THE ROMANCE OF ANIMAL ARTS & CRAFTS

By
H. COUPIN
& J. LEA

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BUILDING A HOME

The brush-tailed rat-kangaroos carry the grass for building their nests by means of their prehensile tails. Their appearance when leaping over the ground bearing a little sheaf in this manner is exceedingly grotesque and amusing.

THE ROMANCE OF ANIMAL ARTS & CRAFTS

BEING AN INTERESTING ACCOUNT OF THE
SPINNING, WEAVING, SEWING, MANUFACTURE
OF PAPER AND POTTERY, AËRONAUTICS, RAFT-
BUILDING, ROAD-MAKING, AND VARIOUS OTHER
INDUSTRIES OF WILD LIFE

BY

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AND

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WITH TWENTY-SEVEN ILLUSTRATIONS

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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. We may do this and yet keep within the bounds of truth; it is when we cease to read honestly in the book of Nature, and begin to pick out a part of a sentence here and a part there, and piece them together to make something quite different, that we do wrong. So long as we try to see just what is taking place, we may yet 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 nothing 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 expends its labour to no 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 if they had the gift of imagination, no doubt they would oftener go astray—and the likeness would be still greater.

In an attempt at classifying animal activities under familiar titles, the arrangement must necessarily be in many ways an artificial one. In their delving, their spinning, their weaving, their paper-making, their sewing, and many of their other occupations, however, animals foreshadow our own industries and arts and crafts clearly enough; the resemblance of the results is obvious, though the motives in the two cases are often widely different. 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, even within the bounds of our limited knowledge, than it would be possible to describe in one small volume. Yet should such instances as we have chosen 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, *The Romance of Animal Arts and Crafts* may 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

A persecuted race—"Underground weavers"—Our native representative—A doubtful tug-of-war—An awkward doorway—The trap-door spider's biographer—The choice of a home—The secret door—A vagrant husband—Dangerous courtship—How spiders dig—A careful workman—A pitiless enemy—The tapestry frame—A spider's door-handle—The importance of a well-fitting door—Eggs within eggs—Strenuous resistance—The family at home—A living bolt—Trapping by night—An unexpected encounter—The capture—An unfortunate shot—The inner door—An ingenious dwelling—An invasion—The secret chamber—Infant phenomena—Tree-dwellers—A versatile family.

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 paralysing 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.

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.

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.

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 cœlebs*) 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 nævia*), 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 fluviatilis*), 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

1.

1. A pair of magpies finishing their nest by building a covering of tough twigs. Owing to this method of fortification, the nest, though often in an exposed situation, is safe from the attacks of carrion crows and other bird enemies.

2.

2. Falcon's nest. A rough structure of sticks and twigs, very characteristic of the nests of birds of prey.

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

¹ J. L.

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.

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 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 suscitāt 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

SQUIRRELS AT HOME

The squirrel's nest or "drey," in which the young are reared, is constructed in the fork of a bough, or in a hole in the trunk of a tree. It is composed of twigs, leaves, and strips of bark, and is often very difficult to detect.

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? Bœnigk 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.

THE NEST OF THE HARVEST-MOUSE

This nest is a round, compact structure about the size of a cricket ball. It is made of strips of grass or the blades of wheat beautifully plaited and woven together.

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

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.

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 automata 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 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 cooey 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

THE ENORMOUS NEST OF A MOUND BIRD

These extraordinary heaps of sand, shells, and pebbles are the work of the Australian megapode, or mound bird, which buries its eggs at a depth of several feet from the surface. When hunting for eggs, it is possible to tell whether the bird has recently opened the mound by probing with a stick, which penetrates easily if a hole with the eggs in it has but lately been filled up.

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 even 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-

A WILLING PRISONER

A hornbill constructing a mud wall to protect his partner while she is sitting. When the wall is finished, the entrance to the nest is only just large enough for the hen bird to thrust out her bill and receive the food which is brought by her attentive mate.

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

FROG "MASON'S"

One of the largest of the Brazilian tree-frogs builds circular mud walls in the shallow margins of ponds to protect her eggs and tadpoles. When this curious nest is completed both parents usually remain in its vicinity and appear to keep an eye upon it.

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.

CHAPTER X

ENGINEERS OF ROADS AND TUNNELS

Ants as engineers—Tunnels and secrecy—Slave-raiders—Length of tunnels—Highways—Advantage of roads for foraging—Economy of labour—Roads adapted to the country—Clearing the track—Covered ways—Visiting the cow-sheds—Stupendous feats—The ants' pavilions—Spacious prisons—An ant 'compound'—Prison-breaking—Resourceful ingenuity—Tortoise roads—Road-building by birds—A mossy path.

IN order to guard against danger, most of the ants dig trenches and construct covered roads leading from one part of the ant-hill to another, or connecting the colony with some rich foraging-ground a long way from home.

Forel, who studied them very closely, points out that a community of ants must, as a rule, seek its food supplies outside the nest. Trees especially are a favourite hunting-ground, and the ants make expeditions to the end of the branches for the purpose of visiting the aphides—those pulpy little insects with long antennæ and big, round eyes, which are often seen on the under side of leaves, and which are detested by gardeners, but regarded with very friendly feelings and much sought after by ants on account of a sweet liquid they secrete.

It is for the purpose of obtaining food, then, that the ants become engineers; but, speaking generally, only the species which live in large communities, and not all of those, carry on the works we are about to describe, which may be

TUNNELS AND SECRECY

considered under three headings—(1) tunnels, (2) highways, and (3) covered roads.

TUNNELS

All ants know how to make tunnels from the underground portion of their nest to the surface of the earth. These tunnels often open a great distance away from the nest, so that the ants are able to go in and out without disclosing the situation of their nurseries to possible enemies.

The ants known as *Lasius flavus* burrow in all directions, for the purpose of visiting aphides.

Some species, such as the timid black ant *Formica fusca*, bore tunnels merely to connect two little colonies which are some distance apart. It is not easy to trace these narrow tunnels in their course through the earth, but we sometimes discover their existence in a very interesting manner, that is, through the raids of ants of a different species. An army of slave-making or Amazon ants (*Polyergus rufescens*) makes an attack on a nest of *Formica fusca*, entering by the first opening it meets with, and reappearing a few minutes later carrying cocoons which have been stolen from their owners. Now such an army was observed by Forel to enter an ant-hill and afterwards to leave it in two separate columns, one of which came out by the same opening through which it gained admission, and the other through the dome of a different nest more than a foot away from the first, thus proving conclusively that those two nests were connected by an underground passage.

Sometimes *Formica fusca* makes no dome at all, and only enters or leaves the nest by tunnels opening some distance away from it, so that it is very difficult for the Amazon ants to find their way in. Bates has recorded a very remarkable instance of the enormous length the underground passages

ROADS FOR FORAGING

may attain. In his interesting book, *The Naturalist on the River Amazons*, speaking of the Saüba ant (*Æcodoma cephalotes*), he tells us that in the Botanic Gardens at Pará an enterprising French gardener tried to extirpate these ants by making sulphur fires over some of the main entrances to their nests and blowing the fumes down the galleries by means of bellows. Bates saw the smoke issuing from a great number of outlets, one of them being seventy yards away; a striking proof of the tremendous extent to which the underground galleries may be ramified.

HIGHWAYS

Some ants which are in the habit of going out in dense columns to forage in hedgerow, tree, or meadow make great roads which enable them to get about more rapidly. Such roads are especially serviceable to them in the fields, where the tangle of herbage hinders them considerably in their march, particularly when they are laden with booty.

Mayr thought these roads were nothing more than tracks worn by the ants in continually passing over the same ground; but Huber had already observed the insects preparing them, and was convinced to the contrary. The highways we are about to describe are peculiar to the red wood ant or horse ant (*Formica rufa*), the jet ant (*Lasius fuliginosus*), and *Formica pratensis*. Some other ants which go out in columns leave no perceptible track behind them, a fact which would of itself seem sufficient to prove that the roads are the result of special labour.

The smaller communities make, as already stated, no highways, or perhaps one only; the larger the community, the greater, as a rule, is the number of roads it constructs. The direction which the highways take depends neither

ROADS ADAPTED TO THE COUNTRY

upon the sun nor upon any instinct impelling the insects to move in a straight line, as M. Robert, a French observer, maintained, but entirely upon the place they wish to reach and the most convenient way of getting there. It is clearly an advantage to the ants to make their roads, if possible, through country rich in game, since they are then able to hunt along the route by leaving the track for a little distance on either side.

When a community is established beside a hedgerow, we usually find roads running parallel with the latter from both sides of the nest so that the ants can go foraging in either direction. As the distance from head-quarters increases, the roads become less distinct and are gradually lost. Should the nest happen to be by the wayside, workers cross over to explore the opposite hedgerow, proceeding by one or several routes, as best suits their convenience. It would obviously be useless for them to make a track across the high road, so they do not attempt it, but content themselves with starting their paths afresh in the hedgerow or meadow on reaching the further side.

The most distinct roads are those which, starting from the nest, lead directly into the meadow or towards trees in the immediate neighbourhood. In the latter case the track often stops short at the foot of the tree, but it may suddenly turn aside and start off afresh in another direction.

Ants are not slow to take advantage of any situation which permits them to circulate freely without the necessity of first toiling to make a road for themselves; thus we often see them hurrying to and fro at the foot of a wall or along the edges of a footpath.

Woods and copses present fewer obstacles to our little road-makers than do the fields and meadows, for there they do not find the same dense tangle of herbage, and the under-

CLEARING THE TRACK

wood which may be almost impenetrable for man does not trouble them at all. In this case their work consists mainly in removing dead leaves and similar obstructions from the track; but as others are constantly falling there, the ants make roads of great width—sometimes as much as six inches—in such a situation, so that they may not be completely blocked at any time. In meadows, on the contrary, where the labour of construction is far greater but accidental obstructions are fewer, they are much narrower, being less than two inches in width; on the other hand, they may be hollowed out to a depth of half an inch, so that they rather resemble a Devonshire lane in miniature. *Formica rufa* and *pratensis* are said not only to remove loose obstacles from the track, but to dig a trench and mow down with their jaws any blades of grass or other small plants which may be in the way. It might be supposed that they would begin at one end, starting beside the nest and working outwards; instead of proceeding in this manner, however, they first prospect all around the country, discover by experience which is the best line to take, and then work upon the whole length of the road at once. Only by continuous observation is it possible to form any idea of the amount of labour the construction of such roads requires, especially those in the meadows and grass lands. Their length and importance vary greatly according to circumstances, but some of them may stretch to the enormous distance of two hundred feet or more from the nest, and one large community may make as many as eight or ten such roads.

