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HOW SOME SPIDERS ESCAPE THEIR ENEMIES AND CATCH THEIR PREY

In the upper illustration a large centipede is shown invading the branched nest of a trap-door spider. The centipede has discovered the second door of the nest, but the spider has taken refuge in the upper branch of the inner tube and is pulling back the door in such a way that her retreat will be hidden. The spider in the other large nest, on the left, has taken alarm and is clinging to the lid of her tube, by the little holes made in it, to prevent it being opened. At the top of the picture a spider is seen pouncing upon an insect; another keeps watch under the half-opened door of her nest. Close to the centipede's "tail" are represented the tiny lids of two nests made by "baby" spiders.

The lower illustration represents a tarantula pouncing upon a cricket from the turret which surrounds the opening of her nest.

THE WONDERS
OF
ANIMAL INGENUITY

BY
H. COUPIN, D.Sc.
AND
JOHN LEA, M.A.
AUTHOR OF "THE ROMANCE OF BIRD LIFE," &c.

WITH NINE ILLUSTRATIONS

UNIV. OF
CALIFORNIA

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INTRODUCTION

IN the pleasant days when we have not long begun to look on a wonderful world peopled with beings great and small all living their busy lives after their own fashion, most of us are in some respects nearer to understanding the ways of the myriad creatures which share the earth with us than we have ever the good fortune to be in later years. Before a sparrow becomes for us "only" a sparrow, or we have been taught to associate the word "horrid" with a score of interesting and often beautiful little animals which we meet day by day, the things that happen in animal-land are not passed over with unseeing eyes; the earth is filled with romance, and we live in a true fairyland. From a few fortunate ones the spell is never lifted; for them its fascination grows stronger with time, and the story becomes constantly more engrossing, for it is one whose secret, though ever unfolding, can never be wholly revealed.

At first, more especially, it is our constant joy to recognize everywhere in the animal world resemblances to man, and each of us reads the doings of its inhabitants according to his own fancy. So long as we try to see truly what is taking place, we may permit ourselves to be reminded of similarities between the doings of animals and our own; but we must be careful not to attribute human motives and reason where they have no existence. That some animals can reason in what seems a very human way is beyond doubt, but the very cleverest of them has not advanced as far as the first savage who sharpened a stick to dig with or to use as a weapon. On the other hand, animals are born with the skill to do the things which are necessary for their existence, while man is born with little more than a greater or less capacity for learning. If we would spin or weave, we must learn to do

INTRODUCTION

these things by long apprenticeship, but the first web made by a baby spider may be as perfect as any it will spin in the whole of its life. This unconscious memory of how to do things and how to act under various conditions, passed on from one generation to another, is what we mean by "instinct," and instinct is a wonderful thing. There are times when it is not to be distinguished in its effects from reason, as when it constantly adapts itself to new conditions: something of the kind we see in the way ants behave when building their chambers and galleries, turning every favourable circumstance to advantage and overcoming many unaccustomed difficulties which arise in the course of their work. At other times instinct appears utterly at fault, as in the case of a certain woodpecker whose habit it is to embed acorns singly in little holes which it cuts in the bark of a tree to receive them, but which often appears to expend its labour to no useful purpose by storing up smooth pebbles in the same manner. Yet even in their mistakes animals do but present one more resemblance to man, and perhaps if the gift of imagination were more common amongst them they would oftener go astray—and the likeness would be still greater.

Nearly all the constructive activities of animals are directed towards self-preservation, or procuring food or shelter for themselves or their offspring; their fancy seldom leads them further, but the methods by which they attain their ends are of a wonderful variety—a variety infinitely greater than it would be possible to describe in one small volume. The chapters in this little book have been chosen by the Publishers from the Author's larger volume entitled *The Romance of Animal Arts and Crafts*. Should such examples as they contain help to show how much that is interesting surrounds us wherever we go, if we only care to see it; should they aid even in a small degree towards a greater love of animals and a desire to observe and understand their ways, they may, perhaps, add a little to the romance wherein lies much of the happiness of life.

JOHN LEA.

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THE ROMANCE OF ANIMAL ARTS & CRAFTS

CHAPTER I

THE MASTER CRAFTSMEN

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AMONGST works so various as those we find in the wide range of nature it is not easy to award the palm; some animals excel in one industry, some in another, and we cannot say with certainty to which class the pride of place belongs. There is, however, one chapter in the tale of animal arts and crafts which is so wonderful that anybody who does not realize the almost unlimited possibilities of nature might well think it the result of an unusually lively imagination and regard it as pure romance. Yet this strange story is true in every detail, and some of

A PERSECUTED RACE

the facts related in it are familiar everyday knowledge to thousands of people, while all of them are well authenticated. It is the story of the trap-door spiders, which are not only the cleverest representatives of a talented race, but occupy an important position in the very front rank of Nature's engineers, architects, inventors, and craftsmen.

Spiders of all sorts have many enemies which possess enormous advantages over them in respect of either strength or agility, or both combined : enemies with wings, swift in movement and able to retreat where their opponent cannot follow them ; enemies with stings deadly as the terrible urari-poisoned arrow, watchful, merciless, quick to attack ; enemies clad in an impenetrable coat of mail, against which the spider's weapons are powerless, whilst the spider's own body is soft and vulnerable. But the spiders are themselves hunters and trappers, expert as any, and the exigencies of their existence make it necessary for them to capture prey which has many physical advantages on its side.

These difficulties and dangers have been met by a multitude of clever contrivances, and if invention and skill are to be regarded as some sort of index of intellectual development, it is a little startling to realize how far the spiders are in advance of our near relations, the man-like apes.

The family of spiders is, we have good reason to believe, a very ancient one ; it is spread far and wide over the earth, and it is not surprising to find that, with some fundamental characters in common, various branches of the family have developed special activities, and that some excel in one direction and some in another. What is truly astonishing is the skill they exhibit in solving difficult problems, and the highly complex character of their undertakings.

Amongst them all, none are more intensely interesting than the trap-door spiders, which belong to the tribe known

OUR NATIVE REPRESENTATIVE

as *Territelariæ*, or “underground weavers.” In England we have no trap-door-making spiders, but the tribe is represented by one species which works in the same way as its more talented relatives up to a certain point, though it has not hit upon the idea of fitting a door to its dwelling. This spider, called *Atypus Sulzeri*, was, I believe, first found in the neighbourhood of London and Exeter. You are not likely to meet with it very often, but perhaps it is commoner than it is generally supposed to be, for its house is not as a rule a conspicuous object in the landscape, and the number of people who go out of their way to make friends of spiders is not large; on the contrary, most people go out of their way to avoid them, and thereby are the losers—at least, that must be the opinion of everybody who has the privilege of being even moderately well acquainted with these delightful and learned creatures.

Atypus Sulzeri is an unobtrusive little spider that usually makes its home in banks where the earth is moist, digging a subterranean gallery which starts almost horizontally, but curves downwards a little towards the inner end. In this tunnel it spins a compact tube of whitish silk, about half an inch in diameter, which completely lines the cavity. The tube does not stop short at the mouth of the burrow, but is continued for several inches over the surface of the ground. It is sometimes described as being closed at both ends, and sometimes as having the external end left open. I have only once, and that many years ago, come upon a nest of this spider, which I found in a damp hedge-bank in Hampshire, not very far from Selborne.¹ There was a rent or slit in the top of the tube near the free end, but as the spider was “not at home” it would be unsafe to draw any conclusions from that one single instance. Perhaps the owner had

¹ J. L.

AN AWKWARD DOORWAY

for some reason decided to have a new dwelling and, not having a doorway, had been obliged to make a hole in the wall in order to walk out of the old one; at all events the hole was there. *Atypus* is said to feed on insects that alight on the outside of the tube, approaching cautiously, and invisible all the while, along the inside until directly underneath the intended victim, which is then seized through the wall: a hole is torn in the web, the prey is dragged inside, and the rent repaired by the spider, who retires underground to devour her captive at leisure. It has also been stated that this spider eats earth-worms, which are introduced into the den through the inner portion of the tube; but any one who has observed the swiftness with which a worm retreats into its burrow when alarmed, or the very effective resistance it offers to forcible removal, will have difficulty in believing that a weak-limbed spider could ever succeed in getting the better of one in a tug-of-war.

Our British Territelarian, then, excavates a dwelling and covers the walls with silken tapestry, which is continued through the doorway into the open air in the form of a long, narrow bag. Every time the inhabitant wishes to walk abroad, or has occasion to take in supplies, she is obliged to cut a hole in the bag and repair it again afterwards—an arrangement which does not strike one as being very convenient, though it is certainly effective from one point of view, for it makes it quite impossible for undesirable visitors, such as wasps and ichneumon-flies, to gain admission to the habitation. The true trap-door spiders attain the same end in a far more ingenious manner, as we shall see. They inhabit warm countries all round the globe, and are especially plentiful in Jamaica. In Europe they are found on the shores of the Mediterranean, where they were studied by their famous biographer, Mr. Moggridge, who devoted the leisure

THE CHOICE OF A HOME

of an invalid life to observing their ways and recording their doings, and then wrote a beautiful book about them.

Like our *Atypus*, the true trap-door spiders dig a deep hole in the ground and line it with silk to prevent the sides from falling in, but they add a neat little door to keep out the rain and other troublesome things. The burrow is usually placed in a sloping bank, or in an old, crumbling terrace wall, where there are mosses and lichens growing in patches, or creeping plants trailing over the ground. The door, built of layers of silk, strengthened and solidified with particles of soil, is round, and has a strong silken hinge at one side. When situated on sloping ground, the hinge is attached to the edge of the door at the highest point, so that the door has a tendency to "swing to" by its own weight after being opened, the closing being also assisted by the elastic nature of the hinge. Now you may suppose these round, silken doors dotted over the dark earth are almost as conspicuous as silver coins lying upon the ground, and make the discovery of the spiders' home a very easy matter. In that case you underestimate the genius of the little creature, which would never permit her to advertise her presence in such a reckless manner. Instead of doing so, she disguises or conceals the entrance to her home with admirable art by planting moss on the outside of the door—living moss taken from the immediate neighbourhood—so that the top of the nest harmonizes perfectly with its surroundings and is often exceedingly difficult to detect, its discovery being in many cases made more difficult by the fact that in her careful choice of a site for her dwelling the spider appears to be influenced by the presence of patches of white lichen which distract the eye. Some species adopt a different method, weaving into the structure, or fastening on with silk, dead leaves, bits of stick, grasses or

DANGEROUS COURTSHIP

roots. Of these, dead leaves are decidedly the most effective, for unless they be removed the door is absolutely invisible, however carefully you may search for it.

In speaking of the spider as "she" we are literally correct, for the male appears to take no part whatever in designing, constructing, or decorating the dwelling, and is seldom found inhabiting it even as the temporary guest of his mate. Amongst spiders in general it is rare indeed to find the sexes associating; it is not in the nature of the female to live in harmony with her mate, and should he be bold enough to make tender advances, the reception he meets with is often highly discouraging. Courtship is for him a proceeding fraught with danger; the female has to be approached with the utmost circumspection, and even when, after much careful wooing, she appears to be "in a holiday humour, and like enough to consent," he must still be alert and distrustful, for the "cruel fair" has been known to prefer, on sudden impulse, a headless mate, and at last to eat him! It is for this reason probably that male spiders are almost invariably of lighter build, swifter, smaller, and altogether more agile than the females, for in the development of the race the individuals who excelled in these respects would stand a better chance of surviving the courtship. But we must leave the arts and crafts of a spider's wooing, and return to those with which we are more properly concerned. The male, then, is seldom met with; he does not share the nest, but seems to live a vagrant life, camping out, so to speak, in holes and crannies; so we may dismiss him from our minds and turn our attention to the female. Let us watch her at work while she makes her wonderful nest. In the first place there is a shaft to be sunk in the ground, and if she be a well-grown spider (that is to say from three-quarters of an inch to an inch in length), begin-

HOW SPIDERS DIG

ning an entirely new nest, the tunnel she has to dig will be about an inch in diameter, and perhaps nine inches in depth. The excavation of such a tunnel is no small undertaking, for these spiders are not very swift in their movements, and the digging is done principally with the mandibles and their fangs, the legs taking no part in the proceeding. In other families of spiders the mandibles strike sideways, but in the *Territelariæ* they strike downwards, a modification which is probably connected with their digging habits. The earth is removed in tiny pellets and taken some distance away from the nest, every pellet being carried forward in the jaws and deposited separately on the tip. It is a slow process, but in an hour the spider succeeds in digging a hole about the size of half a walnut. As it becomes deeper the removal of the fragments becomes more laborious, but no other method appears to be adopted. Before the tunnel has attained any great length the spider, like a good engineer, very wisely shores up the walls with patches of silk to prevent them falling in upon her, and afterwards covers them entirely with several layers of the same material. She also makes the door before the excavation is finished, and a moment's consideration will show the advantage of this order of procedure. The labour is long and occupies a considerable time, and while so engaged the spider is especially open to attack. Mr. Bates stated that he had frequently seen certain species of the genus *Pepsis*, insects which are allied to wasps, on the Amazon, hawking over the ground where the huge trap-door spiders lived, and suddenly pouncing down upon one of these creatures, often many times larger than themselves; then, after paralyzing their victim with their sting, they would deliberately saw off the legs before dragging away the body. With such terrible enemies to harass her, it is not to be wondered at that the spider prefers to work

THE TAPESTRY FRAME

under cover; and as to the silk lining, it forms a foothold far firmer and safer than would be afforded by the loose soil while she is passing to and fro with her loads of earth.

At length the excavation is completed, and the finishing touches are then given to the lining. The first or outer layers are coarse and irregular, while their colour is brownish, possibly owing to their being stained by contact with the earth. The inner layers, on the contrary, are light in colour and of fine texture, closely woven, smooth and compact, resembling in appearance fine kid. The mouth of the tube is made very strong and tough, and is usually from an eighth to a quarter of an inch in thickness.

The lining is continuous with that of the door, of which it also forms the hinge—indeed the door may be regarded as simply a bit of the wall bent at right angles. When building it, the spider attaches it by ties at a number of points around the edge to the margin of the tube; it is thus woven on a frame, just as mediæval tapestry was wrought upon a frame, and the ties are severed afterwards, the spider biting through them until the edges of the door are free everywhere except at the hinge. One species inhabiting the Ionian Islands adds to the outside, above the hinge, a spur-like projection which is supposed to be a lever by means of which the spider can open her door conveniently when returning home from an expedition.

The doors are of two kinds, quite distinct from one another. Those made by spiders of the genus *Nemesia*, abundant in the Riviera, and by a West Indian species named *Cteniza nidulans*, are thin, light, and composed entirely of silk; these belong to what is known as the "wafer" type, and being larger than the mouth of the tube they lie on the ground over the aperture—or to be accurate, they rest upon the mouth of the tube, which spreads out at

STRENUOUS RESISTANCE

its edge into a wide flange. The other sort of door is thick and heavy, being built up of a number of layers of earth and silk. It is beautifully bevelled around the edge, and fits tightly into the mouth of the tube, which is similarly bevelled to receive it—just as a cork fits into the neck of a wide-mouthed bottle; hence this kind of nest is known as the “cork” type. We need not be surprised that the spider takes care to have a well-fitting door; it is an important matter, for there are certain minute hymenopterous insects which lay their eggs inside the eggs of spiders whenever they get a chance of doing so, and these intrusive little creatures must be kept out of the nest at all costs. All the same, the perfection of workmanship with which the cork doors are constructed is amazing; when closed, they are exactly flush with the surface of the ground; they fit so neatly that they are quite difficult to detect, and so tightly that they resist opening even when the spider is away; while they are so substantially constructed that collectors’ specimens have been opened and shut hundreds of times without being materially damaged. It is on the cork doors that we find the larger mosses growing, the wafer nests being usually disguised with fragments of dead vegetation.

When at home, some spiders resist any attempt at forcing an entrance into their dwellings with all their might. All the cork-nest spiders offer resistance, and though it is not very easy to observe exactly what is going on inside a nest, Mr. Moggridge, after many attempts, succeeded in doing so. He forcibly raised the lid of a cork nest a fraction of an inch—only just enough to enable him to peer inside through the cranny. He then observed the spider hanging on to the lid with its fangs and all its claws driven into the silk lining on the under surface, its head being turned away from the hinge, and its body jammed across the tube. The resistance

A LIVING BOLT

they can offer is very considerable. Mr. Moggridge says, "Many a time when I have wished to raise the lid to drop in flies or other food, I have been obliged to desist because the bending blade of my penknife showed that I should injure the nest if I used greater force." *Nemesia cæmentaria*, a native of Southern Europe, is very courageous and determined in this respect. On the left side of our picture (p. 30) you will see a representation of one of these spiders inside her nest, which is an excellent example of the "cork" type. She has taken alarm at the commotion going on outside her front door, and has taken up her post in readiness to guard her home. Around her are assembled her children, for like some other animals, though the spider is incapable of living in harmony with her mate and can scarcely bring herself to tolerate his society, she may be an excellent mother, and it is no uncommon circumstance to find in the nest of a trap-door spider a number of little ones—sometimes over forty, at others only two or three.

Around the margin of a cork lid, just inside the bevelled part, there is often a neat row of tiny holes which occur in pairs, and look as though they had been made with a needle. In the part next the hinge there are no holes, but they are found at intervals along the remainder of the circumference of the lid, just as they appear on the open lid of a nest near the left of our picture. These are the holes in which the spider has placed her claws and fangs when holding on to the door, and the arrangement enables her to obtain a very firm grip. A nest in the possession of Mr. Gosse had needle holes in the side of the tube as well as in the lid, and there seems to be little doubt that the spider sometimes takes hold of the door with some of her feet and clings tightly to the wall of the burrow with the others, thus resisting still more effectively any intrusion into her stronghold.

AN UNEXPECTED ENCOUNTER

Most of the trap-door spiders are nocturnal in their habits; they spend the day shut up closely indoors and go out hunting at night time, or lie in wait at the mouth of the nest, with the lid slightly raised, peering out of the chink in readiness to pounce upon their prey. The majority seem to close the door after them when leaving home, but the *Cteniza ariana* of the island of Tinos, in the Greek Archipelago, emerge about nine o'clock, and fasten their doors open by a few threads attached to any convenient grass stems or little stones. They then spread a long, low snare close to the ground, and return to their holes to await the capture of a beetle or some other night-wandering insect, which is promptly dragged to the den and eaten; the fragments of the feast are then carefully removed and deposited at a distance of several feet from the nest.

There are, however, a few trap-door spiders that venture abroad during the day. Such spiders are found, for instance, in both California and New South Wales, and they leave their doors open while they are away. Others come out at dusk, and it was one of these which first gave me an opportunity of becoming personally acquainted with a trap-door spider—an event which, when unexpected, is apt to give rise to a momentary feeling of surprise and bewilderment.¹ It was towards the close of a warm day in Morocco, and I was resting awhile by the side of a small orange grove on a low bank topped with aloes, enjoying the indescribable fragrance of the orange blossom, but conscious all the same of the necessity for keeping a pretty sharp look-out for ants and other creatures calculated to interfere with one's appreciation of the tranquillity of the scene. Close beside me was something that looked like a bit of leathery fungus or a small fragment of bark; I should not have noticed it at

¹ J. L.

AN UNFORTUNATE SHOT

all if it had not moved slightly. I was on the point of turning it over with a small grass stem to see what was beneath it, when it was suddenly raised on its edge, and a smallish dark-coloured spider appeared. I suppose some sudden movement on my part alarmed it, for it immediately darted back again and clapped the door down, so that there was nothing to be seen but the little patch which I had mistaken for a fragment of bark, but which was really, of course, the lid of a nest. At the moment the incident was as startling as the opening of one of those toys known as "Jack-in-the-box," for trap-door spiders are not, so far as I was able to discover, very common in Morocco, and I had not the least expectation of coming upon one—certainly not at that particular time. After a while the spider again ventured into the open, and I was careful to remain quite still until it had proceeded to some little distance from its nest, when I managed to secure it, intending to take it home to examine at leisure, for by that time the light was failing. But a difficulty presented itself: I had no box to put it in, and not even a scrap of paper out of which I might make a small bag; however, the spider was not large—not more than half an inch in length excluding the legs, and I managed with some difficulty to introduce it into the barrel of my .380 bore Colt, making all snug by screwing a leaf into the muzzle, whereupon I started upon my way rejoicing over an interesting capture. But "there's many a slip," etc., and so it proved in this case, for on the road some half-dozen mongrels, of the sort that are known in Egypt as pariah dogs, which were disturbed while snarling over a loathsome supper of dead mule, made themselves objectionable, and as stones proved of no avail I thoughtlessly fired my revolver to frighten them away, and thus, to my lasting regret, made a living projectile of my prize. What species

AN INGENIOUS DWELLING

it belonged to I am therefore unable to say; probably it was the *Cteniza ædificatoria*, for though the lid of its nest fitted into the tube, it was not so stoutly built as the ordinary cork lid, and was rather oval in outline.

So far we have only considered the very simplest kind of habitation—that is to say, nests consisting of a single chamber closed by a single door. Many spiders, however, construct dwellings of more elaborate architecture, the first step in advance being the addition of a second door part way down the tube. This style is affected by *Nemesia Eleanora*, of the Riviera, who places a wafer at the top of the tube and, from two to four inches below this, a solid underground door of earth encased in silk. The upper door conceals the aperture of the nest, while the lower one, which opens in the opposite direction, that is to say downwards, serves for resistance. The inner door is horseshoe-shaped, and lest it should be moved too far up when closed, or become jammed and thus imprison the spider in her own nest, she ingeniously attaches a silk gusset to it on each side.

The next advance is made by those spiders which dig a side gallery to the burrow and place the second door at the junction of the two tunnels. The scheme of some of these branched nests is very complicated, and requires such nice adjustment in being carried out that we seem to reach at this point the very acme of animal ingenuity. On the right of our picture there is represented a beautiful example of such a nest made by *Nemesia Manderstjernæ*, a species which, like the last named, is found in the Riviera. This nest is shaped, roughly, like a St. Andrew's cross. The inner door, which is tongue-shaped and has a tab at the end which serves as a handle, is hung from the point of the V-shaped mass between the two upper arms of the X, and can be swung at will either against the point of the Λ between the

INFANT PHENOMENA

two lower arms of the X (in the picture you will see the end of a root in the earth just where I mean), or back against the opposite side of the gallery (close to that rather large fragment of stone on the right), thus dividing the right upper arm of the cross from the rest of the habitation. Let us now suppose that while the spider is at home some dangerous enemy, such as the centipede represented in the picture, discovers the entrance to the nest and ventures inside. What will happen? The spider, who has probably offered no resistance at the upper or wafer door, on finding her home invaded, immediately retreats to the lower part of the burrow and slams the swing door in the face of the intruder, who, having explored the upper tube and found it empty, may depart believing the nest to be tenantless. But supposing the inner door should be discovered, as in the case depicted, and that the spider should be beaten in the pushing match which follows, she then slips into the upper part of the inner gallery, the door is closed over the secret passage—the invader on this occasion unwittingly aiding in the manœuvre—and our centipede, descending precipitately to the bottom of the gallery, once more finds his victim has escaped him! There the matter probably ends; but in the unlikely event of the secret upper den being discovered and the door forced once more, there is still a chance of retreat, for this chamber is roofed over with a thin cover of silk and earth which could easily be torn away in case of need. What could be more ingenious?

The most wonderful fact, however, remains to be stated: baby spiders, not larger than small flies, make tiny nests for themselves which reproduce perfectly in miniature the upper door, lower door, main tube, and branch! The lids of some of these astonishing nests are indicated in the picture; they are sometimes scarcely one-twelfth part of an inch in diameter.

A VERSATILE FAMILY

Whether the young spider makes careful observations during the early days spent in the parental home and reproduces its architecture in detail from these mental notes when the time comes to set up house on her own account, or whether she is able to turn out a masterpiece by what we, to cloak our ignorance, conveniently term "blind instinct," and without any previous technical self-education, I cannot say; but the facts are as stated.

Some of the trap-door spiders, like the South African *Moggridgea*, have taken to an arboreal life, and make their homes upon the trunks of trees by first building a silken framework in some natural crevice of the bark and then covering it over with a coating of wood-chips and lichen; others, such as the *Pseudidiops* of South America, hollow out their own crevices by cutting away the bark with fangs and mandibles.

Carpenters, weavers, miners, engineers, and architects, skilled in everything they attempt, the trap-door spiders by their versatility may claim to be the master craftsmen of the animal world.

CHAPTER II

EXCAVATORS AND MINERS

MAMMALS

A national industry—Notable diggers—A neglected genius—The varnished tale—Too clever by half—An underground fortress—How it is made—A strange nest—The bolt run—Accident or intention?—Building on the ruins—The fox's home—Unscrupulous strategy—Arctic foxes—Frozen meat—The badger's den—A retiring disposition—The hamster's dwelling—Living-room and store-room—A tell-tale landmark—Entrance and exit—Well-filled granaries—Harvesting—Emergency doors—Early independence—Pocket-gophers—A rare distinction—Convenient locomotion—Filling the pockets—and emptying them—An interesting scene—Pariah dogs—Slinking through life—The fascinating fennec—Prairie-marmots—"Dog-town"—An animal Utopia—Winter sleep—Sounding the alarm—Animal gossip—Marmots—Summer and winter quarters—Laying in supplies—A picturesque fiction—Our old familiar friend.

OF all animal dwellings, those which are hollowed out of the earth are perhaps the most numerous, and we find them, of one sort or another, made by members of almost every branch of the animal kingdom.

The Mammalia in particular are notable excavators; digging is, indeed, their national industry, as nest-building is that of birds.

The Mole (*Talpa Europæa*) is perhaps the most expert of all burrowing animals, and its whole structure is beautifully adapted to its mode of life. Its snout is tough and pointed, and it has broad, powerful fore-paws armed with claws of great strength, by means of which it makes its way through

NOTABLE DIGGERS

the ground with surprising ease. As a rule it works quite close to the surface—so near, indeed, when tunnelling through loose soil, that the earth over the burrows is elevated into ridges, by means of which, as well as by the actual movement of the ground, the animal's course can be traced without difficulty. A very considerable part of its existence is spent in making these burrows, for the mole not only excavates a dwelling underground, but hunts there day by day for its food, and as it is an extraordinarily voracious little creature you will readily understand that its energy in burrowing is very great. In a single night it often digs a passage many yards in length—a tremendous achievement for so small an animal.

