the hot sea-shore, where the heat of the sun then proves powerful enough to hatch them; but that in the mountains, and especially in the shady forests of the interior, for the warmth of the sun must be substituted some other power, and for this purpose the moleo chooses the vicinity of warm water springs, which it searches out, and makes its breeding-pits in the ground warmed by hot springs. Accordingly, where moleos are encountered in the interior of Celebes, these warm springs will be found not far off."

The other megapodes provide for their eggs in a rather different fashion, forming huge mounds of some five or six yards high, and thirty feet in circumference. These mounds are made up of earth, leaves, and rotten wood. In a short time the heap becomes a most perfect hot-bed, and a most admirable incubator. Here the eggs are laid, and the parent from that time ceases to take any further care of them.

Considering the great distances the birds come to deposit the eggs . . . "often ten or fifteen miles," writes Mr Alfred Russel Wallace, "it seems extraordinary that they should take no further care of them. It is, however, quite

certain that they neither do nor can watch them. The eggs being deposited by a number of hens in succession in the same hole would render it impossible for each to distinguish its own; and the food necessary for such large birds (consisting entirely of fallen fruits) can only be obtained by roaming over an extensive district, so that if the numbers of birds which came down to this single beach in the breeding-season, amounting to many hundreds, were obliged to remain in the vicinity, many would perish of hunger."

The chick is remarkable in that it is hatched covered with curious feathers, differing somewhat from the nestling down of other birds, and from the feathers worn at a later date. The quill-feathers are so long and well-developed that the young are able to fly at birth! This occurs in no other bird.

The object of the present chapter has been not to bring together a collection of curious facts regarding nests, but rather to illustrate how rich in variety, and vigorous in force, is the life of the birds during this phase of their existence —the period of nidification. By the intelligence they display at this time we have an indication of the height to which they have risen in the scale of evolution.

The question which most naturally arises here is, how did this habit of building nests arise?

We may take it, I think, as an approximately correct guess at the truth, that the earliest birds laid their eggs upon the bare ground and hatched them out, partly by the aid of the sun, and partly

by brooding over them. Soon the latter fashion would prevail entirely. Then, it may have been that those which had to lay their eggs in damp places would discover the advantages of saving their treasures from actual contact with the ground by first making a sort of bed of dry grass or sticks. Just as the common swan, for instance, will add material to its nest to raise the eggs, immediately before a flood, the coming of which it seems to anticipate instinctively. Later, from various causes, and in different times and places, such birds would be driven to seek refuge in trees and bushes for the greater security of themselves or their eggs; and would then construct, as best they could, a receptacle among the branches precisely similar to that which they had previously built on the ground. This receptacle we call a "nest." Indeed migration so to speak from the ground to the trees, or *vice versâ*, happens commonly to-day. Birds like the herons for instance that usually build in lofty trees will, in the absence of these, make their nest upon the ground; whilst gulls, ducks, and other ground-building birds, will often nest in trees.

At first rude, and more or less untidy structures, it would seem that as the bird's æsthetic sense and love of the beautiful developed, more pains and care were taken in the construction of the nest. Another contributing cause may have been the need of disguise for the purposes of protection. The addition of moss, lichen and pieces of bark on to the outside of the nest caused it to blend so perfectly with the trunk

and branches of the tree that it became difficult of detection and so escaped destruction. The more successful of these survive to-day. Thus may we briefly trace the evolution of the bird's nest.

CHAPTER VIII.

FAMILY CARES—NURSERY DUTIES.

From the nest we very naturally pass to a consideration of the eggs contained therein.

Mr Alfred Russel Wallace has endeavoured to show that female birds, which are brilliantly coloured like their mates, lay their eggs in holes or build domed nests. This they do for the purposes of concealment, and of hiding their gay dresses. Female birds of a sombre hue—though the male may be brilliant—do not lay in holes or build domed nests. Their dull plumage effectually protects them by causing them to assimilate with surrounding objects. Mr Darwin who analyzed this hypothesis has pointed out many objections thereto.

Mr Wallace has also endeavoured to show that birds which lay white eggs lay them in holes or concealed nests, or, in other words, adopt precisely the same tactics as they would if blessed or cursed with brilliant plumage.

It so happens that these two features—brilliant plumage and white eggs—often occur in one and the same bird; but frequently birds in no sense brilliantly coloured, as petrels, lay

their eggs in holes, and these eggs are white also.

Now, it is quite probable that there is no desire and no need to build in holes either because the plumage is brilliant or the egg is white. Why these particular birds nest in dark places has no place in the present connection, we have simply to offer an explanation of why, whenever this occurs, the egg is white. Very probably it is for the purpose of rendering the egg visible; otherwise it would stand in hourly danger of being crushed by the parent every time it entered the nest, or lost if laid in caves or spacious cavities.

Our British puffin seems to furnish us with a concrete example of the truth of this hypothesis. At one time, like its relations the auks and guillemots and razor-bills, it laid richly coloured eggs in the open; later it has resorted to burrows, and now covers its eggs with a wash of white, sometimes so thinly that the pattern can be plainly seen shining through, sometimes the pattern is almost entirely concealed. We take it that the bird has had to whiten its eggs in order to see them in so dimly-lighted a place as a burrow. Birds lay white eggs *because* they lay in burrows, and not *vice versâ*. For a somewhat similar reason plants that are fertilized by night-feeding insects have white flowers, white being conspicuous in the dark whilst colour is invisible.

We ourselves adopt a similar expedient. Thus in the dark corridors of the Natural History Museum a piece of white paper is pasted around

the keyhole to serve as a guide thereto: in underground railways the edge of the platform is painted white to make it conspicuous, as are the edges of stairs in dimly-lighted places.

As to the coloration of the eggs and their form, and the number laid by each bird, we need say but little.

In colour and coloration—for there is a great difference between these two—there is an immense range and variation. As we have already remarked, the ancestral bird probably laid white eggs. It is also probable that the majority of those that breed in holes have never at any time laid eggs with coloured shells. Colour probably owes its introduction to two factors: the need for protection from egg-eating enemies, when the general tone of coloration is for the most part of a nature resembling its immediate surroundings; and the need for protection from the action of the excessive light of the sun's rays. These last have, as is well known, a deleterious effect upon protoplasm or living matter. It is this need for protection from the light that has caused the black skin of the negro.

The brilliancy and the exquisite beauty of the coloration of eggs cannot be dealt with here. Some eggs, such as those of our common British starling, wild-duck, pheasant and heron, are uniformly coloured. Those of the hawks and eagles, the razor-bills and guillemots, the terns and grouse, are beautifully blotched and mottled with black or colours darker than the ground-work: those of the thrushes and red-shanks are spotted. In many buntings the

markings take the form of scribblings all over the egg, and so on. The exact meaning of these various patterns of coloration is unknown, and perhaps will for ever remain so.

The colouring matter of the egg is deposited during the passage down the oviduct—the long coiled tube leading from the ovary or place where the eggs are formed to the outer world. The walls of this oviduct secrete or manufacture the colouring matter. The spots, streaks and blotches which add so much to the beauty of the egg, tell how the pigment, or colouring matter forming the same, was deposited. Thus, spots show that the pigment was deposited whilst the egg was at rest, blurred markings, whilst in motion. Sometimes the motion seems to have been rotatory inasmuch as the markings are spiral in character, as is well seen in the eggs of many guillemots.

For the most part birds nearly allied lay similar eggs, but there are many exceptions to this rule. The general truth of this fact, however, is unquestionable. It was the recognition of this that led ornithologists to perceive the close relationship between the gulls and plovers which, till then, had always been considered very distantly allied; other and anatomical characters were later brought to light which confirmed their observations.

The texture of the shell varies much. It may be most extraordinarily smooth and polished resembling burnished metal or highly glazed porcelain, as in the tinamous, or smooth and greasy as in the ducks; or covered with a thick chalky

layer, as in the cuckoos known as the guira and the ani; or in the rosy flamingo and our British Sclavonian grebe. In the ani, if this layer be removed, the shell beneath will be found to be of a brilliant blue colour. In the ostrich and emu and some others the surface is deeply pitted.

The condition of the young when hatched depends largely upon the relative size of the egg. Thus in birds which lay small eggs the young are, at birth, blind and helpless; when the egg is relatively large the young will be found to be very active within a short time after birth, and able to feed themselves. The former group of birds build more or less elaborately constructed nests, the latter little or none. This ratio between the size of the egg and the condition of the chick at birth has caused a great disproportion in the relative size of the egg and the bird which produces it. Thus the guillemot and the raven are birds of equal size, yet their eggs vary as ten to one, the egg of the guillemot being relatively huge, and as large as that of an eagle.

The smallest egg of living birds is that of the humming-bird, the largest that of the ostrich. The largest known bird's egg is that of the extinct Æpyornis of Madagascar. An egg of the latter is often found in the lap of the skeleton of some chief, as though placed there to afford the spirit sustenance on its long journey to the other world, the custom of providing the dead with food and even raiment and weapons being a very wide one amongst primitive people. The girth of this egg is about thirty inches, its longest circum-

ference is about thiry-six inches, and its capacity about four gallons!

The form of the egg varies; it may be almost perfectly spherical elliptical, oval, or pear-shaped. Some owls and the diving-petrel lay round eggs; in the sand-grouse they are elliptical, oval in the common partridge and turkey, pear-shaped in the plovers.

The shape of the egg in most birds has apparently no definite use or meaning. In the guillemot, however, the long conical form has evidently a definite use. These birds lay their eggs on the bare flat surface of some ledge on a rocky cliff; when the wind blows with sufficient force to move the egg it turns round upon its small end. If it were round, it would roll off into the sea. In the case of the plover the pear-shape is a most economical one, as, in the nest, but little space is taken up, the eggs being deposited with their small ends inwards, and thus the female is enabled to cover them all when sitting.

The eggs laid and brooded over at one time, in one nest, form a "*clutch.*" The number of eggs in a clutch varies. The razor-bills of our coasts for instance lay but one, the guillemots two, the sand-grouse three, the common sandpiper four, the robin five, the long-tailed tit nine, the partridge twelve. The number of the eggs in a nest affects their size, for it is necessary that all the eggs in the nest should be covered at the same time by the sitting-bird to ensure their hatching out together. Thus, if the partridge lays twelve eggs, it is obvious they cannot be as large relatively as in the snipe which lays but

four. Since the young of both run almost as soon as they are hatched, we are admonished to exercise caution in generalising as to the size of the egg and the condition of the young at birth. In the main, however, the remarks made on this point hold good.

We have seen something of our feathered friends during the period of courtship when they appear perhaps at their best, we have followed them through the first period of their trial—the building of the nest—and we have incidentally got a glimpse of them at a stage later still—the period of incubation. We have already, in this present chapter, briefly surveyed the various forms, colours, numbers, and so on, of the eggs these nests were made to contain, and now we are about to pass on to see how birds acquit themselves as parents.

In all but a few exceptional cases the bulk of the work of incubation and feeding the young falls upon the female. When not actually sitting on the eggs, or feeding, she sits near and watches them with the tender care and solicitude that has become synonymous with the name of mother. For example, the female osprey (a fish-eating bird of prey), which is in the habit of leaving her eggs for a short time each day exposed to the sunlight, has been seen to plunge headlong into the lake below, and rising to shake her dripping plumage over her treasures lest too much heat should injure them. Having done which she returned to her perch to meditate.

Among the ducks, the building of the nest, the hatching of the eggs and the feeding of the young,

all devolve upon the female. The male either retires from the neighbourhood with other males, or fills up the time in moulting. The eider-duck for this purpose goes out to sea; the common British wild duck retires to the seclusion of some reed-bed.

With the hawks and eagles the thoroughness with which these duties are carried out varies.

Of the eagle, for instance, Capt. Bendire writes that, "notwithstanding the many sensational stories of the fierceness and prowess of the golden eagle, especially in the defence of its eyrie, from my own observations I must confess that, if not an arrant coward, it certainly is the most indifferent in respect to the care of its eggs and young that I have ever seen. This may possibly be due more to utter parental indifference than to actual cowardice. . . ." A pair of merlins, on the contrary, gave proof of real affection. Having been fired at several times when on the nest they transported the eggs to a bank forty yards distant, placed under them a few leaves by way of a nest, and succeeded in hatching them out successfully.

In the common buzzard both male and female sit upon the eggs: in the harrier the female only. In both species the males assist in feeding the young.

In the courser, a plover-like bird sometimes visiting Britain, the female only attends to the eggs, the male returns to assist in the feeding and care of the young.

In most of the game-birds the duties of incubation and the care of the young fall entirely

upon the female. In defence of his family, however, it would seem that the cock will often fight courageously. A story is related of a hawk which attacked a hen and her chickens, when the cock rushed to the rescue and drove his spur right through the eye and into the skull of the would-be spoiler. The hawk was killed instantly, and when disentangled from the cock, which it had gripped with great tenacity, the victorious champion was found quite uninjured.

With the owls it does not appear that the males actually take any part in the incubation, but it is certain that they remain in the neighbourhood and jealously attack all who approach within what are considered desirable limits.