Our own roads are made higher in the middle than at the sides, so that in wet weather the water may run off the surface; ant-roads, on the contrary, are hollowed out of the ground, and are therefore soon flooded by rain.

ANTS MAKING A COVERED ROAD

COVERED WAYS

COVERED WAYS AND PAVILIONS

Amongst ants this industry seems to be peculiar to a few species in Switzerland, and it has been described so well by Huber that there is very little to add to what he has told us on the subject. The species in question are the common brown garden ant (*Lasius niger*), *Lasius alienus*, *brunneus*, and *emarginatus*, *Myrmica lævinodis*, *scabrinodis*, etc., which want to go a-milking their cows, the plant-lice, or aphides, in peace, and also wish to keep other ants away from them and to protect them against the larvæ of ladybirds and other enemies, which are numerous.

To this end *Lasius niger* excavates roads very like those made by *Formica rufa*, but generally makes use of the earth he has dug out, while it is moist, to build a roof over the top, thus converting them into covered ways. On reaching places which are much exposed the roads dip down under the ground and become tunnels, which open further on and are continued as covered galleries again. On the other hand, in such sheltered situations as the foot of a wall the insects dispense with a roof altogether, and they are compelled to do the same when crossing a high road, for though even under these conditions the ants of this species try hard to keep a roof over their heads, it is broken down as fast as they build it.

You can imagine how varied are these roads of *Lasius niger*, and how interesting they are to observe. Forel states that one he examined was entirely covered, from end to end, by a roof of earth. It was half an inch, more or less, in width, and about one-third of an inch high. Passing up one side of a high wall, it crossed over the top, and was continued to the ground on the other side—a tremendous work of engineering which was carried out merely for the purpose

VISITING THE COW-SHEDS

of making a convenient way for the ants to pass from a courtyard to a garden. Even the vast enterprises that one sees nowadays in the streets of London seem conceived in a niggardly spirit beside such as this ; but perhaps some day when we are no longer hampered by the possession of money, but are all leading the simple life and making roads, we may become even as the ants in prodigality of labour, though not, perhaps, in liberty of action.

In a community of ants comprising several colonies, such roads are used to connect the different nests ; but more commonly they lead to plants or shrubs on the stems of which there are aphides. Over these insects, the ant-cows, galleries are built on the stem of the plant, extending sometimes to the height of a foot above the ground ; in other cases chambers are constructed, supported by the leaves of a plant. *Lasius niger* uses fragments of decaying bark to make similar sheds on tree trunks where there are aphides ; but this must be regarded as the special industry of an allied species, *Lasius brunneus*, which has a great taste for dairy farming, and lives almost entirely by this means, keeping aphides of huge size.

The ants known as *Myrmica* are not such inveterate makers of roads as those we have just described. On the other hand, they build huts on plants around their aphides, connecting them with the nest in some cases by a vaulted chamber of the same material attached to the stem, but more frequently leaving them quite isolated and without any covered communication with the ground. It was to these isolated huts, suspended as it were in mid-air, that Huber more particularly applied the name of ‘pavilions.’ In them aphides and gall insects are literally immured—walled in ; for the tiny openings through which the little ants visit them are too small to permit the fat aphides to escape.

THE ANTS' PAVILIONS

But the prison is spacious, and one mentioned by Forel, made by *Myrmica scabrinodis* on the branch of an oak sapling, a few inches from the ground, was half an inch in length. It was cocoon-shaped, and inside it he found aphides

ANTS' "COW-SHEDS"

Built to imprison and protect their aphides. One shed or 'pavilion' is connected with the nest by a covered road.

of the kind known as *Chermes*, which the ants tended with care. When such pavilions are connected with the nest they must often be looked upon as outlying wings of the main dwelling, since the ants keep some of their larvæ in them.

RESOURCEFUL INGENUITY

In connexion with the engineering achievements of these insects another observation of Forel's is of interest. He placed some ants of the species *Tetramorium cespitum* in a space surrounded by a little wall of powdered gypsum or plaster of Paris, which prevented their escape, because every time they tried to climb over it a miniature landslip occurred and sent them tumbling to the bottom again. For a fortnight they struggled in vain to escape, but at the end of that time they profited by their experience and tried a different way out of the difficulty. They set to work to bore tunnels, very carefully, through the wall of plaster. For some time their efforts were not more successful than before, for the tunnels fell in as fast as they were bored; but after many failures they at last managed to pierce the wall in several places, and one tunnel even divided into two branches in its course through the barrier. A slight touch was enough to destroy completely all that they had achieved, but the ants seemed to have perfected their method of procedure, for in a few hours they invariably bored a fresh tunnel. Thereupon Forel rewarded their perseverance by permitting them to escape with their larvæ and pupæ.

A further striking instance of the intelligent way ants have of surmounting difficulties is furnished by an experiment made by Leuckart. Round a tree which was frequented by these insects he spread a band soaked in tobacco water. After a while the ants above this dangerous obstacle simply let themselves drop to the ground, but those which wanted to ascend the tree were long baffled. At last, however, each brought a pellet of earth in its mouth, and by their combined efforts they constructed a road by which they could pass up the tree in safety.

Termites are also famous road-makers. Perhaps we may mention also the great Land Tortoises of the Galapagos

ROAD-BUILDING BY BIRDS

Islands (*Testudo nigra*) in this connexion, for although there appears to be no special reason for supposing that their roads are intentionally constructed, they are nevertheless very remarkable.

Darwin tells us that when he first landed at Chatham Island he "could not imagine what animal travelled so methodically along well-chosen tracks." In these islands the springs are always situated towards the central part and at a considerable height. Now the tortoises are very fond of water and drink large quantities of it, so those which frequent the lower-lying parts of the island have to make long journeys when they become thirsty. The frequent passing to and fro of these giants—which are now becoming comparatively rare—has produced wide, well-beaten paths which branch off in every direction from the wells to the sea-coast, and are so conspicuous that the Spaniards first discovered the watering-places by following up the tortoise roads.

Everybody who has lived in the country and has kept his eyes open, as the saying is, could name a number of birds that have well-marked runs, but it is rarely indeed that we find a bird actively constructing anything like a definite road. It is therefore all the more interesting to read of such a case recorded by the French ornithologist, M. Lescuyer. He states that on one occasion, when walking through a forest in the neighbourhood of Saint-Dizier, he came upon a decayed tree in which a pair of Cole Tits (*Parus ater*) had made their home, as these birds commonly do. The opening—a very small one—leading into the cavity where the nest was placed, was as usual quite low down, indeed it was at the foot of the tree, and in such a position that the birds might conveniently run in and out. But it seemed that they had been confronted by an un-

A MOSSY PATH

expected difficulty, for the ground had become covered with water. What were they to do under such circumstances? Well, they had solved the problem most ingeniously. On the ground in front of the opening they had constructed a sort of causeway, composed of a layer of moss which extended about three-quarters of a yard from the tree and was nearly an inch in depth. It was clear from the way it was flattened that the birds had made constant use of it for some time.

These clever little birds will, if it be necessary, enlarge a hole in a tree which is not quite wide enough to suit their requirements. It is, however, surprising to find what a very small opening suffices as an entrance to the nesting cavity.

CHAPTER XI

CARPENTERS

Sound wood seldom attacked—Woodpeckers—The mistakes of an expert—A neat workman—Macaws at home—The parrot's siesta—Insect carpenters—A distinguished foreigner—A tremendous undertaking—Putting in the floors—Arrangements for escape—British carpenter bees—An insect's glue-pot—Destructive beetles—"Death-watches"—'Worm-eaten' wood—Forests destroyed—A scented dandy—A famous veteran—Tailed wasps—Two-edged fret-saws—Unexpected guests—Carpenter ants—A dwelling of many stories—Interesting architecture—A sombre dwelling—Disposing of the evidence—Gangs of workers—Termites—Carpentry extraordinary—Deceptive appearances—Ichneumon-wasps—The gardener's friend—More deceptive appearances—Remarkable divination—A delicate instrument—The common gribble—Life on a whale's back—The ship-worm.

ANIMALS that work in wood are numerous. Many birds practise the craft in order to provide themselves with a shelter and to hunt for insects; the insects, on the other hand, gain a double benefit from the wood itself, in which they find both board and lodging. It is but seldom, however, that an animal attacks a tree which is perfectly healthy and sound; we nearly always find that the wood chosen for its operations already shows signs of decay, and the reason for this is not difficult to understand, for such wood is, of course, far softer and easier to work than sound timber. Besides various birds and a multitude of insects, certain molluscs and crustaceans are to be counted amongst the carpenters.

WOODPECKERS

BIRD CARPENTERS

Nearly all the members of the Woodpecker family make nesting-places by boring holes in tree stems, in which they hollow out a bottle-shaped cavity. The opening is at the top, and is horizontal in the first part, but afterwards it descends perpendicularly to a depth which varies from a few inches to several feet, according to circumstances and to some extent with the particular species to which the workman belongs. The structure of the woodpecker is beautifully adapted to the work it has to do. Its feet are of the climbing type, with two toes directed forwards and two backwards, and they enable it to move with wonderful ease in any direction over the trunk and limbs of a tree. They are very powerful, and afford, with the aid of the stiffened tail, a good purchase and firm base of support while the bird is engaged in hewing holes with its strong, chisel-shaped bill, or prising off pieces of bark in order to get at the insects which lurk beneath.

The sides of the nesting hole are neatly smoothed and rounded, but no real nest is formed, the glossy white eggs being deposited on a bed composed of chips of the soft decayed wood of the tree.