As the mole advances in his hunting grounds, he disposes of the earth he has scooped out by throwing it up at intervals upon the surface of the ground, thus making those little hillocks which are so well known to everybody as "mole-hills." It is not in these small mole-hills that the animal dwells; his habitation, or "fortress," as it is called, is a far larger structure, which usually measures a foot or more in height and three feet in diameter. Considering how extremely common moles are, it appears strange that few people are at all familiar with their habits; but then we must bear in mind that its subterranean life makes this a very difficult creature to observe. At the same time, had it been a very rare animal, and only met with very occasionally, it would probably have received far more attention; for those who concern themselves to observe what lies at their feet during a country ramble are few, and almost the only people who take any interest in this remarkable animal are the farmers whose land it disfigures with piled-up heaps of earth, and the men they employ to free their property from the pest. Both classes, naturally enough, regard the mole as

THE VARNISHED TALE

“varmint,” and all they care about is its destruction. The few other people who are really interested in the animal’s works and ways unfortunately seldom take the trouble—and not a little trouble is called for—to observe its habits for themselves; they are content to read the account given by another man, who has himself relied on what some one else has written, and so forth, until at last a time-honoured tradition arises, and nobody thinks of inquiring whether or not it is a true one. Of course, if the man who told the story first watched the animal very carefully, and wrote down just exactly what he saw, and if the other people copied very carefully what he wrote, no great harm would be done, though it would be better if they all used their eyes now and then to make sure that they were not talking nonsense, instead of relying wholly upon books.

The mole’s fortress is one of the things about which a great many learned people have made foolish statements, merely because they have never taken pains to examine one. About a hundred years ago a French gentleman wrote an interesting book about the mole, in which he gave on the whole an accurate account of the animal. Here and there, however, he added little touches—for which there was not the least need—to the picture, to make it still more interesting and wonderful, and this embellished and decorative narrative has been handed down from one writer to another, receiving other picturesque touches by the way, during a whole century, without a single one of these learned people seeming to suspect that it was anything more than “a round, unvarnished tale.”

If, therefore, you turn to an account of the mole’s fortress as given in almost any popular treatise on natural history, you are pretty sure to find it stated that the animal, after a careful study of the surrounding neighbourhood, selects with

AN UNDERGROUND FORTRESS

rare wisdom some sheltered spot that is difficult to approach, a place, for instance, which is protected by tree roots or the foundation of a wall. You will learn that the dwelling is constructed with great skill and cunning on a most ingenious and complicated plan, which is described in great detail, and you are led to suppose that the plan never varies. You wonder how the mole ever manages to remember it all, and how he contrives to find his way out of such an intricate labyrinth of passages, for you are quite sure that *you* never could! Of course this ingenious description is "too clever by half," and when I was a boy it sadly strained my confidence in the accuracy of an author who was my greatest hero, for I always failed to find a mole-hill anything like the beautiful picture in his book.¹ I came to the conclusion that the moles in my part of the country were very ignorant, and that if they didn't make fortresses like the picture, they certainly ought to. It was the picture that was at fault, however, and not the moles; for though their nests have a certain resemblance to one another, no two are exactly alike, and while some are very complicated, others are just as simple. Mr. Lionel E. Adams recently devoted much time during a period of four years to the study of the mole, and amongst three hundred fortresses examined by him, not one corresponded with the famous picture in the natural history books!

The fortress is usually situated in an open field, and only occasionally under a tree or hedge. Here and there, however, probably as the result of good fortune rather than good judgment, a mole hits upon a situation of extraordinary safety, as in one instance when a fortress was constructed within the wall formed by a hollow tree trunk. What the animal likes is abundance of food and water, and he does

¹ J. L.

HOW IT IS MADE

not appear to be greatly influenced in his choice of quarters by anything else. Sometimes his runs are made in soft, loose soil, at others in sand so hard that a spade can scarcely be made to penetrate it, heavy stones weighing as much as a quarter of a pound being turned out, all of which goes to show that he is a very expert digger. Having decided where he will make his home, he first digs a globular hole a few inches below the surface of the ground, and as he digs he pushes the earth on to the surface of the ground, by way of a tunnel which runs upwards from the nest chamber. Mr. Adams says: "When this superincumbent earth has reached an inconvenient height another tunnel is made, sometimes from another part of the nest cavity, but more often sideways from the first upward tunnel. All this takes time, and the mole meanwhile makes fresh runs from the fortress, the seat of its labour, in various directions in search of food. Much of the earth displaced in making these fresh runs falls into the nest cavity, and has to be disposed of in the same way as before. Now the tunnel (or tunnels) leading upwards from the nest cavity becomes longer and longer, winding round under the surface of the growing fortress. The tunnels in the fortress are for two distinct purposes: (a) Tunnels to eject earth from the nest cavity and bolt run. These are generally in the shape of a corkscrew ascending from the nest, and often diverging into blind terminals. (b) Tunnels not connected directly with the nest cavity, but traversing the fortress from runs outside it. Through these tunnels the mole has brought the earth to heap over the nest, and they seldom occur except in boggy land, where the nest is of necessity near the surface of the ground, or even in the centre of the piled-up mound.

"The nest cavity is roughly spherical, about the size of a large cottage loaf, and quite smooth from constant friction

THE BOLT RUN

and use. The nest, which completely fills the nest cavity, is a ball of grass or leaves, or a mixture of both. I have found a nest made entirely of dead beech leaves, others entirely of dead oak leaves, and when it is remembered that this material must all be brought in by the mouth the amount of labour required can be appreciated. When the nest is taken out bodily, it has to be unwound (if made of grass) to find the centre. There is never a hole apparent, and not only is the nest always found closed when the young are within, but in all cases, even when old and long deserted. When dry grass is not obtainable fresh green grass is used, which soon withers and gets dry with the heat of the mole's body. When a nest containing young is found it is invariably infested with fleas and mites.

"Nearly every fortress has a bolt run, by which the mole can escape when surprised in the nest. This run leads downwards from the bottom of the nest, and then turns upward and out of the fortress by a tunnel of its own, and is very rarely connected with any of the other numerous exits of the fortress. The only fortresses that I have seen without the bolt run have been on marshy land, where such a tunnel would have led to water."

Sometimes there is a tunnel which sinks almost straight down into the ground under the nest for several feet, some people believe that it is intended for a well which the mole digs in order to have a supply of drinking water on the premises at all times, while others think it is a larder in which a supply of paralysed worms is kept at hand; but there appears to be very little reason to suppose that it is anything more than a badly planned bolt run which the mole abandoned on finding out that he had made a mistake in his reckoning.

A mole never uses the same nest for more than one season,

THE FOX'S HOME

but he frequently returns to the same *fortress* for several years, making a new nest on the top, or by the side, of the old one, bringing in fresh grass and leaves from outside. The young, usually three or four in number, are born in the spring or early summer, and the nest which the female mole makes to serve as a nursery for her little ones is usually quite simply planned and seldom has a bolt run. Her tunnels, on the other hand, often wind about hither and thither in a curious fashion, while those made by the male are driven, as a rule, straight ahead; the reason for the female's preference for a tortuous course is unknown to naturalists—and perhaps to the moles also.

The Fox (*Canis vulpes*) passes a considerable portion of his life in an underground den or "earth," where he is usually free from the persecution of his enemies and can devour his prey in comfort. He shows a marked preference for the outskirts of a thicket or a stony hillside. Sometimes—perhaps even in the majority of cases—his dwelling is made entirely by his own efforts, but he is by no means averse from avoiding the labour of digging his own den by taking possession of the burrow of some other animal and adapting it to his particular requirements. He very often makes use of rabbit burrows; the den of a badger, too, offers advantages which induce him to practise grossly unscrupulous acts in order to drive out its rightful owner.

Reynard has earned the reputation of being the most cunning and cautious of animals, so that it is scarcely surprising to find that he is in the habit of providing himself with a dwelling which has several outlets, while to make assurance doubly sure he has nearly always more than one such den at his disposal. In the case of our English fox, the earth varies more or less in plan according to its origin. Should it happen to have belonged at one time to a badger,

THE BADGER'S DEN

it will often be found to be not only extensive, but somewhat elaborate also, as we shall see presently; while a natural cavity amongst the rocks, of which Reynard occasionally avails himself, may of course be of almost any size or shape. But when he has to do his own digging he contents himself with a home which, though fairly spacious, has but a single chamber, in which the burrow terminates. The Arctic Fox (*Canis lagopus*), on the other hand, excavates a far more complex dwelling, several distinct tunnels opening into a large common chamber and providing the means of escape in various directions in case of danger. The tunnels are said to be occasionally connected by cross passages. The living-room is situated at a considerable depth, and thus affords ample protection from the severity of the climate; but it is not the only retreat with which the animals provide themselves, for an inner den, which is approached from the first apartment by a single tunnel, serves the purpose of a nursery for the young. Usually a number of foxes make their homes close together, forming a little colony of twenty or thirty families. Their food in summer consists mainly of birds and their eggs—members of the auk family being their chief victims. When the birds have migrated, small rodents probably take their place in the Arctic foxes' bill of fare, and Sir G. Nares found that these animals stored up vast numbers of dead lemmings in crannies of the rocks as a provision for their needs during the winter.

The Badger, or "brock" (*Meles taxus*), is one of the most notable of animal excavators. Its favourite haunts are thickly wooded quarries and hillsides, where it digs for itself a large and roomy den. The main tunnel often branches towards its inner extremity, and frequently the den has several outlets—in some cases as many as six or eight. The burrow is very spacious, so that there is ample room not

A RETIRING DISPOSITION

only for the animal and its young family, but for a thick bed of dry fern for them to lie on. Here the day is spent in sleep, and at nightfall the animals emerge in quest of food, which they sometimes seek in company with others of their kind.

When a burrow has several openings, as a rule only one, or perhaps two, is used for passing in and out; the others are "emergency exits," by means of which the inhabitants can escape in case of danger. They also serve to ventilate the dwelling-room, for this much-abused creature is far more sanitary in its habits than most animals which live in burrows, and keeps its home scrupulously clean. Occasionally the den is found in a quite open spot on some stony hillside; but in any case one that is remote, quiet, and solitary, for the badger loves an uneventful life, and is above all extremely independent. This animal is very powerful in build, and has strong forepaws with stout claws and webbed toes, which are admirably adapted for digging. It burrows with the greatest ease; with extraordinary rapidity—in a few minutes indeed—a badger thirty inches in length can completely bury itself in the ground. As the burrow grows deeper and the accumulation of loose earth begins to embarrass the animal in its movements, the hind limbs also come into play and fling the soil backwards with vigorous strokes. After a while, however, owing to the depth of the hole, the animal has to adopt another method of getting rid of all the material he has dug out. to keep the passage clear he finds it necessary to work backwards towards the entrance, sweeping up the rubbish as he goes—a simple matter, for a badger can walk, and even trot, backwards almost as well as forwards.

The badger's is the most extensive of all underground dwellings, and perhaps the one which shows, in some instances, the most elaborate provision for the animal's safety.

THE HAMSTER'S DWELLING

The passages are often twenty or thirty feet long, their openings above ground are a great distance apart, and the den is made at a depth of at least four or five feet from the surface. Often the chamber is situated much deeper, as when it happens to be dug out of the side of a hill, and in that case the animal usually makes ventilating holes leading directly upwards to the open air. Badgers are probably less uncommon in England than they are generally supposed to be, but owing to their retiring nature and nocturnal habits they are seldom seen except by those who come under the spell of woods by night. There were recently, and probably there are still, a few of these animals that made their home in Epping Forest, and not very long ago I saw two fine specimens in a wood in Sutherlandshire.¹ At one time badgers were undoubtedly very widely distributed in these islands, as we may judge both from the frequency with which their remains are met with in caves and elsewhere, and from the various places, such as Brockley and Brockenhurst, whose names are derived from this animal; while in many parts of the Continent, especially in Germany, they are still very common.

There is an animal called the Hamster (*Cricetus frumentarius*) which frequents cornfields in the temperate parts of Europe, Asia, and America. It is a rodent—a relative, that is to say, of the rats and mice; but it is larger than they, being about ten inches in length exclusive of the tail, which seldom, however, measures more than two inches. Its general appearance is rather pleasing and scarcely suggests its true nature, which is far from amiable, for it is a sulky, ill-tempered creature.

This animal is also a burrower, and makes under the ground a spacious living-room and at least one other chamber, which is used as a granary. Brehm, a celebrated

¹ J. L.

A TELL-TALE LANDMARK

German naturalist, tells us that its burrow is formed with some skill. Its dwelling-room is usually from three to six feet from the surface of the ground and is approached by a perpendicular tunnel, while a second tunnel, or creeping hole, affords an easier means of exit by being sunk in a sloping direction. Other passages, deep down, connect the living or sleeping apartment with the store-room. The burrows vary in character according to the age of the owner; a young animal makes its dwelling nearer the surface and of smaller dimensions than an older one. Furthermore, the female hamster constructs a more spacious dwelling than the male; but the latter, at all events when old and experienced, excavates the chambers at a greater depth in the earth.

A hamster's burrow is easily recognized by the heap of earth in front of the creeping hole being strewn over with grain. The entrance tunnel is always perpendicular for the greater part of its course, but before reaching the sleeping chamber it turns aside and becomes either sloping or horizontal. The creeping hole, on the other hand, is invariably more or less curved throughout its whole length. The openings of the two tunnels are from a yard and a half to four yards apart.

One can readily see whether a burrow is inhabited or not. If moss, fungi, or grass be found sprouting inside, or if the sides are beginning to moulder or crumble, it is certainly deserted, for such a state of affairs is, of course, impossible in a burrow which is occupied.

When a dwelling has been inhabited for a long time the walls become quite smooth and polished from the constant rubbing of the animal's fur. The chambers are not of equal size, the living-room being the smaller of the two. This apartment is liberally furnished with a soft bed of very fine

WELL-FILLED GRANARIES

straw, and has three tunnels converging into it, those of entrance and exit, and a third leading to the store-room. The latter chamber is round or oval in shape, and towards the end of autumn is filled with corn. Young hamsters only make one granary, but the older animals have from three to five, and store up more than a peck of grain in each, packing it very tightly, and in some cases even filling the passages as well. Often, however, the entrance to the granary is carefully blocked up with earth. Formerly it was believed that the hamster sorted out different kinds of grain and stored them separately; but as a matter of fact, he gathers in his harvest just as he finds it, and when the various grains are discovered in separate stores it is not due to any special love of order on the animal's part, but merely to the circumstance that each kind—linseed, beans, and so forth—is gathered as it ripens, and at different times of the year.

The burrow of the female is not quite the same as the one we have described; as in the other case, there is a single creeping hole, but the entrances are numerous—usually from two to eight—and are often connected with one another. These holes enable the young hamsters to enter their home quickly in case of need; while they are still very young, however, one doorway serves for them all. The mother hamster seldom makes any store-rooms; she is kept far too busy in caring for her family to have time for anything else so long as the children remain in the parental home.

Hamsters sleep through the winter, and wake up again about February or March when the ground begins to soften. They do not open up their burrows immediately, however, but go on living indoors for a while, obtaining food from the plentiful supply in their granaries. The females are the first to venture abroad in search of young shoots of corn or

POCKET-GOPHERS

grain that has recently been sown, which they carry to their burrows in their capacious cheek-pouches. The males stay at home for a month or five weeks longer, by which time fresh food is more plentiful.

The young are born quite destitute of fur, but with well developed teeth, such as you might expect in an animal which afterwards becomes so pugnacious, not to say vicious. When born, eight of the youngsters weigh little more than an ounce; but they grow very rapidly, and by the end of the eighth or ninth day, when they first open their eyes, they are about twelve times their former weight. As soon as they can see they begin to make a tour round the nest, as if to familiarize themselves with its architecture, for after a fortnight or so they begin to dig on their own account, and very soon the mother, who has hitherto behaved towards her children in the most irreproachable manner and displayed strong maternal instincts even towards youngsters not her own, drives them from the burrow and compels them henceforward to take care of themselves, which, indeed, they prove themselves perfectly well able to do.

Belonging to the same order as the hamster, i.e. the rodents, but to a different family, there is a remarkable group of rat-like animals known as the Pocket-gophers, which inhabit North and Central America, being most abundant on the extensive plains of the Mississippi region. As you would suspect from their strange name, they are creatures of great distinction, and some account of their peculiar structure and habits may be interesting. We will confine our attention to the common pocket-gopher (*Geomys bursarius*), the best-known member of the group, a little, brown-and-grey, white-footed animal, about seven or eight inches long (not counting the rather short, thick tail), with a coat of soft fur rather like that of a mole. It has very

A RARE DISTINCTION

small eyes and ears, and its neck is hardly worth mentioning ; but it has remarkably strong feet, the fore paws being armed with long, curved claws. Its great claim to distinction, however, consists in the possession of a pair of large fur-lined pouches which open outside the cheeks, and are put, as we shall see presently, to a peculiar use.

The pocket-gopher spends practically the whole of its life underground, where it makes long tunnels about a foot below the surface for the purpose of reaching the roots of plants, which form the chief part of its food. At the foot of some large tree it sinks a deep, winding passage, at the end of which, four or five feet from the surface of the ground, it makes a large living-room. The chamber is usually furnished with a bed of soft grass, with the addition, when it is used as a nursery, of a quantity of fur which the mother takes from her own coat, just as a rabbit does. At one side of the living-room there is usually the opening of a second passage which leads to another chamber, in which the animal stores quantities of roots, nuts, and in cultivated districts pieces of potato.

Dr. Merriam, who observed the animals very closely, states that in digging their tunnels they use their strong upper teeth, or incisors, as a pick to loosen the earth. "At the same time the fore feet are kept in active operation, both in digging and in pressing the earth back under the body, and the hind feet are also used in moving it still further backwards. When a sufficient quantity has accumulated behind the animal, he immediately turns in the burrow, and by bringing the wrists together under the chin with the palm of the hands held vertically, forces himself along by the hind feet, pushing the earth out in front. When an opening in the tunnel is reached, the earth is discharged through it, forming a little hillock." The curious cheek-pouches, or

FILLING THE POCKETS

pockets, reach back as far as the shoulder, and are used only for carrying food—not for carting dirt out of the burrow, as many people believe. It is curious to observe that the pocket-gopher, like the badger, can run backwards almost as readily as forwards; being both burrowing animals, the peculiarity has probably been acquired on account of its obvious convenience in passing to and fro along narrow tunnels. Referring to a captive pocket-gopher, Dr. Merriam says: "This method of progression was particularly noticeable when the animal was in his own quarters, where he could follow a runway or an accustomed route. When carrying food to one of his storehouses he rarely turned round, but usually ran backwards to the place of deposit, returning for more, and repeating the operation again and again, the to-and-fro movement suggesting a shuttle on its track." The animal's manner of eating and filling its pockets was peculiar and interesting, and showed an ability to use the huge fore feet and claws in a way previously unsuspected. "After satisfying the immediate demands of hunger, it was his practice to fill one or both cheek-pouches. His motions were so swift that it was exceedingly difficult to follow them with sufficient exactness to see just how the operation was performed. If a potato was given him, or a piece too large to go into the pouch, he invariably grasped it between the fore paws, and proceeded to pry off a small piece with the large lower incisors. He would then raise himself slightly on his hind legs and hold the fragment between his fore paws while eating, for he usually ate a certain quantity before putting any into the pouches. As a rule one pouch is filled at a time, though not always, and the hand of the same side was used to push the food in. The usual course is as follows: A piece of potato, root, or other food is seized between the incisor teeth, and immediately

POCKET-GOPHERS IN THEIR HOME

These peculiar creatures spend their lives underground, like the mole. The animal in the upper division of the illustration is represented thrusting a mass of earth out of its burrow. In the lower division the interior of the "living-room" is shown; the animal on the left is stretching the opening of a pocket with one paw while it thrusts in a fragment of potato with the other. The young pocket-gopher on the right is eating in a characteristic attitude, the food being held between the paws. Just behind it, the opening of the tunnel which connects the living-room with the animals' store-room may be distinguished.

AN INTERESTING SCENE

transferred to the fore paws. The piece is then rapidly passed across the face with a sort of wiping motion, which forces it into the open mouth of the pouch. Sometimes a single rapid stroke with one hand is sufficient; at other times both hands are used, particularly if the piece is large. In such cases the long claws of one hand are used to draw down the lower side of the opening, while the food is poked in with the other. The most remarkable thing connected with the use of the pouches is the way they are emptied. The fore feet are brought back simultaneously along the sides of the head until they reach a point opposite the hinder end of the pouches; they are then pressed firmly against the head and carried rapidly forward. In this way the contents of the pouches are promptly deposited in front of the animal. Sometimes several strokes are necessary. I have never seen them emptied in any other way." The scene, suggested by Dr. Merriam's interesting description, of this curious little animal busily engaged in conveying supplies to his store-room would be an extremely entertaining one to watch if we could but see what is taking place a few feet underground. We can imagine him hurrying to and fro, pausing in the living-room to fill his pockets, tasting each piece of potato and trimming it down to a convenient size before tucking it away into the pouch, stretching wide the opening with one hand while he pushes in an extra large fragment with the other, and when at last his pockets are well filled, hurrying along the corridor backwards to save the trouble of turning round. Then, on reaching his storehouse, we picture him sitting on his haunches and, by a good hard sweep with both hands, squeezing all the little pieces of potato out of his pockets on to the floor, where they lie in a heap while the busy animal hurries away for another load.

SLINKING THROUGH LIFE

I do not know how soon young *Geomys* becomes the possessor of full-sized pockets, and whether he always knows what he must and must not put into them, or has to be instructed by his mother as to their proper use. Argument by analogy in natural history is apt to lead us astray, so we must leave these interesting points an open question.

Most mammals display not a little sagacity in choosing for their dens the most favourable aspect in order to escape rain, wind, or excessive heat, as the case may be. In this respect the Pariah Dogs of Egypt are remarkable. They live a perfectly independent life amongst the mounds of rubbish in the neighbourhood of towns and villages, sleeping most of the day and prowling about after nightfall. Each dog makes his own particular lair, or rather lairs, for in most cases there are two, one facing east and the other west. If the mounds run north and south, so that both holes are exposed to keen north winds, the dog will even dig himself a third shelter with a southern aspect, but he never uses this unless driven from the others by cold.

Each morning until about ten o'clock the dogs may be found in their easterly lairs enjoying the warmth of the early sunshine; but as soon as they find the day growing uncomfortably hot they slink away to a shady spot, moving round one after another to their dens on the western side, there to continue their sleep. In the afternoon, when the westering sun once more beats down upon them, they return again to the first den, where they remain until dusk.

Not a few of the burrowing mammals make their dwellings more comfortable by the addition of a snug lining of various soft materials. We have already met with instances of this habit in the badger, the hamster, and the mole, and we find yet another in the case of the common Fennec (*Canis zerda*), the smallest of the dog tribe—a strange-

“DOG-TOWN”

looking animal with immense ears, which lives in the deserts of North Africa.

Like the fox, the fennec makes a burrow; this is usually situated in the neighbourhood of one of those patches of low-growing, tough plants of which the vegetation of the desert consists, for in such places the sand is more coherent, and the animals' tunnels and chambers are therefore less likely to fall in. The passages are generally quite near to the surface; the den, but little deeper, is lined with hair, feathers, and shreds of vegetable substance, and is always kept remarkably clean. The fennec burrows with great rapidity, its fore feet working away so quickly that it is by no means easy to follow their movements. No doubt this extraordinary skill in excavating often saves the animal's life, for when pursued it appears to sink into the earth, disappearing in an incredibly short time.

During the day the fennec remains in its burrow sleeping with its head buried under the thick bushy tail. But its great ears remain exposed, and the slightest sound is enough to arouse its attention; when thus disturbed it whimpers like a little child to show its displeasure. At nightfall the animal leaves its snug burrow and sets out for the drinking places.

The Prairie-dog (*Cynomys*), or Prairie-marmot as it is more properly called (it is not really a dog at all, but a kind of squirrel), lives on the prairies, those great grassy plains of North America, in numerous companies or colonies. The animals make little mounds of earth, and you always find a great many of these in one locality, which is known amongst the people of the country as a “dog-town.” Let us see what sort of place a dog-town is.

To have any real idea how extensive it may be, you must have travelled for days together through country which is dotted over with mounds, every one of which is the home of

WINTER SLEEP

two or more of these peaceful little animals. The hillocks are generally about six yards apart, and each one consists of as much earth as would fill a very large wheelbarrow, thrown up by the *Cynomys* when he digs out his subterranean home. The dwelling has sometimes one and sometimes two entrances, and there are well-worn paths between the different habitations, so you can tell at a glance that the animals are very friendly and sociable with one another. In selecting a spot on which to establish a colony, they choose one which is covered with short, coarse grass, such as is found especially on the high tablelands, because it is on this grass and upon various roots that the prairie-marmots feed.

On the tablelands of New Mexico, where for miles you will not find a drop of water unless you dig down into the earth for a hundred feet or so, and where at certain seasons there is no rain for several months, there are very large colonies of prairie-marmots; hence it is quite clear that these animals are able to live without drinking, and that they can obtain enough moisture for their needs from a heavy fall of dew.

In the autumn the grass dries up and the ground soon becomes frozen hard, so that digging is out of the question. How is the *Cynomys* to obtain food? He has laid up no store, as some animals do, and apparently he must starve. Not at all! He just goes to sleep and remains asleep all through the winter. About the end of October he begins to grow drowsy, so he creeps into his burrow, blocks up the openings in order to keep out the cold and make all snug, and is seen no more until the following spring. The Indians say that he sometimes opens up his house again before the end of the cold weather, and that when he does so it is a sure sign that warmer days are near at hand.

PRAIRIE MARMOTS, OR "PRAIRIE DOGS" MAKING THEIR BEDS

These animals live in large colonies known as "dog towns." They make little mounds of earth in front of their burrows and use them as watch-towers. On the slightest alarm they emit a shrill yelping sound, which is the signal for the whole company to take refuge in their entrenchments.