The value of these birds, by the way, at that time of the year, during which they have young to feed, is hard to estimate, for they devour—as at all times of the year—rats and mice and voles for the most part, and the number which is brought daily to the nest by *both* parents—for the male assists in the feeding—is prodigious. Yet, these birds are slain right and left by gamekeepers and others who should know better, and their poor mutilated bodies gibbeted on barn-doors as those of malefactors!

The bar-tailed pigeon (*Columba fasciata*) of North and Central America appears to have the parental feeling largely developed. It has been several times seen when frightened to carry its egg from the nest and bear it away to another tree. Selecting a large branch thereof on which to deposit its precious burden, it proceeds with the incubation forthwith.

The plovers, and many other birds, draw intruders from the neighbourhood of the eggs or young by feigning to be wounded, the object being to entice all such away by holding out the hope of an easy capture. As soon as a sufficient distance has been covered the bird takes wing and leaves its would-be captor greatly discomfited.

The woodcock has frequently been known to carry its young long distances when threatened by any danger. This it does by pressing the little chick to its breast by the aid of its beak, and giving support from below with its feet. Some however say it is carried between the legs without any aid from the bill.

Amongst the ostrich tribe, the duties of incubation are almost entirely performed by the male, who with the female accompanies the young for some time.

This also occurs in some other birds. For instance, the phalaropes (plover-like birds), the painted snipe, and the bustard-quails. In all these, strangely enough, the females excel both in size, and beauty of colouration. Whenever their superiority in these respects obtain, as we have remarked in an earlier chapter, it is the female bird which does the courting.

The period of incubation lasts from ten days in the little Australian zosterops to sixty in the ostrich.

Some of the methods of feeding the young are well worth notice. In the pigeons, for instance, the mucous membrane lining the interior of the crop becomes extraordinarily active during the breeding-season, and peels off in the form of a

cheese-like or milky secretion with which both parents feed the young for some time. This secretion is familiarly known as pigeon's-milk." In feeding, the nestling thrusts its beak into the mouth of the parent, who then forces down its throat this peculiar food with a kind of pumping action.

In the cormorant, a similar method of feeding is followed: the baby cormorant thrusting its head and neck down the throat of its fond parent, and taking from its well-filled gullet as much fish as it can manage to swallow.

In the pelican—a near relative of the cormorant—the female only attends to the feeding of the young. This is effected by the parent pressing its beak against its breast and raising the upper jaw, upon which the young help themselves to the fish in the pouch. This habit probably gave origin to the fable of the pelican feeding its young on the blood of her own breast.

As we have seen already, the male hornbill feeds his mate by regurgitating his latest meal enclosed in the form of a neat package, furnished by the inner lining of his gizzard.

The woodpeckers again feed the young by regurgitation. The partly-softened food from the parent's crop is passed into the mouth of the young which is opened to receive the beak of the parent.

The condition of the young at birth varies very much. They may, on this account, be divided into two great groups: (1) Those which remain for a longer or shorter time in the nest, perfectly helpless, and requiring to be fed by

the parents, and (2) those which are enabled to leave the nest immediately after birth.

Those of the first group are born blind and often naked. One may roughly divide the members of this group into four separate sections :—

1. Those born clothed in a thick coat of downy feathers, such as hawks, owls, and petrels.
2. Those born naked or almost naked, but which rapidly develop a downy covering, such as the herons and storks and gannets.
3. Those born naked but which never develop more than a few dark down feathers in no wise capable of covering the body, such as the crows.
4. Those born naked and never developing any kind of nestling down whatsoever, such as kingfishers, hornbills, swifts, woodpeckers, and humming-birds.

The nestling down is of two types, one or both of which may be present at the same time. The first kind is that which is followed by feathers; the second, that which is followed by down. The second is sometimes absent in young birds, — as in ducks ; — and sometimes forms the greater part of the clothing of the body at this time.

The nestlings of the second group are all born with their eyes open and clothed with nestling down, which is sometimes hard to distinguish from the feathers ; they run soon after they are hatched. Such are chickens, ducks, geese and swans, plovers, cranes, and so on.

These are able to feed themselves almost at once, and only require the mother to guide them to places where food is procurable, to instruct them what is good to eat, and to keep them warm at night, and protect them from enemies. Without her they would roam about and soon get lost.

In almost every case, so soon as the young are old enough to look after themselves, they are driven away from the neighbourhood of their birthplace to seek homes elsewhere. This is really a wise act. It prevents too many of one species collecting in the same area, and thus obviates two serious evils threatening the welfare of the whole species. The first of these is the danger accruing from too many of one kind feeding in the same area, since the demand for food would soon exceed the supply. The second is the danger of too close interbreeding, which would weaken the race and bring about its inevitable extinction.

In all birds, except perhaps those of the ostrich tribes, the tip of the upper jaw is armed with a tiny, but very hard, conical boss called the "egg-tooth"; with this it breaks the wall of its shell and so liberates itself. Soon after the egg-tooth is thrown off.

For some hours before hatching, the chick can be heard giving vent to that peculiar little cry known as "cheeping." If danger threatens, a warning note is given by the parents, then all is still at once. So that the little stranger begins his education actually before he is born!

We have reserved till the last a consideration of the remarkable habits of certain unnatural

parents, commonly and rightly described as parasitic birds. Though individual cases of this kind are comparatively rare, the facts concerning them are really striking.

First of all let us take that of our British cuckoo. It is a matter of common knowledge, probably that this bird always lays its eggs in that of other birds, and leaves to them the entire responsibility of hatching and rearing its offspring.

Exactly how the egg is placed in the nest was, until recently, a matter of much controversy. For it was often found in a nest so completely fenced in by brushwood, or in one so small as to make it quite impossible that it could have been "laid" in the ordinary manner. It is now known that it is laid first upon the bare ground, then taken up in the beak, carried to the home of the victim selected, and dropped in.

From the laborious observation of a German naturalist named Rey, we have learned much concerning the choice of nests made by the cuckoo.

A large per centage of the nests selected in his district were those of the red-backed shrike; but, as in England, those of the wagtail, robin, blackbird, thrush, hedge-sparrow, pipit, bunting, reed-warbler, and so on, were also requisitioned. He further found, and his observations have been confirmed from many sources, that each particular cuckoo will always select the same kind of nest in which to lay; and that probably of the species by which it had itself been reared. The egg, moreover, generally bears a striking re-

semblance to that of the species selected to act the part of wet-nurse. He claims to be able to recognise every egg laid by any particular bird, not only during that season but during every season so long as she continues to return each year to the same district to lay in. This he seems able to do from the fact that each cuckoo has a more or less distinctive colouration for its shell, which makes it perfectly easy to identify; it is a sort of visiting-card. Thus, if a bird lays in a red-backed shrike's nest its egg will resemble that of this species; if in a pipit's, then of this, and so on. If the red-backed shrike be the victim selected then she will go the round of all the red-backed shrikes' nests in the neighbourhood laying an egg in each, till all her stock of eggs for that year is exhausted. Only, it appears, when there are no more nests of the required species to be found will she drop her egg into that of some other. The resemblance between the egg of the cuckoo and that of the foster-parent selected is attributed to the influence of the food during the nestling period of each particular cuckoo. The colouring matter of say the red-backed shrike's egg is more or less determined by the nature of the parent's food. The nestling cuckoo, being fed like a nestling shrike, the influence of this feeding is transmitted through the germplasm to its offspring. Shrike and cuckoo, in this respect, are influenced alike. The soundness of this conclusion has yet to be tested.

Having been reared by shrikes, it seems that it cherishes a certain sort of affection for them, and on arriving at maturity entrusts its offspring to

the same fostering care. In course of time we thus get a "*gens*" of shrike-reared cuckoos, another of robin or wag-tail, reared, and so on.

The same cuckoo will return year after year to the same locality to lay, and will permit no other of its species to share her territory, not even such of her own offspring — should she recognise them—as were born there the year previously.

If we feel that this desire to shirk the responsibilities of parentage is somewhat reprehensible what shall we say of the young, when we learn that its earliest act, before it has seen the light of day—for it is born blind—is *murder*! The story of the deliberate, relentless fashion with which this is carried out has been graphically told by Mrs Hugh Blackburn as follows: "The nest (which we watched last June after finding the cuckoo egg in it) was that of the common meadow-pipit (titlark, moss-cheeper), and had two pipit's eggs besides that of the cuckoo. It was below a heather bush on the declivity of a low abrupt bank on a highland hillside in Moidart.

"At one visit the pipits were found to be hatched, but not the cuckoo. At the next visit, which was after an interval of forty-eight hours, we found the young cuckoo alone in the nest, and both the young pipits lying down the bank, about ten inches from the margin of the nest, but quite lively after being warmed in the hand. They were replaced in the nest beside the cuckoo, which struggled about until it got its back under one of them, when it climbed backwards directly

up the open side of the nest and hitched the pipit from its back on the edge. It then stood upright on its legs, which were straddled wide apart with the claws firmly fixed halfway down the inside of the nest, among the interlacing fibres of which the nest was woven, and stretching its wings apart and backwards, it elbowed the pipit fairly over the margin so far that its struggles took it down the bank instead of back into the nest. After this the cuckoo stood a minute or two feeling back with its wings, as if to make sure that the pipit was fairly overboard, and then subsided into the bottom of the nest.

"As it was getting late, and the cuckoo did not immediately set to work on the other nestling, I replaced the ejected one and went home. On returning next day both nestlings were found dead and cold out of the nest. I replaced one of them, but the cuckoo made no effort to get under and eject it, but settled itself contentedly on the top of it. All this I find accords accurately with Jenner's description of what he saw. But what struck me most was this: the cuckoo was perfectly naked, without a vestige of a feather, or even a hint of feathers, its eyes were not yet opened, and its neck seemed too weak to support the weight of its head. The pipits had well-developed quills on the wings and back, and had bright eyes partially opened, yet they seemed quite helpless under the manipulations of the cuckoo, which looked a much less developed creature. The cuckoo's legs, however, seemed very muscular, and it appeared to feel about with

its wings, which were absolutely featherless, as with hands, the bastard wing (unusually large in proportion) looking like a spread-out thumb. The most singular thing of all was the direct purpose with which the blind little monster made for the open side of the nest, the only part where it could throw its burthen down the bank. I think all the spectators felt the sort of horror and awe at the apparent inadequacy of the creature's intelligence to its acts that one might have felt at seeing a toothless hag raise a ghost by an incantation. It was horribly 'uncanny and gruesome.' "

His fell purpose effected, the little murderer settles down to greedily absorb the nourishment which should rightfully have been shared between himself and foster brothers and sisters. In about a fortnight he is completely fledged and can leave the nest. But he by no means releases those upon whose charity he has been thrown. Up to within a short time of his leaving the land which gave him birth he holds them in thraldom,—"the victims of his mother's dupery," to quote Prof. Newton. As this writer further remarks, "Their actions when he attains his full stature become almost ridiculous, for they have often to perch between his shoulders to place in his gaping, upturned mouth the delicate morsels he is too lazy or too stupid to take from their bill. The time during which he is thus supported by his foster-parents has not been determined, but it seems to last for some weeks."

If we have an instance of crime in Nature it seems to be here. The desire to explain the origin

of habits so extraordinary is a natural one. If we take into consideration the habits of the adult, the nature of its food, and the proportion of the sexes, we shall have the first clue to the mystery.

All these seem to combine in favour of a degraded habit of life. They are the factors at work in the making of our avian criminals. The bird by disposition has been described as a "discontented, ill-conditioned, passionate, in short, decidedly unamiable bird." The note itself, and the manner in which it is emitted, are typical of the bird's habits and character. Abruptness, insatiability, eagerness and rage, are noticeable in its whole conduct. "These birds verify in many ways the old myth that they are sparrow-hawks in disguise. The parasitic habit is consonant with their general character."

There is "too much hunger and gluttony," write Messrs Geddes and Thompson, "for the higher development of love."

Our common cuckoo is not the only offender, for one of the cuckoos of South Europe and North Africa selects the nests of magpies and crows to serve as nurseries for its young. The eggs of this cuckoo are said to resemble those of the crows and magpies so closely as to make it difficult even for the expert egg-collector to distinguish between them.

The cow-birds of North and South America are parasitic in the same way. The habit is probably due to the same causes. Innutritious food and predominance of males, resulting in polyandry. These birds have a habit of pecking

holes in some of the eggs in the nest of the selected victims, and this is about the only mark of care which they show for the future of their progeny. But for this precaution the little uninvited guest might starve in the midst of plenty. Of the eggs which are left, most, if not all, hatch out; the little nestlings are soon however despatched, —not in the way adopted by our cuckoo, but either by the simple expedient of sitting on and smothering them, or by seizing all the food brought to the nest and so starving them. The cow-bird is probably doomed to extinction, for though a large number of eggs are apparently produced by each bird, only a small proportion ever succeed in being hatched. A considerable percentage are said to be laid in empty nests, some are dropped on the ground, and some destroyed by the parents themselves by being spiked like those of their victims!

Another South American bird, one of the hangnests (*Cassidix oryzivorus*), places its egg in the nest of another hangnest (*C. persicus*); but so far as is known no destruction of the young of the host takes place in consequence.