Though the three species of woodpecker which are natives of Britain have all conspicuous plumage, more especially the Green Woodpecker (*Gecinus viridis*), with its green coat and crimson crown, they are seldom seen except by the quickest of observers, for like many other gaily-feathered birds they are extremely shy, and show much skill in dodging behind the trunk and limbs of a tree. They are, however, more often heard, and the sound of their resounding blows as they hammer away upon the bark in search of food carries to a considerable distance. They are sometimes said to be

MACAWS AT HOME

able to distinguish at once between sound and decayed wood, by tapping upon it with their bill; but there is no doubt that, expert as they are, they are not infallible, for it is no very uncommon thing to find a hole which has been commenced in perfectly sound wood and afterwards abandoned by the bird when it discovered its mistake. The holes made by woodpeckers are nearly always remarkable for their beautiful symmetry, the circular opening being so perfect in outline that it appears to have been made with a carpenter's drill.

The Macaws are dwellers in the dense forests of tropical America, where they associate in flocks which form a conspicuous feature in the landscape, for these birds are the most gaily coloured of the parrot tribe. Bates compared a flock of Red-and-blue Macaws (*Ara macao*), feeding on a palm tree, to a cluster of flaunting banners hung beneath its crown; and Waterton tells us that in the Macoushi country the trees are sometimes absolutely covered with these brilliant birds, any number of which may be killed with a blow-pipe and arrows such as the natives use.

All the members of the macaw family nest in the hollows of trees, which they enlarge to suit their needs, and one can understand that they find little difficulty in cutting away the wood with their tremendously powerful beaks, since they are able to crush to pulp palm nuts which are so hard that it is difficult to break them even with a hammer! They do not usually make a very deep hole, however, and the situation of a nest is often betrayed by the protruding tail of the sitting bird.

Not the macaws alone, but nearly all the parrots make their homes in the hollows of trees. According to Wilson, the Carolina conures (*Conuropsis*) are in the habit of roosting in companies of thirty or forty, or even more, in a

A DISTINGUISHED FOREIGNER

single cavity, often in a large sycamore, which they may be seen entering one after another by the same hole. There they nestle as close as possible to each other, hanging to the sides in a perpendicular position, supported by their beak and claws; and being very fond of sleep they often retire to their holes in the same way during the daytime for the purpose of taking a siesta.

INSECT CARPENTERS

There are, amongst the British solitary bees, several species which may be classed as carpenters, but as they are surpassed in skill and ingenuity by a member of the family which has not yet, so far as is known, become naturalized in this country, we will give an account of the distinguished foreigner first, and content ourselves with briefly mentioning one or two native species that practise the same craft.

The Violet Carpenter Bee (*Xylocopa violacea*) is an inhabitant of the southern parts of Europe, and I have also frequently observed it at work in Morocco in the early springtime.¹ It is a handsome insect of fine presence, resembling a large humble bee in appearance, but of a beautiful violet colour. Its aspect is rather terrible, and one is disposed to approach it with caution until one discovers that, like many other big fellows, it is really a very peaceful, inoffensive creature. In spite of its royal robe and noble air it is entirely devoted to its business of carpentry, the object of its operations being, as in the case of other solitary bees, to provide nurseries for its offspring. As with most other solitary bees, also, it is the female who undertakes this task, the male not troubling his head about the matter and paying no attention whatever to the progress of the work. Filled, then, with a sense of the importance of her duties and buzzing loudly meanwhile, the female flies about examining posts, palisades, and stumps, searching in the warmest and sunniest

¹ J. L.

A TREMENDOUS UNDERTAKING

spots she can find for one which is just beginning to soften with decay. Wood which is affected by dry rot, or actually decayed, will not do; she wants a firmer material for the construction of her nurseries than that would afford. When she has found exactly what is required in some old post or dead tree trunk from which the bark has been removed, she begins at once to bore into it a little obliquely, making a round hole just wide enough to admit her body easily—that is to say, a little more than half an inch in diameter. She cuts away the wood with her strong, chisel-edged jaws, using them separately to gouge out small pieces, or together like a pair of sharp-edged pincers. After penetrating a very short distance—seldom more than half an inch or so—inwards, she changes the direction and bores downwards, parallel to the sides of the wood. She throws out the chips and the ‘sawdust’ as she proceeds, and labours almost incessantly until she has made a tunnel upwards of a foot long—or more than twelve times the length of her own body—in the solid wood. Now and then she emerges to sun herself and take a brief rest, or to feed upon some flower not far distant, and well may she do so, for when the boring is finished her task is still very far from completion. Her next care is to go gathering honey and pollen, which she places at the bottom of the shaft and mixes together into a little homogeneous cake. With this she deposits an egg; and then she begins an exquisite and delicate piece of joinery, which consists in making a ceiling for the tiny storehouse. This she does by taking some of the ‘sawdust’ which has been formed in boring the hole, and cementing it together in a ring round the wall. Within this ring she forms another of smaller diameter, and in this way gradually works to the centre, the result being a circular plate built in concentric circles, of considerable hardness and rather thicker

ARRANGEMENTS FOR ESCAPE

that a shilling. The cavity thus cut off is a little deeper than the diameter of the shaft, and is destined to become the nursery of the single grub which will in course of time be produced from the egg deposited therein. A series of such little nurseries, or cells, is constructed one above another, each containing an egg and a supply of food sufficient for the needs of a single larva, until the whole shaft is filled in. Then the bee closes the main entrance with a stout barrier of wood chips cemented together.

The construction of the cells is a complicated labour which occupies a considerable period, and as they are formed in succession it follows that the eggs are deposited at appreciable intervals, and do not all hatch at the same time. In due course each one passes through the successive stages of grub and pupa to that of a perfect bee, and it is obvious that the lower ones will be the oldest, and ready to make their escape before those in the cells above them. It is therefore not very clear how they are to make their *début* into the world without disturbing their younger brethren, who would be seriously disturbed if their nurseries were broken into and converted into a corridor for the passage of their more hardened elders.

According to Réaumur, the careful mother foresees the emergency, and provides for it by making a second opening at the bottom of the series of cells; and it is stated that the young bees, each in turn, gnaw through the floor of their cells, never through the ceiling, and thus pass only through those compartments from which their seniors have already made their escape. In some cases Réaumur also noticed a third external opening about the middle of the series, which he supposed the mother bee had made in order to remove more conveniently and with less labour the fragments of wood from the lower end of the shaft.

BRITISH CARPENTER BEES

In the countries where carpenter bees abound they often make use of old nests, and by thus saving much time and labour they are able to leave behind them in favourable seasons offspring more numerous than they could hope to do if they had to excavate a fresh series of nurseries for every brood. Several instances are also recorded in which these insects have taken advantage of convenient cavities to save themselves the trouble of making tunnels. In one case a bee had constructed its cells in the brass tube of an old surgical appliance that had been thrown aside on the roof of the Paris Museum ; in another they had utilized the series of holes in the post of some outdoor gymnastic apparatus.

There is a tiny British bee called *Ceratina cœrulea*, of a deep shining blue colour, and scarcely more than a sixth of an inch in length, which has been observed excavating the pith from dead bramble sticks, selecting those which have been broken and effecting an entrance by the fractured extremity. This bee, like others of its tribe, divides the cavity into cells and furnishes each with a ball of pollen kneaded with honey into a little cake. Another species, *Prosopis signata*, lines the cells with a membrane and stocks them with liquid honey. Some of the *Osmia* genus also burrow into bramble branches, and divide their cells by means of plugs of masticated leaves. Others, again, form their partition of clay ; but in all these cases the general plan of construction is the same as that adopted by the master carpenter *Xylocopa*.

On the Amazon there is found a handsome gold-and-black bee called *Euglossa Surinamensis*. This bee has 'pollen baskets' of very large size which it puts to peculiar use. It builds a solitary nest in crevices of walls or trees, closing up the chink with bits of stick and dried leaves, and when out collecting these materials for its wooden partition it takes

“DEATH-WATCHES”

the precaution to provide itself with a glue-pot before returning home again—that is to say, it visits the caju trees and gathers into the expansions on its hind shanks some of the gum which exudes from their trunks, and which makes an excellent cement for its subsequent carpentry operations.

By far the most numerous of the insect carpenters are the wood-boring beetles, troublesome little creatures which are responsible for an incalculable amount of injury to timber and woodwork. Like the clothes moths and various other insects, they are most mischievous during the larval state; but whereas the moths are practically powerless to do any more harm when once they have arrived at maturity, some of the beetles never quite lay aside the troublesome propensities which their powerful jaws enable them to exercise to the last. One of the longicorn beetles (*Cerambycidæ*), for instance, to which the significant title of *amputator* has been given, has a habit of ‘ring-barking’ trees, eating through the bark in a circle and thus destroying the branch which it attacks. Large beetles of this family have been known absolutely to lop stout branches in a manner precisely similar to that in which a beaver cuts down a tree.

Perhaps the most generally troublesome of the beetle carpenters, however, are the Death-watch Beetles (*Anobium*), which live in old furniture and the woodwork of houses, and by tapping the wood with their head make a noise like the tick of a watch—their method, apparently, of calling to one another, for by imitating the sound you can get the insects to answer back. These beetles are more often heard than seen, but their ‘handiwork’ is familiar—too familiar indeed—to everybody, for by boring into furniture and floors their larvæ produce the condition commonly known as ‘worm-eaten.’

Other beetles, whose ravages are conducted on a larger

A SCENTED DANDY

scale, are the *Scolytidæ*, small insects which live under the bark of trees. *Scolytes destructor* is an important member of the great tribe of insect pests. The mother insect excavates a gallery between the bark and wood, usually parallel with the axis of the trunk or limb in which it is formed, and along the sides of it deposits her eggs at short intervals. When the grubs appear they begin, as is the way of grubs, to eat voraciously, and in eating they too excavate long tubular galleries between the wood and bark. These galleries are not cut haphazard in any direction; it is a curious fact that they branch off from the central gallery almost at right angles, and though they do not keep to an absolutely straight line, the grubs contrive in a truly wonderful way to avoid breaking into each other's runs. Each gallery gradually widens out as it proceeds, on account of the growth of the larva, and the whole system forms a very curious and characteristic pattern. Eating thus under cover, the presence of these hungry little creatures may not be suspected until they have done so much damage that the bark becomes detached and the tree perishes, and whole forests have been destroyed in this manner.