THE STICKLEBACK'S NEST

This fish's nest is loosely woven of bits of grass and fragments of water-weed. When the eggs have been deposited, the male fish keeps a strict watch over them, fiercely attacking and driving away any fish that ventures to intrude within the limits of his domain. Even his mate cannot be trusted within the sacred area.

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Small clusters of dots at the top of the page.

ANIMAL GOSSIP

A large dog-town presents a curious sight to anybody who approaches very cautiously so that the animals do not observe him. As far as the eye can reach it rests upon the same gay, animated, happy scene. Everywhere you may see the little animals, sitting up like squirrels, on the top of their mounds, waving their tails from side to side and yelping to each other cheerfully, until they produce quite a concert of sound.

But as you draw nearer, if you listen carefully you will hear a different note from the old and more experienced animals, and that is the signal for the whole company to disappear in a moment into the burrows. Here and there, however, you may still perceive a sentinel peeping out and "barking" to warn his comrades that a man is approaching.

If you hide and wait patiently for some time, the sentinels will again mount up to their posts of observation on the hillocks, and announce in the same way that the danger is past, whereupon the animals come out of their burrows one after another and begin to play about as before. One respectable old fellow goes to visit a neighbour who is sitting on the top of his mound and seems, by the way in which he waves his tail about, to be inviting his friend to sit down beside him. All the while they keep uttering the peculiar sound which for want of a better word we may term a bark or yelp; you would think they were exchanging opinions on the latest news. After an animated conversation of this kind they will perhaps go into the house for a moment, and on coming out again proceed both together to call upon another neighbour, who is apparently very glad to see them and joins them in their walk. On the way they meet other friends and stay with them awhile, whereupon the party breaks up and they all go home.

SUMMER AND WINTER QUARTERS

You may see them behaving after this fashion for hours together, and you feel quite sorry that you are not able to speak their language and go amongst them to hear what they are talking about.

Although prairie-marmots are so timid that the slightest movement of a hunter will, as we have seen, cause a whole colony of them to disappear underground, leaving no signs of their existence except the mounds in front of their burrows and a chorus of little yelps which seem to come from the depths of the earth, yet they are not in the least terrified by buffaloes, but will play about amongst their hoofs quite fearlessly.

There are some mammals, though not many, which have two dwellings every year, one for summer and the other for winter. Amongst them are the Marmots (*Arctomys*), whose homes have been described very accurately by Tschudi in a well-known book about the Alps.

Marmots, he tells us, choose for their abode in summer grassy oases surrounded by rocks and chasms; they prefer spots where they can enjoy plenty of sunshine, avoiding damp and shady places. They dig holes which are in many cases three or four feet deep, and galleries a fathom or two long, but so narrow that they will only just admit a closed fist. These galleries lead into the actual dwelling, which in shape is something like a big basin. The entrance to the burrow is occasionally found piercing the turf quite in the open, but more often it is hidden amongst rocks or under stones, where it is by no means easy to discover. The galleries run up and down in various directions; some are single, while others divide into branches, and their walls are beaten and pressed so hard by the animal passing to and fro that you would think he must have squeezed his way through the ground without troubling to dig out any of the earth.

LAYING IN SUPPLIES

It occasionally happens that marmots have only one home all the year round, in that case it is made on the plan of the winter quarters, and is more spacious than a dwelling which is intended for occupation in the summer-time only. As a rule, however, they like to spend the warm months on grassy slopes high up amongst the mountains, about ten thousand feet above the sea—partly, perhaps, because at such a height they are comparatively safe from meeting with dangerous neighbours. But the coming of cold weather drives them down to the pasture lands, which have by that time been deserted by the shepherds, and there they begin to dig out winter burrows which are spacious enough in some cases to accommodate a family of fifteen individuals.

The middle of October is the time when they shut themselves in for the winter, and to prepare for this event they bring in a quantity of dry grass, which forms a soft carpet for the burrow and is used, together with earth and stones, for blocking up the entrances. This shutting up of the home is effected at a distance of one or two feet from the outer opening, where, if the animals are at home for the winter, you find a solidly built door. Just before that point the tunnel divides, forming a branch road; it is probable that this is made after the door has been constructed, for the purpose of keeping the burrow free from refuse and waste materials. A similar branch passage which is occasionally found in the summer burrow must, however, have some other use: perhaps it is meant as a means of escape when the animal is pursued, or it may have been intended originally for the main road, and abandoned on account of a stone or some other obstacle.

It is seldom that the main road is less than ten feet long, and occasionally it extends three times that distance from the entrance. As it approaches the end it rises a little before

OUR OLD FAMILIAR FRIEND

opening into the living-room, which measures from three to six feet across and is filled with soft, dry grass ; this is replenished in the autumn of each year, for the marmot is a prudent little fellow, and begins to put by a store of provisions as early as August, cutting down grass and herbage with his sharp teeth and then, when it is dry, carrying it home. There are still many simple folk who believe, as Pliny did, that one of the animals lies on his back and allows himself to be loaded with hay by the others, who then drag him home by the tail, like a living sledge. In this way they account for the worn-out appearance of the fur on his back. But his shabby garment is more probably, if less picturesquely, explained by the narrow entrance through which he has to pass in order to get into his burrow.

We can hardly leave the digging mammals without just mentioning our friend the Rabbit, whose official title is *Oryctolagus cuniculus*. A rabbit warren consists, as most people are aware, of an intricate system of underground tunnels which communicate with one another and run in all directions. Besides the main entrance, the individual burrow is commonly provided with a back door or bolt hole, the advantage of which is obvious. The rabbit's nursery, however, has but a single opening, and the mother lines her nest with fur which she plucks with her teeth from her own chest and body.

CHAPTER III

EXCAVATORS AND MINERS

OTHER ANIMALS

Bird excavators—Sand martins—Delicate labourers—Prodigious industry—The kingfisher—A nest of bones—Tortuous burrows—An unmistakable dwelling—A dying race—Larks and their nests—Ostriches and their relations—Kiwis—"Sniffing" for worms—A remarkable egg—Tortoises—Strange use for a tail—Depositing the eggs—Interesting behaviour—"Robber-crabs"—A Munchausen-like story—Crab and cocoa-nut—The underground bed—Ghoulish habits—Fiddler-crabs—Laughable antics—Swift land-crabs—Warning to trespassers—A mile of crabs—Floods caused by cray-fish—Tarantulas—A well-planned den—The spider's tower—Spider-eating sheep—A brooding spider.

WE will now turn our attention to the birds, amongst which excavators are no less numerous than in the great division of the animal kingdom which we have already considered.

Some birds make tunnels of such great length that they may very well be counted amongst the miners. The most notable example of these in our own country is the Sand Martin (*Cotile riparia*), which comes to us early in the spring from Africa, and lives in companies or colonies wherever it finds a steep or overhanging bank of sand, as in ballast-pits, beside rivers, and so forth, wherein to tunnel.

It is not easy to understand how so small and delicate a bird manages in a short time to sink a shaft of the relatively enormous dimensions of some of those in which the sand

PRODIGIOUS INDUSTRY

martins make their nests. It sometimes happens that a pair of these birds succeed in a few days in piercing a hole a yard or more in depth and about three inches wide. Whilst they are thus occupied their activity is prodigious. You may see them laboriously gathering up in their claws the loose earth which results from the tunnelling and casting it out of the hole with great energy. After beginning one hole, it is no uncommon thing for them to abandon it and to commence a fresh one; indeed, they sometimes act thus when the first dwelling has actually been completed; for what reason it is difficult to say. The birds are so completely engrossed in their labours that one might imagine, no longer seeing them flying about, that they had left the country again; but you have only to strike the ground over their nesting-place with your foot, and in a moment you see them dart out of their tunnels. When the bird is sitting, however, she often will not leave the nest even though a hand or a stick be thrust into the hole.

The nest-holes vary considerably in depth, some being comparatively shallow, while others may, as we have already stated, extend more than a yard from the opening, which is usually narrower than the part beyond. Each ends in a spacious chamber containing a slight nest composed of a little soft straw, with some feathers, and perhaps a few hairs. Generally from twenty to a hundred or more pairs nest in close proximity to one another; it sometimes happens, however, that the birds take up their abode in holes in a rock or in an old wall, and in such cases their dwellings are of necessity not only further apart, but much more shallow than those bored in sand.

There is a little South American bird called *Geositta cunicularia* which is nearly allied to the oven-bird, but has habits very different from those of its relative, for instead of

A NEST OF BONES

building a stout mud house in an exposed situation, it excavates in a bank a deep burrow with a round chamber at the end, and in the chamber it builds a beautiful nest. The tunnel, from two to six feet long, has an opening which is only just large enough to allow the bird to pass in and out, and from this slopes gradually upwards, so that there is no danger of the heaviest rains penetrating to the nesting chamber. Owing to the direction of the burrow the chamber at its further extremity is in complete darkness, and there the bird makes a domed nest of soft grass, with an opening at the side.

The Kingfisher (*Alcedo ispida*), the most brilliantly clad of all our native birds, is also one of the miners. Peculiar and striking in appearance, its habits are not less curious. In the early spring, when choosing a nesting-place, it invariably selects for the purpose some steep, dry bank, destitute of all vegetation, up which neither rat nor weasel, nor any other carnivorous animal, can make its way. There, a foot or two below the edge of the bank, the kingfisher bores a round hole not much more than two inches in diameter. Sloping upwards a little, the tunnel penetrates into the earth for more than half a yard and ends in a smooth, round cavity a little higher than the width of the burrow and about twice as broad. The dry earth which forms the floor of the little chamber is covered with small fish-bones, and on this strange and odorous nest are placed from five to seven relatively large, almost round eggs, with shells of lustrous whiteness. When recently laid the eggs appear to have a pinkish hue owing to the presence of the yolk within the thin translucent shell, but after being blown the latter has the brilliance and purity of fine white enamel. They are about the same size as a quail's eggs, and as Bechstein, the well-known German naturalist, has observed, it is difficult to

AN UNMISTAKABLE DWELLING

understand how the kingfisher manages, with its short, stiff feathers, to brood on them all at once.

The excavation of its nesting hole occupies the kingfisher during two or three weeks, for these birds are by no means such rapid workers as the sand martins. When a stone happens to lie in the course of the tunnel it is removed if it be not too large; otherwise the burrow is diverted to one side of it; and from this cause the tunnels made by kingfishers are often very tortuous. If there be too many obstacles in the way of progress, however, the bird abandons the tunnel and makes a fresh attempt elsewhere. In their method of nesting the kingfisher and the woodpeckers present certain similarities, but with this difference, that while the former excavates its home in the earth, the latter attacks dead or diseased wood. So long as they are not molested a pair of kingfishers may occupy the same nest year after year; but if the entrance to their dwelling be enlarged no eggs are ever deposited there afterwards.

Bechstein states that it is quite easy to recognize a nest which has already been inhabited by the presence of heads and wings of dragon-flies amongst the fish-bones. In a new nest the fish-bones are fewer, and the remains of dragon-flies are not found until it has been occupied by a young brood. A kingfisher's nest can, of course, be distinguished at a single glance from a rat-hole or the burrow of any other animal. Nor is it more difficult to tell when it is inhabited, for then the fishy odour is obtrusive and unmistakable.

The pertinacity with which a kingfisher remains on her eggs or with the newly hatched young within the nest is remarkable. Beat on the earth as hard and as long as you will, it is impossible to drive the bird from her hole; even the noise and violence attending the enlargement of the

LARKS AND THEIR NESTS

tunnel will not cause her to leave the nest, where she remains quite still until she is on the point of being captured.

The Weka-rails, or Wood-hens (*Ocydromus*), of New Zealand are known sometimes to make burrows, which they use both as a retreat and for nesting purposes. They dig these holes with their beaks only, without the help of their claws. Though they have ample wings, these birds have entirely lost the power of flight, and as they are much sought after by the Maoris for food they are doomed to extinction at no very distant date.

The birds we have mentioned hitherto in this chapter all make burrows or tunnels; but there are many others, amongst them numerous game birds, which are content with a mere hollow in the ground.

The Skylark (*Alauda arvensis*) nests in meadows and cornfields. The nest, a very simple one of bents lined with finer grasses and rootlets, is always made on the ground and very often in a slight hollow, which both birds are said to co-operate in scratching out.

The European Short-toed Lark (*Calandrella brachydactyla*), whose sweet song is to be heard in Malta during the summer months, and which is frequently offered for sale in the Paris bird-shops, nests in the same manner as the skylark. The nest, however, is often more artfully concealed by being placed under the shelter of a clod of earth or beside a small bush.

Nests which are built on the ground are usually coarsely constructed, but this is not an invariable rule. Thus the common Horned Lark (*Otocoris alpestris*), which inhabits the whole of the northern parts of Europe and often winters on our eastern coasts, makes a rather deep nest in a hollow of the ground, and lines it with fine grasses and husks of seeds,

KIWIS

willow down, or reindeer hair, all well shaken out and carefully disposed to form a soft bed.

Ostriches and other similar birds, that is to say, Rheas, Cassowaries, and Emus, lay their eggs in a large hollow excavated in the sand. In the warmer districts in which these birds dwell they only sit during the night, when it is necessary to protect the eggs from jackals; in the daytime they cover them over with sand and abandon them to the heat of the sun. Several hens lay in a single nest, but they take no part in the duty of incubation, which is left entirely to the male bird.

That wholly remarkable bird the Kiwi may fittingly be mentioned here, partly by reason of its supposed relationship to the ostriches and its manner of nesting, but also because its strangeness in many respects makes it a creature apart from its race, and one which may appropriately serve to conclude our series of bird excavators. The kiwis (*Apteryx*) are found only in New Zealand, where they spend the day in burrows and sally forth at dusk in search of worms and other food. As their name, *Apteryx*, suggests, these birds are apparently wingless: they are not really so, however, and though the wings are very small they are readily felt under the long, narrow, soft feathers. The kiwi is also apparently tailless, but to make up for these deficiencies it has very stout legs and feet with long curved claws, and a remarkably elongated, probe-like bill, the nostrils of which are placed near the tip instead of being close to the head as is the case in most birds, an arrangement which permits it to "sniff" for worms down their burrows. The kiwi's own burrow is a short tunnel with an enlarged space at the end lined with dry fern on which is deposited an enormous egg, which weighs about a quarter as much as the bird itself, and is, in proportion, the largest egg known. As in the other more or

STRANGE USE FOR A TAIL

less allied species mentioned above, the male undertakes the duties of incubation.

Most Tortoises dig holes in the ground to receive their eggs, which they afterwards cover up with earth. They make these cavities in a very curious way, first drilling holes with their tails and afterwards enlarging them with their hind feet. This strange proceeding was observed very carefully by Brehm, who describes how, towards the close of a warm day of early summer, after a long period of dry weather, five European Pond-tortoises (*Emys orbicularis*) all laid their eggs at the same time. They had chosen their ground by seven o'clock in the evening—not all in one place, but a considerable distance apart. After deciding on a suitable spot where the earth was bare, each of them at once began to bore a hole with its tail, stiffening it by contracting the muscles strongly, and placing the tip firmly against the ground. The middle part of the tail was then moved round and round in a circle, until a cone-shaped hole was produced, wide at the top but tapering to a point below, and almost as deep as the length of the tail. When this curious operation was completed, the animal immediately set to work to enlarge the cavity with the help of its hind limbs. This it did by scooping out, first with one hind foot and then with the other, alternately, 'shovelfuls' of earth which were heaped up like a rampart all the way round the sides of the trench. The tortoise used its feet like hands, placing the earth carefully in a circle at some little distance from the edge of the pit, and the work was continued until the hole had been dug as deep down as the hind limbs would reach.

All this time the body had scarcely moved and the head was kept inside the shell. The pit measured about five inches across and was shaped more or less like an egg, being wider inside than at the top.

INTERESTING BEHAVIOUR

When the animal found that it could remove no more earth, that is to say, at the end of an hour or more, it seemed to be satisfied that the nest was ready, and without changing its position it proceeded to place its eggs inside very carefully (just as you would put hens' eggs into a basket), using for the purpose first one hind paw and then the other. The eggs, of which in most cases there were nine, had soft shells at first, but they soon became hard when exposed to the air.

It required about a quarter of an hour to deposit the eggs, and at the end of that time the animal appeared to rest, remaining quite still, with the foot which had been used to put the last egg in place still hanging limply in the nest and the tail drooping in a lifeless manner. After an interval of about half an hour the final and, to all appearance, the most arduous part of the work was begun—that of filling up the hole and levelling the ground. The earth was placed carefully over the eggs, a handful at a time, the hind limbs being used alternately as before for the purpose. As the hole was gradually filled up the animal strove to press the earth down with the outer edge of her foot. When at length the cavity was quite full she took another rest for half an hour, after which she began beating down the mound of earth and stamping the soil firm and flat with the under side of her hard shell. She raised the hind end of the body and then hurriedly let it drop to the ground again, turning round and round in a circle meantime. She worked very hard and very quickly, indeed you would not have thought a tortoise could move so briskly; at the same time she did all she could to remove any traces which might have led to the discovery of her nest, and in this she was so successful that if the spot had not been marked, it could not have been detected the following morning.

“ROBBER-CRABS”

The tortoise's eggs remain underground for ten or twelve months.

The European pond-tortoise is still found in Southern and Central Europe, but it disappeared from England with the beaver, the roe-deer, and the pelican long ages ago. As a “pet,” however, it is by no means uncommon, and it is frequently exhibited for sale in London shops and elsewhere.

If that highly imaginative person Baron Munchausen had informed his friends that one day he had landed upon an island where, on penetrating into a forest several miles from the sea, he came upon some immense crabs busily engaged in digging holes in the ground, whilst others were climbing trees and gathering cocoa-nuts, his friends would probably have said, “Oh, come now, Baron, we don't mind believing that little story about the whale, but this is too much!” Yet there are such crabs—millions of them: which is probably the reason why Baron Munchausen did not tell the story.

There are several species of land-crabs, but perhaps the most famous of them all is the great Robber-crab (*Birgos latro*), which is found on islands in the Indo-Pacific seas—a creature of immense strength, which climbs palm trees and breaks open cocoa-nuts, and lives in a den which it digs for itself in the earth. Darwin gives an interesting description of these extraordinary animals, which is well worth quoting at length. He says: “I have before alluded to a crab which lives on cocoa-nuts: it is very common on all parts of the dry land, and grows to a monstrous size: it is closely allied or identical with the *Birgos latro*. The front pair of legs terminate in very strong and heavy pincers, and the last pair are fitted with others weaker and much narrower. It would at first be thought quite impossible for a crab to

CRAB AND COCOA-NUT

open a strong cocoa-nut covered with the husk, but Mr. Liesk assures me that he has repeatedly seen this effected. The crab begins by tearing the husk, fibre by fibre, and always from that end under which the three eye-holes are situated, when this is completed, the crab commences hammering with its heavy claws on one of the eye-holes till an opening is made. Then turning round its body, by the aid of its posterior and narrow pair of pincers, it extracts the white albuminous substance. I think this is as curious a case of instinct as ever I heard of, and likewise of adaptation in structure between two objects apparently so remote from each other in the scheme of nature as a crab and a cocoa-nut tree. The *Birgos* is diurnal in its habits; but every night it is said to pay a visit to the sea, no doubt for the purpose of moistening its branchiæ [gills]. The young are likewise hatched, and live for some time on the coast. These crabs inhabit deep burrows, which they hollow out beneath the roots of trees, and there they accumulate surprising quantities of the picked fibres of the cocoa-nut husk, on which they rest as on a bed. The Malays sometimes take advantage of this, and collect the fibrous mass to use as a junk. . . . To show the wonderful strength of the front pair of pincers, I may mention that Captain Moresby confined one in a strong tin box . . . the lid being secured with wire; but the crab turned down the edges and escaped. In turning down the edges, it actually punched many small holes quite through the tin!" In the Natural History Museum at South Kensington there is a photograph of a palm grove with a number of these crabs, one of which is in the act of climbing up—or descending, I forget which—a tree.

According to the account given by Mr. Arthur Adams in *Zoology of the Voyage of the Samarang*, these somewhat terrible creatures are not always satisfied with a diet of

ROBBER-CRABS

These powerful land crabs inhabit deep burrows, which they make for themselves beneath the roots of trees. They climb trees and eat cocoa-nuts, which they break open by hammering upon one end of the shell with their huge "pincers." In their burrows they accumulate immense quantities of cocoa-nut fibre, which the Malays sometimes collect to use as junk.

SWIFT LAND-CRABS

cocoa-nuts, for in the Meïa-co-shimah group of islands he found that they frequented cemeteries and fed on the bodies of the dead.

It is really quite a pleasant relief to turn from a story with such a gruesome ending to the amusing antics of another crab which is largely terrestrial in its habits. This crab is appropriately named *Gelasimus*, which means "laughable," and a queer little fellow he is. The male has one claw of immense size, the other being quite small. The big claw is gaily coloured, and when the animal runs he waves it about as if energetically beckoning, or playing some very stirring tune on a violin; hence he is often known as a "Calling-crab" or "Fiddler-crab." The calling-crabs inhabit various parts of the world, and are usually found in large numbers on muddy or sandy flats left dry by the tide, where they may be seen hurrying over the sand or peering out of their holes, into which they immediately vanish when alarmed. The burrows, which are about a foot in depth, are made by the crab persistently digging up and carrying away little masses of mud or sand. When thus engaged the appearance of the animal is extremely comic. Scraping up a quantity of sand into a little heap, he grasps it with three of the legs of one side and hurries away with it to some distance. Having deposited his load, he raises his eyes (he can do that quite effectively, because they are situated at the end of very long, slender stalks), peers curiously around, and scuttles back to the burrow for another load of sand. The male is less timorous than the female—as indeed he ought to be, with such a mighty claw—and occasionally makes some show of guarding his retreat.

The Swift land-crabs (*Ocypoda*), which run with such speed that catching them is quite an exciting game, bore deep holes in the sand below high-water mark, so that they

A MILE OF CRABS

spend half their time under water, and the other half, when the tide is out, wandering about the beach in search of food. Though crowds of them frequent the same locality they never venture to intrude into one another's burrows, and should one attempt to do so, a loud scraping noise made by the rightful owner warns him as plainly as possible that "trespassers will be prosecuted." Even when hard pressed one of these crabs will rely on his agility to bring him safely to his own home rather than risk the peril of intruding into the dwelling of a stranger.

Before taking leave of the crabs, we will mention one more species. *Gecarcinus ruricola*, a native of Jamaica, usually takes up quarters two or three miles from the sea, where it spends the day hidden away under rocks, in hollow trees, or in holes and burrows. Like other land-crabs it is able to run with extraordinary swiftness, and in the pairing season the whole colony sets out *en masse* for the sea. Issuing in myriads from their lurking-places, the crabs form a mighty band, which sometimes, according to Mr. Browne, covers an area more than a mile in length and forty yards wide. Nothing turns them from their course. With the males leading the way, they make a bee-line for the sea, passing over all obstacles—not only hills and hedges, but even houses and cliffs—and constantly risk their lives rather than make a circuit. In the late summer they change their coats, for which purpose they retire to their burrows and carefully close up all the apertures in order to keep out any possible enemies until the new shell has become hard enough for them to venture in the open once more.

It occasionally happens that the mining propensities of crustaceans become decidedly troublesome, for it is stated that "the embankments of the Mississippi are sometimes

A WELL-PLANNED DEN

weakened to such an extent by the burrowings of the crayfish as to give way, and allow the river to inundate the surrounding country."

The famous Tarantula Spider (*Lycosa tarentula*), the bite of which, in Italy, is so greatly dreaded by the peasants, who believe that it is followed by a disease called "tarantism," and that it can only be cured by a certain kind of music, is an expert in the making of burrows. When digging, it first loosens the earth with its mandibles, and then, after scraping it together into a small heap, makes it into a neat little packet by means of silk and slime from its mouth, and flicks the pellet away to some distance. Inhabiting by preference dry, barren, open ground, which is fully exposed to the warmth of the sun, it sinks in the earth a cylindrical shaft more than a foot long and about an inch in diameter, in which it lies hidden during the day, coming out at nightfall to seek for prey, for it is one of the wolf spiders and hunts its game without the aid of snares.

The burrow is artfully planned. At first there is a sheer descent four or five inches in depth, but at that distance below the surface the tube turns aside before dipping straight down again to its termination. It is at the angle or elbow of the tube that the tarantula watches for the approach of enemies or prey, like a vigilant sentinel, never for a moment off its guard. "It is there," says M. Léon Defour, "that at the time when I was hunting for tarantulas I saw its eyes sparkling like diamonds, shining in the darkness like a cat's. The external orifice of the burrow is ordinarily surmounted by a separately constructed tube, a true piece of architecture, which rises about an inch above the surface of the ground, and is sometimes as much as two inches in diameter, being thus larger than the burrow itself. This last arrangement appears to be the result of careful calculation on the

SPIDER-EATING SHEEP

spider's part, for it enables it to spread out its legs as it must do before pouncing upon its prey. The tube is principally composed of fragments of dry wood fastened together with clayey earth, and so artistically disposed one above the other that they form a scaffolding having the shape of a hollow cylinder, and its strength is greatly added to by a silk lining which the spider warps over the inner surface and continues over the whole of the inside of the burrow." "The outwork, or tower, is not found in all the nests, but when present it is no doubt very serviceable in preventing loose sand and other rubbish from being blown into the burrow. Besides chips of wood, the spider often uses pine-needles and bits of lichen for building its rampart, fastening them together with silk. In winter it makes a cover or lid of the same materials, and remains snugly indoors until the cold weather is past.

In the lower part of the illustration opposite page 30 you will see a tarantula represented as it springs from its turret to pounce upon a large field cricket. According to Baglivi, the peasants sometimes lure tarantulas from their holes by blowing into a haulm of oats and thus imitating the buzzing of an insect. Without resorting to some such strategy it is a difficult matter to secure these spiders, for it is not easy to catch them by digging them out of their burrows. Nevertheless they are not immune from danger, in spite of their ingenuity, for M. de Walckenaer states that in the steppes of Asiatic Russia a species of black sheep unearths tarantulas and—eats them!