The case of the koel, a cuckoo found in India and the Malay Archipelago, is one of great interest, combining the habits both of mimicry and parasitism.

The female of this cuckoo—as with others—differs in coloration from the male, which is black. But though it generally happens when this is the case, that the young resembles the female, in this particular instance the young cuckoo, like its *male parent* is *black*. Now the host

selected by this cuckoo to perform her own neglected duties is a species of starling known as the Myna (*Eulabetes Javanensis*). The peculiarity of this bird is, that both male and female are alike, black, and the young is also black. If the young cuckoo was clad like its mother, the Mynas would promptly kill it on detecting the fraud. Dressed in black, it passes as one of their own, and as such is carefully reared.

CHAPTER IX.

MIGRATION.

THE facts of migration are being constantly thrust before us, yet but few do more than dimly realise the marvels that they represent, or that they exist at all.

Some of us find a passing interest in the announcement by the morning paper, of the appearance of the first swallow or of the cuckoo, but how many are aware of what this means?

And yet, as Prof. Newton remarks, we "are brought face to face with perhaps the greatest mystery which the whole animal kingdom presents —a mystery which attracted the attention of the earliest writers, and can in its chief point be no more explained by the modern man of science than by the simple-minded savage or the poet or prophet of antiquity. Some facts are almost universally known, and have been the theme of comment in all ages and in all lands. The hawk that stretches her wings towards the South

is as familiar to the latest Nile-boat traveller or dweller on the Bosphorus as of old to the author of the Book of Job. The autumnal thronging of myriads of water-fowl by the rivers of Asia is witnessed by the modern sportsman as it was of old by Homer. Anacreon welcomed the returning swallow in numbers which his imitators of the colder north, to whom the association connected with it are doubly strong, have tried in vain to excel. The Indian of the fur-countries, in forming his rude calendar, names the recurring moons after the birds-of-passage whose arrival is coincident with their changes. But there is no need to multiply instances. The flow and ebb of the feathered tide has been sung by poets and discussed by philosophers, has given rise to proverbs and entered into popular superstitions, and yet we must say of it still that our 'ignorance is immense.'"

We may however take "heart of grace" for this pile of ignorance is being slowly demolished; and the traditions, legends and superstitions, of which it was made up, are being slowly consumed by the fire of criticism. As a result, we can now class the observed phenomena under three heads and speak of (1) accidental migrants, (2) birds-of-passage, and (3) migration proper.

As this last is the most important and the most typical, we will discuss it first. This section then treats of the periodic movement of large bodies of birds from one place to another, often thousands of miles apart.

Concerning migration proper, we have learnt this—that species which winter with us, leave in

the spring to nest nearer to or within the arctic circle, and the species which summer and nest with us, winter near the equator.

With some species every individual disappears, as for instance our swallow and fieldfare; with others, such as the robin, thrush, and lark we receive immigrants every year. Emigration of these species is less marked, but occurs.

Nearly every bird, as Prof. Newton reminds us, migrates in some part or other of its range; a fact which suggests that the phenomena of migration are probably universal.

But whether this migration be extended to its farthest or confined to its smallest possible limits we find one trait common to all—a "passionate fondness for the old home."

Prof. Newton has given us two very striking instances of this. The first of these is one of our most sedentary birds—the blue titmouse (*Parus cæruleus*). A pair of these birds in 1779, or according to some, 1785, "built their nest in a large earthenware bottle placed in the branches of a tree in a garden at Oxbridge near Stockton-on-Tees. With two exceptions only, this bottle . . . was tenanted by a pair of birds of this species from the year in which it was first occupied until 1873, when I saw it . . . but I regret to add that I learnt through Canon Tristram in 1892 that the occupancy had ceased for four years."

The second case is that of a stone-curlew, a very migratory species. A pair of these birds returned year after year to the same spot to breed though the character of the locality had

completely changed. "It had been part of an extensive and barren rabbit-warren, and has become the centre of a large and flourishing plantation."

The affection of the swallow for its old nesting-place is well-known, and many of my readers will doubtless recall other instances.

In studying the phenomena of migration we must pay careful attention to the sources of food-supply, the nature of the food, and the method of procuring it.

Hawks, as we know, drive away their young from the neighbourhood in which they were born, as soon as they have taught them to hunt and kill for themselves. The apparent selfishness and cruelty on the part of the parents in such treatment is, in reality, an act of kindness. From their mode of life, a given area can only support a few individuals, and for parents and offspring to remain in the same locality would rapidly mean starvation for all. Some birds there are which traverse the country-side during the autumn and winter in small family parties. Such are, for instance, insectivorous birds. Amongst these it is obviously an advantageous plan; for the discovery of food at this time is an arduous task, and if undertaken individually, many would surely starve, as Prof. Newton points out. "A single titmouse searching alone might hunt for a whole day without meeting with a sufficiency, while if a dozen are united by the same motive, it is hardly possible for the place in which the food is lodged to escape their detection, and, when

discovered, a few call-notes from the lucky finder are enough to assemble the whole company to share the feast. . . . One tree after another is visited by the active little rovers, and its branches examined: if nothing be forthcoming, away goes the explorer to the next that presents itself, merely giving utterance to the usual twitter that serves to keep the body together. But if the object of search be found, another kind of chirp is emitted, and the next moment the several members of the band are flitting in succession to the tree, and eagerly engaged with the spoil."

This need of food, it is suggested by the same writer, is probably largely responsible for the movement of the birds of our northern hemisphere, southwards, a movement which ceases only at the equator. But what, he asks, induces the return journey with all its attendant dangers? Probably again a lack of food, not necessarily for the migrants, but for their nestling offspring. There is sufficient for the parents, but this is not of a nature adapted for the requirements of the nursery, which can only be found in the lands lately left, where, at this time the supply will meet all demands likely to be made upon it. Perhaps, he suggests, this may be the explanation; but perhaps again the real motive is "the passionate fondness for the old home."

Indirectly, these periods of passage are a great benefit to the race generally, for in the course of them, the ranks of the travellers are greatly thinned by reason of the numbers who fall by the wayside. Only the strongest and most

active survive to perpetuate the species. The number of swallows often found dead on the seashore washed up by the restless waves after a storm affords a proof of this mortality.

The regularity of these migratory movements is wonderful. Fair weather or foul the puffin turns up at his accustomed breeding-place with clockwork regularity. The swift again is peculiarly punctual in the date of his arrival.

Mr Wallace seems most strongly of opinion that food is the mainspring of migratory movements. He says:—

"It appears to me probable that here, as in so many other cases, 'survival of the fittest' will be found to have had a powerful influence. Let us suppose that in any species of migratory birds, breeding can as a rule be very safely accomplished in a given area; and further, that during a great part of the rest of the year sufficient food cannot be obtained in that area. It will follow that those birds which do not leave the breeding area at the proper season will suffer, and ultimately become extinct; which will also be the fate of those which do not leave the feeding area at the proper time. Now, if we suppose that the two areas were (for some remote ancestor of the existing species) coincident, but by geological and climate changes gradually diverged from each other, we can easily understand how the habit of incipient and partial migration at the proper seasons would at last become hereditary, and so fixed as to be what we term an instinct. It will probably be found that every gradation still exists in various parts of the world, from a

complete coincidence to a complete separation of the breeding and the subsistence areas; when natural history of a sufficient number of species is thoroughly worked out, we may find every link between species which never leave a restricted area in which they breed and live the whole year round, to those other cases in which the two areas are absolutely separated."

We have one striking instance of the relations between migration and food in the passenger pigeon, *Ectopistes migratorius*. Concerning this Dr Brewer writes, "The wild pigeon appears to be almost entirely influenced in its migration by the abundance of its food, excepting in those parts of the country in which it has not been known to remain during the winter. Even in these movements it is largely influenced by considerations of food. . . . They are capable of propelling themselves in long continued flights, and are known to move with an almost incredible rapidity, passing over a great extent of country in a very short time. It is quite a common and well ascertained fact that pigeons are captured in the state of New York with their crops still filled with the undigested grains of rice that must have been taken in the distant fields of Georgia in South Carolina, apparently proving that they must have passed over the intervening space within a very few hours. Audubon estimates the rapidity of their flight as at at least a mile a minute. . . . Mr Audubon relates that in 1813 . . . in crossing the barrens near Hardensburg, he observed these birds flying to the south-west in greater numbers than he had ever known

before. . . . The air seemed filled with pigeons, and the light of noonday to be obscured as by an eclipse. Not a single bird alighted, as the woods were destitute of mast, and all flew so high that he failed to reach any with a rifle. He speaks of their aërial evolutions as beautiful in the extreme, especially when a hawk pressed upon the rear of a flock. All at once, like a torrent, and with a noise like that of thunder, they rushed together into a compact mass, and darted forward in undulating lines, descending and sweeping over the earth with marvellous velocity; then mounting almost perpendicularly in a vast column, wheeling and twisting so that their continued lines seemed to resemble the coils of a gigantic serpent. During the whole of his journey from Hardensburg to Louisville, 54 miles, they continued to pass in undiminished numbers, and also did so during the three following days. At times they flew so low that multitudes were destroyed, and for many days the entire population seemed to eat nothing but pigeons."

"There can be little doubt," to quote another writer, "but that the vast numbers of these pigeons have greatly diminished during recent years; and though at present by no means on the verge of extinction, it seems certain that unless laws be made for its protection its extermination is only a matter of time." Mr Brewster writes that in Michigan, "we found the flocks of pigeons had passed there late in April, while there were reports of similar flights from almost every country in the southern part of the State. Al-

though most of the birds had passed on before our arrival, the professional pigeon-netters, confident that they would finally breed somewhere in the southern peninsula, were busily engaged getting their nets and other apparatus in order for an extensive campaign against the birds."

The largest nesting-place he ever visited was in 1876 or 1877. It began near Petosky, and extended north-east past Crooked Lake for 28 miles, averaging 3 or 4 miles wide. The birds arrived in two separate bodies, one directly from the south by land, the other following the east coast of Wisconsin, and crossing at Maniton Island. He saw the latter body come in from the lake at about three o'clock in the afternoon. It was a compact mass of pigeons, at least 5 miles by 1 mile wide. The birds began building when the snow was twelve inches deep in the woods, although the fields were bare at the time. So rapidly did the colony extend its boundaries, that it soon passed literally over and around the place where he was netting, although, when he began, this point was several miles from the nearest nest. Nestings usually start in deciduous woods, but during their progress the pigeons do not skip any kind of trees they encounter. The Petosky nesting extended 8 miles through hardwood timber, then crossed a river—bottom wooded with arborvitæ, and thence stretched through white pine woods about 20 miles. For the entire distance of 28 miles every tree of any size had more or fewer nests, and many trees were filled with them. None were lower than about 15 feet from the ground. Pigeons are very

noisy when building. They make a sound resembling the croaking of wood-frogs, and their combined clamour can be heard at a distance of 4 or 5 miles when the atmospheric conditions are favourable.

There are one or two notable facts which are well worth mentioning in this connection. Thus, it seems to be well-established that in many species the males arrive sometimes days, or even weeks, before the females. In the autumn the adults often leave first, leaving the young to follow later—and generally by a different route. The cuckoo is an instance of this. How these young find their way is a mystery. An innate sense of direction has been suggested as a possible explanation, but this is not very convincing.

The routes followed by some of our more familiar friends will doubtless prove of interest. Concerning this subject comparatively little is really known. Facts however are being slowly accumulated. In Great Britain, much valuable and lasting work has been, and is being done, by Mr Eagle Clarke. Much more has been done by the careful collection of birds' skins from all parts of the world as may be found at the British Museum. From such collections, for instance, we gather that our common swallow winters on the west coast of Africa.

The "birds-of-passage" to which we referred at the beginning of this chapter are those on their way to and from their breeding-grounds, outside the limits of these islands. They make but a brief sojourn—possibly for rest and food—and then disappear.

Besides these, as already hinted, we have occasional stragglers. Such, for instance, are many North American birds breeding in high northern latitudes; which, on their return home, get blown out of their course by violent westerly gales.

But how is it, some will naturally ask, that we see little or nothing of all this movement? Chiefly, we may answer, because for the most part it takes place at such great altitudes as to make it invisible and inaudible. What we *do* see and hear is only an indication of what is going on above.

Mr Chapman, in America, by directing a powerful telescope towards the moon, has detected birds passing at night in great numbers at a height of from one to (?) five miles. Similar observations have been made by day, by directing a telescope against the sun. It seems to be only in stormy or cloudy weather that migrants descend low enough to be seen or heard. Our lighthouse-keepers have rendered valuable aid in observation of the movements of the birds which pass their stations. Their records have been published in a series of reports instigated by the British Association, the net result of which will be shortly given to the world by Mr Eagle Clarke, one of our greatest authorities on bird-migration. It has been shown that during bad weather the birds descend, and then seem to be attracted to, and dazzled by, the powerful beacons of the lighthouses and lightships—an attraction which proves fatal to thousands, for in many cases they are killed instantly by the

violence of their impact with the glass condensers of these beacons. Hundreds of all species: woodcocks, snipes, curlews, ducks, finches, crows, owls and so on, hover around till daybreak then make for the shore; but hundreds remain, either utterly exhausted with their exertions, or killed by concussion.