Another carpenter, common enough in England, is the Musk Beetle (*Aromia moschata*)—a handsome insect of bronze-green colour, which is found on old willow trees. Its presence can usually be detected quite easily even at a distance by the powerful and agreeable odour which it emits. The larva bores winding galleries which are sometimes many feet in length.

Some of the wood-boring grubs attain to a very great age before their transformation takes place. As an example of their longevity we may mention an instance that occurred at the Natural History Museum in South Kensington some years ago. A small block of hard wood containing the

TWO-EDGED FRET-SAWS

burrow of some insect was brought to the Museum and deposited there. The burrow was that of the larva of a longicorn beetle, and was still inhabited by the living grub which, there is reason to suppose, was then about seven years old. The larva was watched with interest, and it continued to burrow and eat with steady determination for seven long years after its arrival at the Museum. At the end of that time, instead of proceeding in the conventional way to vindicate its extended period of preparation by turning into an exceptionally fine beetle, for some undiscovered reason—whether being “born a duck it aspired to be a swan,” and was overcome by unsatisfied ambition, or whether it had the misfortune to meet with an unusually indigestible layer in its progress through the wood-block, I cannot say—from some unknown cause, the larva died.

The Tailed-wasps (*Siricidæ*) deserve special notice. They are large members of their family, more especially the Giant Tailed-wasp (*Sirex gigas*), which is marked with conspicuous bands of black and yellow. The ‘Common’ Tailed-wasp (*S. juvencus*) is very rare in England, but more plentiful on the Continent. The female has an ovipositor, the end of which is rather like a double-edged fret-saw, with the aid of which she can pierce holes in the bark of pine trees for the purpose of depositing her eggs. When surprised while thus engaged the insect is easily captured, because the “saw” is not readily withdrawn when once it is well inserted into the tree trunk. The caterpillar-like larvæ burrow into the wood, which forms their food, and may do a lot of damage, though standing timber is seldom attacked if it be quite sound. It often happens that their presence in the wood is unsuspected, and when the timber, after being sawn up into planks and beams, is used for building, the larvæ continue their placid and uneventful existence

A DWELLING OF MANY STORIES

until the time comes for them to turn into perfect insects, which are thus apt unexpectedly to make their appearance in new houses. If by chance wood thus affected has been used in conjunction with other materials for any purpose, such as the manufacture of packing-cases, the *Sirex* sometimes succeeds in piercing the most unlikely substances. Sheets of lead have been penetrated in this way, and in the Crimea even bullets had holes made in them by *Sirex*.

It is not surprising to find amongst the ants, of whose versatile genius we have already met with such remarkable proofs, several which can claim to be excellent carpenters: carpenters on a gigantic scale, for they carve out vast dwellings with halls, colonnades, arcades, and a thousand chambers, all from one solid block of wood.

Those clever masons the red ants can turn their skill to carpentry on occasion; but they are far outstripped in this employment by the little shining black ants called *Formica fuliginosa*, which easily hold first rank. Working inside the trunk or large roots of a tree, their operations are unfortunately hidden from us; we cannot watch them at work as we can the mason ants, so we have to be content to observe the result of their labours, and a very wonderful result it is. Let us picture to ourselves vast tracts of the interior of a tree—it may be an oak tree, for these sturdy little workers are not in the least deterred by the hardness of the wood—large portions of the once solid wood sculptured and hollowed out so as to form a dwelling of more stories than would be obtained by piling one on the top of another all those dreadful examples of the possibilities of engineering which in America are called ‘sky-scrapers.’ In this towering dwelling the stories are more or less horizontal; the floors and ceilings are about half an inch apart, and as thin as a card; in the spaces between them we find, in

A SOMBRE DWELLING

one place, slender upright partitions, forming a myriad of chambers; in another, innumerable slender columns, through which we may peer over the greater part of a story—a vista which recalls the vast hall of some old Moorish mosque.

Most of the upright partitions are parallel, for in carving out their halls the ants are apt to follow the ‘rings’ of the wood, so that their architecture has a concentric character which produces an orderly effect on the whole. The little columns are of various degrees of thickness; some of them are very slender in the middle, but rather thicker at each end, at the points which correspond to the base and capital in our own architecture. By careful study of the whole structure we are able to conclude that the ants first hollow out corridors side by side, and then cut little archways through the thin walls between them, thus joining one to another. The archways may be gradually enlarged, so that the interior no longer resembles that of a corridor with doorways here and there, but rather the nave and aisles of some primitive cathedral, separated by rows of irregular columns. As the corridors are cut out independently, these floors are not all on the same level, and so the floor of a story resulting from the connexion of several corridors is of course uneven; but this is an advantage to the ants, for it results in convenient hollows wherein to place their larvæ.

A curious point about this vast and intricate dwelling is that the walls, floors, ceilings, and columns are all black. Whatever the original nature of the wood, whatever the tree may be, whether oak or willow, the labyrinth is completely blackened, and the stain penetrates through the whole substance of the walls except where they are unusually thick. A sombre dwelling and dark, but a scene of incessant busy life and strenuous effort.

Nobody, so far as I am aware, has yet succeeded in

GANGS OF WORKERS

accustoming the carpenter ants to work under observation. M. Huber made the attempt, but his ingenious efforts met with no success. Not that the ants object to the fact that “a chiel’s amang ’em takin’ notes”—they probably have no perception of such a circumstance, which is too remote to be taken account of in their busy little world. The warmth of the sun, the falling of raindrops, night and day, winter cold—such things have a direct influence on their daily life; but the gaze of a benevolent giant is something beyond their ken. What the carpenter ants do object to very strongly is working when exposed to the light; they love darkness and secrecy, and, like some of the wood-boring bees, they often take extraordinary precautions to remove any evidence which might reveal the presence of their nest. Mr. McCook relates how, for instance, a colony of the carpenter ant of Pennsylvania (*Camponotus pennsylvanicus*) that had made its nest in a beam of a mill was at great pains to clear away the chips which resulted from the work of excavation. The chief entrance to the nest was through a fissure in the beam, from which the workers were constantly appearing with fragments of wood. The splinters were deposited on a cross-beam about eighteen inches below, where they formed a little heap. The rubbish was not allowed to remain there, however, for a whole crowd of workers was busily engaged in carrying the fragments to the edge of the beam and dropping them down upon the staircase below, where another gang was in waiting to remove them still further away. The staircase gang, however, was dispensed with after a while, for the ants discovered, apparently, that the stairs were swept every morning, and being so obligingly relieved of that part of their labour, they devoted themselves instead to helping their comrades to destroy the beam overhead—or, from *their* point of view,

CLEARING AWAY THE DÉBRIS

to enlarge the home. Another colony observed by Mr. McCook had made its quarters in a small maple which grew in one of the streets of Philadelphia. The opening of the nest was hidden under a piece of projecting bark, but the presence of the ants was disclosed by the 'sawdust' lying at the foot of the tree. Two ants were occupied in carrying the débris away, grain by grain, and throwing it into the gutter; and Mr. McCook gives a minute account of the amusing way in which they behaved whilst thus occupied. On arriving with its burden at the edge of the sidewalk, the insect stooped on its hind legs, rested a moment in that position and then, leaning forward, dropped the fragment from its jaws, after which it made rapid movements with its fore legs as if to brush away any bits of sawdust that might cling to its mandibles. The mandibles are hard, triangular structures, each bearing five strong teeth, but the insect does not appear to be a very rapid worker; it is not nearly so destructive, for instance, as the termites. The nest in the mill beam referred to above was about two feet in length, the beam being seven inches thick, and the ants had been working at it for eight or ten years. When cut open it presented the usual appearance of galleries, chambers, and arcades arranged in irregular stories one above another, but the top part of the nest was peculiar in being planned on a more noble scale, for there the great domed halls were from one to three inches in height, and suggested caverns rather than colonnades—caverns with stalactites and stalagmites from ceiling to floor, but unlike the glistening white stalactites you see in a limestone cave, those made by the ants were dusky, stained all black by their acid secretions.

We shall have something to say later on about termites and their doings in speaking of their covered roads and the huge nests they make around the branches of trees, but we

ICHNEUMON-WASPS

must also give a short account of their carpentry. In our previous remarks we mentioned the enormous damage they may do by eating away the wood of a tree and lining the cavity with a wall of mud; that is, however, but one of their objectionable habits, and one of the least inconvenient. To realize the annoyance that may arise from the presence of termites, it is necessary to follow them in their invasion of a house. Their carpentry is of the destructive kind, and they are rapid workers. They have been known, it is said, in a single night to tunnel from the floor through the leg of a table up to the top, across the top of the table, pausing by the way to devour whatever was lying there, and then down through another leg to the floor again. Beams, pillars, and furniture are destroyed before the inhabitants have a suspicion of what is taking place, for these terrible pests always leave the outside of the wood intact, and wherever they have been busy things are not what they seem. You attempt to raise the lid of what appears to be a strong, solidly made box; your fingers break through—it is nothing more than a fragile shell, thin as paper; termites have been at work. In the Natural History Museum at South Kensington there are some specimens which show very beautifully how complete is the destruction wrought by these insects, and how cleverly they just stop short of biting through the outer layer of the wood during their operations. Happily for us, termites are unknown in England; that is one of the compensations for our much-abused climate, for they are essentially inhabitants of warm countries; one species, however, is sometimes met with in the south-west of France.

Whether we ought to include some of the Ichneumon-wasps (*Ichneumonidæ*) amongst the insect carpenters I cannot be sure; but even if they appear here under false pretences, it will not be their fault if they do not extenuate their in-

THE GARDENER'S FRIEND

trusion by being interesting. The family of ichneumon-wasps is a very extensive one, as you may judge from the fact that something like six thousand species are already known; and most of them make it their business in life to hurry silently and untiringly about the world looking for caterpillars, insects of various kinds, or spiders. Their object is not a benevolent one—from the other insect's point of view, at all events; from the gardener's or agriculturist's it is, for having succeeded in its quest, the ichneumon-wasp deposits an egg upon or under its victim's skin and hurries away to continue its hunting. When the egg hatches the ichneumon grub feeds upon the body of its host. Sometimes the latter—the victim is usually a caterpillar—is entirely absorbed before it has time to turn into a chrysalis, but in other cases the episode takes a different course. The big *Ichneumon pisorius*, for instance, attacks the larva of a pine hawk-moth. The caterpillar appears to be unaffected in any way; after a placid existence it becomes a chrysalis from which there emerges in due course—a pine hawk-moth? No; a fine ichneumon!