In the Natural History Museum at South Kensington you may see a great block of earth containing four wonderful burrows made by spiders called *Santaremia pocockii*, a South American species common in the neighbourhood of Pará and Santarem. This spider, which is a great brown

A BROODING SPIDER

fellow with a body as large as that of a small mouse, and stout, hairy legs, digs in the sand a wide tube about a foot deep. The tunnel ends in an enlarged chamber, where the spider deposits about seventy spherical eggs, enclosing them in a cocoon, over which she broods, as you may see her doing in the interesting specimen in the Museum. The burrow is of course lined with silk, which is continued above the surface of the ground in the form of a funnel; the latter is strengthened with grass or leaves, and serves to keep the nest free from drifting sand in the same manner as the tarantula's turret.

CHAPTER IV

MAKERS OF BASKET-WORK

Stability of birds' nests—Variety of architecture—The typical nest—Goldfinch and chaffinch—A beautiful tissue—Outside decorations—Crossbills—The birds at work—Choice of material—More solid structures—A warm-blooded race—The perfect incubator—A nest made of lichens—Homes over the water—Slender foundations—Nature's cement—A beautiful cradle—Homes on the water—Concealing the eggs—Floating nests—A damp bed—Building enthusiasts—"Invisible" nests—Birds of prey—Aeries—The lordly eagle—Notice of tenancy—Piracy on the high trees—An interesting faggot—The honey-buzzard's screen—The type of parental devotion—Protection and rubbish—Apes and their beds—A lofty platform—Family parties—Paul Du Chaillu's strange story—A leafy canopy—The orang-outang's couch—Our ignorance concerning gorillas.

WHAT we may call the constructive instinct is more widely spread and more highly developed amongst the birds than in any other group of the animal kingdom. With comparatively few exceptions they build nests which give evidence of admirable architectural skill; and if we bear in mind that a bird has no implements except its beak and claws, we cannot but wonder at the ingenuity which enables it to make a dwelling which, poised as it very often is on the slightest of supports in mid-air, and exposed to the wind and rain, can yet withstand the wear and tear of a turbulent family of youngsters who would very quickly wreck or capsize it if it were not both firmly founded and strongly built. It is interest-

VARIETY OF ARCHITECTURE

ing to note that the bird which displays so much energy, zeal, skill, and foresight where the welfare of its family is concerned is in its own life an utter Bohemian, living carelessly from day to day and seldom making any provision for the future. Fortunate it is for him, in many cases, that when the cold weather comes and food is scarce, he can fly away to a kinder and more congenial climate, there to remain until the return of summer.

Birds attach a great deal of importance to the stability of their nests. Those species which have no great skill in building, such as the redstart, the rock dove, and the nut-hatch, plant them firmly on the ground, in a hole in a bank or hollow tree, or within some crevice or cranny of a rock. The more expert architects, on the other hand, often show great daring in their selection of a site, constructing their nests high in a bush or in some tall tree; yet taking care, for their greater security, to place them on the fork of a branch, or even in many cases building around two or three stout twigs, which pass through the walls of the nest and prevent it from being dislodged by the strongest wind. Birds which build in marshy places give the same attention to the security of their foundations, and anchor their nests to the surrounding reeds by cables, as it were, of flexible rushes.

The walls of different nests vary in thickness and strength not only in proportion to the weight of the brood they are destined to contain, but also with the number, position, or firmness of the points of support. Thus the side of a nest which is in contact with the trunk of a tree, a wall, or a rock is commonly very thin and may in some part be wanting altogether; while the side which projects into space without any direct support is necessarily made much thicker and stronger.

Most birds bind together more firmly the materials which

GOLDFINCH AND CHAFFINCH

form the framework of the nest with scraps of moss, wool, spider's web, mud, and even by means of their own saliva.

The walls of a nest are usually formed of three layers, of which the outermost is roughly made of coarse materials, and the middle one somewhat finer and more carefully put together. But it is the inner layer, forming the lining of the nest, to which the bird usually devotes most skill and attention, making it of the finest grasses, soft moss, hair, feathers, thistle-down, and the like, and choosing those substances which are best adapted to form a soft bed and to retain the warmth which is imparted to the eggs during incubation.

A nest of the common shape with which everybody is more or less familiar may be somewhat fancifully compared to a basket without a handle, or to one of those panniers one so often sees on the Continent, slung over the backs of donkeys or mules. Birds interlace and weave together strips of vegetable matter much as the basket-makers do, forming a hollow, cup-shaped structure. The general method is similar in nearly all cases, though different species employ different materials, the nature of which naturally influences to some extent the operations of the worker. For the purpose of description we have adopted a classification of nests which is quite arbitrary and artificial, but which seems convenient for our purpose.

NESTS MADE OF SOFT MATERIALS

A great number of our song birds build nests which come under this heading. It will be sufficient if we give a few examples of those which are best known.

Amongst our British birds the Goldfinch (*Carduelis carduelis*) and Chaffinch (*Fringilla cælebs*) make nests

A BEAUTIFUL TISSUE

which are unsurpassed for beauty of material and perfection of delicate workmanship. Of these two the latter is to be found from time to time in almost any bush or hedgerow, and every boy is familiar with it; but owing to the popularity of the goldfinch as a cage bird, the former is unfortunately no longer as common as it used to be.

In general shape these nests resemble a hollow ball with the top sliced away. They are thick-walled, soft, and extremely neat. Owing to their small dimensions—neither of them measures more than three and a half inches across—the birds can very well dispense with the earth and stout bents and roots used by thrushes and blackbirds; they are satisfied with soft mosses, wool, etc., which they bind together with perhaps a little fine grass and a few small rootlets.

The materials are interlaced so skilfully that they form a tissue which is both strong and elastic—as soft and as springy as a knitted web; yet it is not soft enough, it seems, for these fastidious little birds. The goldfinch adds a lining of fir-needles, feathers, wool, thistle-down, willow-down, etc., according to the choice afforded by the locality in which the nest is built, and then a few hairs to keep everything neat and trim, for otherwise the mass of light down would have a tendency to spring up and become displaced, however carefully the bird arranged it. The chaffinch does much the same, lining the nest with hair and feathers; yet even then she has not finished her labours. One of the most beautiful of our British birds, this little creature is equally endowed with self-respect and excellent taste; so when she has finished the structural part of her nest she turns her attention to the outside decorations. The fragments of moss are so beautifully arranged, and woven together with such regularity, that the surface texture resembles the fleece of a lamb,

OUTSIDE DECORATIONS

the general colouring being a yellowish green. On this foundation the bird applies an inlay, so to speak, of pale-grey lichens and bleached scraps of moss, secured more firmly by means of spider's web, and forming a sort of arabesque over the whole surface. The result is a truly beautiful specimen of craftsmanship. One nest I discovered some years ago in the vicinity of a farm-house had tiny scraps of bright-blue paper woven into the wall; despite the meanness of the material the effect was peculiarly brilliant.¹ The goldfinch pays rather less attention to the adornment of the outside of its nest, making a few spiders' webs and fragments of bleached moss suffice. As the nest is often placed in the fork of an apple or other fruit tree, the branches of which are not uncommonly covered with patches of lichen and similar vegetation, it harmonizes well with its surroundings, and it may well escape notice altogether or be mistaken by the inexperienced eye for a knotty outgrowth from the tree itself.

Both goldfinch and chaffinch are in the habit of building the walls of their nest around one or more of the twigs on which it is supported, thus making it very firm and secure.

The Crossbill (*Loxia curvirostra*), that roving bird which is seen in various parts of the country from time to time, from the extreme north of Scotland on the one hand to Bournemouth on the other, frequents those districts which are plentifully wooded with pine and fir trees, on the branches of which it may be observed hanging in all sorts of attitudes whilst it extracts seeds from the cones with its powerful beak. It builds its nest in these same trees, often at a great distance from the ground, and always in the shelter formed by a cluster of small branches. The structure is small for the size of the bird, and is usually difficult to detect, as it may readily be mistaken for an enlargement or angle of the

¹ J. L.

THE BIRDS AT WORK

branch on which it is placed. It is composed of slender dead twigs of fir, larch, or pine, and has a lining of moss, lichens, pine needles, or fine flakes of bark, together with wool or feathers and hair.

Brehm states that he once had an opportunity of observing a female crossbill engaged in building her nest. She began by bringing dry twigs, and then went amongst the branches gathering scraps of lichen, of which she bore a whole beakful at a time to the nest and arranged them in their proper place. As soon as the framework of the nest had been put together, the bird spent some time in shaping it, pushing it with her breast and pressing it together, turning round and round meanwhile. She took all her materials from a neighbouring tree, and so industrious was she that she went on working all through the noontime, and only took two or three minutes over collecting, carrying, and arranging each load.

From the moment the first egg is laid the hen bird never leaves the nest, where her partner tends her, supplies all her wants, and sings to her while she is sitting.

NESTS COMPOSED ENTIRELY OF GRASSES AND THE LIKE

The number of birds that make their nests of vegetable substances alone, without any admixture of hair, wool, or spider's web either as ties or for the purpose of lining, or without the addition of earth and feathers, is comparatively small. The Nuthatch (*Sitta cæsia*) commonly makes such a nest of dry leaves, small twigs, chips of bark and wood, but these are so loosely heaped together in the hole of a tree that the bird can scarcely take rank as a craftsman amongst those which appear in the present chapter. The vast majority of well-constructed, cup-shaped nests owe

MORE SOLID STRUCTURES

more or less of their stability to the use of animal substances, which have greater binding powers than grass, straw, and the like. The Land-rail or Corn-crake (*Crex crex*) makes a nest of dry herbage, stalks, and grass, on the ground amidst growing corn or clover, or in a meadow ; but here again the structure is a very loose affair. A better architect and a more skilful builder is the Grasshopper Warbler (*Locustella naevia*), that shy and vigilant little summer visitor of ours, whose shrill chirping note is the origin of its name. This bird and the Pied Wagtail (*Motacilla lugubris*) build nests of coarse dry grass with finer pieces within, the wagtail using also dead roots, moss, etc. Birds generally prefer dry herbage and vegetation for their nests, for it is not only finer and more supple, and therefore easier to work with, than green leaves and stems, but also far warmer and by no means so liable to decay.

NESTS MADE OF VEGETABLE MATERIALS AND EARTH

Among the song birds there are some that increase the solidity of their nests by the addition of earth to the soft vegetable materials of which they are otherwise composed. The nests of the Blackbird (*Turdus merula*) and the Thrush (*Turdus musicus*), well known to everybody, are of this kind. Both birds excel in the art of working up earth or mud and spreading it so that it forms a hard, smooth layer. Mixing pieces of grass, etc., with the mud (just as a bricklayer mixes hair with his mortar to make it "bind" better), disposing these in a more or less circular direction—yet in such a way that the pieces cross one another—and afterwards drying the composition by the warmth of their body (which is about 109° F., or 10° higher than our own bodily temperature), they succeed in constructing a cup which is at the same time

THE PERFECT INCUBATOR

both thin and strong. This cup is surrounded by a thick coating of grass, bents, roots, and similar materials.

Consider for a moment what an excellent arrangement it all is for incubating the eggs and keeping the young birds warm and snug: the impervious lining, through which neither wind nor rain can penetrate; the stout, closely woven wrapper which keeps out the cold; could anything be better? Nothing is wanting to complete the incubator except a radiator of some kind, and a lid to prevent heat escaping at the top. Well, the parent bird provides these; its own warm body is at once both radiator and lid. When sitting on the nest, the wings are spread a little so as to cover the whole cavity, and thus every requirement is satisfied.

The need for solidity and warmth is therefore beautifully provided for in these nests; but there is still another point to notice in their construction. The inner surface of the cup is made smooth and soft, and in their method of accomplishing this the two birds differ. The blackbird lines the whole cavity with a layer of very fine grass, covering the mud wall so completely that it is entirely hidden. The thrush, on the other hand, has resort to a process of which no other bird possesses the secret. Tiny fragments of dead wood are covered with saliva, and this curious composition is spread in a thin layer over the lining of mud or cow-dung, forming a smooth, elastic surface. It is almost as if the bird laid over the floor of its little chamber a covering of cork carpet.

Similar as the nests of these two birds are in many respects, they are at once distinguishable by the nature of the lining; and there can be no mistake as regards the eggs, as every boy knows.

HOMES OVER THE WATER

NESTS COMPOSED OF LICHENS

In Great Britain, as we have already seen, the Crossbills use a variety of materials in the construction of their nests. In Sweden, however, they often build them almost entirely of lichens; and on one occasion I discovered such a nest in the north of Scotland, in a large fir wood, where the trees are hoary with tufts and tresses of this kind of vegetation.¹

NESTS BUILT OF MARSH PLANTS, RUSHES, &c.

Most of the birds that are found living in marshy places build their nests amongst the rushes which grow about the water's edge. But this situation is not without its disadvantages, for animals of all sorts are in the habit of coming to the sides of streams and ponds, which form an attractive hunting-ground for many of them, not excepting man himself; so that if every species of water bird were to nest there, not a few of them would run considerable risk of being disturbed, and perhaps destroyed. So some kinds very wisely build over the surface of the water, where they are in less danger of being interfered with.

Now and then we find a bird taking advantage of a little hummock of earth that stands above the level of the water, or a deserted shelter that has been used for wild-duck shooting, or a drifted heap of weeds and rushes, or even a piece of stranded timber; but as a rule such things are not available, and the most natural expedient is for the bird to support its nest on the reeds and rushes growing out of the water. This is what the Sedge Warblers do; on the other hand, Coots and Moorhens, which are much heavier birds, sometimes construct a sort of half-floating stage which they anchor amongst the rushes or other water plants. The Black Tern, too, does exactly the same thing.

¹ J. L.

SLENDER FOUNDATIONS

Twigs and earth would not be well adapted to such conditions, so we find that the building materials generally used are much the same as those employed by shrikes and woodcock. There used to be another bird in this country that had similar nesting habits. It was known as Savi's Warbler (*Locustella luscinioides*), and not very many years ago it was a constant inhabitant of the Cambridgeshire fens; but drainage has destroyed its favourite haunts, and you would be fortunate indeed if you were to come across a specimen nowadays.

Although the materials for its nest are the same, the Reed Warbler sets to work in a manner very different from those birds we have just mentioned, so perhaps you would like to hear about it. Suppose we take as an example the Great Reed Warbler or Reed Thrush (*Acrocephalus arundinaceus*), a bird which is common enough on the Continent, though it does not often pay a visit to our country.

In building its nest the reed thrush has to take great care to fasten it quite securely to its support, because the eggs would sink if they were to fall into the water, and the young birds too, not being provided with webbed feet, are unable to swim. Now the nest itself weighs fully two ounces, and when it contains the hen bird with her five eggs that weight is more than doubled. When the young fledglings are almost big enough to leave the nest the whole mass that has to be supported may amount to as much as three-quarters of a pound—far more than any single reed could be expected to carry! So the very first thing the bird has to do is to find at least three reeds which grow at about equal distances apart, and in such a way that they may support the nest at three or more points of its circumference. That, however, is not enough; the reeds are all the better for the purpose if they have leaves which form a fork with the stem,

NATURE'S CEMENT

and are attached to it at a convenient height, that is to say, at about a foot or a foot and a half above the water ; not too near the surface, but not too high up either, because there the stems would be so flexible that they would bend under the weight of a nest.

Having at length found three or four convenient reeds, the bird proceeds to make the framework and lay the foundation of its nest ; it has no scaffolding to stand on—not even a twig—so it is obliged to maintain itself in an upright position on one slender, swaying stem whilst carrying out this very important task. However, in spite of all difficulties, the little workman labours most industriously. He looks about amongst the rushes and reeds and sedges for withered leaves which are about a foot in length and not too stiff ; he moistens them and puts them together so that they form a fairly stout thong, and places it in the fork of a leaf. Then he gives it a twist round the stem of the reed, then round the next one, and so on, doing the same with other pieces of dried grass, all in the most careful fashion, until at length the reed stems are connected with one another just as you might tie them with a piece of string or gardener's bass.

Working in this manner from below upwards, he at length succeeds in weaving the walls of his nest, very much as a basket-maker plaits a basket.

It sometimes happens that a reed is not forked in a place quite convenient for his purpose ; then the bird moistens pieces of dried grass with his saliva, and when these are rolled round the stem they adhere quite firmly. By the same means he sticks to the framework of the walls, and especially to the bottom of the nest, fragments of broad grasses, leaves, and so on, which he plasters well over. After this, to make all comfortable, he adds a lining of the finest

A BEAUTIFUL CRADLE

herbage and vegetable down, gathered from the neighbouring plants.

If during the building operations any of the fastenings and ties seem to be weak or likely to come loose, others are added, and in this way it comes about that some nests are as much as ten inches high. In all cases they are so deep that when the sedges sway about in a high wind there is not the slightest danger of eggs or young ones falling out.

The edge of the nest is strengthened with coarse grasses woven and interwoven like the top of a basket; so you see the reed thrush leaves nothing undone to provide for its offspring a cradle which is both strong and springy; and warm too, even though it hangs over the open water of a pond or marsh.

Our native Reed Warbler (*Acrocephalus streperus*) builds its nest in a similar manner, but it is altogether a smaller and lighter structure than that of the reed thrush just described, though by no means less beautiful. Sometimes the most extraordinary skill is shown in the way the nest is poised. I have seen some which were attached at one side to a twig of a shrub which overhung the river, and on the other to a reed growing in quite a different direction; others I have found were suspended like an oriole's nest.¹ The cuckoo frequently deposits an egg in the nest of this species.

The Coot (*Fulica atra*)—sometimes called the "Bald Coot" on account of the horny oval white patch on the forehead, which shows up in strong contrast with the black plumage—is quite a common bird in many parts of Britain. Its nest is a very strong and compact structure, and of great bulk, hundreds of reeds, sedges, rushes, etc., being used in its construction. Its foundation is often below the surface of the water; yet so solid does the coot contrive to make

¹ H. C.

HOMES ON THE WATER

this great mass of material that it is often capable of supporting a very considerable weight. Sometimes the bird takes advantage of a small islet covered with rank grass, or a thick tuft of flags or rushes which grow out of the water, above the surface of which the hollow of the nest is never raised more than a few inches. When the coot has found a clump of reeds to its liking, it twists and binds them together so that they form a firm support on which it piles up the coarse materials of its nest, winding the long stems and blades round and round until the walls are strong enough. Occasionally the nest does not form an absolutely solid mass based on a fixed foundation, but is rather anchored amongst the reeds and only partly supported by them, the buoyant nature of the materials of which it is built helping to keep the upper part of the structure above water. In any case, the bird nearly always contrives to build in some situation which cannot easily be reached from the land. Although it is so bulky, the nest is by no means a conspicuous object, so perfectly does it harmonize with its surroundings, as do also the dingy, stone-coloured, brown-spotted eggs, of which the bird usually lays from seven to twelve.

The Moorhen, or Water-hen (*Gallinula chloropus*), makes a somewhat similar nest, but is far less particular about the exact locality in which it is placed. It is invariably found in the neighbourhood of water, but it may be on a mass of flags and rushes, or on the bank well above high-water mark, or even on the branch of a tree—very often on one that overhangs and dips into the water, in which case the nest may readily be mistaken for a mass of weeds which has drifted down the stream and been intercepted by the branch—such a mass as you may constantly see after flood-time. Mr. Waterton, the famous naturalist, tells us that a little brick house which he had built for a duck, and furnished

CONCEALING THE EGGS

with a comfortable nest of hay, was unexpectedly occupied by a moorhen, to the exclusion of its rightful tenant. So you see this bird can make itself quite at home in a variety of situations.

When leaving its nest deliberately—that is to say, when it is not disturbed and obliged to retreat hurriedly—the moorhen, like certain other birds, has a habit of covering her eggs with the same kind of material as the nest is composed of, and thus concealing them from the sight of possible intruders. The young birds are excellent swimmers from the first, and they take to the water almost as soon as they emerge from the shell.

FLOATING NESTS

The beautiful Water-pheasant of India, Ceylon, and Kashmir (*Hydrophasianus chirurgus*) makes a nest of grass and similar herbage, which floats on the surface of the water, though occasionally, when built in a rice patch, it is more or less fixed or anchored to the growing stems.

The Little Grebe, commonly known as the Dabchick (*Podiceps fluvialis*), is equally aquatic in its nesting habits. Almost every patch of water of moderate depth, and not too rapid, is frequented by these expert little divers. The nest is a heap of water weeds somewhere about the edge of the water or in a reed bed; it is invariably steeped in wet, and is very often half floating. The eggs, four to six in number, are white when laid, but they very quickly become stained and discoloured with mud and the decaying weeds on which they lie. Some people think the bird daubs them over intentionally in order to render them less conspicuous; however that may be, it is certain that when leaving the nest it covers them over with weeds, often taking advantage

BUILDING ENTHUSIASTS

of its skill in diving in order to obtain material for that purpose. As in the case of the moorhen, the young dab-chicks swim and dive almost as soon as they are hatched.

MULTIPLE NESTS

As a rule, a bird loses no time in proceeding to the more serious business of bringing up a young family when once its nest is completed, though, as we have seen, much labour and skill and loving care may be devoted to the preparation of their nursery. But some birds appear to revel in the exercise of their craftsmanship to such a degree that they are not content with making one nest; they build and even complete several before finally settling down to family life. We have already mentioned an instance of this exuberant instinct for construction in our chapter on the masons, but the Syrian Nuthatch is by no means the only example. The common Siskin (*Spinus viridis*) has similar proclivities, and in both cases the peculiar habit of these birds seems equally unaccountable, for owing to their manner of nesting they are not very liable to be molested, and to us there does not appear to be any particular reason why they should abandon a nest which, as far as we are able to judge, is perfectly adapted to the purpose for which it was intended, and begin their labour all over again.

The siskin inhabits countries from the British Isles eastward as far as Japan, nesting chiefly in the more northerly regions. It is a lively little bird, and until the fledglings leave the nest the cock bird sings merrily, especially while on the wing. It is seldom known to build in England, but in Scotland, amongst its favourite firs and pines, it does so regularly.

The nest is very similar to that of the goldfinch, but it is not finished with the same extreme neatness. That, how-

AERIES

ever, is a distinct advantage; placed as it usually is, on or near the lichen-covered branch of a fir tree, the outside of the nest, loosely woven with the same sort of grey vegetation, harmonizes so wonderfully with its surroundings that it is almost impossible to detect it from below, and even from above, whence it might be recognized by the cavity, it is often so perfectly concealed by a branch as to escape notice even at close quarters. It is quite possible that you may watch a siskin busily engaged in building its nest and yet, on climbing the tree, be quite unable to discover the structure. This has given rise to a curious belief in some parts of the Continent that these birds place in their nests stones which have the property of making them invisible.

NESTS MADE CHIEFLY OF STICKS, TWIGS, &c.

Birds which make the framework of their nests of twigs and sticks are very numerous, and include nearly all the diurnal birds of prey (such as eagles, falcons, hawks, kites, harriers, vultures, and buzzards), besides many others.

It is perhaps rather an excess of courtesy to include some of these birds amongst the makers of basket-work; their nests are commonly quite coarsely and roughly made, the best of them being feebly suggestive of those carelessly constructed wicker trays which are used in some countries for carrying fruit and fish; while others are mere faggots, thrown together with very little attempt at arrangement. Such structures can scarcely be called nests at all, and it is fortunate that in the case of the larger birds of prey we have another term to apply to them. This is the word "aerie" or "eyry," which is generally used when speaking of the loftily situated nest of an eagle.

The Golden Eagle (*Aquila chrysaëtus*) usually makes his eyry on a rocky platform high on the face of a precipice in some wild mountainous district, often below an overhanging

NOTICE OF TENANCY

crag, so that it can be neither seen nor approached from above. There he piles up a heap of sticks, some of them of a considerable size and an inch or more in thickness. The nest is a very large one, often fully five feet in diameter, and as the birds utilize the same eyry year after year, and add to it in each successive season, it may attain to an enormous bulk, some old nests containing, it is stated, as much as two cartloads of materials! As the latter are stout and unpliable it is obvious that the bird could do very little in the way of weaving them together, and there is practically no attempt at anything of the kind, the sticks being merely laid across one another and holding together by their very roughness and irregularity. The hollow of the nest is but slight, and even when it is lined with softer materials—which is by no means always the case—it is difficult to imagine how it can form a comfortable bed for the young birds. The eagle is an indefatigable hunter, and in districts where prey is plentiful its larder is kept well stocked with game of all kinds, such as hares, rabbits, grouse, ducks, geese, and partridges, while sometimes even lambs and fawns are carried thither by this powerful bird. In America the little “prairie-dog” is a frequent victim. In Colorado when an old nest has been repaired the bird places a bough of evergreen upon it, as if to give notice to other birds that the eyry is no longer unoccupied. When a rocky ledge is not available the nest is placed on some great tree, one which commands a wide look-out being almost invariably chosen.

The smaller birds of prey, such as Kestrels, Sparrow-hawks, Hobbies, and Buzzards, frequently avoid the trouble of building by taking possession of the deserted structure of some other bird, more especially that of a crow or magpie; they are even said to annex a new nest on some

AN INTERESTING FAGGOT

occasions, driving away the unfortunate owner by force. But though they are always ready to act on the principle that "foolish folk build fine houses for wise folk to live in," when none suitable is to be found ready-made these birds resign themselves to the inevitable and build one for themselves. Being smaller than the kingly eagle, it naturally follows that they choose smaller sticks and twigs; and as these are to a certain extent pliable, the resulting nest is both firmer in construction and shapelier than the eyry that we have described above, though still very rough and rather ragged in appearance, as you may see from the picture of the falcon's nest facing this page. M. Lescuyer has dissected and analysed a great number of nests of all sorts, and it may be interesting to give an example which is fairly typical of all those made by the birds we are speaking of, because we may gather from it some idea of the great labour and the many journeyings to and fro that go to the making of even so rough a structure as this. Suppose we take as an instance a buzzard's nest which Lescuyer tells us was built in an oak tree. He found that the foundation was composed of forty-two fair-sized oak twigs: over these the bird had placed a hundred and ninety finer twigs of the same kind of tree, thirty-five of the holly, eighty-two of the birch, and a round dozen of elm and aspen—in all, just three hundred and sixty-one separate sticks! The slight cavity in the middle was lined with earth, which not only helped by its weight as ballast to make the nest more stable, but also formed a screen capable of keeping out the wind, and thus contributed not a little to the warmth of the nest. Lastly, the bird had added an inner lining of extremely fine birch twigs, mingled with bits of bark, roots, leaves, and lichens, for the eggs to rest on.