If the lighthouses have told us much, the lonely island of Heligoland—an island which is peculiarly well situated for work of this kind—has told us more. The observations from this quarter are by far the most numerous, and the most valuable that have yet been made. These we owe to the late Herr Gätke who spent the greater part of a long and useful life on this circumscribed spot. He studied the movements of the birds as they passed and repassed, as the seasons rolled, with the greatest care and minuteness. Sometimes they would come to the lighthouse, as to the lighthouses in other places, in enormous numbers. One night for instance in October, "Goldcrests eddied as thick as flakes in a heavy snowfall . . . on the morrow literally swarming on every square foot of the island; and twelve months later larks in myriads thronged to the bright beams of this same beacon four nights in succession, accompanied by starlings in hardly fewer numbers."

There is another form of migration, hinted at in the beginning of this chapter, which might almost be described as spasmodic. It is just possible however that it is really periodic, or at least occurs in cycles.

This is the immigration of vast hordes of birds

normally sedentary in their habits. Our shores have at different times harboured thousands of the refugees belonging to different orders of birds.

The most remarkable of these immigrations is that of the Pallas's sand-grouse (*Syrrhaptes paradoxus*). This bird, an inhabitant of the plains of Tartary, has, so to speak, invaded England on several separate occasions. The first of these was in 1863 when numbers were killed. Another of far greater magnitude occurred in 1888. In Norfolk alone between 10,000 and 12,000 are computed to have been seen, exclusive of the large number killed.

The cross-bill frequently, and the waxwing more seldom, cross to these islands in more or less numerous bands ; but these occurrences are very irregular, and so far remain entirely unexplained.

CHAPTER X.

THE DISTRIBUTION OF BIRDS IN TIME AND SPACE.

THE present chapter is intended to serve more or less as a prelude to the one that follows.

The distribution of birds in time is witnessed by their fossil remains. Thus, if we know the geological formation from which they were taken, we are enabled to gather some notion as to the nature of the bird-life of that particular period of the world's history, and an idea as to the extension backwards in time of this group.

If our notions concerning the evolution of higher from lower groups, and of their gradual transformation into species, be correct, we should expect to find that the further back in time we could trace any given animal, the more unlike its present self, so to speak, would it become. At first the change would be hardly perceptible, but at the last it would be marked indeed, so much so, that could we compare the ancestral form with its latest descendants, we should find that they would have but very little in common. The history of some of the hoofed mammalia very well bears out this hypothetical case.

With the birds, unfortunately, the "missing links" are numerous. The marvel is that we have any record at all. As that distinguished authority on fossils, Mr Arthur Smith Woodward, of the British Museum, has reminded us. "We may . . . without exaggeration, declare that every item of knowledge we possess concerning extinct plants and animals depends upon a chapter of accidents. Firstly, the organism must find its way into water where sediment is being deposited, and there escape all the dangers of being eaten; or it must be accidentally entombed in blown sand or a volcanic accumulation on land. Secondly, this sediment, if it eventually happens to enter into the composition of a land area, must escape the all-prevalent denudation (or destruction and removal by atmospheric and aqueous agencies) continually in progress. Thirdly, the skeletons of the buried organism must resist the solvent action of any waters which may percolate through the rock. Lastly, man must accidentally excavate

at the precise spot where entombment took place, and someone must be at hand capable of appreciating the fossil and preserving it for study when discovered."

The most ancient bird known carries us as far back in the world's history as the period and age we call the Jurassic. Its contemporaries were the huge marine fish-lizards—the ichthyosaurus and the plesiosaurus. On land there roamed the mammoth lizards, Brontosaurus and Atlantasaurus. The former was 50 feet long, and has left footprints measuring a square yard in area. The latter was some 100 feet long, and 30 feet or more in height.

The mammals were yet in their infancy. Probably none exceeded a few inches in length.

Amongst the rivals of this ancient bird in creatures that fly, there were no mammals as at the present day—the bats. But their place was filled by swarms of flying reptiles—the pterodactyles, or wing-fingered lizards. Lizards indeed were the dominant form of life. At this period they had reached the zenith of their glory, and ruled where now the bat and the bird hold sway, and not only in the air, but on *terra firma* as well.

This bird we know as the *Archæopteryx*,—the ancient winged-bird. As we shall see in the next chapter, it differs in many important details from all other known birds. But, at the same time, it is undoubtedly a bird. It possesses, in a remarkable degree of perfection, one of the birds' most striking characteristics—feathers. The form of its leg and foot is scarcely

different from that of the rooks and crows of to-day. The fashion of wing-bones is the same as theirs. Where it differs from them, its counterpart can be found in living birds.

These are points of great significance. We have no reason to suppose that they reached this particular form by any other than the ordinary routes, which were then as now. The wing and foot as we see them in the fossil must be the result of a gradual modification of some other pre-existing type of fore- and hind-limb.

This modification must have been a very very slow one, and pre-supposes a long line of ancestors stretching back far beyond the Jurassic period.

The argument for descent with modification, which is the outcome of the evolution hypothesis, may be admitted to have received strong support then from this skeleton.

The two birds now to be discussed afford us additional evidence, for in the one we see what evolution has accomplished by specialisation accompanied by degeneration; in the other we have an object lesson in evolution with progression, and in both we have evidence of a distinct advance in type. Both the forms moreover are contemporaries, showing that the two were being evolved at the same time.

These are *Ichthyornis* and *Hesperornis* of the cretaceous period.

Both of these were more advanced in type than *Archæopteryx*. In *Ichthyornis* the form of the tail and wing is like that of modern birds, so is the pelvis. Its powers of flight were probably vastly superior, for its breast-bone was

provided with a deep keel for the attachment of powerful muscles to move the wings. From the general form of the body and legs there is no doubt that it was a dweller on the sea-shore, and could swim, and perhaps even dive, easily. In this, you will note, we have evidence first of progress in development, in time; and secondly, of the modification of the skeleton to suit changed requirements. The first bird was a dweller in trees, the second a frequenter of the seashore.

In *Hesperornis* we see this adaptation to an aquatic mode of life pushed to its extremest limit. From being a dweller on the seashore this bird has become a dweller on the sea itself.

Possessing abundant food in the immediate vicinity of a gently sloping coast-line free from violent surf, which served as a breeding-ground, and with the absence of enemies, flight became no longer necessary to existence, and was exchanged for great diving powers. The saving effected in the non-maintenance of the wing as an efficient organ of flight was applied to the increased development of the leg, upon which the powers of diving depended. To this end, other changes were also effected. Thus, the decline of the wing brought about the degeneration of the breast-bone, by the complete loss of its keel. The wing itself became reduced to a mere vestige, only the upper arm-bone remaining; whilst the pelvis, or hip-girdle, became specially modified in accordance with the diving habits. Exactly what changes have taken place

in this part of the skeleton and its muscles can only be appreciated by a comparison of the skeletons of say one of the modern divers, and an eagle or albatross, for the pelvis of *Hesperornis* is scarcely distinguishable from that of the former, and differs from that of *Ichthyornis*, as does the living diver from the eagle.

From this we gather that the distribution of this ancient group—the divers'—was a moderately wide one, and that some retained the power of flight, finding it still necessary. From these have sprung our modern divers and grebes. The form of the hip-girdle is exactly the same, both in living and fossil forms.

Hesperornis, then, was a highly specialised, or intensified water-bird, built for diving. We will now pass on to consider its opposite, the intensified land-bird.

This we have in the gigantic moa of New Zealand which stood some ten feet or more in height, but other species existed, the smallest of which was not much bigger than a large turkey. They are now extinct, and are generally believed to have been exterminated for the purposes of food by the ancient Maories, as the charred bones and egg-shells have been found mixed with charcoal representing the fuel which served to cook them.

This "intensified land-bird," as we have called it, is only one of many, but is selected for illustration here because of the completeness with which this intensification has been carried out.

First and foremost it was flightless. The wing

remains a wing only so long as it is used for flight. As we have seen already, so soon as it ceases to be used for the purpose of flight, it more or less rapidly degenerates to a mere vestige, unless, as in the case of the penguin, it becomes transformed so as to perform other functions.

As we have shown in an earlier chapter, examples of flightless birds are numerous. But the moa is perhaps the only bird that has carried the process of suppression so far as to have lost not only all traces of the wing itself, but sometimes of the bony girdle which supported it.

The rest of the skeleton bears out our first description of this bird as an intensified land-bird. In *Hesperornis* we find the hind-limb and hip-girdle peculiarly modified for the purpose of swimming; in the moa the hind-limb and hip-bones are just as obviously modified to serve the purposes of walking and running.

It would be well here to take a brief survey of the gradations in degeneration furnished by the wings of some living birds, probably closely related to the moa.

These are the rhea, ostrich, apteryx, emu, and cassowary.

In these we have a series of stages in the degeneration of an organ. The wing of the South American rhea most nearly resembles that of an ordinary functional wing, and we imagine, therefore, has most recently passed the stage when it can no longer serve even as an organ for feeble flight. The wing, though large, is not large enough to support the weight of the body.

Next comes the ostrich. As in rhea, the primary and secondary quill-feathers still persist and retain their full strength in point of numbers. They are however too weak and feeble to serve the purposes of flight. The New Zealand apteryx furnishes the next stage, having greatly reduced the number of quill-feathers, and the size of the wing. So diminutive is this last that it cannot be found without careful search.

Lastly follow the emu and the cassowary. In both, primary feathers are greatly reduced in number. In the former they have lost the stout "quill" portion by degeneration, and retained the feathery vane. In the latter the "quills" have become extremely specialised, and project beyond the wing as huge spines, whilst the "vane" has been thrown off. This is an interesting example of the specialisation of a degenerate structure.

Not only then have the feathers in these birds degenerated, but the skeleton too shows every gradation of decrease and decay by gradual absorption. We may gather from this the almost absolute certainty that we are, in these wings, studying so many stages in the decline of a once functional organ—an organ of flight or, as we call it, a wing. For additional and even more convincing evidence we might turn to the anatomy of the soft parts, *e.g.* the muscles. These, we should find, were in every way arranged as in the birds that fly, proving, by this disposition, that they have undergone a similar adaptation to the mechanical require-

ments of flight. Even the very folds of skin which invest these wings agree with those of birds that fly, and tell the same tale.

We may conclude then that though the wing in the moa had completely vanished, or that of the *Hesperornis* was worse than useless, both almost certainly were not only descended from birds that fly, but once possessed this power themselves. A conclusion fraught with considerable importance when considered in relation to the distribution of birds in time as we shall see presently.

For the purpose of illustrating the fact that one organ may be developed at the expense of another, more clearly we may instance the swift and the frigate-bird. These two, though not in the most remote degree related one to another, agree in this, that the wing has reached a comparatively high grade of specialisation—though taking a different form in each—whilst the leg has in both become so much reduced in size as to render walking a difficult process. In the swift they are so short that the bird can only rise from the ground, should it alight thereon, with extreme difficulty. The powers of flight possessed by these two birds are too well known to need description.

But what connection can all this have with the distribution of birds in time? Briefly this: the discovery of the fossils just enumerated shows us that birds existed as far back as the Jurassic epoch; but these same fossils are those of birds which have reached a considerable degree of specialisation, or, as we sometimes call it, of

intensification: and they must therefore be the descendants of less specialised, or, as we say, more generalised forms, of which, at present, we have no record whatever. Thus, far from supposing that birds had their origin in the Jurassic period, we must conclude that they had already appeared before this epoch.

The discovery of so extremely specialised a form as *Hesperornis* is one of deep significance, and shows that the divers must have been already long in existence, possibly extending as far back as *Archæopteryx* itself.

Moreover, we must guard against supposing, as some do, that such and such a group of birds must be descended from such and such a fossil. *Hesperornis* for instance is not the ancestor of the modern divers, which so closely resemble it. A form which had lost the power of flight so completely cannot have begotten offspring in which the wing is fairly well developed. The present divers are the descendants of *flying* birds. *Hesperornis* is a collateral branch of the same family.

We shall see in the next chapter, wherein we shall discuss pedigrees, how intricate this problem of descent is.

Closely connected with the question of the distribution of birds in time is their distribution in space, or as we generally call it their "Geographical distribution."

A moment's reflection will convince us that the distribution of animals—whether birds, or beasts, or fishes—is not likely to be influenced by political boundaries, nor even necessarily

by those more ancient, and naturally circumscribed areas which we know as continents and islands.

Yet it is a fact that certain kinds of animals—using this word in its proper sense—are only found in certain parts of the world. To confine ourselves to birds : We go for instance to Africa for secretary-birds and touracous, or to South America for toucans and humming-birds. And so we get a notion that the sharply defined political distinctions, Indian, African, Chinese or European, are synonymous with real, natural boundaries, each with its peculiar groups of birds and beasts.

To a certain extent this is true. To Dr Sclater is due the credit of having first shown us the real inwardness of this distribution. He proposed the recognition of six zoo-geographical regions, determined according to the nature of the bird fauna inhabiting the same. They are the Palæarctic, Ethiopian, Indian, Australian, Nearctic and Neotropical regions.