Very well, then, the ichneumon-wasps want grubs for *their* grubs to feed upon; but many of them have very special preferences in the choice of grubs, and some species only attack wood-boring larvæ. We saw, a few pages back, how the giant tailed-wasp (*Sirex gigas*) bores a hole in a tree trunk and deposits an egg in the wood, upon which the grub feeds—in security one would have supposed. Presently, however, there appears on the scene an ichneumon-wasp, the insidious *Rhyssa persuasoria*, with a tail still longer than that of the giant tailed-wasp; she hurries over the tree trunk, pauses, hurries on again, and at last comes to a halt, for by some wonderful means she has discovered that just at that spot, deep under the bark, there lies hidden the grub of a *Sirex*! How she divines its presence we do not

A DELICATE INSTRUMENT

know ; the grub is invisible from the outside, for it is walled in by an inch or more of solid bark and wood ; yet she discovers exactly where it lies. Perhaps she hears it gnawing away the timber, or it may be some other delicate sense whose seat is in those imperfectly understood organs the antennæ, enables her to detect her prey ; but however that may be, her long, fine, almost hair-like ovipositor is inserted through the bark and pierces the skin of the ill-fated *Sirex* grub, leaving an egg there. This extraordinary rapier-thrust at an invisible victim seems to me to be one of the greatest marvels of insect life. I have stood by while a great surgeon cut down, down, with unerring certainty, straight to a small disease spot hidden deep in a man's lung, and have wondered at the almost uncanny degree of skill required for such an operation ; but here we have an insect which, with no landmarks, no long experience to guide it, performs what almost appears a greater miracle still.

We have said that the ovipositor is long and hair-like ; in the case of *Rhyssa persuasoria* it is almost two inches in length, and in some foreign species it attains to as much as six or eight inches. Some naturalists think it impossible that so slender an instrument could be made to pierce wood ; if it cannot, the alternative seems to be that the grub is reached through the tiny hole made by the mother insect—*Sirex* or another, as the case may be ; but as the grub eats its way through the wood and does not spend its life on the exact spot on which the egg from which it was born was deposited, that explanation appears merely to substitute one difficulty for another.

CRUSTACEANS

Some crustaceans are notorious for their habit of burrowing into submerged woodwork and thus doing much damage to wooden piers, etc. One of the most destructive is the

LIFE ON A WHALE'S BACK

common Gribble (*Limnoria lignorum*), a little creature which rather resembles a small wood-louse, about one-sixth of an inch long and of an ashy-grey colour. It is well known to fishermen, and its narrow burrows, running deep into the wood, are constantly seen in timber which has been submerged for any length of time in the sea. The immense length of the burrows is accounted for by the fact that the gribble is a vegetarian and feeds upon the wood in which it dwells. Even more destructive is the *Chelura terebrans*, which is an altogether larger animal than the gribble and makes much wider burrows. The holes are drilled slantingly into the timber and expose a large surface which becomes softened and frayed, so that wood thus attacked is rapidly washed away by the sea. Whilst speaking of burrowing crustaceans it is interesting to note the curious little *Tubicinella trachealis*, or Burrowing Barnacle. Unlike those you may be familiar with hanging from floating timber, or the acorn barnacles so commonly seen covering rocks on the coast, the burrowing barnacle attaches itself to the skin of a whale and proceeds to make a snug retreat for itself by boring a deep round hole, which sometimes penetrates as far as the blubber. Scores of these holes are found quite close together, looking as though they had been stamped out with a sharp punch, and it is difficult to imagine that even a whale does not find such intrusive and persistent visitors a little troublesome—especially as each of them constructs a substantial stony lining within its burrow.

MOLLUSCS

In these days of iron and steel ships the injury caused by the boring propensities of marine animals is comparatively small, but in former times, when all vessels were built of wood and before the invention of copper sheathing, the damage they inflicted on shipping was enormous; and not on shipping

THE SHIP-WORM

alone, for the wooden piles of harbours, dykes, and piers suffered in an equal degree. There was a period, indeed, when the great dykes of Holland came near to being destroyed by such animals, the most serious offender being the well-known ship-worm *Teredo*. As the name 'ship-worm' indicates, this animal has a worm-like aspect, though it is really a shell-fish of the kind naturalists call a *bivalve mollusc*, that is to say, a mollusc which secretes a shell consisting of two pieces or valves. In the ship-worm the true shell is by no means a conspicuous feature, being nothing more than a small globular structure confined to the neighbourhood of one extremity. The worm-like appearance of the animal is due to the extraordinary length of the siphons by means of which a current of water is kept flowing over the gills, and which are a foot, or even two or three feet, in length. Wherever they settle, the ship-worms soon become numerous, and there is no wood sufficiently hard, no balk stout enough, to resist their attacks. Teak or oak, mahogany or pine, it is soon riddled through with holes and destroyed. It is not easy to understand how the excavation is carried on. It usually follows the course of the grain, but turns aside to avoid a knot, a bolt, or even the burrow of another *Teredo*, for the tubes seldom touch or run into one another. Some people think that it is produced by chemical action, that is to say, by the secretion of a substance capable of dissolving the wood; but the holes look too clean-cut for this explanation to appear a very likely one. The more general opinion is that the holes are bored mechanically by the constant rubbing away of a surface softened by the contact of the water, the animal's foot being the boring instrument. As the hole is made, the sides of it are protected by the addition of a shelly lining. One tropical species bores into cocoa-nuts and similar hard fruits which it finds floating in the sea.

CHAPTER XII

TRAPPERS

An uncommon craft—Ant-lions—A deadly pitfall—Bombarding the victim—Original methods—Peculiar manœuvres—Sisyphus and the stone—The worm-lion's methods—A ferocious infant.

EXCEPTING the many spiders, of whose admirable and well-known skill in making nets to capture their prey we shall have occasion to speak later on, but few animals have developed the art of trapping; indeed we are acquainted with three only—the larvæ of ant-lions, worm-lions, and tiger-beetles.

The ant-lions are not British insects, but several species are found in the southern parts of Europe, and one of the best known of these is the common Ant-lion (*Myrmeleon formicarius*). The insect itself is not unlike a dragon-fly in appearance, having four long, narrow, transparent wings; but its body is shorter than that of a dragon-fly, and its antennæ are clubbed at the end. It is often to be seen about the end of summer or the beginning of autumn in pine forests, where it passes the day at rest upon the vegetation and hovers about in the evening seeking for food and company. But it is with the larva that we are concerned—a very different creature. It has a flat, oval body connected by a narrow neck-like portion with a head which bears two long, sharp-pointed, sickle-shaped jaws, very terrible in appearance, with three teeth on the inner side of each. Jaws like these are clearly made to kill; but how is their

BOMBARDING THE VICTIM

obese owner, whose walking pace cannot be described as rapid, and who has no wings at all, able to capture the ants and other agile insects which form the greater portion of his prey? He cannot fly, he is unable to compete with his quarry in running; so he has done what you or I would do, or try to do, if we had similar difficulties to overcome before dining—that is to say, he has invented a trap, or perhaps we should say a pitfall, of a very efficient kind.

It consists simply of a hollow in the sand, shaped like the mouth of a funnel, at the bottom of which the larva (to which the title of “ant-lion” more properly belongs) lies buried with nothing exposed but its head armed with the murderous jaws. Now let us see what happens when an ant or other small insect passes that way. Unconscious of all danger, it walks over the margin of the innocent-looking hollow; the loose sand gives way under its feet, a miniature landslip occurs, and in a moment the unfortunate insect is precipitated to the bottom of the pit, where it is pounced upon by the hungry larva. If by chance the prey recovers its footing half-way down, or attempts to escape by scrambling up the side of the pit, its efforts to get away are seldom successful, for the ingenious ant-lion bombards it with a shower of sand and thus hastens the descent of its victim. Once the prey is captured it is half buried in the sand and devoured at leisure; if it be an ant, nothing is left at the end of a quarter of an hour except the limbs, head, and hard external parts, while two or three hours suffice for the extraction of all that is succulent from the body of a fat blue-bottle fly. Having finished its meal, the ant-lion by a dexterous jerk of its head flings the remains of its victim outside the pit and lies in wait for fresh arrivals.

The way in which a pit is excavated is peculiar. Working as it does in dry, loose sand, the ant-lion cannot proceed

ORIGINAL METHODS

with its task in the same manner as the trap-door spiders or ants which make their dwellings in earth which is more or less moist, by removing it in the form of little pellets and depositing each one carefully beyond the limits of the hole. Were the ant-lion to adopt the same plan, it would by continually scrambling up the sloping sides of the pit produce little avalanches of sand whereby all its efforts would be brought to nothing. It has, however, hit upon an ingenious and decidedly original method of procedure, which is as follows. Having found a suitable spot, that is to say, one where the surface of the ground is composed of very loose sand, it first, like a good engineer, makes a plan of the works; in other words, it marks out a circular area of the size it intends the mouth of the pit to have when completed. This it does by forcing its body through the superficial sand, moving round in a circle meanwhile, and thus hollowing out a shallow ditch. The space thus marked out is usually proportioned to the age of the larva. A very young individual of small size does not as a rule undertake extensive works which would be a severe tax on its powers of endurance, nor does it try to lay a trap for big insects which might prove troublesome to tackle when caught; so we find larvæ which have not long emerged from the egg making tiny pits scarcely a quarter of an inch in diameter. On the other hand, an ant-lion which is almost full grown will often make a pitfall measuring three inches from side to side and two inches deep in the centre.