It is interesting to note that, as Professor Newton was

PROTECTION AND RUBBISH

informed, Honey-buzzards in France erect a barrier of green boughs around the nest after the young are hatched, and replace it from time to time as the leaves wither. Whether this is intended to prevent the young birds from falling out of the nest, or as a screen, is not quite clear; probably it serves both purposes. We can recall no other instance of a bird acting in this manner.

The White Stork (*Ciconia alba*) is looked upon in the countries where it commonly dwells, such as Holland and Germany, as the type of a devoted parent. It is particularly fond of making its nest on roofs and chimneys, where a box, an old cart-wheel, or some similar accommodation is often provided for it by the householder, who regards the bird with much favour, partly because it is an excellent scavenger. The nest is a very rough structure of sticks, lined with straw, dry leaves, feathers, rags, paper, or almost any material that the bird finds at hand. When first built it is quite a shallow affair, but the birds return year after year and add a little each season, until at last it may attain a height of several feet. Where there are no buildings, the stork makes its nest on rocks or trees. During the nesting season, or when annoyed, the birds throw their heads back and make a loud clapping noise with their long, powerful beaks. The sound can be heard at a considerable distance, and it is possible to recognize it when a flock of storks is passing overhead at so great a height as to be almost invisible, as I have several times observed in the neighbourhood of Tangier in the early part of the year, when these birds migrate northward.¹

Though birds are the principal makers of basket-work, they are not quite alone in practising that industry, for the great man-like apes weave beds for themselves, and perhaps

APES AND THEIR BEDS

canopies too, in some cases ; but there appears to be a great deal of confusion in the various accounts of these structures that have been given from time to time. This is perhaps not altogether surprising, because not only are the regions where the great apes dwell difficult of access, so that but few people ever visit them, but as the animals are shy and easily disturbed, they are seldom seen occupying their nests ; and when the structure is deserted it is perhaps not always easy to tell exactly the manner in which it is used, or to what species it belongs.

But although we cannot speak with certainty about these "nests" or beds or shelters in every particular, we are able to form a general idea of their character from the accounts given by various travellers.

The Chimpanzee (*Anthropopithecus niger*) makes his bed on trees, far from the abodes of men. Some travellers have stated that the animal constructs a regular hut for itself or for its family, but this seems to be an error. According to Dr. Savage's observations published in the *Boston Journal of Natural History* as long ago as 1843, the chimpanzee builds his nest or bed by bending or partly breaking branches and twigs in such a way that they rest on a large limb of the tree, or in a crotch. The materials are crossed and perhaps interwoven a little so that they form a fairly firm platform which may be as high as fifty feet from the ground, though it is usually not more than twenty or thirty. The male animal is said to spend the night on a branch underneath the nest, and perhaps that accounts for the belief to which we have already referred, that he constructs a sort of shed.

These retreats are not permanent, but are changed in pursuit of food or solitude, according to circumstances. As a rule they are found in elevated situations, because the low grounds are often cleared by the natives for their villages

PAUL DU CHAILLU'S STORY

and rice farms. It is seldom that more than one or two nests are seen upon the same tree or in the same neighbourhood, for, unlike the monkeys, these apes associate in pairs or family parties of two adults and from two to four young ones, rather than in gangs. Occasionally, however, four or five pairs are known to take up their quarters at no great distance apart, and sometimes they assemble in rather large bands which go on excursions together.

According to Paul Du Chaillu, the *Anthropopithecus calvus*, a near relation of *Anthropopithecus niger* which inhabits the same districts, makes a still more elaborate shelter, as you may see from the picture in that traveller's book on *Explorations and Adventures in Equatorial Africa*. He states that these animals make their nest about fifteen or twenty feet from the ground on a tree which stands a little apart from others and which has no limbs below the one on which the nest is placed—probably in order that they may be safe at night from beasts, serpents, and falling branches. They build only in the loneliest parts of the forest, and are so shy that they are seldom seen even by the negroes. Du Chaillu was informed by the natives that the male and female together collect the leafy branches and strong creepers of which the nests are made. The branches are tied to the tree in the middle of the structure by means of pieces of wild vine and creepers, and are so arranged that they form a thick, leafy roof which is rounded at the top so as to make a shelter capable of keeping out the rain, like an umbrella. Under this roof the animal is said to rest on a projecting bough, with its arm about the trunk. The male and female do not occupy the same tree, but have nests not far apart. When the leaves become so dry that the roof is no longer watertight, or when he has eaten all the berries in the neighbourhood, the owner builds a new shelter in another

A FAMILY PARTY OF CHIMPANZEES IN THEIR HOME

The chimpanzee makes a bed of branches about thirty feet from the ground. The male chimpanzee is said to sleep on a bough underneath the bed.

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THE ORANG-OUTANG'S COUCH

spot. Nowadays naturalists doubt the accuracy of Du Chaillu's description of this wonderful structure. It is certain, however, that this bald chimpanzee possesses intelligence beyond that of other animals, for the famous Sally, who lived for eight years at the Zoological Gardens in London, was taught before her death to count up to ten straws, and her education was still progressing when she succumbed to our climate.

For a long time people differed in their opinions as to whether the Orang-outang (*Simia satyrus*), that great man-like ape of Sumatra and Borneo, made a "nest" or not, but that it does so is now quite certain on the evidence of such famous naturalists as Mr. Wallace and Professor Selenka. The orangs make their homes in the great primeval forests, dense and unbroken, through which they are able to travel from tree to tree as easily as a man can traverse open country.

The nest or sleeping-place, Mr. Wallace informs us, is usually constructed in one of the smaller trees at no very great distance from the ground, being seldom situated higher than fifty feet or so. It is therefore well protected from wind by the taller trees around. Professor Selenka sent one of these nests to the Berlin Academy. It consists of a sort of platform about a yard and a half in length and from twelve to thirty inches wide, composed of sticks half an inch or an inch thick. These sticks all run more or less in the same direction and are simply placed side by side or one upon another, without any attempt at interweaving, forming a bed eight or nine inches deep; and most of them are broken in the middle and doubled up, so that the two ends of a stick come together. To make his bed softer and more comfortable, the orang allows the leaves to remain on the branches just as they are when he tears them from the

IGNORANCE CONCERNING GORILLAS

tree, and he covers the surface with more big leaves of the same kind.

The Dyaks believe that the animal makes himself a fresh bed every night, but Mr. Wallace thinks if that were so the nests would be much more common than they appear to be. In passing through the forests, however, one may come upon a dozen of them in a single day, so it is just possible that the Dyaks are correct in their opinion, for in spite of the sheltered position in which these loosely made platforms are placed, the strong winds must at last blow them to pieces.

If you observe an orang as he lies sleeping, with legs drawn up and folded arms, you will be able to judge how nicely the bed we have described is proportioned to his size.

The Gorilla (*Gorilla savagei*) appears to make a bed of reed-like herbage on the ground or on the trunk of a large tree at a distance of a few feet from the earth. It was stated by a German traveller, Herr von Koppenfels, that this creature constructed a sort of nest in the trees by bending boughs together and covering them with moss and twigs. On this couch the female and young were stated to pass the night, the male remaining at the foot of the tree to guard them from the attacks of leopards. This account, however, does not receive support from other travellers, and we have still much to learn concerning the habits of these huge creatures—the largest and most powerful of the apes.

CHAPTER V

ARCHITECTS OF SPHERICAL DWELLINGS

The advantage of spherical architecture—The astute sparrow—An evil reputation—Magpie fortifications—False pretences—The wren's many houses—A tiresome partner—Catholic tastes—The squirrel's "drey"—Changing quarters—A Lilliputian genius—Sticklebacks' nests—"Jack-sharps" and "tinkers"—Homeric combats—Making a home—Wedding finery—Bringing home the partner—A careful father—Fierce battles.

ANIMALS which build nests shaped like a hollow ball, with an opening in the side, use materials similar to those employed in the construction of the cup-like nests which we have already described, but their dwellings have one obvious advantage over the latter in possessing a roof, and thus affording more complete shelter and protection to the inmates.

Such nests are made not only by many kind of birds, but by mammals also, and strange as it may seem, even by fishes.

One of the most interesting examples of the spherical style of architecture is furnished by that familiar (in every sense of the word) acquaintance of man, the common Sparrow, whose scientific name of *Passer domesticus* at once suggests its inveterate habit of attaching itself to human habitations. The birds which aroused Evander at dawn by their twittering—

Evandrum ex humili tecto lux suscitât alma
Et matutini volucrum sub tegmine cantus—

THE ASTUTE SPARROW

were no doubt sparrows. In any nook or hole in a wall or under a roof, the hollow of a waterspout, the thatch of a barn, a chimney—wherever there is room for its bulky nest, there the sparrow will establish itself with the utmost confidence. Often it takes possession of the nest of a house martin after driving away the rightful occupants, though it occasionally suffers for its audacity, for the martins have been known to “make the punishment fit the crime” by walling up the opening of the nest with mud, and thus imprisoning the unwelcome intruder. At other times the sparrow builds in a hollow tree, or in the hole made by a sand martin. The interesting point is that whenever it can find a convenient shelter such as those we have named, whether it be under a roof, in a hollow tree, or in a hole in a sand-bank, the sparrow makes a cup-shaped nest; it is only when it is placed in an open tree or hedgerow, or in ivy or some other exposed situation, that the nest is spherical. Then it is thickly roofed over with a dense mass of material which effectually protects the interior from rain, and it appears probable that this was the original method of nidification, but that the sparrow found it could save itself a vast amount of trouble and labour by taking advantage of the roofs made by other bipeds, such as men and martins, and very astutely adopted a policy of protection at the expense of others, flourishing exceedingly ever afterwards.

The nest is, for the size of the bird, a very cumbrous structure; it is made of hay, straw, wool, rags, scraps of paper, or any other dry substance that comes handy, and is, as a rule, lavishly lined with feathers. The sparrow begins housekeeping early in the season; the first brood is ready to leave the nest in May, and others are produced in the course of a year. Owing to their numbers these birds, which are harmless and pleasant companions in towns, do an immense

MAGPIE FORTIFICATIONS

amount of damage in the country to the crops in both fields and gardens.

The nest of the Magpie (*Pica pica*) is usually placed high up in the fork of the tree, but is sometimes found in thorn bushes and tall hedges. It is a large domed structure composed mainly of dry branches, the projecting thorns on which render it very secure from the intrusion of the smaller birds of prey. The lower part of the nest forms a deep cup, and the sticks are there cemented together by a layer of mud or clay. Within there is a double lining of fine twigs and, lastly, rootlets; an arrangement which has important advantages, for when the nest is exposed to a heavy storm a considerable quantity of rain may fall into the cavity without swamping the eggs or young before it has time to filter out through the mud wall. Besides this, it makes a very springy bed. Lescuyer relates that on one occasion when he wished to secure a magpie's nest, he gave instructions for the thin branch on which it was situated to be sawn off the tree. This was done; the nest and bough fell to the ground together, a distance of about seventy feet, but so soft and elastic was the lining of the nest that the single egg which it contained was found to be uninjured.

For the dome of the nest the bird selects long, tough, thorny twigs, which it fixes firmly into the general structure and crosses in all directions, so that they form an open network which does not entirely conceal the interior; nevertheless, it constitutes a strong fortification which makes it possible for the magpie to build in an isolated tree where its nest is often a conspicuous object. As this bird is not armed with beak and claws capable of placing it on equal terms with the birds of prey, it would in such a situation stand a poor chance in the struggle for existence if the nest

FALSE PRETENCES

were not provided with some such defensive covering. Two openings which are left in the sides afford the magpie a convenient way of passing in and out, but they are only just as wide as is absolutely necessary for that purpose, so that any large bird, such as the buzzard or carrion crow, would find itself at a disadvantage in attempting to make its way into the nest with hostile intentions (illustration, p. 87).

It has often been observed that magpies have a habit of building several nests at the same time, though they only finish the one which is destined to contain the eggs. Their object appears to be that of putting their enemies on the wrong scent.

Mr. Nordmann says: "Four or five pairs of magpies have nested for several years past in the Botanical Gardens at Odessa, where I live. The birds know me very well—me and my gun—and although they have never been molested, they are up to all sorts of tricks to mislead any one who appears to be watching them. They build in a little wood of old ash trees not far from the houses, between which and the wood there are some acacias and large elms. In these trees the wily birds build sham nests, every pair making at least three or four, and this keeps them busy until March. During the day, especially when they perceive anybody watching them, they are as busy as can be, and if by chance some one comes to disturb them they fly around the trees and make a great deal of noise and fuss; but all that is the merest pretence, for all the while they gradually push on with the construction of the nest in which they intend to lay, working there very quietly and secretly, as it were, at daybreak and at dusk. If some inquisitive person surprises them when so engaged, they immediately fly back, without a sound, to their other nests, and set to work again as though nothing had happened, in the same

A TIRESOME PARTNER

noisy, excited way as before, with the object of distracting attention."

Very different from the rough, strongly fortified construction we have just described, the thorny walls of which seem to cry out a warning *noli me tangere* to possible intruders, is the beautiful domed dwelling made by the Wren (*Anorthura troglodytes*). The fondness for building seems to be even more remarkably developed in this lively little bird than in the siskin or Syrian nuthatch, indeed it amounts almost to a monomania. Not only do the paired wrens frequently make several nests, but the cock birds which have not yet found a mate are often equally industrious. Many explanations of this habit have been suggested, but none of them appears to be quite satisfactory. Are the nests intended merely for arbours or pleasure houses, or are they built in anticipation of future broods? Boenigk observed some wrens from April until August, and saw one cock bird almost finish four nests before he met with a partner. After pairing, the couple together constructed four other nests, but for some unknown reason they did not settle down in any of them. At last the hen bird lost all patience and deserted her partner, who treated the matter very philosophically and went on building for several weeks longer, during which time he finished and abandoned two more nests. Many naturalists are of opinion that they are intended as houses of refuge to which the birds can retreat for shelter during inclement weather, for wrens are very susceptible of cold, and in winter-time a whole family of them will often huddle together in some hole or cranny for mutual warmth.

To make good use of any materials that come to hand is the test of a born craftsman, and in this the wren excels. Not in the substance only, but in the situation of his nest he displays most catholic tastes; it may almost be said that he

THE SQUIRREL'S "DREY"

can build anywhere and with anything. He will fix his dwelling in a tree or on the ground, in the hollow of a tree trunk or in a hole in a bank or wall, in a bush or the crevice of a rock, under a low roof or the root of a tree, or in a wood pile. I have seen them in all these situations.¹ As for materials, though the nest is often carefully woven of moss and lichens, or moss, grass, and leaves, it is sometimes formed of hay and straw, and frequently there is a lining of feathers. The outer materials are usually taken from the surroundings, and both the nest as a whole and the opening in the side are beautifully rounded.

MAMMALS

The Squirrel (*Sciurus vulgaris*) is, as everybody knows, arboreal in its habits, and the ease and grace with which it leaps from bough to bough are wonderful to see. Living thus in trees, and descending but seldom to the ground, it is not surprising to find that it builds itself a dwelling up aloft, much as the birds do; indeed it is usually not satisfied with one home but makes several, and it is no very uncommon thing to find a single individual or a pair of squirrels possessed of as many as four nests, some of them being, perhaps, those of magpies or crows, which the animal has adapted to its own use. The 'drey' or nest in which it passes the night and in which the young are reared is always, however, constructed by the squirrel itself, either in the fork of a bough or in some hole or hollow in the stem of a tree. It is ball-shaped, and composed of twigs, fibres of bark, and leaves, all carefully intertwined. The dome or upper part of the nest is dense and thick enough to keep out the rain, while the interior is softly bedded with moss and leaves. The principal opening is near the lower part of the nest, and usually, it is said, on the east side; there is frequently

¹ J. L.

CHANGING QUARTERS

another aperture, smaller and not so well defined, opposite this. During a storm the openings are carefully blocked should the wind happen to blow from the side on which they are situated, and so they are also during the winter when, in England and other countries of the northern parts of its range, the squirrel hibernates. Even in winter, however, the animal ventures out at intervals on mild sunny days to feed on the stores of nuts and beech-mast which it has laid up in several of its haunts for future use. It is well known that in case of danger squirrels will at once abandon the dwelling they happen to be occupying at the time and take up fresh quarters in one of the accessory nests, removing their young one by one to the new nursery, which may be situated at a considerable distance through the tree tops.

Well constructed and comfortable as is the nest of a squirrel, it falls short of that made by the Harvest Mouse (*Mus minutus*) in both respects. This tiny creature is at once the most elegant and, excepting only the lesser shrew, the smallest of the British mammals, seldom weighing more than one-sixth of an ounce. It frequents cornfields and pastures, and is scarcely ever found in the neighbourhood of houses except when carried home in the sheaves of corn. In winter it makes a burrow in which it passes the cold months in a state of torpor; it is, however, of its summer residence or nursery that we have to speak. This nest is, as described by Gilbert White who first discovered the animal in England, "perfectly round and about the size of a cricket ball." It is suspended amongst the cornstalks, or occasionally in a bush two or three feet from the ground, or even on a stem of a reed, with which it sways about in the breeze. The walls are made of blades of the wheat or grasses amongst which the nest is built, and are plaited and interlaced with extraordinary skill. The little architect takes

STICKLEBACKS' NESTS

the broader leaves between its teeth and tears them up into strips before using them, and the whole structure is so beautifully and compactly woven together that White found it "would roll across the table without being discomposed, though it contained eight little mice that were naked and blind." The nest is lined with vegetable down and other soft materials, and has a tiny opening in the side which, however, the mother takes care to close whenever she leaves her little ones while she goes to feed. So ingeniously and perfectly does she cover up the hole under these circumstances that it is a matter of impossibility to discover where the entrance has been. The young are soon able to look after themselves, and they leave the nest before the herbage of which it is composed has had time to wither. Their nursery is thus always of the same colour as its surroundings—an important consideration as far as the safety of its occupants is concerned.

We find other builders of ball-shaped nests amongst the fishes, a circumstance which has always seemed very wonderful to naturalists.

Everybody knows the common Stickleback, a pretty little fish which is very plentiful in our ponds and streams. It is no favourite amongst anglers, because it often comes to nibble at their bait and arouses vain hopes which end in disappointment; while a man who has a fish-pond which he wishes to have well stocked with carp and the like becomes very angry indeed if he finds sticklebacks there, for their numbers increase rapidly and they are greedy creatures, so that they very soon destroy all the other inhabitants of the pond.

With all the rest of the world against them, it is but fair that sticklebacks should receive a little kindly attention from learned people who do not worry about practical

HOMERIC COMBATS

things, and who find these fishes very interesting for several reasons.

The Three-spined Stickleback, or "Jack-sharp," is the commonest kind, though the ten-spined species, which is popularly known in some districts as the "Tinker," is also very plentiful. The Jack-sharp's body is very thin, as though it had been squeezed on both sides, and ends in a tail which is not forked, but spreads out like a fan. Its back and sides are armed with exceedingly sharp spines, which lie close against the body when their owner is undisturbed, but stick out and look very terrible indeed when he thinks he is in danger. He is a hot-tempered little fellow; when he is at rest he glistens as though he were covered with quicksilver, but if you annoy him ever so little he becomes red with anger, then turns pale, then purple, in the most surprising way. You can see these changes particularly well if you place two male sticklebacks in the same aquarium. The single combats in which they engage are Homeric, and it would require the aged Poet himself to narrate all the varying fortunes and all the changing aspects of the combatants, from the dull green of the vanquished to the brilliant purple of the victor. The most interesting thing of all, however, is the way in which the stickleback looks after the safety of his offspring. Curiously enough, it is the male who attends to this matter; the mother, contrary to what we find in the case of so many animals, troubles very little about it.

When a male stickleback is tired of living all alone and thinks he would like to have a family, you may see him swimming about in every direction in a restless manner, as if he were seeking something. What he is trying to find is nothing more nor less than a suitable place to build a nest. When he has discovered one, he fetches in his mouth

WEDDING FINERY

bits of dead plants, scraps of leaves and shreds of algæ, which he brings back to the chosen spot and lays down carefully, spreading them out like a soft carpet. He places the pieces so that they cross one another in all directions; he weaves them, after a fashion, and rubs himself against them so that they become stuck together by the sticky fluid which oozes out of his skin, and glued to the underlying mud. But this bed, however well it may be made, has a tendency to float upwards because it is so light, and if that were to happen all the work would have to be begun over again. To guard against such an occurrence, the stickleback fetches little stones and places them on the leafy carpet, and so prevents it from rising to the surface. The foundation, however, is not yet firm enough; a second layer is put on the top of it, then a third, and so on until the whole is sufficiently strong. After that, the stickleback pays no further attention to the part in the middle but contents himself with building round the edges; in other words, he makes a kind of circular wall, leaving the central part hollow, like a cup. The outer coats of the nest are woven quite roughly and form a mere tangle, whereas the interior is an object of peculiar care, and is made of the softest algæ and the finest mud. The walls rise further and further, not straight, but so that they gradually meet at the top, until at last the nest is finished: a hollow ball the size of your fist, with a nicely rounded hole at one side which serves as an entrance, and just opposite this another opening which is smaller and not so neatly shaped.

The stickleback, whose colouring was still rather dull a little while ago, is now decked out in the gayest fashion; his back turns a beautiful emerald-green, his eyes sparkle, while a lovely red tint appears on his cheeks and the under side of his body. Altogether he looks in excellent trim

FIERCE BATTLES

after his labours. In this natural finery he brings to his little house the female stickleback, who deposits her eggs in the nest and then swims away again. The male, however, stays at home and watches over his offspring jealously and with the greatest care, remaining almost motionless except for his fins, which he waves to and fro very rapidly and thus produces currents so that the water surrounding the eggs is continually changed. Now and then he puts his head in at the window to make sure that all is well, and, being satisfied, comes out again to keep watch. The new-laid eggs would furnish a royal feast for the neighbouring fishes, and the frail shelter is threatened by many enemies; even the female sticklebacks are such cruel mothers that they would enter the nest if it were left unguarded and devour the whole "sitting." But the male fish's fatherly instinct is the source of unequalled daring and courage; small as he is, he copes with all assailants, taking no rest and giving no quarter, and after tremendous battles he usually ends by putting his enemies to flight badly wounded.

When the eggs are hatched the rash youngsters show a disposition to wander away, but their father drives them home again, and it is only when they are becoming strong enough to take care of themselves to some extent that he will permit them to set out and seek adventures of their own.

CHAPTER VI

MAKERS OF MOUNDS

ANTS

Ant-hills—The ant's adaptability—Rival builders—The roof of the nest—Doorways—Life in the open—Wood ants compared with other species—Closing the doors at night—On guard—Early morning scene—Keeping out the rain—How a nest is made—How to watch ants at work—Formation of halls—The living-room—Earth nests of the mason ants—Methods of the black ants—Home of the brown ant—Columns, walls, and buttresses—Streets and crossings—Range of nurseries—Studying the weather—Night work—Working in the rain—Laying out a new story—Building walls—Vaulted chambers—Putting in the ceilings—Taking advantage of the rain—A successful ruse—Black ants—Marking out a new story—An industrious labourer—Road making—An error of judgment—Advantages seized—Independent labour—Nature's implements—Robbers' caves.

ANTS, as we know, form huge societies, and most of them build vast dwellings which we call ant-hills—tumuli or mounds remarkable not only for their size, but also for the ingenuity with which they are planned and the skill displayed in their construction.

Before describing one of their habitations it is as well to make a general statement of considerable interest concerning these insects, namely, that they know how to adapt themselves to a considerable extent to the circumstances of the moment and to the surroundings amidst which they happen to find themselves. Their operations are governed by no hard-and-fast rules; for instance, the species which makes its

RIVAL BUILDERS

nest under a stone when living on barren ground may under other conditions raise a dome of twigs. "The characteristic feature of the art and architecture of ants," says Forel, "is the complete absence of any unalterable plan. They understand to perfection how to modify their constructions according to circumstances and to seize upon every advantage. Moreover, every worker proceeds with its task independently, following out a plan of its own; and sometimes it receives no assistance from its companions until they have understood and adopted its scheme. Naturally, they are often at cross purposes, one destroying what another has made. In this we have the key to the construction of their labyrinths. As a rule, the worker which hits upon the best method and shows the most determination succeeds, not without struggle and competition, in getting its idea adopted by the majority of its companions and finally by the whole colony. But scarcely has it got its own way, than another individual comes forward and in its turn forms a party, and the first is soon lost in the crowd."

NESTS BUILT PARTLY OF EARTH

The nests of most species of ant are excavated in the ground, and are surmounted by mounds composed of earth mixed with various other materials and pierced with galleries continuous with those in the subterranean portion of the nest.

Amongst the largest of the ant-hills found in woods are those made by the red Wood Ants (*Formica rufa*), of which Huber has given the following interesting account:—

"The little mound which seems, at the first glance, to be nothing more than a mass of materials heaped up in confusion, is in reality an invention adapted in a manner as in-

DOORWAYS

genious as simple, to carry off the waters from the ant-hill, to protect it from atmospheric influences and from hostile attacks, and to temper the sun's heat or retain its warmth in the interior of the nest. The heap of materials of which it is composed always takes the shape of a rounded dome, whose base, often covered with earth and pebbles, forms a zone above which the wooden portion of the building rises like a sugar-loaf.

But this is merely the outer covering of the ant-hill; the larger portion descends underground to a greater or less extent and is thus out of sight.

Funnel-shaped avenues, carefully though irregularly constructed, lead from the roof to the inside of the nest, their number varying accordingly to the population and extent of the colony. The entrance is not always the same width; sometimes we find one large opening at the top, but usually there are several apertures of similar size around which many narrower passages are placed almost symmetrically, disposed in circles right down to the level of the ground.

These doorways were necessary to give a free passage to the vast multitude of labourers of which the colony is composed; not only do the insects emerge when it is necessary for them to do so in order to work on the outside of the nest, but differing greatly from other species who gladly remain inside where they are sheltered from the sun, the red wood ants prefer living in the open air, and do not hesitate to carry on the greater part of their operations in our presence.