The Palæarctic region includes Europe, Africa and Arabia, north of the Tropic of Cancer, the whole of Asia, except India, Burma and South-East China, together with Japan, Iceland, the Azores and Cape de Verde Islands. The grouse, pheasants, and capercailzies, long-tailed titmice, robins, magpies and bullfinches are the characteristic birds of this region.

The Ethiopian region includes Africa, south of the Sahara, Madagascar and Arabia, south of the Tropic of Cancer. The ostrich, touracou,

black hoopoe and secretary-bird, are some of the more striking forms it contains.

The Indian region embraces Southern Asia from the Himalayas and Yangtze River in China. Its western limit has been defined by Dr Sharpe at about 55°east longitude, where the Palæarctic and Indian regions find a frontier. Its most characteristic birds appear to be the peacock and the broad-bill.

The Australian region embraces the Australian continent, and the islands lying to the east of a line passing through the narrow strait between Bali and Lombok, called "Wallace's line." Of this we shall have more to say later. Its most noticeable birds are the emu, cassowary and the apteryx, birds-of-paradise, bower-birds, megapodes, the lyre-bird and cockatoos.

The Nearctic region corresponds more or less with the whole of North America and adjacent islands. It possesses so many features in common with the Palæarctic that many have suggested the blending of the two to form a "Holarctic region."

The Neotropical region may be taken as representing the whole of South and Central America. The rhea, tinamous, opisthocomus, the guans, trumpeters, jacamars, puff-birds, humming-birds, toucans, and many more combine to give this region a remarkable interest.

Each of these different regions has been divided and subdivided into sub-regions and provinces of varying extent. It would be impossible to discuss the relative merits, or even to detail the boundaries of these in this little

work. Those who are interested in this fascinating subject should consult the works of Dr Sclater, Mr Alfred Russel Wallace, Prof. Newton, or Dr Sharpe.

The basis upon which these boundaries rest is their resident or non-migratory population. For, besides which, there is a floating population, which periodically leaves one place of residence, often a high northern latitude, for another often not far removed from, or even within, the tropics. Concerning these migratory tribes we shall have more to say later.

The study of the resident populations then—of birds or otherwise—of each of these great regions is one of extreme interest and importance. Not because it tells us that such and such a bird or beast is found in such and such a region, but because we learn from it much concerning the past history of the earth that would otherwise never have been suspected. Zoo-geography may be regarded as a sort of hand-maid to geology.

For instance, when we come to study the fauna of the British Islands, and to compare it with that of the European continent, we find that the two are almost identical, though the further we get away, the more emphatic becomes the difference.

That the same species of birds occur in both areas does not seem strange, for we know that they can easily pass, what is to us an insurmountable barrier, the sea that divides us from the continent. But what about the mammals and reptiles, the hare, the fox, the hedgehog and

badger, the mice and squirrels, the snakes and lizards ?

Now here will come in the value of our study of the distribution of animals in time, showing us as it does that the connection between the British islands and the continent is still more intimate than we at first suspected. For we learn now that the bear, the wolf, the reindeer, the wild boar, the beaver, and even the lion, elephant and rhinoceros, once roamed in both areas. The three last have disappeared more or less completely throughout the greater part of what we call the Palæarctic region. The rest remain still on the continent but have long since passed away from amongst the British fauna. But how came any of these to gain an entrance into these islands ? One or other of them might have crossed by swimming, but we can scarcely suppose all did. Our only other alternative is to postulate a former land connection. For confirmation on this point we turn to the geologist, and we are supplied with an abundance of the most convincing evidence, which need not be discussed here.

The distance of time which has elapsed since two isolated areas of land were last in connection, we gather approximately from the degree of dissimilarity in the fauna of each. Thus, when the date is comparatively recent, the differences are slight; when of great antiquity, they will be found to be very great.

For instance, as Mr Alfred Russel Wallace points out, the absence from Madagascar of almost all the characteristic mammalia, birds and

reptiles of Africa, shows that this island must have been separated from the continent very early in the period known as the Tertiary, or even earlier. This conclusion receives additional testimony from the fact that Madagascar is stocked with a very rich mammalian fauna, and one which presents many remarkable peculiarities. Many of them are of a very lowly and archaic type.

The richness of its mammalian fauna proves its former connection with the mainland; whilst the archaic character of this fauna shows that the connection must have existed during a very remote period when the fauna of that portion of Africa at least, which was nearest the island, was of a different and more primitive type than the fauna now inhabiting this continent. Those primitive forms have disappeared from the mainland, and have given place to the more specialised and vigorous types of to-day. No other island possesses so many peculiar and archaic mammalian forms; and no other island on the globe, possessing a moderately rich mammalian fauna, is separated from the mainland by a sea whose depth exceeds one thousand fathoms. What the great depth of this sea teaches us will be shown presently.

New Zealand carries the record of remote isolation a step further. It possesses but two known mammals, and these are bats; and only one frog-like animal. Its reptiles and birds are very peculiar.

Now the almost entire absence of endemic mammals would point to an isolation from the

mainland—Australia—before the advent of even the low mammalian types which characterise this continent. The birds, reptiles, and flora of the island are such as occur in Australia and the adjacent Pacific Islands, and suggest an origin from these sources. They are a part of a fauna and flora once forming a common area. It is supposed, however, that the island has been isolated since the Cretaceous period.

Soundings show that the "sea which directly separates New Zealand from Australia is more than 2000 fathoms deep, but in a north-west direction there is an extensive bank under 1000 fathoms, extending to, and including, Lord Howe's Island; while north of this are other banks of the same depth, approaching towards a sub-marine extension of Queensland on the one hand, and New Caledonia on the other, and altogether suggestive of a land union with Australia at some very remote period." This suggested connection is made almost a certainty by the evidence contributed by the animal and plant life. The great depth of the sea, as in the case between Africa and Madagascar, together with the peculiarities of the fauna in each case, furnish then strong evidence that the period of isolation has, in each case, been one of great length.

We have one more instance of the significance of a deep sea between two adjacent land areas. This is furnished by the Malay Archipelago. A line drawn between the two islands of Bali and Lombok divides the Archipelago into two distinct zoo-geographical regions. The islands to the west of this line belong to the Indian region,

those to the east to the Australian. The islands lying on either side of this line lie in a shallow sea, and were doubtless connected, at no remote period, with one another, and with the nearest mainlands—Asia and Australia, with which they respectively agree in the nature of the fauna and flora. The width of the sea between Bali and Lombok is only fifteen miles. Its depth is over 1000 fathoms. These two islands are the extremest limits of two vast continents which formerly extended from Asia on the one hand and Australia on the other. The contrast in the fauna is abrupt. In Bali, representing the Asiatic continent, "we have," says Mr Wallace, "barbets, fruit-thrushes and woodpeckers; in passing over to Lombok, these are seen no more, but we have abundance of cockatoos, honeysuckers and brush-turkeys, which are equally unknown in Bali, or any island further west. The strait is here fifteen miles wide, so that we may pass in two hours from one great division of the earth to another, differing as essentially in their animal life as Europe does from America. . . . The birds which are most abundant in the western islands are the woodpeckers, barbets, trogons, fruit-thrushes and leaf-thrushes; they are seen daily, and form the great ornithological features of the country. In the eastern islands these are absolutely unknown, honey-suckers and small lories being the most common birds; so that the naturalist feels himself in a new world, and can hardly realise that he has passed from the one region to the other in a few days, without ever being out of sight of land."

The imaginary line drawn through the sea to serve as a boundary between Bali in the east, and Lombok in the west, with the islands belonging to each, was called "Wallace's line," in honour of Mr Alfred Russel Wallace, who first pointed out the significance of this barrier of deep water.

So far, all the islands of which we have spoken have been, at some time or another, parts of the nearest mainland. The fauna and flora represent more or less the fauna and flora of the mainland at the time when this particular portion became isolated. The rocks will be found to be stratified, and to agree in character with those of the mainland.

Other islands there are, however, which are of quite different origin. They are known as "Oceanic," as opposed to those just described which are called "Continental." An Oceanic island is either of volcanic or coral origin. At no time, therefore, has it ever formed part of the mainland. Its fauna and flora are peculiar, being derived from the nearest mainland, and carried thither by the wind, or from the flotsam and jetsam of the sea. The sea contributes such vegetable seeds as have hard shells, impermeable to salt water. These are cast up by the waves and often manage to find a root-hold on the shore; and such small mammalia as may have been conveyed on trunks of trees brought down from the nearest mainland by flood; or birds, as may have flown thither from some other island or continent.

The wind brings seeds of plants and

insects, often in great numbers, especially after gales.

As regards existing continents, it seems there is no good ground for supposing that their position, as a whole, has changed. In other words, the great ocean basins which divide them have remained the same for countless ages. It is true that each of the great continents may have suffered a sojourn beneath the sea, but this has never been more than a partial submergence. This has taken the form of denudation, or subsidence in one part, with a proportionate encroachment of the sea, only to be balanced by a proportionate elevation in some other part.

CHAPTER XI.

PEDIGREES AND FAMILY TIES.

Amongst ourselves "blue-blood" and ancient lineage, if not exactly "convertible goods," have undoubtedly a certain market value in the world of to-day. To have come of "a race of kings" is almost sure to procure for the proud descendant—where these things are appreciated—a certain deference that is never accorded his more obscure brethren, always provided, of course, that he shows himself worthy of our respect in other things. Nevertheless this same descendant may, in all things else, prove in no way superior to his obscurely born neighbours. In mental capacity, in energy and physique, he may even be inferior. In spite of this, his credentials are good, and he

gets a hearing. The feeling that lies behind all this is the same that prompts us in our distrust of strangers. We like references or letters of introduction when the individual claiming ought from us has no record or achievement of his own sufficiently notorious to supply their place.

If amongst ourselves "pedigree" is a marketable commodity, it becomes even more so when we descend to the consideration of our domestic animals, our horses, cattle and dogs, our fowls, pigeons, and so on. Here undoubtedly it is no mere sentiment but real worth that we pay for. The horse or the dog we buy that is thorough bred or pure-bred, as we call it, possesses certain qualities which his mongrel brethren have not. In each case the particular quality was present in their more or less remote ancestor, and was the cause of their being held in special esteem.

These thorough-bred or pure-bred animals we owe to the acumen and forethought of our forefathers, who, by carefully selecting mates most nearly approaching their ideal of perfection in certain points—say speed, or the quality of wool—gradually increased the desired property both in quality and quantity. This increase came about by virtue of what we call the law of heredity, the principle which causes an animal to resemble its parents; or, if you will, which causes an animal to produce offspring like itself. Thus, as we have already remarked, the young of a particular kind of bird or a particular kind of snake will reproduce all the peculiarities of form and colour which characterised its parents,

and by which they are distinguished from their neighbours.

This process of creating new forms by modifying old ones we call the process of "Artificial Selection." But, mark that whatever changes have taken place have been changes wrought in already existing structures. There have been no sudden introductions of structures hitherto non-existent or foreign to their nature as—say, pigeons. The rock-dove from which each particular breed of pigeon is derived was already a delicately organised, and highly specialised animal, so that any changes which could possibly be effected in its form must necessarily proceed along certain lines by the exaggeration of already existing structures. It would have been impossible for instance to change it into a form resembling a hawk or a crow.

It sometimes happens with the pedigrees of distinguished people that the further back we trace their ancestry, the more humble and obscure does it become. So is it with animals and plants. The exact manner in which these have come by their present forms, and what their ancestors were like, is the puzzle which men of science are trying to unravel. The machinery which has been largely responsible is at work all round us, and has been going on since the beginning of living things.

> "For though the mills of God grind slowly,
> Yet they grind exceeding small."

We are daily sifting these fragments in the hope of finding now and again a few that will fit

together and make a whole, cracked and with bits missing it may be, but yet showing us enough to give hints of new lines of research.

Till comparatively recently—within the present century—the outcome of this collection of fragments seemed but a lumber-room of useless facts. True, some sort of order had been introduced, but no system or intelligible explanation had been given. When Charles Darwin began to inspect this lumber-room he discovered it to be in reality a vast treasure-house, and he immediately set about collecting more material to fill up vacant spaces and missing gems. The result of his labours has revolutionised modern thought. His interpretation of these isolated facts and of the motive power behind them he gave us in what we now know as the theory of natural selection or descent with modification.

An enormous amount of work yet remains to be done. He gave us the key to what before were but hieroglyphics. We are now all engaged in doing our best to translate. Alas, many essay the task before they have learnt the language, and many work badly, the best of us but slowly, still knowledge is gradually growing.

We are hunting now amongst the records of the past to find pedigrees for the living and the dead. This we can only do by collecting evidence of every possible description. Much of it is derived from inorganic nature—floods and earthquakes, cold and heat, wind and rain. Thus we learn how forms no longer represented in the life of the globe, struggled and failed and

died in their endeavour to overcome these vicissitudes, so the dead point to the living to show by what means they have managed to survive. The living are the adaptable descendants, who have succeeded in shaking off certain of those family traditions and family idiosyncrasies which stood in the way of advancement, or even of continued existence. Advancement followed as a result of ability to obey. Thus we get the evolution of a species.