Let us suppose, then, that the larva has marked out a round patch of ground in the way described above. Its next concern is to remove a mass of sand amounting to several hundred times the bulk of its own body, and to remove it in such a way as to form a cavity with smooth, even, sloping sides, devoid of any lumps or irregularities

PECULIAR MANŒUVRES

which would afford foothold to an insect. It accomplishes this by walking round and round backwards, in an ever-diminishing circle, and flinging out the sand with its head as it goes. It is all done in the most careful and systematic way ; not a 'shovelful' is taken up at haphazard. In order to make a cavity of gradually increasing depth as the centre is approached, it is necessary to take up the sand from the inner side only ; to do this the ant-lion uses the front leg of that side like a hand and with it heaps sand upon the top of its large, flat head. As soon as a load has been prepared it is thrown out of the hole with a quick jerk, and then, with great rapidity, the manœuvre is repeated. No labourer using a spade could do his work more accurately or as quickly. After acting in this manner several times in one spot the larva takes a step backwards and begins again, always using the inner leg in the same way as before. After a while it may happen, especially when a large pit is being excavated, that the one leg becomes tired ; in that case the little creature continues the spiral course in the opposite direction and thus brings the other front leg into use ; but instead of merely turning round in order to do this, it walks across the heap of sand which remains in the middle of the pit and starts afresh from the opposite side.

Sometimes the excavation is completed in a single spell of work, in half an hour or less, at others there are intervals for rest ; it seems to depend on the necessity for food. If hunger is pressing, the work is hurried on ; otherwise the larva can afford to take its time. Réaumur observed also that, like other labourers, the ant-lions do not care about working in the heat of the day if they can avoid doing so ; when the sky is overcast, however, and they are not exposed to the direct rays of the sun, the time of the day appears to be a matter of indifference to them.

SISYPHUS AND THE STONE

Occasionally during the progress of their labour they come upon coarse grains, tiny stones, or little lumps of earth. Should these prove to be too heavy to be flung out of the pit in the usual manner, the ant-lion emerges completely from the sand and carefully backs under the load until it is balanced on the middle of its body, whereupon, still moving backwards, it carries its burden up the sloping side of the pit. But this is a difficult feat of equilibrium, and very often in spite of all efforts the stone, like that which Sisyphus was doomed eternally to roll up the mountain, tumbles back to the bottom of the slope. The ant-lion, however, is not easily discouraged; it returns to its task time after time, and only when the stone is too large or too awkwardly shaped to be removed in this manner is the pit sometimes abandoned and a fresh beginning made elsewhere. As a rule, however, the obstacle is thrust against the side of the hole, for as long as the bottom is kept clear such a slight imperfection does not greatly interfere with the efficacy of the trap.

The ant-lion's method of obtaining food has one disadvantage: it is entirely dependent on the chance arrival of an insect. Fortunately for its well-being, the larva is capable of very long fasts, some individuals which have been kept under close observation having been known to go without food during several months; also when game is plentiful it can absorb large quantities, and can thus obtain enough nourishment in a short time to satisfy its needs for many weeks.

The ant-lion's pit is not, as it is often supposed to be, absolutely unique of its kind. The larva of the two-winged fly known as *Leptis vermileo*, or "Worm-lion," makes a somewhat similar pit by burying a portion of its extremely agile though legless body in the sand, and moving the remainder round and round in a circle. A little conical hollow with

A FEROCIOUS INFANT

very steep sides is thus formed, wherein the grub lies waiting for its prey. Though unknown, so far as we are aware, in England, these creatures are found in the central and southern parts of France. Our last example of the trappers is, however, represented in England, and is probably known, in its mature form at all events, to most boys. This is the larva of *Cicindela*, the Tiger-beetle. The tiger-beetles themselves are handsome, active insects of predaceous habits, and their larvæ or grubs, though they do not share their good looks, are equally ferocious; in that respect at least it may be truly said that "the child is father of the man." Instead of hunting far and wide for their prey they, like the other trappers, make a pit and lie in wait for the small insects which are necessary for their subsistence. In this case, however, the pit is merely a hole bored straight down in the ground. Therein the larva supports itself with its flat head level with the surface, and seizing its unsuspecting prey as it passes over this veritable death-trap, drags it underground, where the episode ends in a tragedy and a meal.

CHAPTER XIII

HARVESTERS &c.

Ants in fable and history—A well-founded reputation—Agricultural ants—Making a clearing—Highways and avenues—Gathering the harvest—Ants' granaries—Care of the grain—Malting—Robbery by force of arms—A woodpecker's store-rooms—Another method of laying up supplies—An unreasoning habit—Mushroom growers—Parasol ants—A remarkable spectacle—Cutting the leaves—Engineer and naturalist—Ants' "mushroom beds"—Laying down a bed—Slips and cuttings—Honey ants—"Honey from the weed"—Within the gates—The honey-rooms—Living honey-pots.

EVERYBODY knows the fable of the Ant and the Cicada, wherein the prudence and forethought of the one is extolled to the discredit of the other. I think we should have liked the ant better if she had tempered justice with mercy, and had finished by giving the poor songstress a few grains from her store, instead of sending her away with nothing better than a churlish answer; but that is beside the question. For many centuries the ant was by common consent praised for her providence; she was seen carrying grain and seeds to the nest, and it seemed quite clear that she was filling her granaries so that when the summer had gone and food was scarce she would have an abundant supply for her needs. "Go to the ant, thou sluggard," says Solomon: "consider her ways and be wise; which, having no guide, overseer, or ruler, provideth her meat in the summer, and gathereth her food in the harvest." Horace and many others through the

AGRICULTURAL ANTS

centuries, almost down to our own times, credited ants with this habit, and everybody believed the same thing as a matter of course, until some learned people said it was probably all a mistake, and that ants in *their* opinion did nothing of the kind. But the learned people were wrong after all, though not altogether so. In England we do not find ants garnering great quantities of grain in store-rooms under the ground, but in warmer climates—in the countries around the Mediterranean, for instance, and in some parts of America—they certainly do.

Mr. Moggridge, to whose intensely interesting observations of the habits of trap-door spiders we had occasion to refer in an earlier chapter, showed conclusively that the ancient belief in the provident nature of ants was a true one, at all events as far as certain species (*Aphenogaster structor* and *barbara*), which he studied in Southern Europe, were concerned. He saw the insects gathering seeds and conveying them to their nests, where he found them stored away in numerous granaries; he saw them taking means to keep their grain in good condition, and he proved that the precious store was used for food, so that by his observations these wonderful little insects were restored once more to the proud position from which they had lately been deposed. Following in Mr. Moggridge's footsteps, Mr. McCook performed a similar act of justice for the agricultural ant of Texas, whose imposing title is *Pogonomyrma barbatus*. These ants are harvesters on a grand scale, and there are few things more interesting to observe than the very business-like way in which they pursue their occupation. They love the warmth of the sun, and always make their nests where they will be fully exposed to the open sunlight. According to Mr. McCook, this habit has precisely the same effect upon the insects as it would have upon a man, for

MAKING A CLEARING

while the very young ants are of a pale yellow colour, as they grow older they gradually become sunburnt by their daily exposure until the old and seasoned workers acquire a rich dark-brown complexion. Whether it is really due to the sun, however, and is not merely a change which takes place with advancing age, is by no means certain. The first peculiarity to be noticed about a colony of these ants is that they clear the ground over and around their habitation and make good roads which lead into the surrounding country. The stumps of the grass stalks are left standing, dry, dead, and black, so that the ground has exactly the appearance of a miniature 'clearing' in the backwoods of America. Round the edges of the clearing gangs of workers may be seen busily engaged in cutting down the standing tufts of grass with the saw-like edges of their mandibles—sawing, biting, twisting, and pulling with great energy. After making a small cut, they swing themselves to the under side of the grass, press the body firmly against it in order to get a good purchase, and then by tugging and swaying the leaf from side to side they strain and weaken the fibres until at last with a final wrench or cut it is completely severed and falls to the ground. When once the ground has been cleared they take good care to keep it free from weeds, which are at once vigorously attacked and destroyed wherever they spring up.

Such is the energy of these small creatures that it is no uncommon thing to come across a clearing ten or twelve feet in diameter in the midst of a thicket of wild sage and other sturdy weeds, whose thick stalks stand a yard high and make an almost perfect circle around the ants' domain. This habit is a great source of annoyance to farmers, whose crops of corn are often seriously injured by the attacks of agricultural ants. The worst of it is that when they have settled

GATHERING THE HARVEST

in a locality, the ants are exceedingly difficult to drive away. Even if their nests be ploughed up, and that more than once, they emerge from their underground chambers, open their gates again, and put everything in order, so that by the time the young corn has made a good start the ants are ready to cut it down and establish their clearing anew.

There are usually three or four roads which penetrate into the surrounding herbage: grand avenues which are several inches in width at the commencement and gradually become narrower, until sooner or later they blend with the open spaces between the tufts of grass. Some of these avenues can be traced for a distance of sixty feet, and Dr. Lincecum describes one great road, smooth and even, which ran through thick weeds, mowing-grass, and beside a rail fence to the enormous distance of three hundred feet.

Now what object have the ants in devoting such a vast amount of energy to opening up the country around their colony? It is merely to facilitate the bringing in of food supplies and the gathering of the harvest. The Texas agricultural ant seems never to pluck the grain from the stalk, though the Florida harvester (*Pogonomyrmex crudelis*) certainly does so. The former is content to gather up the seeds which have dropped to the ground or have been trodden off by the feet of men and animals, but he will not take any seed indiscriminately; he is fastidious in his choice, though often no difference can be detected between the seeds which are passed by and those which are afterwards taken. Having discovered a grain to his liking, the ant turns and pinches it on all sides to find the best way of holding it, and then, gripping it firmly with the mandibles, he starts homewards. It may be that he has penetrated deep into the grass forest during his search, but he has not forgotten the way; he makes no mistake in the direction. Hurrying along

PRESERVING THE HARVEST

over, under, or around all kinds of obstacles, he reaches the road and sets off at a swinging pace. Soon he reaches the clearing, and disappears with his burden through the gate of the nest. If we could follow him further we should see that the grain is carried to a vast chamber—almost a cavern compared with the size of the insect—and there deposited with a multitude of other grains, which are heaped up until the granary is packed from floor to roof. In a large nest there may be many such chambers, so that the whole amount of grain thus garnered under the ground may be very considerable.