If we examine the dwellings of the yellow ant, the black ant, the sanguine ant, the brown ant, etc., we find that the openings are never so wide as to allow their enemies to gain admission easily, or to permit the rain to enter. Their habitations are covered with a dome of earth, closed on all sides; the only outlet is near the base, and even that is ap-

CLOSING THE DOORS AT NIGHT

proached by a long and tortuous passage that winds to a distance of several feet through the grass. The smallness of these doorways, which are always carefully guarded inside, prevents the entrance of any insects or reptiles that might otherwise creep in.

During the day, when they are collected in crowds upon the dome of their nest, the wood ants have no fear of being disturbed inside; but in the evening when they have retired to their quarters, and can no longer perceive what is going on outside, how are they protected from the dangers by which they are threatened? And why does not the rain penetrate into a dwelling which has doorways on all sides? Naturalists do not appear to have paid any attention to these simple questions. Can it be that they have not foreseen what misfortunes would have happened to these ants if the wisdom which governs the universe had not provided for their safety? Struck with these reflections when I noticed the red wood ants, I turned the whole of my attention to this subject and was not long left in doubt.

I noticed that the appearance of these ant-hills was constantly changing, and that those roomy approaches where so many ants could pass one another freely at midday became gradually narrower towards night and at last disappeared altogether: the dome was closed on all sides and the ants retired to the bottom of their nest.

By observing the ants' doorways for the first time, I got a much clearer idea concerning the work of the inhabitants: until then I had not been able to understand exactly what object they had in view, for the surface of the nest presented such a busy scene, and so many insects were occupied in carrying materials in all directions, that the only impression I had received was one of confusion.

I then saw clearly that they were engaged in stopping up

EARLY MORNING SCENE

their passages, for which purpose they first brought up little pieces of wood to the neighbourhood of the galleries they wished to close, and then placed them above the aperture or even, in some cases, sank them into the thatch. After that they went for more fragments and laid them across the top of the first, and they appeared to choose smaller pieces as the work approached completion. At length they brought in a number of dried leaves and other larger materials, with which they covered the roof. Is not this, on a small scale, the art of our builders when they form the covering of any building? Nature seems everywhere to have anticipated the inventions of which we boast, and this is doubtless one of the most simple.

Our little insects, now in safety in their nest, retire gradually to the interior before the last passages are closed, and one or two only remain outside or concealed behind the doors to keep guard, while the others either rest or engage in various occupations in the most perfect security.

I was impatient to know what took place in the morning upon these ant-hills, so I visited them at an early hour. I found them in the same state in which I had left them overnight. A few ants were wandering about the surface of the nest; others issued from time to time from under the margin of the little roofs found at the entrance of galleries; and I soon saw others appear and begin to remove the wooden bars that barricaded the entrance, which they readily succeeded in doing. This labour occupied them for several hours. At length the passages were free, and the materials with which they had been closed were scattered here and there over the ant-hill.

Every day during the fine weather I was a witness to similar proceedings both morning and evening.

On rainy days, however, the doors of all the ant-hills

FORMATION OF HALLS

remain closed. When the sky is cloudy in the morning and it seems likely to rain, the ants, who are apparently aware of it, only partly open their doorways and hasten to close them again when the rain commences. It would appear from this that they are quite conscious of the reason for which they form these temporary closures.

To have an idea how the straw or stubble roof is formed, let us take a view of the ant-hill from the beginning, when it is simply a hollow in the ground. Some of its future inhabitants are seen wandering about in search of materials fit for the outside work, with which they at once make a rough but sufficient covering for the entrance; whilst others are busy mixing the earth which has been thrown up in hollowing the interior with fragments of wood and leaves which are continually being brought to them. This gives a certain solidity to the edifice, which increases in size daily.

Here and there our little architects leave cavities where they intend to construct galleries leading to the exterior, and as every morning they remove the barricades of the night before, the passages are preserved during the whole time the nest is being made. We soon observe that it becomes convex; but we should be greatly mistaken if we considered it *solid*. This roof is intended to include many apartments or stories.

I observed the motions of these little masons through a pane of glass which I fixed up against one of their dwellings, so I can speak with some degree of certainty about the way in which they are built.

It is by excavating or mining the under portion of their edifice that they form their spacious halls, which are low and of heavy construction, but convenient enough for the use for which they are intended, that is to say, for receiving at certain hours of the day the larvæ and pupæ.

EARTH NESTS OF THE MASON ANTS

These halls have free communication with each other by galleries made in the same manner. If the materials of the ant-hill were merely interlaced, they would give way too easily and fall into confusion every time the ants attempted to put them right again. This, however, is avoided by their tempering the earth with rain-water, so that it afterwards hardens in the sun and completely and effectually binds together the various substances; fragments can then be removed without injury to the rest. Besides, it keeps out the rain, and even in the wettest weather I never found the interior of a nest soaked to more than a quarter of an inch from the surface, provided that it had previously been in good repair and not deserted by the inhabitants.

The ants are extremely well-sheltered in their chambers, the largest of which is near the centre of the buildings. This apartment is much loftier than the rest, and crossed only by the beams that support the ceiling; in it all the galleries terminate, and it forms a common living-room for most of the inhabitants.

As to the underground portion, it can only be seen when the ant-hill is placed on a slope; the whole of the interior may then be brought into view by simply raising up the straw roof. The subterranean residence consists of a range of apartments excavated horizontally in the earth."

NESTS BUILT ENTIRELY OF EARTH

Several ants build their nests entirely of earth, and deserve to some extent the name of Mason Ants given to them by Huber.

"There are," he says, "several species of mason ants. The earth of which their nests are composed is more or less compact. That employed by ants of a certain size, such as

AN ANT-HILL BY DAY

The red wood-ants cover their dwelling with a thatch of leaves and straw or pine-needles, to keep their nurseries and living-rooms warm and dry. During the daytime in fine weather the roof is crowded with busy insects, but at nightfall or when it begins to rain the ants retire within the nest and "shut up house" by closing all the entrances with bits of stick and leaves.

HOME OF THE BROWN ANT

the black and mining ants, appears to be less carefully chosen and forms a paste less fine than that of which the brown, microscopic, and yellow ants form their abode. It is, however, adapted to their capacities, to their needs, and to the nature of the edifice they intend to build.

To form a correct judgment of the interior arrangement of an ant-hill, it is necessary to select such as have not been accidentally spoiled, and the shape of which has not been altered by local circumstances; a little attention will then be enough to show that the homes of different species are not constructed after the same system.

Thus the hillock raised by the black ants always has thick walls formed of coarse, lumpy earth, well-marked stories, and large chambers with vaulted ceilings resting upon solid pillars; we never find roads or galleries properly so called, but large passages of an oval form, and all around them large cavities and extensive embankments of earth. We further notice that the little architects have preserved a certain proportion between the widely arched ceilings and the pillars which are to support them.

The brown ant, which is one of the smallest, is particularly remarkable for the extreme finish of its work. Its body is of a shining reddish brown, its head a little deeper and the antennæ and feet a little lighter in colour. The abdomen is dark brown, the scale narrow, squared, and slightly scalloped. The body is an eighth of an inch in length.

This ant, one of the most industrious of its tribe, forms its nest in stories rather less than half an inch in height. The partitions are not more than one twenty-fifth of an inch in thickness, and the substance of which they are composed is so finely grained that the surface of the inner walls appears quite smooth and unbroken. These stories are not horizontal; they follow the slope of the ant-hill, so that

RANGE OF NURSERIES

each curves over all those which lie below it, down to the ground floor, which communicates with the subterranean lodges. They are not always, however, arranged with the same regularity, for ants do not follow an invariable plan; it appears, on the contrary, that nature has allowed them a certain amount of freedom in this matter, and that they can vary their method at will according to circumstances. But however fantastical their habitations may appear, we always observe that they have been built in concentric stories.

On examining each story separately, we see a number of carefully formed cavities or halls, lodges of narrower dimensions, and long galleries which serve for general communication. The arched ceilings covering the most spacious places are supported either by little columns, slender walls, or regular buttresses. We further notice chambers that have but one entrance, communicating with the lower story, and large open spaces serving as a kind of crossing or junction in which all streets terminate.

Such is the general plan on which the habitations of these ants are constructed. Upon opening them we discover the apartments, as well as the large open spaces, filled with adult ants; but we always find their pupæ collected in chambers which are nearer to or further away from the surface according to the time of the day and to the temperature; in this respect ants are endowed with great sensibility and appear to know what degree of heat is best suited to their young.

The ant-hill contains sometimes more than twenty stories in its upper portion, and at least as many under the surface of the ground, an arrangement which must enable the ants to regulate the heat to a nicety and with the greatest ease. When a too-burning sun makes the upper apartments overwarm, the insects withdraw with their little ones to the

STUDYING THE WEATHER

bottom of the ant-hill. The ground floor becoming, in its turn, uninhabitable during the rainy season, the ants of this species transport what most interests them to the higher stories, and it is there that we usually find them assembled with their pupæ and eggs when their apartments underground are flooded.

Having ascertained the internal arrangement of their habitations, it still remained to discover how ants, making use of such a harsh material, could trace out and complete works so extremely delicate with the assistance only of their teeth; how they could soften the earth for the purpose of mining, kneading, and building with it; and what cement they employed to make the particles adhere to one another. Did it depend upon a sort of mucilage or resin, or some other liquid furnished by the ants themselves, resembling that which the mason bee employs in building the nest to which it gives so much solidity? I ought, perhaps, to have analysed the earth of which the ant-hills are composed, but I hesitated to engage in a difficult task which hardly came within my province. I therefore kept to the slow but sure method of observation, by which I hoped to obtain the same result.

I hastened, then, to observe one of these ant-hills until I should perceive some change in its form.

The inhabitants of the nest I had selected stayed at home during the day, or only went out by the subterranean galleries which led into the meadows several feet away. Though there were two or three small openings on the surface of the nest, I saw none of the labourers pass out that way, because it was too much exposed to the sun, which the insects greatly dread. This ant-hill was round in shape; it rose in the grass at the border of a path and was uninjured.

LAYING OUT A NEW STORY

I soon perceived that the freshness of the air and the dew invited the ants to walk over the surface of the nest, where they began making new openings. Several ants might be seen arriving at the same time, thrusting their heads from the entrance, moving their antennæ, and at last venturing out to wander about in the vicinity.

This reminded me of a curious opinion of the Ancients, who believed that ants laboured during the night when the moon was at its full. Perhaps this belief was not entirely without foundation, for although it is certain that the moon had no kind of influence on their conduct, I perceived that there was a certain amount of truth in the observation.

Having noticed the movements of these insects during the night, I found that they were almost always abroad and busy about the dome of their dwelling after sunset. This was exactly the reverse of what I had observed in the conduct of the wood ants, who go out only in the daytime, and when evening comes close their doors. The contrast was still more remarkable than I had previously supposed, for upon visiting the brown ants some days later during a gentle rain I saw them make full use of their architectural skill.

As soon as it began to rain they left their subterranean residence in great numbers, re-entered it almost immediately, and then returned bearing in their jaws pellets of earth which they deposited on the roof of their nest. At first I could not imagine what this was intended for, but I soon saw little walls start up on all sides with spaces left between them, while in several places columns ranged at regular distances announced halls, lodges, and passages which the ants proposed to construct; it was, in short, the laying out of a new story.

I watched the most trifling movements of my masons with great interest, and I soon found that they did not work in

VAULTED CHAMBERS

the same way as wasps and humble bees when occupied in constructing a covering to their nest. The latter sit astride, as it were, upon the border or margin of the covering and take it between their teeth to shape and thin it as they wish. The wax of which it is composed, and the "paper" which the wasps employ, moistened with a sort of glue, lend themselves to this kind of work ; but the earth of which the ants make use has often but little tenacity, and must be wrought in a different manner.

Each ant, then, carried between its jaws the pellet of earth it had formed by scraping the bottom of its dwelling with the end of its mandibles. This little mass of earth being made of particles only just collected together could readily be moulded just as the ants wished, and when they had put it into the position it was intended for, they divided it and pressed upon it with their jaws so as to fill up the smallest crannies of their wall. Their antennæ followed every movement, touching each pellet of earth ; and as soon as a particle had been placed in position, the whole mass was made more compact by being lightly pressed by the fore feet. This work went on very quickly.

After tracing out the plan of their masonry by laying here and there foundations for the pillars and the partitions they wished to erect, the insects raised them higher by adding fresh materials. It often happened that two little walls, which were to form a gallery, were raised opposite one another, a little distance apart. When they had reached a height of rather less than half an inch, the ants busied themselves in covering in the space left between them by a vaulted ceiling.

After a while they ceased to work upwards, as if they considered the walls high enough ; they then placed particles of moistened earth against the interior and upper part of

PUTTING IN THE CEILINGS

each wall almost at right angles to it, thus forming a ledge which would, as it extended, join that coming from the opposite side. These ledges were about one twenty-fifth of an inch in thickness, and the breadth of the galleries was usually about a quarter of an inch.

In one part several upright partitions formed the scaffolding of a lodge which communicated with a number of corridors by openings in the masonry, in another place there was a regularly formed hall with numerous pillars sustaining its vaulted ceiling. Further on it was possible to recognize the plan of one of those squares of which we have spoken before, in which several avenues terminate, and these were the most spacious parts of the ant-hill; yet the work of constructing a ceiling to cover them in did not appear to cause the labourers any embarrassment, even though the spaces were often two inches or more in breadth. The first foundations of such a ceiling were laid in the angles formed by the upper part of the different walls, and from the top of each pillar, as from so many centres, a horizontal and slightly convex layer of earth was carried forward to meet the several portions coming from different points of the large public thoroughfare.

The busy crowd of masons arriving from all parts with the load of concrete they wish to add to the building, the order they observe in their operations, the prevailing harmony, and the eagerness with which they avail themselves of the rain to increase the height of their dwelling, present a most interesting spectacle to one who is a lover of nature.

I was sometimes afraid that the building was not strong enough to support its own weight, and that the wide ceilings, sustained only by a few pillars, would fall into ruin from the rain continually dropping upon them; but I was reassured when I saw that the earth which the insects brought stuck

TAKING ADVANTAGE OF THE RAIN

together everywhere on the slightest contact, and that the rain, far from lessening its cohesiveness, appeared to add to it, thus making the building still more secure instead of causing any damage.

The parcels of moistened earth, which are only held together by contact, seem to require a fall of rain to cement them more closely and to varnish over, as it were, the ceilings they compose and the walls and galleries which are not yet covered in. Then all unevenness of the masonry is removed, and the upper part of the stories, composed of so many separate parts brought together, presents a united layer of compact earth which requires nothing but the heat of the sun to make it perfectly solid.

It is not to be supposed, however, that a too violent storm will leave the apartments uninjured, especially when the ceilings are almost flat ; but under these trying circumstances the ants quickly restore them with wonderful patience.

These different labours were carried on at the same time all over the ant-hill we have been describing, and they succeeded one another so rapidly in the various quarters that a complete story was added in the course of seven or eight hours. As all the vaulted ceilings stretching from wall to wall were at one level, they eventually joined edge to edge and formed when finished but a single roof. Scarcely had the ants completed this story when they began constructing another, but they had not time to finish it, as the rain ceased before it was completely roofed in. They took advantage of the dampness of the earth, however, and went on working for a few hours longer ; but a keen north wind sprung up and dried the collected fragments so quickly that they lost their adhesiveness and fell into powder. Finding their efforts were ineffectual, the ants at last became discouraged and left off building ; and to my astonishment they then destroyed

A SUCCESSFUL RUSE

all the apartments and walls that were still uncovered, and scattered the debris over the last story of the ant-hill.

These facts prove beyond doubt that the ants use neither gum, nor any other kind of cement, to bind together the materials of their nest, but knowingly take advantage of the rain to work and knead the earth, leaving the sun and wind to consolidate it. In the simplicity of these means I recognized Nature's own methods, but I thought I ought to verify my results by experiment.

A few days later I attempted to excite the ants to begin work again by an artificial shower. With this object I took a stiff brush and after dipping it in water I drew my hand backwards and forwards over the bristles, causing a fine spray to fall upon the ant-hill. The insects within perceived the dampness of their roof and came out, running quickly over the surface. The sprinkling was continued; the masons were deceived; they went to the bottom of the nest for little masses of earth, which they brought up and laid on the roof, and they built walls and chambers—a complete story, in short—in the course of a few hours.

I frequently repeated this experiment and always with the same success. It is in the spring more especially that the mason ants take advantage of the rain to enlarge their nest; they even work by night, and I have often noticed in the morning stories that had been completely constructed between sunset and sunrise.

The ants are not content with adding to the height of their dwelling; they also hollow out underground apartments which are still more spacious than those above, and the materials which they excavate are used as we have said, for the outer works. The art of these insects therefore con-

BLACK ANTS

sists in their knowing how to carry on two contrary operations, mining and building, at the same time, and how to make the one subservient to the other.

What is still more singular, they display the same genius in excavating as in building above-ground. The moisture which penetrates to the bottom of their nest is doubtless of great assistance to them in their labour.

The black ants, *Formica fusca*, build in a manner very different from the brown ants. We have already seen from the description of their dwelling that it is exceedingly simple and heavy in its construction as compared with the latter, but its simplicity was favourable to the object I had in view of examining, if possible, how many ants could work together intelligently on the same design, and of discovering whether they acted independently, or helped one another; of their own accord, or from some general impulse.

I do not flatter myself that I have solved these important questions, but the facts I am about to describe will at all events throw some light on the subject.

When the black ants wish to add to the height of their dwelling, they begin by placing over the roof a thick layer of earth, which they bring from the interior, and in this they trace the plan of a new story in low relief.

They first hollow out here and there, more or less close to each other, little dykes of a breadth proportioned to the use for which they are intended, and all of very nearly the same depth; the masses of earth left between them afterwards serve for the foundation of the inner walls, so that when the useless earth has been removed from the bottom of each chamber and the foundation of the walls reduced to a proper thickness, all the architects have to do is to increase the height of the building and build a roof over the apartments.

AN INDUSTRIOUS LABOURER

After observing the manner in which these ant-hills were constructed I felt that the only way of thoroughly understanding the secret of their organization was to watch carefully the behaviour of individual labourers. My notebooks are filled with observations of this kind, and I will quote a few of the more interesting. I will describe, then, the operations of a single ant whose movements I followed until my curiosity was satisfied.

One rainy day I noticed a labourer digging the ground near the entrance to an ant-hill. It placed in a heap the fragments it had scraped up and made them into little pellets, which it deposited here and there over the nest. Time after time it returned to the same place, apparently with some definite object in view, judging from the eagerness and perseverance with which it worked. First I remarked a slight furrow excavated in a straight line, which apparently represented the beginning of a road or gallery. I watched every movement. The labourer next made the furrow wider and deeper, clearing out its borders; and after a while I was satisfied that it intended opening up a road leading from one of the stories to the chambers underground. The path, about two or three inches in length, and formed by a single ant, was open above and bordered on each side by an embankment of earth; the gutter-like hollow of it was quite smooth, for the architect had removed every superfluous particle of earth. I followed and understood so well what this ant was doing, that I could nearly always guess what its next proceeding would be and which fragment it was about to remove.

Beside the opening where the path ended there was a second to which a road had to be made. The same ant carried out this undertaking also, and without any assistance made another furrow and opened a second path parallel to

AN ERROR OF JUDGMENT

the first, leaving between the two a little wall about a quarter of an inch in height.

When ants trace out the plan of a wall, chamber, or gallery in this independent manner, it sometimes happens that the various parts of the work do not fit in with one another. This is by no means an infrequent occurrence, but the ants are not embarrassed by it, and I will now tell you of an instance in which the workman found out his mistake and knew how to rectify it.

A wall had been raised with the apparent object of supporting a vaulted ceiling, still unfinished, which stretched from the opposite side of a large chamber. The workman who had begun this had made it not quite high enough to meet the wall on which it was to rest, and if it had been continued on the original plan it must have met the wall about half-way up—a thing to be avoided. I was very much interested in this circumstance, when one of the ants arrived and after visiting the works appeared to be struck with the same difficulty, for it at once began taking down the ceiling and raising the wall on which it had rested. Then, as I looked on, it constructed a new ceiling out of the fragments of the old one.

When the ants begin an undertaking, one would suppose that they were working on a plan thought out beforehand and then carried out. Thus when an ant discovers two stems of grass upon the nest, lying crossways, in a position which favours the construction of a lodge, or some little beams which suggest its sides and corners, it examines the various parts and then sets out in a very workmanlike fashion to fill in the spaces along the stems with tiny parcels of earth, taking suitable materials from all quarters, and sometimes not hesitating to destroy for this purpose the work begun by others, to such an extent is it dominated by

NATURE'S IMPLEMENTS

one idea to the exclusion of all else. It goes to and fro about its work until other ants realize the plan of it.

In another part of the same ant-hill there were several pieces of straw which appeared to have been placed there expressly to form the roof of a large chamber; a workman took advantage of the way they were disposed, which was in the form of an oblong lying horizontally half an inch from the ground. The industrious insect began placing earth in the angles of this framework and along the little beams of which it was composed, afterwards adding row after row of the same material until a distinct roof appeared. Perceiving then that it could take advantage of another plant to support a vertical wall, it began laying the foundation of one. By this time other ants had come upon the scene, and they helped in the completion of the work.

From these observations and a thousand others of the same kind, I am convinced that each ant acts independently of its companions. As soon as one hits upon a plan easy to carry out, it makes a sketch of it, and then the others only continue what the first has begun, judging what they should do from an inspection of that part of the work which has already been carried out. They all know how to make a beginning, how to carry on the work, how to retouch and give a finish to it as occasion requires. Water furnishes them with the necessary cement, and the sun and air harden the material of their dwellings. They have no other chisel than their jaws, no other compass than their antennæ, and no other trowel than the fore feet which they use in such an admirable manner to lay down and make firm the moistened earth.

These, then, are the material and mechanical means which ants employ in their building. If, as might have been the case, they had simply obeyed a mechanical instinct, they

ROBBERS' CAVES

might have carried out with precision an unvarying geometrical plan, constructing walls of equal length and breadth, and vaulted ceilings curved always in the same manner, thus following blindly an impulse to build ; then we should have been but moderately surprised at their industry. But to form these irregular domes composed of so many stories ; to distribute the apartments they contain in a convenient yet varied manner ; to take advantage of the weather most favourable to their labours ; to vary them (above all) according to circumstances and to profit by the happy accidents of the building site ; to form a judgment of the advantage of such and such operations—to do all these things, must they not be endowed with faculties very near to intelligence, and enabled by Nature to be not mere automats but creatures capable of perceiving the intention of the work which it is their business in life to carry on ? ”

As a rule each species of ant lives by itself ; but there are a few interesting cases in which ants of a smaller species are found in the nests of their larger brethren, where they make themselves thoroughly at home. Sometimes they live together on friendly terms, but not always so. The tiny ants called *Solanopsis*, for instance, hollow out tunnels in the walls of dwellings constructed by larger species and there lead the lives of robbers, making raids on the home of their hosts and carrying off booty into their caves, which are so narrow that the victims cannot pursue the little brigands.

CHAPTER VII

MAKERS OF MOUNDS

BIRDS

Flamingoes—Hillock nests—A quaint narrative—Stalking flamingoes—An old story disproved—An albatros “rookery”—Albatros-nesting—The mallee-bird—Preparing the incubator—An immense mound—Burying the eggs—The Australian mound-bird—Nests upon which trees sometimes grow—A nest of iron-stone—Digging for eggs.

THE Flamingo (*Phœnicopterus*), that strange-looking bird which has on rare occasions been reported as a visitor to British shores, but whose home is in the extreme south of Europe and other countries where the climate is warmer than ours, erects a mound of earth with a cavity at the top for the reception of its eggs.

The earliest definite account of these remarkable structures which has been handed down to us appears to be that given by Dampier of his own observations near Querisao (i.e. Curaçao) as long ago as 1683, and is well worth quoting for its quaintness. He tells us that the flamingoes “build their Nests in shallow Ponds, where there is much Mud, which they scrape together, making little Hillocks, like small Islands, appearing out of the Water, a foot and a half high from the bottom. They make the foundation of these Hillocks broad, bringing them up tapering to the top, where they leave a small hollow pit to lay their Eggs in; and when they either lay their Eggs, or hatch them, they stand all the

A QUAIN T NARRATIVE

while, not on the Hillock, but close by it with their Legs on the ground and in the water, resting themselves against the Hillock, and covering the hollow Nest upon it with their Rumps: For their legs are very long; and building thus, as they do, upon the ground, they could neither draw their legs conveniently into their Nests, nor sit down upon them otherwise than by resting their whole bodies there, to the prejudice of their Eggs or their young, were it not for this admirable contrivance, which they have by natural instinct. They never lay more than two Eggs, and seldom fewer. The young ones cannot fly until they are almost full-grown; but will run prodigiously fast; yet we have taken many of them."

This account of the manner in which the hen flamingo incubates her eggs was generally accepted as the right one until quite recent years; indeed, it still survives as the local tradition in the parts of Southern France where these birds occasionally breed. To anybody who is unacquainted with their habits, it would appear a very simple matter to observe the way in which they sit upon their eggs. There are, however, considerable difficulties to be surmounted, for the marshes and remote lagoons in which the flamingoes nest are often by no means easy of access. The birds, moreover, are extremely shy, and the greatest care is necessary in stalking them; otherwise the whole colony, numbering, it may be, several hundreds, will be alarmed and take to flight, floating through the air like a beautiful pink cloud.

Sir Harry Blake, who was at some trouble to study the nesting habits of flamingoes in the Bahamas, informs us that in those islands they begin to repair their old nests or to raise new ones in the month of May. They build them in the shallow margins of lagoons or on the banks, sometimes as many as four hundred in a group and but three or

AN OLD STORY DISPROVED

four feet apart. Standing on the nest, they scoop up with their beak the surrounding mud, together with sticks, shells, or anything else that may happen to be lying about the base, and pat the mass into shape with the foot—not merely treading it down, but giving it vigorous slaps, the sound of which can be heard at a considerable distance. In this way they form a somewhat conical mound with a slight hollow at the top, which may contain a few feathers, though it usually has no lining of any sort. Sir Harry Blake stalked the birds to within a hundred and fifty yards and watched them carefully through field-glasses, but he saw none with their legs dangling outside the nest—they were always folded under the bird in the usual way. Some nests are so low that there would not be room for the legs to hang down. On the mud-flats about the Guadalquivir Mr. Abel Chapman saw hundreds of nests only a few inches high, so that the ground looked like a large table covered with plates; and we have ourselves observed the same thing in that district. You may see the marks made by the bird's folded legs on the rim of the nest. Occasionally the flamingo is content to do without a nest altogether, merely depositing its eggs on the ground.