It must be mentioned here, however, that it becomes a very difficult matter to say exactly what is a species. It is obvious that if a species is the outcome of a gradual change from one form to another, from a short to a long-billed bird for instance, then if we had every member in the series alive before us, it would be impossible to say where the short-bill species ceased and the long-billed began. Yet the lowest and the highest members in the series would be easily distinguished. The "species" living at the present day are isolated links in such a chain of individuals, recognisable as distinct because they *are* isolated. Similarly we know that if we had many of the extinct forms for comparison, the differences between the principal larger existing groups would fade away; and we should have a difficulty in saying, for instance, where the lion begins and the ox ends. For strange as it may seem to many, we have enough evidence to prove that the carnivora and the herbivora are traceable to one common ancestor.

With the birds, if we could go far enough back, and if we had all the links in the chain,

we should have a difficulty in distinguishing between the reptile and the bird.

Furthermore, we shall see that evolution is not always *progressive*, on the contrary it is sometimes retrogressive. We shall also learn something of what we may call the law of correlated variation.

Concerning this Mr Darwin writes, "In man, as in the lower animals, many structures are so intimately related, that when one part varies, so does another, without our being able, in most cases, to assign any reason. We cannot say whether the one part governs the other, or whether both are governed by some earlier developed part." Thus, pigeons with feathered legs have the outer toes webbed.

Let us turn now to the question of the birds' pedigree, and, so far as is possible, trace out their relationships one to another.

The oldest bird of which we have any record is that known as the *Archæopteryx*, meaning the ancient-winged one. It is sometimes called the lizard-tailed bird. The figure (p. 207) is a restoration made by the writer, and is based on a study of the fossil in the Berlin and London Museums.

All that we know of this bird is gathered from the remains of two fossils found in the Solenhofen Lithographic Stone of Eichstadt in Bavaria. The first of these was discovered in 1861, and is now in the British Museum. The other was found in 1877, and it rests in the Berlin Natural History Museum.

In the London specimen the hind-limb and tail only are really well preserved; whilst, in the

Berlin specimen, the head, pectoral girdle, and the wings, are beautifully preserved; so also is the tail.

This tail, as is well seen in the figure, is the most remarkable feature of the whole bird. It is like that of no other bird known. But it exactly resembles the tail of a reptile. It is of great length, and composed of a number of separate vertebrae, each of which supports a pair of long tail-feathers.

This method of disposal of the tail-feathers is found in no other known bird, fossil or living. The accompanying figures show the nature of the two different forms of arrangement. Fig. A shows the tail of *Archæopteryx*; fig. C, that of modern birds. In *Archæopteryx* the feathers are distributed along the vertebrae like the arrangement of flowers along a stem, to form what is known as a spike. In other birds they are clustered around a common centre, as in a composite flower. The tail has been telescoped, as it were, so as to cause the bases of the feathers to cluster together, or to radiate from a common centre.

The possession of teeth in the jaws is another reptilian character, but, as we shall see, birds retained these long after they had changed the form of the tail. Finally, the teeth disappeared.

The wing of *archæopteryx* differed from that of all other birds in that the third digit was armed with a claw, as also were the thumb (or first digit) and the first finger (or second digit). Claws on the thumb and index finger occur frequently in birds of to-day.

The pelvis or hip-girdle was distinctly reptilian in type, as also were the ribs of the neck vertebrae, and those along the abdomen.

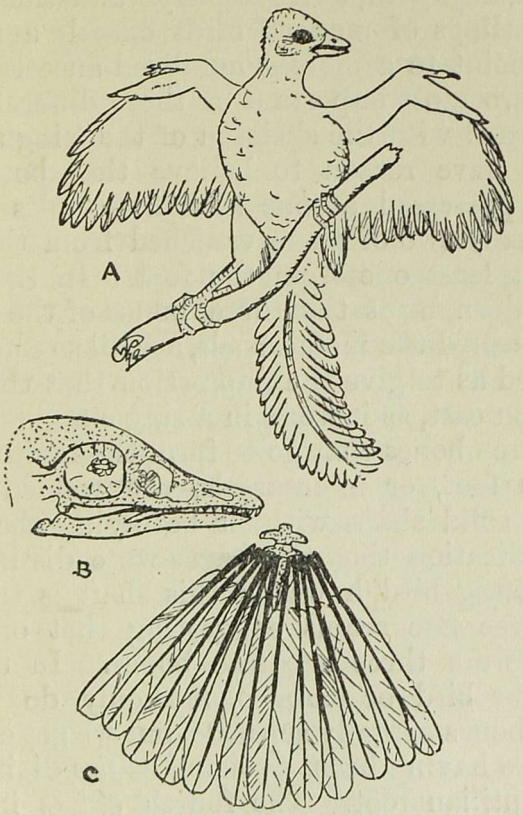

Fig. 4.

A.—A restoration of the extinct bird, archæopteryx.
B.—The head of archæopteryx.
C.—The tail-feathers ranged about the skeleton as in modern birds. Contrast this with the arrangement which obtains in archæopteryx.

In every other part of the skeleton it was dis-

tinctly bird-like in type. Nevertheless many of these bird-like characters undoubtedly bespeak a reptilian origin.

In many points *Archæopteryx* and the embryo or nestlings of modern birds exactly agree, and both point to a more generalized ancestral type. The two most important of these differences are concerned with the skeleton of the wing and leg.

We have reason to believe that both these limbs possessed at one time five digits a-piece. Gradually two of them vanished from the wing, and at least one from the foot. In the adults of modern birds the three bones of the middle-hand, called the metacarpals, are all so completely blended as to give the impression that they have all been cast, as it were, in a single mould, whilst the three bones that go to form the middle bones of the foot, or metatarsals, are welded into a single solid shaft, without betraying the slightest indication that they ever were distinct. In the young bird, however, this shaft is traversed by three fine seams suggesting that originally there were three separate bones. In the still younger bird or embryo, not only do we find these bones actually separate, but we get evidence of there having been as many as *five* digits, as in the reptilian foot. The fourth exists in many living and fossil birds as the hallux or hind-toes. No bird, living or extinct, is known in which the fifth toe is present. The fifth toe of the Dorking fowl is simply a double hallux or hind-toe.

In the wing, as in the foot, in the young bird the three metacarpals, so completely welded in the adult, are distinctly traceable as separate

bones. In the embryo they are undoubtedly separate.

In the wing of *archæopteryx* fusion or welding of these bones was probably never *completely* effected, a trace of the separate elements always remained. We say probably, because there is nothing to show conclusively that the two fossils of *archæopteryx* were really those of perfectly adult birds.

It is extremely significant that the form of the wing and leg of a bird so ancient as archæopteryx should so closely resemble those of modern birds. The wing-bones differ only in the great size of the claw of the third digit, for a minute claw has been found in the wing of the young ostrich. The leg is apparently in no way peculiar. Hence we must wait for the discovery of a yet more ancient bird before we can find out *exactly* from what form of a hand and foot the present has been evolved.

The possession of feathers so perfect in their development is also wonderful. It shows us that ancient as is this fossil, we must go yet further back in time for a hint as to the beginning of these feathers. The wing-feathers in their number and development are as complete as in many living birds, while their form and size would indicate that the power of flight was limited.

The possession of a permanent claw on the third digit has been a great stumbling-block to many who have studied the fossil. It was taken for granted that its presence was a proof that the whole hand was used in climbing among the

trees or in crawling about over the ground. That, in short, progression was quadrupedal and not bipedal. That the wing as an organ of flight was useless: it served as a parachute and nothing more.

As a matter of fact, this claw was probably functional during the nestling period in the life of the bird, enabling it to climb before its feathers grew long enough to serve the purposes of flight, and also during the process of moulting after the bird had reached maturity. At this time it is possible that all the feathers of the wing were cast off at the same time, and until the new ones were sufficiently strong, flight would be impossible. The ducks to-day moult in this way, and for a season swimming and walking are their only means of locomotion. The nestling *opisthocomus*, a strictly arboreal bird—as was *archæopteryx*—uses its wing for climbing purposes, and is aided in this by claws, which however are absorbed as soon as the wing is capable of sustaining the bird by flight.

The disappearance of these claws is instructive. It is a link in the chain of evidence upon which the recapitulation theory is founded. In a general way, this means that an animal in the course of its development from the germ upwards repeats the main phases of the development of the race to which it belongs. Structures which no longer appear in the adult or young after birth put in an appearance for a longer or shorter time during embryonic growth. Thus oxen and sheep which have no cutting, or incisor, teeth in the upper jaw, have tiny ones which never cut the gum in

the embryo. Whale-bone whales have no teeth, except in the embryo where small ones are recognizable, yet small teeth appear in the embryo.

The size of these vestigial teeth bears some proportion to the time which has elapsed since they were useful. They grow less and less as the time since they were useful grows greater and greater, till they finally cease to record themselves any longer. It is as if these structures were originally endowed, so to speak, with a certain amount of material set aside for their support. So long as they were used this capital or endowment gained interest, as soon as they ceased to be used the interest stopped and the capital slowly vanished.

In the bird's wing we have a good illustration of this. The rails are birds of feeble flight and small wings, which in some have become so small as to be rendered useless; in the apteryx they are so tiny as to require a careful search to find them; in the old fossil *Hesperornis* only the upper arm-bone was left, and in the moas even this disappeared. The first in time to become flightless were the moas, the last some species of rails. In the flightless species the wing is developed in every young one that is born; but in every young one it is probably a shade smaller than in its parents, and so it will go on dwindling in each generation, at last appearing only in the embryo, and finally disappearing even in these.

The claw on the third finger of *Archæopteryx* was very probably only used by the nestling, and perhaps also by the adult during the moulting period. Soon the adult learnt to moult his quills

in pairs, as is done by most birds to-day. The usefulness of this claw would at once begin to decline, and its size would begin to decrease. Then it would tend to disappear as soon as the nestling period was over. Then even the nestling would manage to dispense with it—as do most modern birds—and it would appear for a time as a tiny vestige; at last it would crop up only in the embryo, and here in time it would vanish too. We can trace all these gradations in the development of modern birds. It is a long time since the nestling game-birds climbed about in trees, so that the claw has nearly ceased to exist; it appears for a short time in the embryo. The peculiar order of the succession of the quill-feathers, however, is still retained as we have already shown on p. 206. Thus when we suspect that an animal has lost such and such an organ, still possessed by its fellows, we look for it in the nestling or the embryo, and generally with success.

The next most primitive type that we have is that to which the ostrich, rhea, cassowary, apteryx and emu belong. They are generally grouped together under one head as "ratites," because they have a raft-like breast-bone, but this arrangement is rather one for convenience' sake.

Concerning this breast-bone you will remember that we have already pointed out its chief distinctions (p. 72). We need only say here that in the ratite and the stringops-parrot there is no "keel" running down the middle of the breast-bone as there is in all other birds. The breast-bone of the fowl or pigeon looks rather like the wide and shallow hull of a ship with a huge keel;

that of the ratite, from the absence of the keel, looks like a raft.

A much more important character for the purpose of tracing relationships is the method of arrangement of the bones of the palate.

The long since extinct *Æpyornis*, and the moa, measured by this test are seen to be related one to another, and to the living emu of to-day. Moreover these and the tinamous can on this account be separated from all other living birds.

The number of the toes varies. In the *Æpyornis*, the moa and the apteryx, there are four—a hind-toe and three front ones. In the cassowary, emu, and rhea, there are only three, the hind-toe being absent. In the ostrich there are only two, representing the third and fourth. In the young ostrich the second metatarsal bone, for the support of the second but missing toe, is present; but all trace of its distinctness is lost later, and it helps to form the common shaft of the leg. The toe is never developed. There are other anatomical points which show that these birds are related, but they need not be dealt with here.

The tinamou, a South American game-bird, is apparently somewhat closely related to the rhea of the same region. The arrangement of the bones of the palate is precisely similar. The hip-girdle is also of the same type. The down which clothes the nestling is however quite different, differing indeed from that of any other bird.

Here we come to another break. It is impossible to do more than guess at the next nearest allies of the "ratitæ." The game-birds

certainly come very near. Such are the jungle-fowls, pheasants and partridges, grouse, quails, francolins and curassows, for instance.

It is interesting to note here that it is the red jungle-fowl from which all our breeds of domestic poultry are descended, though some of these varieties would scarcely be recognised as such, the Polish, Cochin-chinas, and rumpless fowls being extremely modified types. One of the japanese fowls has the tail feathers developed to an enormous extent, in some individuals to as much as fifteen feet.

More or less close allies of the game-birds—strange as it may seem—are the ducks, geese and swans. The apparent incongruity of such an alliance is however much lessened when we come to study what may be regarded as the ancestral form from which the rest have sprung.

This is a South American bird known as the screamer (*Palamedea*) which in size, about equals a turkey.

In many respects this bird may be regarded as a connecting link between the game-birds, and the duck and goose tribe of which it is undoubtedly a member. Its skull is very like that of a game-bird. The feet, unlike all the other members of the goose-tribe, are not webbed, though in spite of this the bird is a powerful swimmer. Its wings are armed with powerful spurs and in this it differs from the game-birds, and the remainder of its own and closer allies. Some of the habits of *Chauna*, another member of the same family as the *Palamedea* or horned screamer, have already been described (page 93).