Now if you bury seeds in the ground, you know what happens to them sooner or later—they begin to put out tiny rootlets and shoots, and under suitable conditions to develop into young plants. Why do not the ants' seeds, stored away in the earth, follow the same course? It is not easy to find a satisfactory answer to the question. Some people think that the insects are able to prevent the grain from germinating by means of a liquid poured upon them from their bodies—a liquid which must be constantly renewed, for if the ants be driven from their nest, the seeds begin to grow. What is still more curious, it is said that the ants only delay the growth of the seeds while they are all very busy gathering in the harvest; when they are ready to enjoy the stores they have worked so hard to procure, they allow the seeds to take their natural course, that is to say, to put out a rootlet and shoot, their reason for doing so being as follows. Most of the seeds contain starch, but when they begin to germinate the starch is changed into sugar, while the whole grain becomes softer, and the very young plant has a sweet flavour which is apparently much appreciated by the ants. If the germination were allowed to continue, however, the plant would soon lose its

ROBBERY BY FORCE OF ARMS

savour and would not be of much use to the insects; so with their customary ingenuity they have found out a way of preventing anything so disappointing from taking place. It is quite simple: they bite off the tip of the rootlet. Now the tip is precisely the part by which the root grows, and if there be no root the rest of the plant cannot develop; by nipping off the end of the rootlet, therefore, the ant at once prevents any further growth of the seedling. The tiny, mutilated plantlets are then carried outside the nest and placed in the sun to dry, after which they are once more stored away, and the ants have at their disposal a supply of sweet, nourishing food which they no doubt enjoy very much. The process reminds one of the preparation of malt for brewing.

The idea of a liquid which the ants pour upon their garnered grain to prevent it from germinating seems rather fanciful. It may be that the whole secret consists in keeping the seeds perfectly dry, and the ants certainly take pains to do this, for after heavy rains they may frequently be seen busily engaged in placing them in the sun, and afterwards carrying them into the nest again; and it is clear that if the ants were driven away from their nest the grain could no longer be tended in this manner, so that there is nothing at all extraordinary in the fact that it begins to germinate under such circumstances.

We hear a great deal about the virtues of the harvesting ants, but they are by no means "too bright and good"—judged even by our standards. Amongst their failings wholesale brigandage is the most conspicuous. Instead of making long and toilsome expeditions in quest of grain, they sometimes find it saves trouble to lie in wait for other ants returning home laden with provisions, which they promptly seize by force of arms—and mandibles—and ap-

A WOODPECKER'S STORE-ROOMS

propriate to their own use. Occasionally a whole nest becomes a den of thieves, who visit other nests in formidable bands and carry away all the booty they can get hold of. Even ants are not perfect.

The genius of birds is mainly displayed, as everybody knows, in the construction of nests, an industry in the pursuit of which they have attained to a very high degree of proficiency. Though they are all furnished with no more elaborate outfit of implements than beak and feet which, however much they may be modified in different species, are fundamentally the same in all, they have learnt to put them to many uses, and we have described their various methods of working in some detail. Nest-building, however, is almost the only industry to which they devote themselves, except of course hunting for food, which is common to all animals. But there are a few instances of birds which lay up stores of provisions for future use, and which therefore have to make special arrangements for their preservation. Two such cases occur in America amongst members of the woodpecker family, the birds in question being the Californian Woodpecker (*Melanerpes formicivorus*) and the Red-shafted Woodpecker (*Colaptes mexicanus* or *rubricatus*).

The home of the *Colaptes mexicanus* extends over most of the Pacific side of the continent, and the bird is of rather striking appearance on account of certain ruby markings in its plumage. Its habits were studied very carefully by M. Henri de Saussure on the slopes of Pizarro, an extinct volcano which rises abruptly in the midst of a plain. He found the ground covered by immense numbers of small agaves, while here and there a yucca cast a meagre shadow upon the dry and arid earth. "The dreary aspect and the silence of this solitude, which seemed devoid of all signs of life, were beginning to affect me when suddenly, as I

A WOODPECKER'S STORE-ROOMS

advanced amongst the prickly vegetation, I noticed a great number of woodpeckers, the sole inhabitants of this desolate country. It is always a pleasant experience to meet with living creatures after passing through a desert where there are none, and it was long since I had come upon such a busy scene. I was not long in observing that the *Colaptes rubricatus*, conspicuous because of the reddish glint of its wings, was king of that place; other species there were, but none that could compare with him either in size or numbers. All the birds, great and small, were engaged in some strange occupation; there was an air of excitement, of unusual activity, throughout the forest of aloes. The gathering together of so many woodpeckers in one place was in itself a curious circumstance, for these birds are usually solitary in their habits—must be so, if they would not go hungry. Instead of alarming them with the noise of a gun, I crouched in the shadow of a yucca and silently watched what was going on in this winged republic.

“I quickly discovered its secret. The woodpeckers moved hither and thither, approaching each plant for a moment and flying away again almost immediately. They clung chiefly to the stalks of the aloes; worked away for a little while, striking sturdy blows with their short beaks; flew off then to the yuccas to behave in the same manner; then back to the aloes, and so on. On examining the stems of the agaves closely, I found them riddled with holes in an irregular line one above another. The holes evidently communicated with a hollow inside the stem, so I cut open a stalk to examine the middle of it. Greatly to my surprise, I discovered there a perfect store of food.

“The shrewdness which this industrious bird displays in its choice of a store-room and the skilful manner in which he fills it are worth describing. After flowering, the agave

A WOODPECKER'S STORE-ROOMS

plant dries up, but it remains in the ground for some time and the upright stalk becomes hard outside while the pith is gradually destroyed, leaving a hollow channel from end to end. The woodpeckers have chosen this cavity for a store-room for their provisions—not the kind of provisions that most of the creeping birds hunt for under bark, for they are not insects, larvæ and the like, but of an exclusively vegetable nature. Acorns are what the birds store up for winter-time in these natural granaries. The canal is just wide enough to admit the acorns lengthways, so that they rest one upon another like strung beads, and if the tube be split lengthways the hollow is found to be occupied by a row of acorns. They are not always arranged with so much regularity, however, for in large agaves the cavity is wider and the acorns form an irregular heap.

“The store-room is closed on all sides; how does the bird fill it? It is in the solution of this problem that his instinct appears most wonderful. He bores a little round hole through the side of the stalk at the lower end, opening into the central cavity, and through this hole he fills the hollow beneath with acorns. The woodpecker then makes a second hole higher up, and fills the hollow between the two openings. A little higher still he makes a third, and thus proceeds to fill his store little by little until he reaches a part of the stem where the cavity is not wide enough to admit an acorn. We must mention that the canal is neither spacious nor smooth enough to permit the acorns to drop down inside by their own weight alone; the bird is obliged to thrust them in, and as he can seldom fill more than two or three inches from one opening, he must make the holes very close together if he wishes to pack the stem completely from the bottom to the top. . . . In many stalks the pith remains intact, and there is

ANOTHER METHOD OF HARVESTING

scarcely any cavity; the woodpeckers have then to make one for themselves. With this object they bore a hole for every acorn they wish to hide. . . .

“It was then April, and the woodpeckers were busy drawing upon their stores of acorns. Everything leads me to believe that it is the acorns themselves of which their food consists, not merely any grubs they may contain, and the way in which they secure the kernel is as remarkable as the process described above. The round, smooth acorns cannot easily be held in the woodpecker’s claws, which are too large, so to fix them firmly while he cuts them open he has recourse to a most ingenious proceeding. In the dried-up stem of a yucca he cuts a hole just large enough to take the small end of an acorn, but not sufficiently wide for it to pass through; he then drives one in firmly with his beak and when it is thus fixed he breaks it open quite easily, for every blow of his beak tends to force it further in and to give it a tighter hold.” On this account the stems of many yuccas are found riddled with holes, like the agave stalks.

The other woodpecker (*Melanerpes formicivorus*) which has a somewhat similar habit, is common in the lower regions of California, especially where there are oaks, and it is found also on the mountains as far as those trees grow. It is a handsome bird, and very conspicuous on account of its white face and throat, and a skull-cap of bright scarlet upon its head. As its name implies, it has a great partiality for eating ants.

Cooper, in his *Ornithology of California*, says: “Their usual resorts are among the topmost and decayed branches, where they seek their insect food; but they also feed in great part on insects caught among the leaves, and on the bark as well as on fruits. They burrow out the cavity for a nest in a dead branch, making it, according to Hermann,

AN UNREASONING HABIT

from six inches to two feet deep, and laying four or five pure white eggs on the dust and chips at the bottom, like nearly all woodpeckers.

“They have a habit, peculiar to them, of drilling small holes in the bark of trees, and fitting acorns tightly into them, each one being carefully adapted, and driven tight. The bark is often so full of these holes as to leave scarcely room to crowd in another without destroying the bark entirely. These are generally considered as laid up for a winter supply of food; but while, in this climate, no such provision is necessary, it is also very improbable that birds of this family would feed on hard nuts, or seeds of any kind. The more probable explanation is that they are preserved for the sake of the grubs they contain so frequently, which being very small when the acorn falls, grow until they eat the whole interior, when they are a welcome delicacy for the bird. From this strange habit the bird has received the name of ‘Carpintero,’ and this is also adopted by many Americans.”

Professor Newton also states that the acorns are not laid up to furnish food for winter, since the species migrates, and after journeying a thousand miles or more only returns in spring to the forests where its supplies are laid up. It has been asserted that the acorns thus stored up are always those which contain a maggot, and, being fitted into the sockets prepared for them cup-end foremost, the enclosed insects cannot escape from the shell, but remain there unwillingly awaiting the return of the birds from their winter quarters. There is, however, much doubt as to what is the exact use of these acorns, and it has even been stated that the bird is so unreasoning in its habit, and follows it so blindly, that it occasionally fills the holes with pebbles, which it fails to distinguish from acorns.

PARASOL ANTS

A tree upon which this bird has been practising its curious industry is said to have the appearance of being thickly covered with brass-headed nails!