Old nests are often renovated year after year by the addition of a fresh layer of mud, and in this way they may eventually attain a height of eighteen inches or, in rarer cases, two feet. No special preparations are made for the addition of the new story, and the birds do not even take the trouble to remove an addled egg, should one remain in the cavity from the previous season; they merely cover it over with mud and build it into the structure. On the cover of this book there is a picture of flamingoes in one of their characteristic haunts, several of the tall nests and others of the flat "dinner-plate" kind being represented.

AN ALBATROSS "ROOKERY"

These birds nest in great numbers on remote islands of the Southern Ocean, where great havoc is unhappily wrought amongst them by boats' crews. In consequence of this senseless slaughter and robbery, the graceful and majestic flight of the albatross may in time cease to be a familiar sight to those who voyage round the Cape or through the Strait of Magellan.

AN ALBATROS "ROOKERY"

The former are often surrounded by water, above which they rise like miniature islands.

Owing to the length of her neck, the hen bird can feed even when sitting on one of the high mounds, by scooping up shellfish from the water in her queerly shaped beak.

The albatroses, though scarcely able to compete with some flamingoes in this respect, are also mound builders. We are acquainted with about fifteen species, of which the best known is the Wandering Albatros (*Diomedea exulans*), whose flight is more powerful probably than that of any other bird, its great wings measuring as much as eleven feet from tip to tip. It seldom approaches land except for the purpose of nesting, but spends the greater part of its life on the wing, only resting on the surface of the water occasionally in calm or moderate weather. In October immense numbers repair to the more remote islands of the Southern Ocean, such as Tristan da Cunha, where they nest on the tablelands in dense colonies or "rookeries." They make mounds of mud, mixed up with grass and sedge, about fourteen inches in diameter, and rather neatly rounded. The sides of the mound are usually almost upright, but the yellow-billed albatros—or "mollymauk," as sailors call it—often undermines them a little while sitting, so that the mound becomes narrower at its foundation than it is above. There is a slight hollow in the top to contain the single egg, which is white and about as large as that of a swan. In the picture the birds are represented sitting upon their nests, and you will observe that they allow themselves to be approached by the sailors who have come ashore to rob them of their eggs, without showing any signs of excitement.

Gould, that great authority on Australian birds, reckoned the Ocellated Megapode (*Lipoa ocellata*), commonly known in England as the Mallee-bird, amongst the most important

THE MALLEE-BIRD

of the ornithological novelties which had been discovered during the exploration of the western and southern portions of the great island-continent. A description of its remarkable habits was sent to him towards the middle of the last century by Gilbert and Sir George Grey. One September morning Gilbert started out to search for the eggs of this bird, taking with him a native guide. After penetrating into the bush for half an hour they came upon one of the hillocks in a place where the thicket was so dense that they were "almost running over it before seeing it." Gilbert was very impatient to discover the hidden treasures and began hurriedly scraping away the upper part of the mound, greatly to the annoyance of the black-fellow, who made him understand that as he was not accustomed to opening a mallee-bird's mound he was pretty sure to break the eggs in his impatience. Gilbert therefore made way for his companion, who began scraping off the earth very carefully from the centre and throwing it over the side, so that the mound was soon transformed into a sort of huge basin. When the earth had been removed to a depth of about two feet, they came upon two eggs placed in an upright position with the thin end downwards. These were removed with great care, because the shells are very fragile when first exposed to the air; indeed, they are so thin and brittle that it is practically impossible to hatch these eggs under a domestic fowl, because the bird almost invariably breaks them.

About a hundred yards from the first mound they came upon another, somewhat larger, which contained three eggs. It proved to be rather too early in the season, however, for Gilbert's purpose, for none of the other mounds they opened contained any eggs at all.

The place where Gilbert found these 'nests' was amongst gravelly hills clothed with a dense forest of eucalyptus trees

PREPARING THE INCUBATOR

overshadowing a thicket of bushy plants so dense and high that whenever he and his black guide became separated by only a few yards they were obliged to cooeey in order to find one another again.

To make its mound, the mallee-bird scratches up the surrounding gravel and mixes that which is destined to form the inside of the hillock with vegetable matter. As it decays, enough warmth is produced to incubate the eggs; indeed, the temperature within one of these mounds is stated to be as high as 89° F., or thereabout. Of the nests examined by Gilbert, both those with eggs contained large numbers of termites, which had made their little covered galleries of earth around the shell, to which they were attached, "thus showing," he says, "a beautiful provision of Nature in preparing the necessary tender food for the young bird on its emergence."

The largest mound examined by Gilbert measured forty-five feet in circumference. He found the inside or vegetable portion of those mounds which were not quite ready for use cold and wet—in marked contrast to those in which eggs were contained; it appears likely, therefore, that the birds turn out all the material to dry before the eggs are laid. As each egg is deposited the birds cover it up carefully with the soil and make the top of the mound, which was before scooped out into a hollow, perfectly round and smooth, so that it might quite easily be mistaken for an ant-hill by anybody not acquainted with the *Lipoa's* habits. Some seven or eight eggs are laid in a circle around the centre of the nest, about three inches apart. They are very large eggs—nearly four inches long; the colour varies from light salmon to a very light brown.

From Grey we learn that the nest sometimes attains an immense size, measuring thirteen yards around the base and

BURYING THE EGGS

two or three feet in height, and that to accumulate this great heap of material the bird scrapes up sand and grass from more than five yards around. As to the actual way in which she goes to work, we cannot do better than quote Grey's own words from a letter he wrote to Mr. Gould in the year 1842. He says: "The mound appears to be constructed as follows: A nearly circular hole, about eighteen inches in diameter, is scratched in the ground to a depth of seven or eight inches, and filled with dead leaves, dead grass, and similar materials, and a large mass of the same substances is placed all round it upon the ground. Over this first layer a large mound of sand, mixed with dry grass, etc., is thrown, and finally the whole assumes the form of a dome. . . . When an egg is to be deposited, the top is laid open and a hole scraped in its centre to within two or three inches of the bottom layer of dead leaves. The egg is placed in the sand just at the edge of the hole, in a vertical position, with the smaller end downwards. The sand is then thrown in again, and the mound left in its original form. The egg which has been thus deposited is therefore completely surrounded and enveloped in soft sand, having from four to six inches of sand between the lower end of the egg and the layer of dead leaves. When a second egg is laid, it is deposited in precisely the same plane as the first, but at the opposite side of the hole before alluded to. A third egg is placed in the same plane as the others, but, as it were, at the third corner of the square . . . the fourth . . . in the fourth corner . . . the figure being of this form— ; the next four eggs in succession are placed in the interstices, but always in the same plane, so that at last there is a circle of eight eggs, all standing upright in the sand, with several inches of sand intervening between each. The male bird assists the female in opening and

THE AUSTRALIAN MOUND-BIRD

covering up the mound, and provided the birds are not themselves disturbed, the female continues to lay in the same mound, even after it has been several times robbed. The natives say that the hen bird lays an egg every day."

MALLEE-BIRD'S MOUND
AN IMAGINARY SECTION TO SHOW ITS STRUCTURE

A cup-like mass of dead grass and leaves is piled over a shallow hole scratched in the ground. This heap of decaying vegetable matter furnishes the heat which is necessary for incubation. The eggs (of which two are shown in the diagram) are placed in an upright position within the rim of the cup, embedded in a large mound of sand and dry grass.

The story of these wonderful mounds, told by Gilbert and Grey and Gould, has frequently been confirmed by other naturalists. But strange as it is, that of the Australian Megapode, or Mound-bird (*Megapodius tumulus*), is even more surprising. Here we have a bird about the size of a turkey which constructs mounds which in course of time attain such huge dimensions that it is no very uncommon thing to find trees growing upon them! Of course one pair of megapodes will not make such a mound in a single year; probably it is the work of many seasons and of many birds, but it is very wonderful all the same. These mounds

A NEST OF IRON-STONE

are usually found in dense thickets near the seashore, or on the shore itself, and are often covered with vegetation, such as the large yellow-blossomed hibiscus. Those upon the shore are generally formed of sand and shells, without a vestige of any other material. Occasionally they may contain a little soil and decaying wood, but unlike the mallee-birds' nests, there is nothing in the nature of a hot-bed, and it is clear that for their incubation the megapodes' eggs are dependent upon the heat of the sun. These sandy mounds are often very irregular in shape, and might almost be mistaken for banks thrown up by a heavy sea. One in Knocker's Bay was upwards of twenty-five feet long and five feet high; another measured a hundred and fifty feet in circumference, and was made of pebbly iron-stone—a strange material for a nest! As a rule, however, the bird displays a more gentle instinct towards its eggs, for those mounds which are made in the thickets consist of a light, black vegetable soil. It is a remarkable fact that in barren districts megapodes' mounds are sometimes found composed of this same black mould, although there may be no earth like it for miles around, and it has been supposed that the birds fetch it from afar. We have seen, however, how little they seem to care about providing a soft bed for their eggs, being quite content to make use of whatever material they happen to find on the spot, so that it is far more probable that they gather together a few dead leaves and that the black soil is formed by their decomposition. These earthy mounds are not irregular in shape like the heaped-up masses of sand and shells upon the shore, but more or less definitely conical. The eggs are placed in holes which are dug from the top to a depth of six feet or so and generally (but not always) slope outwards to within two feet of the side of the mound. The natives informed Gilbert that the birds lay only one egg in

DIGGING FOR EGGS

each pit, and that as soon as it is laid they fill up the hole level with the surface. It is always possible to tell whether a megapode has lately been excavating by examining the soil and thrusting a stick into it; the looser the earth, the more easily the stick penetrates, and the more recently has the mound been opened. It requires some skill and a great deal of patience to get at the eggs. The natives burrow away with their hands, making a hole just large enough to crawl into, and throwing out the sand or earth between their legs. Their endurance is sometimes severely tried, for it may happen that they dig for six or seven feet without coming upon a single egg, suffering terribly meanwhile from the bites of myriads of sand flies and mosquitoes.

The eggs are about three and a half inches long, and are placed upright on the thin end. The shell itself is white, but it is covered with a kind of thin skin which becomes stained by the materials in which it is buried, so that eggs taken from the sandy hillocks on the seashore are a dirty yellowish white in colour, while those from the black-earth mounds are of a darker reddish-brown tint. The natives say that they are laid between sunset and sunrise, at intervals of a few days.

CHAPTER VIII

MASONS

Architectural ingenuity—Mud houses—Dauber wasps—Catholic tastes—Warm corners—Dauber's daintiness—The builder at work—Laying in provisions—Ingenious cruelty—A spider bomb—Working by rote—A fruitless task—Building improvements—Mason bees and rough-cast—A natural cement—Collecting materials—Building stones—Cake-making—Roofing in—Restoring old buildings—Cupolas—The key-stone—Clusters of nests—Plasterers—Sheltered sites—Keeping out trespassers—A stout wall—Born in the midst of plenty—*Odynerus*—A firm foundation—Softening the ground—Excavations—A Lilliputian leaning tower—Filigree walls—An invader discouraged—Furnishing the larder—A stack of bricks—Bee hodmen—Porches and sentinels.

IN some parts of the world where the materials which we are in the habit of using to build our houses cannot be obtained, the natives construct dwellings entirely of mud, which soon becomes baked into a hard mass by the heat of the sun. Many animals do precisely the same thing; some of them make use of earth which is naturally moist, but in that case they take care to choose sheltered spots for their homes, which would very soon be destroyed and washed away if they were exposed to rain; others prefer dust as a building material, and by mixing it with their saliva transform it into a stiff paste which adheres firmly together and becomes, when dry, almost as hard as stone. Some put the final touches to their work by plastering the inside or outside walls of the nest with a kind of waterproof varnish, the

DAUBER WASPS

product of certain glands, or by embedding particles of grit in them.

The Dauber Wasps (*Pelopæus*) supply us with beautiful examples of these mud houses.

As they are exceedingly chilly little creatures, they choose the warmest places they can find for the purpose of making nests intended to shelter their offspring. The species of *Pelopæus* which is common in the south of Europe builds under eaves and cornices, and in sheds and barns; but the situation she likes best of all is the interior of a peasant's cottage. There no spot seems to come amiss to her, and she makes herself thoroughly at home; she takes possession of walls or ceiling, windows or curtains, with indifference, greatly to the annoyance and despair of the housewife. Rights of property are unknown to her; she bustles about with a cheerful disregard of everything but her own immediate business, and we have it on the authority of that excellent naturalist M. Fabre that whilst some labourers were enjoying their dinner at an inn, dauber wasps came and built nests in their hats and in the folds of their smock-frocks! Of all places, however, the one in which she is happiest is the inside of a wide old-fashioned farm-house chimney. A strange taste it seems to us, and one wonders how the poor insects, which are constantly flitting to and fro, escape suffocation by the smoke or contrive not to be burnt to death. But Fabre noticed that even when the pots were boiling on the fire the insects did not appear to mind in the least, but went about their work as usual, darting quickly through the thick curtain of steam and smoke.

The dauber wasps build their nests at various times of the year; one month seems to suit them as well as another, as long as the weather is warm. When they are ready to commence work they seek in the surrounding country for

THE BUILDER AT WORK

a patch of damp, muddy land, and having found it, it is delightful to see the dainty way in which they set about their task and the pains they take to avoid dirtying themselves. With quivering wings and feet held well up out of the way, with their black body uptilted behind the yellow waist, they scrape away with the tips of their mandibles (or jaws) and skim the glistening surface of the soft mud.

The most careful housewife, who turns up her sleeves and gathers her skirts together while she is busied with the rougher household duties, could not carry on her work with greater regard for cleanliness. These little mud-gatherers are marvels of neatness, but instead of turning up sleeves they keep every part of their body from the least contact with the mud, excepting only the tips of their toes, so to speak, and the points of their mandibles. In this manner *Pelopæus* gathers together a pellet of moist earth about the size of a pea and, holding it in her jaws, flies away with it to the chosen spot. Without mixing it with saliva, she then moulds it roughly and spreads it over the work which she has already begun, fashioning a hollow cell about an inch long and more or less egg-shaped. The cell is carefully smoothed inside, but the outside wall is quite rough and irregular. When she has finished one cell she makes another by the side of it, then a third, and so on, all of them of the same pattern; and sometimes she places a second and a third row alongside the first. Inside every compartment the *Pelopæus* puts a number of spiders, paralysing them first by means of her sting; alongside these she deposits an egg, and then closes up the mouth of the cell.

It is a horrible thing to do, and one likes to believe that the poisonous wound that paralyses the spider deprives it not only of the power of movement, but of all feeling too.

INGENIOUS CRUELTY

Alluding to the wasps, Mr. Hudson says:¹ "These insects, with a refinement of cruelty, prefer not to kill their victims outright, but merely to maim them, then house them in cells where the grubs can vivisect them at leisure. This is one of those revolting facts the fastidious soul cannot escape from in warm climates; for in and out of open windows and doors, all day long, all the summer through, comes the busy beautiful mason wasp. A long body, wonderfully slim at the waist, bright yellow legs and thorax, and a dark crimson abdomen—what object can be prettier to look at? But in her life this wasp is not beautiful. At home in summer they were the pests of my life, for nothing would serve to keep them out. One day, while we were seated at dinner, a clay nest, which a wasp had succeeded in completing unobserved, detached itself from the ceiling and fell with a crash on to the table, where it was shattered to pieces, scattering a shower of green half-living spiders round it. I shall never forget the feeling of intense repugnance I experienced at the sight, coupled with detestation of the pretty but cruel little architect."

When the series of cells is complete, the *Pelopæus* coats them roughly all over with a layer of dirt so that the nest has the appearance of a lump of mud which has been thrown against the wall. The happy idea occurred to Fabre of removing a nest before it was quite finished, and putting it in his pocket in order to see what the insect would do. In the place where the structure had been there was no longer anything but the blank wall and a thin, broken rim of earth where the edges of the patch of mud had adhered. After a while the *Pelopæus* returned with its load of clay, alighted on the same spot without any apparent hesitation, laid down its burden, and began to spread out the mud just

¹ *The Naturalist in La Plata.*

A FRUITLESS TASK

as though the nest had still been there. It was quite clear from the busy but unexcited way in which the insect went about its work that it supposed it was the nest which was being coated over with plaster, and not merely a patch of bare wall from which the nest had been removed. Nor was it ever made conscious of the loss either by the altered colour of the spot or by the absence of the lump of earth; thirty or forty times it returned to its fruitless toil.

Fabre afterwards made another curious experiment. A cell had just been completed by the introduction of a spider and an egg, and the *Pelopæus* had flown off to search for a fresh victim. During its absence Fabre took a pair of forceps and carefully removed both spider and egg. Did the little huntress perceive that she had been robbed of these precious things? Apparently she did not, for on returning with another spider she placed it in the larder just as cheerfully as though nothing vexatious had occurred. One by one a lot more spiders were brought, and one by one Fabre removed them whilst the insect was away, so that it came back each time to an empty storehouse. This went on for two days, the insect toiling hard to fill the insatiable pot while the naturalist stole the contents as soon as its back was turned. When twenty victims had been brought and spirited away in this manner, judging perhaps by the fatigue occasioned by such excessive efforts, the huntress seemed to imagine that her game bag must at last be full, for she carefully closed up the cell which contained nothing whatever. This experiment is very interesting, but it would delay us too long if we were to enter upon a consideration of the conclusions which might be drawn from it, and we must pass on to other insect masons.

Many *Hymenoptera*, or insects belonging to the order of ants, bees, and wasps, seem to have found out that nests

A NATURAL CEMENT

made of mud or dust are not very durable structures even when strengthened with a cement of adhesive saliva, and it has occurred to them to introduce rubble as an additional material. In spite of the circumstance that it is very difficult for them to fly about burdened with pieces of grit, they have succeeded very well in their enterprise, and the substance of their buildings may be compared to that mixture of cement and gravel which is known as 'rough-cast.'

A very good example of this is found in the Mason Bees called *Chalicodoma*, whose cement-built houses are sometimes so firm that it is necessary to use iron instruments if you want to break into them. These nests are placed on rocks, or more usually on old walls, those which face south being preferred for the purpose, and they have the appearance of big splashes of mud made by the wheels of passing vehicles, or thrown up from the horses' feet. The builders are so particular about the solidity of their dwellings that they carefully avoid attaching them to plastered walls or to mortar between the stones, but build them on the stone itself; and, as if not content with this precaution, they nearly always choose in addition the place in which they can be most securely fixed, preferring especially the angles formed by copings, plinths, window-sills, and so on.

As M. Fabre has told us, the mason bee's building material consists of chalky clay mixed with a little sand and hardened with the insect's own saliva. Damp soil, which would not only be easier to work but would also require less saliva for making the mortar, is passed by disdainfully; a *Chalicodoma* rejects moist earth for building as certainly as a bricklayer would reject old plaster or 'spent' lime. Such materials, sodden with water, would not take a good hold. What the insect wants is perfectly dry dust which will readily soak up the saliva which is poured upon it, and form, with the

BUILDING STONES

albuminous matter contained in this secretion, a sort of rapidly hardening cement, not unlike the adhesive substance you can make by mixing quicklime with white of egg.

The body of the male bee is covered with red down of rather a bright tint, but in the female it is of a beautiful velvety black, and the wings show a pleasing shade of deep violet colour. It is the female alone who constructs the nest. For this purpose she seeks out a dry spot, and scrapes together a little heap of cement which she makes into a pellet about the size of those used for shooting rabbits. Carrying this in her jaws, she flies with it to the place she has decided upon and on arriving there deposits her burden on the wall and proceeds to fashion a rounded pad. From time to time she fetches grains of sand and grit and embeds them in the cement while it is still soft.

In order to save labour and at the same time to economize in the expenditure of mortar, the insect chooses coarse materials, using large fragments of grit which are for her, in proportion to her size, true building stones. She selects them one by one with care, seeming to prefer those which are very hard and have sharp corners so that when they are fitted together they give support to each other and contribute to the solidity of the whole structure. Beds of mortar, sparingly spread between the stones, hold them firmly together. The outside of the mass thus takes on the appearance of an irregularly built wall, such as you may see during a country walk, the stones with all their natural irregularities making a rough, uneven surface; but the interior must be smooth so as not to injure the tender skin of the grub, and on that account it is plastered over with pure mortar. Except for this, however, the chamber is finished off quite carelessly, as though with heedless sweeps of the trowel, and to make it more comfortable the grub, as soon as it has

CAKE-MAKING

devoured its cake of honey, hastens to make a cocoon for itself, and so covers the walls of its home with a soft lining of silk.

But we must return for a moment to the little mason. When the bee has laid down a foundation, she builds upon it little by little in such a way as to wall in a thimble-shaped cavity, with the opening turned upwards. When this has been done, the insect gives up her occupation of bricklayer for a little while in order to collect food for her future offspring. She hurries away amongst the flowers and works busily, diving eagerly into those of the broom and emerging afterwards with a crop distended with honey and body smothered in pollen. On her return she immediately plunges her head into the cell she has made and disgorges the honey; then she comes out again and carefully brushes the pollen from her body, so that that also falls in the larder. As soon as she has scraped herself clean she again enters the cell and mixes the honey and pollen into one homogeneous mass or cake; after which she starts out afresh to procure further supplies.

When the cell is about half full the bee deposits an egg in it and begins without delay to close up the nest with a lid of pure mortar, working from the circumference inwards towards the centre. The whole of this work requires about two days for its completion.

Immediately after finishing one cell the little mason proceeds to build another exactly like it, by the side of the first; then a third, and so on, until there are eight or ten of them in all.

Now although these cells are closed in on every side, the lids are very thin, and there is little doubt that they would quickly crack if left exposed to the heat of the summer, and be completely destroyed by autumn rains and winter frosts;

RESTORING OLD BUILDINGS

so the architect takes care not to leave them in this condition. As soon as the last cell is completed she sets about making a thick lid to cover them all in; a lid composed of matter which is both waterproof and a bad conductor of heat, affording protection at one and the same time against rain, sun, and frost. This substance is the ordinary mortar, earth mingled with saliva, but this time without any admixture of tiny stones. The bee lays on, pellet by pellet, trowelful by trowelful as it were, a bed of cement nearly half an inch thick over the whole cluster of cells, which is thus lost to sight and completely buried under a coating of mineral matter. When finished, the nest is roughly dome-shaped and about the size of half an orange.

We have just seen how a new nest is built from foundation to finish, for that is what frequently happens. But not always; very often, indeed, if a *Chalicodoma* comes across an old nest in a more or less dilapidated condition, she is quite content to take possession of it and patch it up until it is in a fit state to receive her offspring. These repairs are not usually a very serious matter, as it is hardly necessary to do more than stop up the holes by which the young of the original architect have made their escape, and to remove the shreds of cocoons lining the walls.

The solitary wasps known as *Eumenes* they (have no common name) also make free use of grit in constructing their cement houses—to an even greater extent, perhaps, than *Chalicodoma*, the mason bee.

These wasps are adepts in the mixing of mortar, and are very clever architects besides. The *Eumenes Amedei* is of a chilly nature and seeks solid rocks exposed to the full glare of the sun, where it builds a nest the appearance of which suggests an Esquimaux hut. This nest is evenly curved like a piece cut off the top of an egg, and measures

THE KEYSTONE

an inch across and not quite so much in height. It is attached by its wide base to the rock, and opens towards the top by a neck the rim of which is gracefully curved outwards. In building this nest, *Eumenes* makes use of saliva mixed with very dry dust collected from dusty roads, combined with tiny fragments of stone, especially quartz, and sometimes with little shells.

Fabre observed that the builder, having selected a suitable spot, first raises a little circular wall about an eighth of an inch in thickness; then before the cement has had time to become hard—which it does very soon—she embeds a few stones in the soft mass as the work proceeds. She half buries them in the cement in such a manner that they project considerably from the outer wall, but do not penetrate to the interior of the cell, which has to be kept smooth for the comfort of the grub. Any inside irregularities are smoothed over when need be with the aid of a little cement. The stones are solidly set, a layer of mortar is spread over them, then another course of stones is laid, and so on alternately. As the work proceeds the walls are gradually made to slope towards the centre so that the building is given just that curvature which results in the more or less spherical shape mentioned above. When we build a vaulted chamber we use wooden arches to support the masonry until the keystone which makes all secure is placed in position; but the *Eumenes* is more daring than we are, for she erects a cupola in space without any scaffolding whatever to aid her. At the summit a round hole is fashioned, leading into a mouth made of pure cement, the edges of which are 'lipped' outwards. It reminds one of the gracefully curved neck of an Etruscan vase. When the cell has been provisioned and an egg has been deposited in it, this neck is closed up with a plug of cement and in the cement a little stone is set—one only,

PLASTERERS

never more—the builder is particular about that, and seems to regard it as a most important ceremony.

This piece of rustic architecture can defy the worst of weather; you can make no impression on it with your fingers, nor can you remove it unbroken with a pocket-knife. Its peculiar form and the fragments of grit which stick out on all sides recall certain ancient cromlechs and tumuli dotted over with gigantic blocks of stone.

Such is the appearance of a single, isolated cell. In most cases, however, the wasp constructs others on the top of this, to the number of five or six or even more, and so saves a certain amount of labour, because where two chambers are side by side the same wall serves for both of them. But the graceful shape is lost, and at the first glance such a group looks like nothing more than a splash of mud covered all over with tiny stones. If, however, we examine this apparently shapeless mass more closely, we can distinguish the number of chambers by the bell-shaped openings, each one being quite distinct from all the others and furnished with its little stone door embedded in cement.

Quite at the beginning of the springtime you may observe, foraging among the flowers, some pretty little hymenoptera whose coppery skin is covered with bright red down. These are the *Osmia* bees, and their arrival, like that of the swallows, foretells the advent of sunny days.