Another ancient form allied to the geese is *gastornis*, an extinct goose-like bird larger than an ostrich.

Next under consideration must come a series of forms, all of which are probably more or less nearly allied. They may be divided into about four great groups as follows :—

(1) The gannets, cormorants, darters, frigate-birds, pelicans and boatswain birds, (2) the storks and herons, ibises and flamingoes, (3) the hawks, eagles and vultures, and (4) the cranes, rails, plovers, gulls, auks, pigeons and sand-grouse.

The birds-of-prey seem to claim affinity with the crane-tribe on the one hand, and the stork-tribe on the other. If they had a leaning more one way than another perhaps it is towards the storks. Amongst other things, like the storks, they nest in trees rather than on the ground, and their young are for a long time helpless. Some doubt whether the vultures of America should really be included amongst the birds-of-prey at all, holding that they are really much more closely allied to the storks.

The most aberrant bird of prey, after American vultures, is the secretary bird of Africa, which, amongst other things, has acquired legs of great length. The Osprey was once supposed to resemble owls in some respects, and on this account was regarded as an aberrant type connecting owls and hawks, but it is now certain that it has no affinity whatsoever to these.

The typical cranes scarcely need description. Yet, many constantly confound the common heron of our river-sides and marshes with the crane.

An excusable mistake, it must be admitted, for there is a superficial resemblance.

The crane group contains many curious and puzzling forms, such as the trumpeter, the seriema, and the sun-bittern of Central and South America. The seriema, in many respects, resembles the birds-of-prey.

Of the rails many have become flightless, such are *Ocydromus*, the wood-hen rail of New Zealand; the *Cabalus* of the Chatham Islands, and *Porzanula* of Laysan.

The little water-hen, so common in the London parks, is a rail. One of the giant members of this group is the notornis of New Zealand, which was first described, from some fossil bones. Later a living bird was seen and killed, when the species was found to be flightless. Only a few months since a third specimen was shot.

The plovers contain many curious forms, some of them, such as the jacana, being hard to distinguish at first sight from rails. The dotterel, sandpipers, curlew, snipe and woodcock, belong here. The lapwing of our marshes and meadowlands must be familiar to most. Every spring large quantities of its eggs are bought by greedy and thoughtless people as an addition to a number of other luxuries to be had only at the expense of those helpless ones claiming protection from us.

Near the cranes and plovers stand the bustards. Of these the largest is the great bustard, at one time numbered amongst British native birds, but now, alas! extinct in these Islands.

There can be no doubt but that the gulls and

terns are very close allies of the plovers. They are younger scions of the same stock. The difference in the colouration of the plumage of the young and adult plover is slight, or non-existent. The difference between the nestling gull and the adult is very marked. Like the more ancient plovers, the young gulls are clothed in a brown livery; in some, as in the common black-headed gull, so frequently seen even near London Bridge, this gives place to the familiar pure white and pearl-grey after the first moult; in others, as the great black-backed gull, it takes three years to gain the adult dress. In the little black-headed gull, both male and female, don each spring a sooty black hood, which is lost directly the breeding-season has passed; but the black-backed gull has no seasonal change of plumage.

The auks, razor-bills, and puffins of our coasts have been most persistently thrust in amongst the grebes and divers, and labelled as their cousins. This was done merely on the strength of a superficial resemblance, which doubtless exists; but those whose business it is to do the work of the heralds' college, and search the records of the past, are now in a position to demonstrate the falsity of such a view, and careful dissection of these birds has proved beyond cavil that they stand very near indeed to the plovers.

It is not so easy to say which are really the nearest relatives of the pigeons and sand-grouse. Some place them near the game-birds, and some regard them as the latest descendants of the plover-tribe. Their pedigree has yet to be

made out. The young of the sand-grouse are like little animated balls of fluff; those of the pigeon are hatched blind and naked, and are at most covered only with a few straggling hair-like filaments, but this is a point of some significance, and shows the pigeon to be the more recently developed of the two.

The tracing of these pedigrees has brought us out amongst forms of comparatively recent development—as pedigree times go. We have now to turn back again into the misty past, and start afresh with forms undoubtedly ancient, but whose records for the time are hidden.

The most aberrant, or outlying group amongst these, is undoubtedly that of the penguins. The most remarkable feature of these birds—and it is remarkable—is the wing. This you will remember we discussed on p. 82. The penguins play the part of the divers of the southern hemisphere—strangely enough, they are confined to this region never having passed the equator.

Very near the penguins stand the petrels and the divers, which probably originated from some stork-like ancestor, since they possess many characters in common apparently only traceable to such a source.

The petrels, or at least many of them, are claimed to be amongst British birds. Such are the Mother Carey's chicken, Leach's petrel, and the Manx shear-water which breeds upon lonely St Kilda, and elsewhere along our shores. The albatross has been found in Britain, too, but only in a fossil state. The petrels contain one strange diving-form, called the diving-petrel; in which

much of the skeleton has been completely but gradually changed in correspondence with the changing habits of the bird. Some of the petrels secrete great quantities of fat, so much so, that the natives of the lonely spots where they breed thread a wick through their dead bodies and burn them like lamps.

The divers are the expert fishermen of our seas and lochs, as the grebes are of our lakes and broads. Like the diving-petrel, and the auks and guillemots, this group has undergone a great change in the form of the skeleton. The legs have shifted far backwards, and developed special process to give power to the stroke in swimming. The divers have become so highly specialised in this direction that they can no longer walk upon land, but simply push themselves along on their breasts by means of their feet. This similarity in the skeleton of these really very different forms at first led many astray, since they mistook what is really but the result of similar habits and environment for a record of characters acquired by descent from a common ancestor.

Again we must hasten back to more ancient forms: this time to the vicinity of the game-birds and the crane-tribe.

These two groups are considered by many of the best authorities to be somewhat nearly related.

Now the bird of which we are going to speak has long been a puzzle to ornithologists, and continues to be so to this day. It is known as the hoatzin or opisthocomus, and is a native of the Amazon Valley.

By some it is regarded as a very aberrant game-bird; by others as more nearly allied to the rail-tribe. Others incline to consider it very near the game-birds, though sufficiently distinct to be regarded as representing a group in itself.

It has yet affinities in another direction, and these, if followed up, will lead us to the most highly-developed members of all the birds—the perching-birds or passeres.

Granting, then, its undoubted claims to kinship, not only with the game-birds, but more remotely to the rail-tribe, let us follow up the new trail.

The first new group which we come to in this direction are outlying members of a series of forms which stand more or less closely related one to another, and distinct from all the rest of the birds. They are the plantain-eaters or touracous of Africa. Opisthocomus serves as the connecting link between them and their congeners and the game-birds.

From the touracous we pass to the cuckoos; from thence to the hornbills and hoopoes; and then on to a group including such forms as the rollers, bee-eaters, mot-mots, and puff-birds. This brings us to the magnificent trogons, and the curious little African coly or mouse-bird.

Now we come to another group of varied forms all closely related. Such are the barbets and honey-guide, the toucans and the woodpeckers.

Before we take the last group of all, we will turn back to survey a few other groups passed in following up the foregoing.

These are the parrots, the owls, night-jars, swifts and humming-birds, and the kingfishers.

All these, it is commonly admitted, are more or less closely related, although they have never before been quite so intimately associated. I have arranged them in this sequence with a purpose. All agree in one particular, which, though an apparently trifling one, is yet probably important — all are gap-winged forms. You will remember that, on p. 67, we pointed out that a gap-winged bird was one in which the fifth pair of great or, as we might say, greatest coverts of the forearm differs from all the other coverts of that series in that they embrace no quill-feather, which all the others do.

We said *all* agree. This is not *quite* true, because humming-birds, some of the kingfishers and swifts curiously enough do not seem to be gap-winged. Recent researches on this subject, however, have shown that in some birds—the pigeons—this pair of covert feathers gradually dwindle in size till they come to look like the coverts of the row next above, and thus till lately not only have escaped notice but have made the wing appear to be non-gap-winged. Now, when we come to study the wings of these exceptional kingfishers and swifts, we shall find they will tell the same story. They will only *appear* to have no gap, or they may even in some cases have quite lost it. But this will not matter; they belong all the same to the gap-winged type.

Having got this little coterie of gap-winged forms cut off from the main body of this large

group, the difficulty is to throw back far enough to find the branch from which they sprang.

We now come to the last group of all, namely, the passeres, as they are called. To this belong our song-birds and the majority of our cage-birds; the swallows and martins, flycatchers, tit-mice and nut-hatches, and so on. The proud position of the head of the house is accorded to the crows, by consent of the majority of naturalists. Some would replace them by the thrushes, others by the larks.

Into the respective merits of the various claimants we need not go here. They will be found discussed elsewhere.

Outlying members of this passerine group are the lyre-birds and scrub-birds of Australia, and the broad-bills of the Indo-Malayan countries. The points which exclude these from the confines of the main group are concerned with the voice muscles and on this account are of too technical a character to be discussed here.

The grouping together of the different kinds of birds according to what we believe to be their natural relationships constitutes what we call the classification of birds.

We might summarise this chapter as follows. Birds may be divided into two main divisions:—

1. Lizard-tailed, including, at present, archæopteryx only.
2. Bird-tailed, including the remainder of the class. This last must be again subdivided into many smaller groups, though how to separate them without violence is not easy.

Taking the ostrich-tribe as our starting-point, and as the most ancient forms of the second division we pass on by means of the tinamous, which serve as a connecting link, to the game-birds.

From the game-birds we pass to the ducks and geese and their kindred, through the curious aberrant forms *Palamedea* and *Chauna*—p. 214.

The stork-tribe follow next, including the gannet and cormorant-like birds. We pass from these to the hawk-tribe, and thence to the crane-tribe, with the rails, plovers and pigeons.

In the neighbourhood of the stork-tribe come the penguins, the petrels and the divers.

Turning to the vicinity of the game-birds again, we come to the opisthocomus, and pass from this ultimately to the highest groups of all. On the way we encounter the touracous and cuckoos, hornbills and hoopoes, rollers, and so on through trogons, rollers, and many more, to the woodpeckers, and from thence to the passeres, the highest group of all.

The gap-winged parrots, owls, night-jars and swifts, and the kingfishers, are more closely related one to another, than to the non-gap-winged forms already referred to.

On account of the remarkable gap-winged condition of these birds it is probable that they must be regarded as branching off low down the avian tree from the galline stock, possibly from an ally of the megapodes (p. 146), just as the kindred forms do from that other aberrant game-bird, the opisthocomus. They bear no such direct

relationship to the passeres, as say the hornbills and hoopoes, or the rollers or woodpeckers.

One word more, these various groups do not permit of arrangement in linear series. They are *not* related one to another like so many steps in a ladder. As we have shown in chapter X. in speaking of the old fossils *ichthyornis* and *hesperornis*, the evolution of two quite different forms may be going on at one and the same time. Rather, the scheme of evolution should be regarded as tree-like. The existing species may be regarded as the leaves thereof—the fossils being the branches from which they have derived existence. Our endeavour is to trace these leaves back to the newly formed twig, and this back to the branch, the branch to the main stem, and this to the root. Finally, we have to analyse the soil in which the tree is rooted.

CHAPTER XII.

PEDIGREES—THE FOUNDERS OF THE HOUSE.

If a bird could tell us of its ancestry and of its ancient lineage, of the stock which gave birth to its distinguished house, it would have to lay aside all "pride, vain-glory, and hypocrisy," and put on the garment of humility. For, however distinguished now, its origin was lowly.

The birds are a branch of that more humble house of interesting, but ugly, people—ugly, at least, by comparison—yclept reptiles.

Two claimants have been pushed forward as

representing the stock from which the birds arose.

The first of these is that remarkable group of extinct flying reptilia known as the *pterodactyles*, the wing-fingered lizards, and there is certainly much to be said, at first sight, for the probability of an alliance with these. The structure of the skull favours this view most. The power of flight and the fact that the bones were pneumatic have also been urged as valid reasons for this relationship.

We may take the wing, I think, as the crucial test, and upon the likeness of this to that of the bird the whole claim must rest. To bring out the full significance of this we will enlarge upon our remarks in chapter IV., and endeavour to show, by comparison, how the wings of the pterodactyle, the bat, and the bird, are all modifications of one common type — a five-fingered hand.

In the wings of all these it is the fingers, or more exactly the hand, which have undergone the greatest changes in this transformation into the wing.

In the pterodactyle all five fingers are retained. The first four, however, are greatly reduced in size. Three of them are provided with small claws, and probably served to suspend their possessor to some rock or tree during rest, just as the bat to-day hooks himself up by the tiny toes of his hind-feet. The fifth, or little, finger was enormously developed, and served as a support to a membrane formed by a drawing out, so to speak, of the skin of the body.

Exactly how this was done, and what this wing was like, can be seen by a reference to our picture (fig. 5).

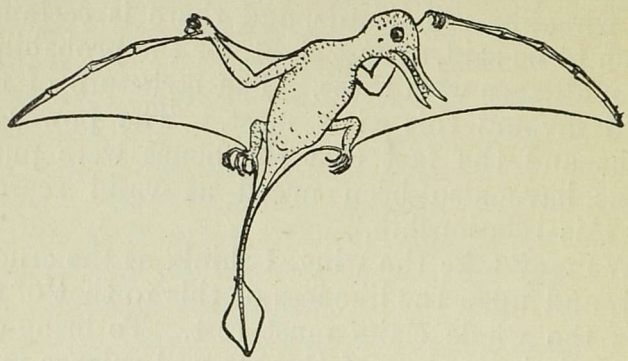

FIG. 5.
A restoration of an extinct flying lizard or pterodactyle. By the author.

The bat's wing differs from the pterodactyle's in that all five fingers are well developed. The thumb in some species is very long and armed with a powerful claw. The four fingers are exceedingly long and slender, and support a thin membrane much after the fashion of the ribs of an umbrella.

Now compare these two with the wing of the bird. Let us begin with the skeleton. At the first glance this will appear to have but one very short finger—representing the thumb—and one very long one, representing the index or first finger. If we look at this closely in a very young bird, we shall find that this long finger really consists of two fingers closely joined together, representing the second and third digits

of our hand. This third digit is in modern birds very short, but in archæopteryx it was long and armed with a strong claw. Now, these two

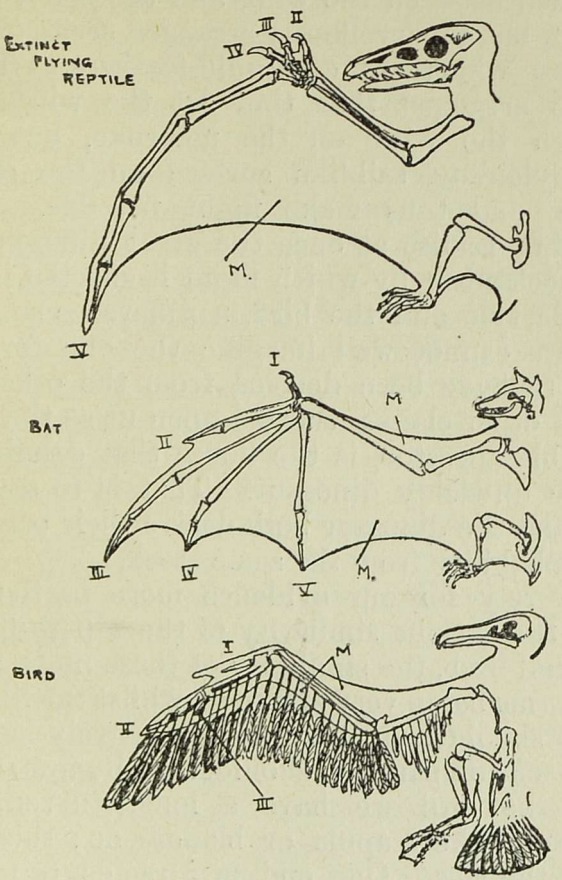

FIG. 6.

Outline figures showing the two different types of wing-membranes (*m.*) and their supports, contrasted with the feathers of a bird which take the place of membranes. The membrane of the bird has shrunk to very slender proportions.

closely-applied fingers form a sort of rod or bar, continuous with the bones of the forearm. Along this is found not a large, thin membrane stretched between the wing and the body, as in the bat, but a marvellously arranged series of stiff feathers which we call quill-feathers. These are so arranged that they let the wind pass through the wing on the upstroke, but offer an unyielding, sail-like surface on the down-stroke, and thus make flight possible. You will thus realise at once the great difference in the mechanism by which flight is effected in the pterodactyle and the bird, a difference so great that we cannot well imagine the one form of wing to have been derived from the other.

The other claimant urged upon us as the most probable ancestor, is the house that culminated in the unwieldy dinosaur. That is to say, the bird and the dinosaur both derive their origin in all probability from the same stock.

We rely for our evidence more particularly upon the curious similarity of the hip-girdle and the hind-limb, the similarity of these limbs in the two forms being very striking: whilst the likeness of the shoulder-girdle of each is scarcely less so.

Let us compare the shoulder-girdle first.

In the bird we have a long, curved, rod-like bone, the scapula or blade-bone; this rests upon the ribs. One end is directed tailwards, and is free; the other, which is directed downwards and forwards, joins a second but often shorter bone, the coracoid, as it is called. To these is added the furcula or merry-thought; the free ends of this are fixed by ligaments or

bands, to the region where the scapula and coracoid join one another. The fixed ends of this merry-thought, the apex of the "horse-shoe" which the two fixed bones form, is joined by ligament to the deep keel of the breast-bone. (In flightless birds there is often no keel and no merry-thought, but this does not affect the question.)

These bones, then, the scapula, coracoid and furcula, make up the shoulder-girdle.

Now, here follows a point to be borne in mind for future guidance. In young birds all these bones are represented first in what is called cartilage. Later this is replaced by bone. Exactly how this is done does not concern us here. This transformation from cartilage to bone is not effected all at once. In the penguin, for instance, the shoulder-girdle becomes bony, or ossifies, long before the breast-bone or sternum. Now, if one of these birds died during this stage of its growth and became fossilised, we should have no record of the sternum left. It would decay with the fleshy parts, and only the shoulder-girdle bones would be left.

In the ancient dinosaur, we get a shoulder-girdle bearing many strong resemblances to that of the bird. As the dinosaur is not a flying reptile, we cannot expect it to do more than *roughly* resemble the birds. The dinosaur then has modified the original shoulder-girdle in one direction to suit its requirements, and so has changed its original form, just as the bird has changed its shoulder-girdle to suit yet other requirements. Neither then represents the original

girdle, but as the dinosaur has undergone less change or specialisation in this region than the bird, we may infer that the dinosaur's girdle more nearly approaches the original clay from which each was modelled, so to speak.

The scapula and coracoid certainly in their general form and arrangement resemble the bird's. But we get no merry-thought, and no sternum. The former may have been lost, as it is in some birds; the latter was probably never ossified, but resembled that of the young penguin in being cartilaginous and was, therefore, not preserved. In the penguin it ossifies late in life, in the dinosaur not at all. The large size and number of the ribs in the dinosaur make it certain that such a sternum once existed, for it is this structure to the sides of which the ribs are attached. The figures should make this clearer.

Turning now to the hip-girdle, we note equally important points of resemblance, but upon the details of these we will not enlarge here. The chief points of difference appear to be in the general outline of the largest and uppermost of the three bones of which this girdle is made up—and in the greater size of the small forwardly projecting spike of bone called the pectineal process. In the bird this is never very large; but as we said before, we must not expect too close a resemblance. Indeed a *very* close resemblance would rather prove too much.

In the form of the hind-limb again, we have one or two curious points of resemblance, that would seem to imply kinship rather than similarity of structure produced by a similar mode of

locomotion. Compare, for instance, the ankle-joint of a dinosaur with that of a young fowl, fig. 7, and then the bones of the foot in the same.

Note in the dinosaur the curious upright spike of bone marked "a.a." This is an upstanding process of a bone known as the astragalus. More bones were really originally present in this region of the foot, but they have all fused or combined together to form one—once on a time they were distinct. Capping the bundle of three bones immediately below is seen a plate-like structure which represents a second row of bones at one time quite distinct. The joint, or seat of movement between the foot and the leg, lay between these two rows of fused ankle-bones. Turn now to the bones of the young fowl's foot and leg and ankle-joint, and a precisely similar arrangement will be seen. The fowl, however, goes a step further. The three long bones of the foot, permanently distinct in the dinosaur, become completely merged together in the adult fowl to form but a single shaft. An ankle-joint such as that just described occurs in some other reptiles, and in *all* birds.

These are the principal points of resemblance between the two, but they are points of very great significance.

The fore-limb, someone will exclaim, is very different in this old reptile and the bird. Quite so. Like the shoulder-girdle, it has in the bird undergone considerable modification and transformation to fit it for the purposes of flight. The fore-limb of the dinosaur has required no

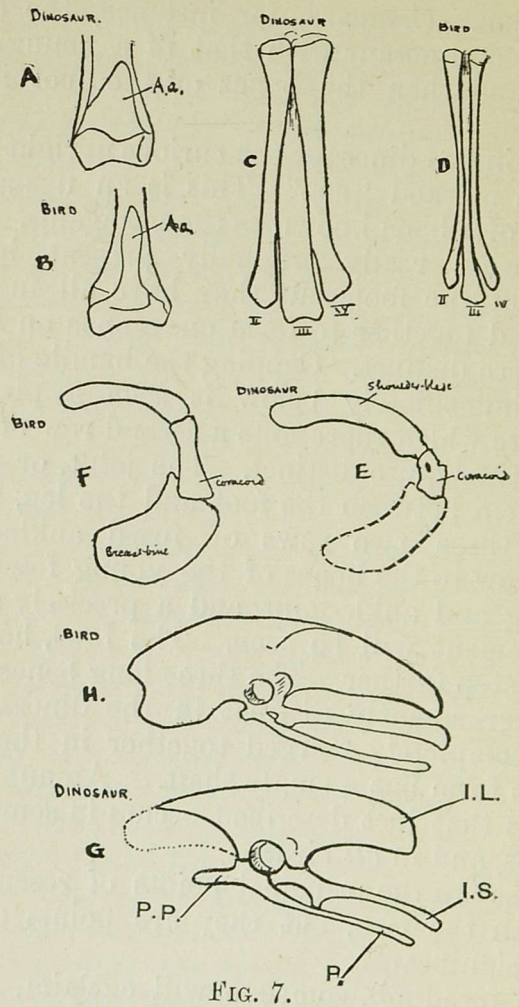

FIG. 7.

A.—The upper part of the ankle-joint of a dinosaur, and B of a bird to show their similarity.

C.—The metatarsal bones of a dinosaur, and D of a bird to show the close resemblance.

E.—The shoulder-girdle of a dinosaur and F of a bird; G the hip-girdle of a dinosaur, and H of a bird. Note the remarkably close similarity between these bones of the bird and of the dinosaur.

such alterations, and retains something like the original five-fingered form from which it started.

The bird then we have agreed is of reptilian origin, and of the reptiles resembles most nearly the dinosauria. Most nearly—this implies that it has also characters wherein it resembles other reptiles; and so it has. Of these we will now select a few examples.

Let us take the skull. In this, in many reptiles, we find true teeth. These are either implanted in the jaws in grooves or in sockets. In the earliest birds—*Archæopteryx*, *Hesperornis*, and *Ichthyornis*—we have also teeth in the jaws. This would suggest that the birds come from a reptilian stock possessing teeth. They were implanted in sockets in *Archæopteryx* and *Ichthyornis*, and grooves in *Hesperornis*. The pterodactyles had teeth, but some of the more specialised amongst them exchanged these for horn-encased jaws like those of our modern birds.

The skull, in all existing reptiles and birds, is joined to the vertebral column by a single rounded knob called a condyle. In the class next below the reptiles, to which the frogs and toads belong, and in the class next above the birds, the mammals, the skull joins on to, or articulates with, the vertebral column by two condyles, arranged pairwise instead of a single median one. But besides these we find in the skull numerous other points shared in common between the bird and reptile which are of too technical a nature to be dealt with here.

Birds and some reptiles, but no other animals,

have curious spine-like processes projecting backwards from the ribs called uncinate processes.

The vertebral column of young birds closely resembles that of reptiles; later in life it takes on the characters which are the special peculiarities of birds, and are found nowhere else.

We might enumerate other connecting links between the two groups; but enough has probably been detailed to serve the purpose of this chapter, which was to show that birds and reptiles are closely akin, however much they may appear on the surface to differ.

In the previous chapter we followed the gradual unfolding and development of the various groups of birds, starting with archæopteryx, and discussed, as nearly as we could guess, the ancestral forms of each. In the present we have endeavoured to pierce the veil of thick darkness that enshrouds the birth of the earliest bird-like forms. A certain measure of success has attended this attempt, it must be admitted; but much yet remains to be done before we are in possession of sufficient evidence to speak with that certainty which will make converts of the most sceptical.

The most that we can say at present is that the "Founder of the House" was of a reptilian nature, and probably sprang from the same stock as that which ended in the gigantic dinosaurs long since extinct. Possibly from this same stock came the flying pterodactyle. In this way we could account for certain strong points of resemblance between the skull of this ancient lizard and that of the bird.

Our "Story" is now told. We hope that those who have followed it carefully will close this little book with a feeling of satisfaction.

In conclusion we would remark that it may seem to many that the bird's wing has come very prominently and frequently to the front in these pages. This is as it should be. It is the standard by which we can best measure the rate of progress or decay, which a species, or a race, as the case may be, has undergone. From the tip of its beak to the tip of its tail, a bird is essentially a flying animal. Whatever progress it has made in development, has been in the first instance to this end. Whatever evidence of decay any given form may bear witness to, is traceable to the loss of flight, the greatest of its possessions: and the date of its fall is approximately to be gauged by the amount of degeneration which the wing has undergone. It is the pulse of its life-history.

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