In spite of their dainty appearance they are sturdy labourers accustomed to hard work, and they pass no small portion of their lives in making mortar from mud. Unlike many of their relatives, these insects are merely plasterers. They are not even skilled in the manufacture of hydraulic cements from road-dust and saliva, but are content to build their nests of no better material than ordinary mud, collected and moulded, apparently, without any special

SHELTERED SITES

preparation whatever. A nest so fragile that a drop of water would cause it to fall to pieces must of course be built in some place well sheltered from the rain, and we find as a matter of fact that the *Osmias* almost invariably nest in cavities which afford them ample protection, displaying excellent judgment in their choice. Their nests are often placed in the hollow stems of reeds, usually in those which have been put to some use by man. The reason for this is not difficult to understand. When reeds have been cut down, the part that is left standing offers an ayslum which the insect might enter without any difficulty by way of the divided end, but such a cavity is exposed to falling rain, and that is just what the *Osmia* ought to avoid. She might, it is true, readily stop up the opening with a plug of mud. She does better than that, however; she chooses for her abode the part which has been cut off, because she finds it lying flat, and in that position no rain can penetrate into the hollow. On this account *Osmias* very frequently make their nests inside the straws and reeds of which thatches are composed.

In their choice of a nesting-place, however, *Osmias* do not by any means restrict themselves to reeds and rushes, but accept almost any retreat that offers, so long as it meets their requirements as a shelter. Perhaps the most curious of these is an empty snail-shell, the interior of which they divide by means of mud walls into a number of chambers, in each of which an egg is deposited. Failing reeds and snail-shells, they will take possession of the deserted nest of a mason bee, or the galleries which *Colletes* hollow out of dry banks; while keyholes and cavities in the woodwork of houses, or glass tubes such as chemists use, do not come amiss to them on occasion, and they will establish themselves without hesitation in any of these places. Furthermore, each species has its own peculiar habits from which it

A STOUT WALL

will not depart unless circumstances compel it to do so. Some of them, for instance, do not make use of mud at all, but cut up either soft or woody plants into small pieces, and after making a true paper-pulp from them employ this material for the homes of their offspring.

As soon as an *Osmia* has found a cavity to her liking, she sweeps it out carefully and carries the refuse away to some distance. Then she proceeds to dust it, working towards the opening and throwing the dust outside. If the tunnel be a narrow one, she gathers her store of honey and pollen for the young forthwith, after merely smoothing the walls with a coating of mud wherever it is necessary to do so. But if the cavity appear too wide, the first thing she does is to make a chamber at the far end by building a cross wall, leaving openings at one side; then she furnishes it with a stock of provisions, blocks up the apertures, and begins a second compartment a little further on, and so forth.

An *Osmia* that has taken possession of a wide tube begins by closing it with a wall, with the object, apparently, of keeping out other insects which might come and lay their eggs there to the detriment of the lawful owner. In order to construct this partition, she first lays down a circular rim, and adds little by little to its edge, turning round and round with her head pointing on one side of the wall in process of formation, and her body on the other, so that the hinder extremity acts as a trowel, and the wall is pressed between this and the jaws, and is thus gradually smoothed and spread out into a perfectly even layer. The first chambers that are formed in a reed are longer, and have walls which are farther apart, than those which are made as the insect gets nearer the end; but there is no regular gradation of size. The final wall, which closes the whole

A FIRM FOUNDATION

series, is very thick, and is clearly intended to protect the contents of the tube against damage from without.

Each chamber is furnished with a collection of pollen in the midst of which the bee disgorges a little honey, which filters and penetrates amongst the grains and forms a nutritious pulp. The egg is deposited with one end embedded in this sweet cake, and thus it comes about that the grub is born with its mouth in the midst of plenty and is able to commence the serious business of eating without the necessity of changing its position. When it has consumed the whole store of food it spins a cocoon, from which there emerges in due course an adult *Osmia*, whose active life endures scarcely a single year.

One of the most plentiful of English insects is the little yellow-banded black wasp called *Odynerus murarius* which may be observed on sunny days flitting about sand-banks, busily engaged in burrowing and building. This wasp is an excavator as well as a mason, and it works on a very curious and ingenious plan, for as it burrows in the ground it makes tiny bricks of the material it digs out of the hole, and builds them up in the form of a round tower about the mouth of the nest. About June and the early part of July you may frequently see these strange chimney-like structures projecting from the surface of sand-banks which are exposed to the glare of the sun. The *Odynerus* chooses hard, compact sand for its operations—sand which is almost as hard as stone, and on which it is difficult to make any impression with your fingers. In this it displays much wisdom, for the building that is founded upon rock is proverbially more likely to stand than one raised upon loose sand; while, as for the burrow, it is even more important that the ground should be fairly solid, for otherwise there would be every likelihood of the sides of the

A LILLIPUTIAN LEANING TOWER

shaft falling in so that the labour would all have to be performed again—even if the worker escaped. But how is so small an insect (for our *Odynerus* is less than half an inch in length) to penetrate into such hard ground to a depth of several inches? This seemingly impossible task is carried out with ease, for the insect has hit upon the simple and effective device of moistening the surface with drops of fluid from her mouth, so that the particles become loose and yield readily to the attacks of her strong jaws. By this means she scrapes up a few grains of sand, which she first rolls into a small pellet with the front pair of legs, and then places on the edge of the cavity formed by its removal. The tiny mass is about as large as the space within the small letter “o” on this page, and it forms the foundation-stone of one of the towers or chimneys mentioned above. With the jaws and feet it is moulded and flattened and pressed into position, and then the work is continued as before. Pellet after pellet is fashioned in this manner and placed around the rim of the hole, the sand being moistened from time to time, as often as may be necessary to facilitate the work of excavation. Before very long the base of the tower is definitely established, and the beginning of the pit is clearly apparent below the level of the surrounding surface. At frequent intervals the operations are suspended for a short space while the busy worker makes an excursion in search of fresh supplies of fluid to pour down upon the hard, dry sand; but in spite of these interruptions the excavating and building proceed apace, and in the course of a few hours a round tower some two inches in height, standing like a Lilliputian citadel above a pit of equal depth sunk in the solid earth, testifies to the untiring industry of the little wasp. The first part of the tower is built perpendicularly to the surface on which its foundation

FURNISHING THE LARDER

rests; but it soon begins to take a curved direction, and the top overhangs to a degree which looks extremely perilous. The unstable appearance is enhanced by the structure of the walls, for the tiny masses of moulded sand of which they are built up are not fitted very closely together—indeed there are often very obvious crannies and openings which suggest a tube of rude filigree work rather than a turret of solid masonry. It is evident enough that such a slight edifice is not meant to endure; but what, in that case, can be the use of it? And why should the wasp trouble to build it at all? The pit we can understand; that is going to be a nest wherein the egg will be deposited; but the purpose of the outwork is not at first sight so clear. Réaumur, who watched these insects working both long and patiently, discovered one possible use of the structure when he observed an ichneumon-fly—that tireless and terrible enemy of other insects—peer into the top of the tower and then retreat, apparently discouraged in his felonious intentions by the depth of the dark tunnel by which he was confronted. The outwork, then, is of service in keeping out malevolent intruders while the cell is being dug and provisioned; but that is only a secondary object, and conjecture failing us, we are enlightened as to its true use by carefully observing the proceedings of the *Odynerus* herself. Having sunk a shaft to the depth of several inches—deep enough, that is, for the extremity to be beyond the undue influence of extremes of heat or cold—the wasp goes a-hunting for live caterpillars, with ten or twelve of which, closely packed, she furnishes her larder. With them she places an egg, and then nothing further remains to be done except to fill in the upper part of the hole in order to make all snug for the future grub. It is at this stage in the series of

BEE HODMEN

operations that we discover the use of that puzzling tower: it proves to be nothing more than a neat stack of material held in readiness to plug the opening of the tunnel. In order to remove the sand when digging, *Odynerus* finds it convenient to mould it into little bricks; and instead of piling them in an untidy heap at haphazard about the edges of the pit, like a good workman she arranges them in a neat stack where they will be ready to hand when wanted, and where they serve at the same time to keep out trespassers. All that she has to do when filling up the hole is to moisten the top of the tower and take down the 'bricks' one by one, placing them inside the tunnel until it is blocked up level with the entrance. The cell is then completed; the wasp has made every possible provision for the welfare of her offspring, and the grub has nothing whatever to concern itself with from its birth to its transformation but devouring the ample supply of succulent food with which its foreseeing parent has provided it.

Some of the flower bees (*Anthophora*) follow the same routine as *Odynerus* in constructing their cells, that is to say, they make leaning towers which are afterwards demolished to fill up the holes.

In tropical America, where the European hive bee is unknown, its place is taken by a much smaller insect, the *Melipona fasciculata*, which has no sting, but bites furiously when disturbed. This bee forms big colonies and the workers go about collecting pollen like other bees, but they also gather clay, and their movements when thus engaged are carried out with great precision. They dig up small portions with their mandibles and, passing them from paw to paw, they load up the 'pollen-baskets' on their hind legs. These bees construct their combs in crevices of trees or banks, and they use the clay to build stout walls in front of the nest,

PORCHES AND SENTINELS

leaving only a little doorway through which they can pass in and out. One small species adds to the entrance a trumpet-shaped porch composed of clay mixed with some adhesive substance, and stations a number of sentinels outside to keep guard.

CHAPTER IX

MORE MASONS

Universal favourites—Chimney swallows—A peculiar taste—A safe spot—Building materials—House martins—Firm foundations—"In the weather on the outward wall"—A piteous sight—Australian relatives—Bottle nests—Working in gangs—The oven-bird's home—"Johnny Clay"—A reputation for piety—A well-built house—Singing duets—A burial—The Syrian nuthatch—Love of building—Hornbills—A willing prisoner—Feeding the prisoners—Storming the prison—A miserable object—Amphibians—The family genius—Frogs building walls.

ALTHOUGH at first sight birds appear to be but poorly equipped for mason's work—even of the primitive kind which is most usual amongst animals, that is to say, the building of mud houses—yet many species pursue this industry with remarkable success. Amongst these birds two kinds are well known to everybody—the swallow and the house martin. Because of their association with the coming of summer, their swift, graceful movements in flight, and their delicately clean, spick-and-span appearance, few birds are more gladly welcomed than these when they return home to our shores after a long absence in the South. Universal favourites as they are, it is surprising—or it should be so—how many people fail to distinguish the two species, notwithstanding the very obvious difference between them; few facts show more clearly how lamentably unobservant we are, and how completely we may fail to perceive what is around us.

CHIMNEY SWALLOWS

The Swallow, or Chimney Swallow as it is sometimes called (*Hirundo rustica*), is the first to return home, usually arriving about the middle of April. It frequents the dwellings of men, and is in the habit of nesting under the open roofs of sheds, against the rafters of barns and outhouses, on the cornices of disused rooms, under porches, and even in the tops of chimneys. The last named was its favourite situation in Gilbert White's time, but the modern chimney-stack with its rows of narrow pots and patent cowls must seem sadly inhospitable from the swallow's point of view! Wherever the nest is placed, it is almost invariably in a situation that affords shelter from rain, which would soon reduce it to a shapeless mass of mud. "Here and there," writes Gilbert White, "a bird may affect some odd, peculiar place; as we have known a swallow build down the shaft of an old well, through which chalk had been formerly drawn up for the purpose of manure: but in general with us this *hirundo* breeds in chimneys; and loves to haunt those stacks where there is a constant fire, no doubt for the sake of warmth. Not that it can subsist in the immediate shaft where there is a fire; but prefers one adjoining to that of the kitchen, and disregards the perpetual smoke of that funnel, as I have often observed with some degree of wonder.

"Five or six or more feet down the chimney does the little bird begin to form her nest about the middle of May, which consists, like that of the house martin, of a crust or shell composed of dirt or mud, mixed with short pieces of straw to render it tough and permanent; with this difference, that whereas the shell of the martin is nearly hemispheric, that of the swallow is open at the top and like half a deep dish: this nest is lined with fine grasses, and feathers which are often collected as they float in the air.

HOUSE MARTINS

“Wonderful is the address which this adroit bird shows all day long in ascending and descending with security through so narrow a pass. When hovering over the mouth of the funnel, the vibrations of her wings acting on the confined air occasion a rumbling like thunder. It is not improbable that the dam submits to this inconvenient situation so low in the shaft, in order to secure her broods from rapacious birds, and particularly from owls, which frequently fall down chimneys, perhaps in attempting to get at these nestlings.”

The material used for building is soft, tenacious earth or mud, which the bird fetches in its beak and agglutinates with saliva, the admixture of the latter causing the mud to set very hard and to form a shell stronger and tougher than would be produced by the drying of mud alone. In favourable weather a whole nest may be finished, from foundation to lining, in about a week. The same nest is often occupied for several successive seasons.

The House Martin (*Chelidon urbica*) is perhaps a more familiar bird than the swallow, because it nests in situations where it is more easily observed; usually, but not invariably, against the side of some building, in a window recess, or under the eaves. It can, however, adapt its habits to the locality it happens to be in, and when remote from the neighbourhood of houses it not uncommonly, in some countries, builds in steep cliffs and rocky river-banks. But as its popular name indicates, it commonly resorts to houses, and

no jutty, frieze,
Buttress, nor coign of vantage, but this bird
Hath made his pendent bed and procreant cradle.

The nest is more elaborate than a swallow's, as it is completely closed above and has a neat round opening in the

“ON THE OUTWARD WALL”

side. When it is placed in an angle formed by an overhanging ledge or cornice, its shape is that of a quarter sphere; sometimes, however, it is built against a flat surface, and not in a corner, in which case it is hemispherical in form. It is clear that the safety of the whole structure depends upon the firmness with which the foundations are fixed to the wall, so the bird devotes a great deal of care to this portion of its labours, often spending a week or more over laying down the rim of mud which has to bear the weight of the whole dwelling. By working only in the early morning, it gives each layer time to dry and harden; but when the base is quite firm and secure the work often proceeds more rapidly. While laying the foundation, the bird not only clings to the wall with its claws, but steadies and partly supports itself with the help of its tail. The material is the same as that used by the swallow and is carried in the same manner. Neither the swallow nor the martin has a very capacious mouth, so many hundreds of journeys have to be made in order to carry enough mud to complete the nest. Any nest that withstands the winter weather is at once reoccupied when the birds return. The construction of an entirely new nest is often delayed by many causes: the weather may be either too wet or too dry; in either case there is difficulty in obtaining mud of the right consistency or in getting a solid foundation. The martin often nests in far more exposed situations than the swallow; she

Builds in the weather on the outward wall,

and much labour may be lost thereby. Gilbert White mentions such a case. “Birds in general,” he writes, “are wise in their choice of situation: but in this neighbourhood every summer is seen a strong proof to the contrary at an house without eaves in an exposed district, where some

BOTTLE NESTS

martins build year by year in the corners of the windows. But, as the corners of these windows (which face to the south-east and south-west) are too shallow, the nests are washed down every hard rain; and yet these birds drudge on to no purpose from summer to summer, without changing their aspect or house. It is a piteous sight to see them labouring when half their nest is washed away and bringing dirt . . . '*generis lapsi sarcire ruinas.*'" In spite of the difficulties they have to overcome, the martins usually contrive to raise two broods in the course of a summer, and sometimes even a third, though offspring born late in the season not uncommonly perish in the nest, for the reason probably that the parents are unable to provide them with sufficient food owing to the increasing scarcity of insects.

In Australia our house martin is represented by the dainty Ariel Swallow, or Fairy Martin (*Hirundo ariel*), a little bird about three and a half inches in length. Its nests are frequently crowded together under eaves of houses, or some other shelter, such as that afforded by an overhanging rock.

Gould says: "Hundreds of this species were breeding under the verandahs and corners of the windows, precisely after the manner of the common martin. . . . The nest, which is bottle-shaped with a long neck, is composed of mud or clay, and, like that of our common martin, is only constructed in the morning and evening, unless the day be wet or lowering. While building these nests they appear to work in small companies, six or seven assisting in the formation of each, one of them remaining within and receiving the mud brought by the others in their mouths. In shape the nests are nearly round, but vary in size from four to six inches in diameter, the spouts being eight, nine, or ten in length; when built on the sides of rocks, or in the

“JOHNNY CLAY”

hollows of trees, they are placed without any regular order in clusters of about thirty or forty together, some with the spouts inclining downwards, others at right angles, etc.; they are lined with feathers and fine grasses.” The eggs are usually four or five in number, and marked with red spots or blotches upon a white ground; sometimes, however, they are pure white.

Quite the most remarkable example of bird masonry is that produced by the famous Oven-bird (*Furnarius rufus*), one of the cleverest members of a talented family to which we have already had occasion to refer in a previous chapter. The oven-birds are natives of South America, and they build nests which are both unique in architecture and in solidity of construction. Burmeister says: “When we have passed the lofty mountain chains which divide the vast coast forests of Brazil from the plains of the campos, and descend the hills of the Rio des Velhas valley, there on all sides one notices in the great trees which stand solitary in the neighbourhood of dwellings, large melon-shaped masses of earth on the stout spreading branches. Their appearance is striking. You might take them to be the nests of termites; but then, they have an opening in one side, and they are all of one size, and shaped alike, while the constructions of termites are irregular in form and are never placed freely on a branch, but always at a point where it is forked. We soon find out, however, what is the true nature of these heaps of earth; we recognize the large oval aperture at the side, and presently we may see going in and out a little bird with warm brown plumage; it is in fact a bird’s nest, that of the oven-bird, known to every native by the name of ‘Johnny Clay,’ *João de barro*.”

The Brazilians look upon the oven-bird as sacred. According to them it has a religious sense, because, they say, it

A WELL-BUILT HOUSE

stops working on Sunday, and always turns the opening of its nest towards the east.

"I soon found out that there was no foundation for the first statement," says Burmeister, "and I succeeded in convincing several of the natives of this. The belief that it does no work on Sunday arises from the rapidity with which it performs its task. If this be commenced in the early part of the week, it is sure to be finished before the following Sunday.

"The nest is wonderful, if we consider what a slender little bird it is that makes it. It is usually placed on a horizontal bough not less than three inches in thickness; very rarely it may be seen on a roof, a balcony, the cross of a steeple, etc. The cock and hen work in company. They begin by spreading a layer of clay softened by the rains. They make little balls of it and convey them to the tree, where they spread them out with the aid of beak and claws. When the bed of clay is about nine or ten inches across, they make a rim all round it, which slopes slightly outwards. This border is not more than two and a half inches in height, but it is more elevated at the ends than in the middle, and is fashioned in such a way that the surface is concave." As soon as the ledge is dry the birds place another on the top of it, similar to the first, but inclined a little inwards, and this is repeated until the dome is completed. A high, narrow opening with a curved margin is left in one side of the edifice; this doorway is usually about four inches high and little more than two inches wide. When the structure is finished it looks rather like a small oven, and weighs about nine pounds. The wall on the right of the opening curves inward, and is continued in the form of a partition from floor to dome. A second opening placed high up at the inner end of the partition leads into an inner chamber. where the true nest of dry grass, feathers, cotton,

THE SYRIAN NUTHATCH

and other soft materials is placed. Five white eggs are laid, and the parents incubate them by turns.

Mr. Hudson mentions a very curious fact in connexion with the song of these birds, which appears to be, like their nest, unique. "On meeting, the male and female, standing close together and facing each other, utter their clear ringing concert, one emitting loud single measured notes, while the notes of its fellow are rapid, rhythmical triplets; their voices have a joyous character, and seem to accord, thus producing a kind of harmony. It is very curious that the young birds, when only partially fledged, are constantly heard in the nest or oven apparently practising these duets in the intervals when the parents are absent, notes utterly unlike the hunger cry, which is like that of other fledglings." The same gentleman also relates a strange story of some oven-birds whose oven was built on the end of a beam which projected from the wall of a neighbour's rancho at Buenos Ayres. One of the pair had both legs crushed in a steel rat-trap; on being liberated, it flew to the oven and was seen no more, having probably bled to death. Its mate uttered shrill cries incessantly for some days, but on receiving no answer it left the neighbourhood. Three days later it returned with a new mate, and the two birds at once got to work and built up the doorway of the oven, thus converting it into an aerial tomb, on the top of which they built a second oven. Mr. Hudson's neighbour was an old native, and it was not strange, he adds, that "after witnessing the entombment of one that died, he was more convinced than ever that the little house builders are pious birds."

The Syrian Nuthatch (*Sitta neumayeri*) is also a mud-builder; it makes its nest on the face of steep, overhanging rocks, choosing, when possible, a situation with an easterly aspect. Mr. Seebohm observed them in the crags about

A WILLING PRISONER

Smyrna, and he describes the nest as a very curious structure. He says: "A recess in the rock is selected, and a funnel made of mud and little bits of dry grass is built in front of it. It is quite an important affair; the base is frequently twenty-four inches in circumference, and the walls vary in thickness from half an inch to an inch and a half. The tube of the funnel, which of course serves for the ingress and egress of the bird, is about four inches long, with an internal diameter of an inch and a quarter at the entrance. The outside of the nest is carefully made to resemble the appearance of the rock against which it is built. One which I brought home with me is curiously corrugated or granulated, to imitate the calcareous deposits on the inside of the cave where I found it. The nest is warmly lined with goats' wool, thistle-down, and all sorts of soft materials." It has been stated that the entrance funnel may be as much as a foot in length, and that the outside of the nest is sometimes covered with the wing-cases of beetles. This bird is said to take extraordinary pleasure in building, and to construct nests which it will never use, or repair others in which it has no personal interest.

Those remarkable Old World birds the Hornbills (*Bucconidae*), whose immensely developed bill gives them such a grotesque appearance, should be mentioned in connexion with the masons, for though the works they have occasion to undertake are by no means elaborate, they are remarkable for their strength and solidity.

The nesting habits of these birds are most interesting and peculiar. The eggs are deposited in the hollow of a tree, and when the time comes to incubate, the hen bird retires to the cavity and is there carefully walled in by her mate, who leaves only a narrow slit at the top of the hole through which she can protrude the end of her bill. The im-

FEEDING THE PRISONERS

prisonment is voluntary, for the female often assists in building the wall, which appears to be intended to afford her protection against the attacks of monkeys and the great monitor lizards which climb trees and work much havoc amongst their feathered inhabitants. It is likely, too, that the process of moulting is more safely completed whilst the bird is thus incarcerated; some species, at all events, moult at this time, and Bernstein suggested that the barricade might be intended merely to prevent the hen bird from falling out of the nest, for the latter being usually at no small distance from the ground, she would, with scarcely a quill remaining in her wings, be unable to fly back again after such an accident.

Whatever the object of the wall may be, there is no doubt about it being an efficient barrier, for it is of extreme hardness when dry, and very difficult to break down. It is made of mud, clay, and dirt, combined in some cases, it appears, with various gums, and in building it up the birds use their great bills like trowels.

The imprisonment lasts until the young are almost or quite fully fledged, and during the whole period the male bird is kept busily employed in supplying his mate, and later on his family also, with the food which they are unable, in their helpless condition, to procure for themselves. If he be killed at this time, other males are said to undertake the task of bringing in supplies. By the time the nestlings are strong enough to be released the male bird is usually 'worn to a shadow' by his heavy responsibilities.

Writing of the Great Pied Hornbill (*Dichoceros bicornis*)—the largest member of the family, measuring almost five feet in length—and of its nesting habits in Tenasserim, Colonel Tickell says that having heard of a pair that had nested in the same spot for several years he "lost no time in going to

STORMING THE PRISON

the place . . . and was shown a hole high up in the trunk of a moderately large straight tree, branchless for about fifty feet from the ground, in which he was told the female lay concealed. The hole was covered with a thick layer of mud, all but a small space, through which she could thrust the end of her bill, and so receive food from the male. One of the villagers at length ascended with great labour by means of bamboo-pegs driven into the trunk, and commenced digging out the clay from the hole. While so employed, the female kept uttering her rattling sonorous cries, and the male remained perched on a neighbouring tree, sometimes flying to and fro and coming close to us. Of him the natives appeared to entertain great dread, saying that he was sure to assault them; and it was with some difficulty that I prevented them from shooting him before they continued their attack on the nest. When the hole was sufficiently enlarged, the man who had ascended thrust in his arm, but was so soundly bitten by the female, whose cries had become perfectly desperate, that he quickly withdrew it, narrowly escaping a tumble from his frail footing. After wrapping his hands in some folds of cloth, he succeeded with some trouble in extracting the bird, a miserable-looking object enough, wasted and dirty. She was handed down and let loose on the ground, where she hopped about, unable to fly, and menacing the bystanders with her bill, and at length ascended a small tree, where she remained, being too stiff to use her wings. At the bottom of the hole, nearly three feet from the orifice, was a solitary egg, resting upon mud, fragments of bark, and feathers."

Frogs, toads, and other amphibians are but poor exponents of the arts and crafts. In this book we shall scarcely have occasion to mention more than one member of that great class, and on the whole it will, perhaps, be best to include

FROGS BUILDING WALLS

our solitary craftsman in the present chapter, though his 'masonry' is nothing more than a rampart or crater of soft mud.

The animal in question is called by naturalists *Hyla faber*, and is one of the largest of the tree frogs. Its home is in Brazil, where it is known as the *Ferreiro*, or smith, and it is quite the genius of its family. During the breeding season the female frog builds regular nests in the shallow margins of ponds and marshes. She dives to the bottom of the water and in her two hands takes up masses of mud, which she places side by side in such a way as to form a circular wall, enclosing a space about a foot in diameter. She continues to build in this manner until the wall gradually reaches the top of the water, and at length stands up for the height of about four inches above the surface, when it has the appearance of a miniature crater of a volcano. The parapet is smoothed most carefully on the inner side, and for this purpose the frog uses its broad, flat hands like trowels. The bottom of the little pond or crater is also made quite even by the under surface of the animal's body, aided by its hands. The building is carried on during the hours after sunset, when these creatures are most active, and by the end of the second night the nest is completed and quite ready to receive the eggs. It no doubt affords excellent protection against their enemies for both the eggs and, later on, the tadpoles.

The male frog gives no assistance whatever in the preparation of the nest; both parents, however, usually remain in its vicinity afterwards and appear to keep an eye on it.

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