MUSHROOM GROWERS

Wonderful as is the industry of ants in the harvesting of grain, it is far from being without parallel in the animal kingdom; both birds and mammals, for instance, lay by stores of food for future use, though they do not, it is true, give evidence of any remarkable amount of intelligence in caring for it until such time as it may be required. Often, of course, there is no necessity for them to do so; the squirrel's nuts require no attention—they are sufficiently protected by their hard shells, and the same is true of the woodpecker's acorns. Mammals such as the hamster, however, which establish underground granaries in much the same way as the harvesting ant, appear to take no means whatever to prevent the deterioration of their stores by damp, and therein the ants may certainly claim superiority over the more highly developed creature. We now come to an ant industry, however, beside which mere harvesting is almost commonplace: that of making mushroom beds and cultivating mushrooms—not exactly mushrooms as we commonly understand them, but a spongy growth of mould which occupies a very important place indeed in the ants' bill of fare.

This remarkable industry is practised by the Saüba or "Parasol" Ants, which are well known—*too* well known—to the inhabitants of tropical America, on account of their destructive habit of clipping pieces out of the leaves of trees and carrying them away to their nests; as they show a marked preference for cultivated trees, the damage they do in this way is very considerable. The appearance of the

A REMARKABLE SPECTACLE

ants when at work is very striking. They move over the ground in broad columns, which irresistibly suggest that scene in *Macbeth*, where Malcolm's soldiers hew down boughs and under shelter of their "leavy screens" march upon Dunsinane, for every ant of the incoming host bears in its jaws a piece of leaf, and the irregular, swaying, streaming movement of myriads of these tiny green banners borne onward by the hurrying ants, themselves to some extent concealed by their burdens, is a remarkable spectacle. Other ants are hurrying along the broad road in the opposite direction; they are not laden like their fellows, and are inconspicuous as they thread their way beside and between the homeward-bound legions. These are ants which are starting out in quest of leaves, or which have deposited their burdens and are returning for a new load. Let us follow them on their course and observe their movements—an easy matter, for the road is wide and well worn, almost like the impression of a cart-wheel. Here and there it divides, and at last one of the branches brings us to a foot of a tree, up which the ants are streaming. Up the trunk, along the boughs, and out upon the twigs they hurry, until they reach the foliage. Approaching the edge of a leaf, each ant sets to work with its sharp jaws to clip out a piece which may be about as large as a sixpence, but is often much smaller. It cuts round in a semicircular direction, pivoting itself, as it were, on the hinder end of its body; when the incision is almost complete, it takes a footing upon the rest of the leaf and with a sharp jerk detaches the little piece. Sometimes the fragment falls to the ground and is carried off by one of the numerous workers at the foot of the tree, but usually the ant holds it firmly in its jaws so that it stands up edgeways over its head and, descending the tree with its trophy, joins the procession to the nest.

ANTS' MUSHROOM BEDS

What is the object of all this labour? to what use are the leaves applied? At one time everybody thought they served as food for the insects, until Mr. Bates announced in his admirable book *The Naturalist on the River Amazons* that they "are used to thatch the domes which cover the entrances to their subterranean dwellings, thereby protecting from the deluging rains the young broods in the nests beneath. . . . The heavily laden workers . . . troop up and cast their burthens on the hillock; another relay of labourers place the leaves in position, covering them with a layer of earthy granules, which are brought one by one from the soil beneath." This was observed only "after much time spent in investigation," although the lines of ants are constantly to be seen winding along the ground like enormous long green serpents, and it appears strange that the inquiry was not sooner crowned with success if all the vast quantity of leafy fragments brought home to the nest is placed above ground to make a roof for the home.

It remained, however, for another Englishman, Mr. Thomas Belt, to show that the ants make another and far more interesting use of their material. By digging down into the nests, and likewise during the course of mining operations from below (Mr. Belt was an engineer) he found that they contained great rounded chambers, as large as a man's head, connected one with another by tunnels. Now though he had seen the leaf-bearers disappearing down the openings of the nest, he could not find any quantity of green leaves under the ground; what he did discover was a light, spongy-looking mass of a speckled brown substance which three-parts filled the great chambers above referred to, and which turned out to be composed of leaves cut up very fine, withered to a brown colour, and penetrated in all directions by the thin threads of a growth of white fungus. The brown masses

LAYING DOWN A BED

were, in fact, the ants' mushroom-beds, and it was the fungus—the “mushroom”—and not the leaves, that they ate, for some chambers which were filled with particles of leaves were entirely deserted by the ants; that was because the manuring properties of the vegetable heap were exhausted—it was no longer capable of producing mushrooms, and was abandoned to the larvæ of various beetles, which still found it an agreeable food.

The process of laying down one of these mushroom-beds is as follows: The fragments of leaf, having been brought into the nest by the foraging ants, are taken up by small workers who carry them to their destination and cut them up, when necessary, into smaller pieces. These are licked over and cleaned by the large workers and manipulated into tiny balls of pulp, which are pressed upon the surface of the mushroom-bed, where they soon become covered by a growth of the fine white threads. When the bed is well established, the small workers may be seen constantly clipping off the ends of the threads for food; if the nest be broken up, it is the precious fungus that the ants hasten to bear away to a place of safety, not the leaf-pulp. The latter is apparently of no use, in itself, as food, for if some of the ants be kept in a box and supplied with fragments of leaves such as they are in the habit of gathering, they die of hunger; but they thrive on a diet of fungus taken from their mushroom-beds.

Mr. Edward Tanner states that the newly made bed is actually planted with slips or cuttings of fungus brought from the old cultures—an act which indicates a very high order of instinct from which we can scarcely withhold the name of intelligence. It appears certain, at all events, that the beds never contain more than the one special kind of fungus, which is precisely what we should expect if it be always grown from cuttings; whereas if the little gardeners

HONEY ANTS

trusted to chance 'spores' to find their way into the beds, they would probably get nothing better, very often, than a vigorous growth of what, from their point of view, would be weeds.

HONEY ANTS

In Texas there is found a species of ant (*Myrmecocystus melliger*) which has a very peculiar habit. In its underground chambers it lays up stores, not of grain or seeds of various kinds, but of honey. So far, there is nothing very strange in that; other hymenoptera—some wasps as well as bees—do it, why not the ants? The peculiarity, however, consists in the vessels in which the honey is stored, as we shall see presently. The honey ants like warm, dry spots, and usually make their nests on the tops of ridges or on slopes which are exposed to the sun. The nests are not large, and the little hillock above the ground is seldom more than ten inches wide or three inches high—a low, cone-shaped mound of gravel, covered with little stones, and having a wide entrance at the summit, shaped like a funnel and smoothly paved inside. During the day there are no signs of activity about the nest, but at nightfall the colony wakes up; it is the time for working. In a long string, the ants march out of the gateway and make their way to a neighbouring oak thicket. Their destination is a young oak tree, up the stem of which they climb with fixed purpose, for they have come there to gather honey. At first it does not seem very clear how they are to get what they want in such a place, but if we watch them very carefully, we shall see that they know quite well what they are about. Climbing along the branches, they come to some little, red-brown swellings about the size of a currant or smaller; these are galls caused by a fly, a species of *Cynips*. The ants eagerly

THE HONEY-ROOMS

approach them and begin to lick the surface. What do they find there so much to their taste? A close examination shows that the galls are bedewed, when the ants have visited them, with minute droplets of a white, transparent liquid—a liquid which, we find, is very sweet and pleasant. The ants lick it up greedily, hurrying from one gall to another and returning again often to the same spot after an interval, for then they find that more of the sugary fluid has exuded. “Thus may we gather honey from the weed.” When they are satisfied with their store they return to the nest, where we will, in imagination, follow them. Let us take a peep inside. The ‘gate’ leads into a shaft which extends straight down into the ground for several inches, where it reaches a point from which galleries run in various directions. These galleries are tubular tunnels wide enough to admit your finger, and they lead to the honey-rooms, half a foot or more beneath the surface of the ground. The honey-rooms are vaults about the size of a hand—some small, some large. The floor is smooth, but the arched roof is roughened and rather irregular, and from it hang the honey-pots. Each of these is a transparent, amber-coloured bladder, of the size and form of a currant or a small grape; but it is more than that, for it has a head, and ‘feelers,’ and six legs by means of which it clings to the roof: it is, in fact, an ant! Its body swollen to a monstrous size with a plethora of the sweet liquid, it clings to the rough vault in the company of others like itself, moving with difficulty or not at all. Should one of these strange creatures drop to the floor, it is usually quite helpless, and lies there, legs a-dangle, an inert mass.

It is to one of these chambers, then, that the home-coming ant proceeds with the spoils from the oak-galls. Climbing up to the roof, it approaches a ‘honey-pot’ and

LIVING HONEY-POTS

disgorges its treasure into the mouth of the living receptacle. Thus the store is increased during the season of plenty. It now remains to see what use is made of it. When winter comes, and food is scarce, the ants which have laboured so busily during the summer-time find themselves in possession of abundant supplies, for all they need to do is to visit their strange sisters and caress them gently with their antennæ. It is their way of begging for food, and the immediate effect is the appearance from the mouth of the honey-pot of a drop of honey, which is eagerly licked up by the visiting ant.

CHAPTER XIV

HUT BUILDERS

Beavers in England—A fatal garment—Engineering on a grand scale—How the beaver became a builder—What a 'lodge' is like—Varieties of lodges—How a lodge is enlarged—'Musk-rat houses'—"Contrived a double debt to pay"—"The beaver's little brother"—Brush-tailed rat-kangaroos—Building a grass hut—A grotesque and amusing spectacle—The wily black man—The hammer-head's hut—An elaborate dwelling—Quaint behaviour.

THE king of the hut builders is unquestionably the beaver. A long time ago—exactly how long we do not know, for there are no records to tell us—beavers were fairly abundant in England; their bones are found in the fens and in caves, and many places, such as Beverley in Yorkshire and Beverstone in Gloucestershire, derive their names from this animal. In Wales they existed as recently as the year 1188, but none appear to have lived there during the last eight hundred years. At the present day, indeed, the European Beaver (*Castor fiber*) is almost extinct; a few linger on here and there, principally about the Rhone and the Danube, but they are becoming increasingly rare and are now seldom met with. Apparently a similar fate awaits the American Beaver (*Castor canadensis*—it is hardly to be distinguished from its European brother, but its nose is a little broader, so most naturalists have agreed to give it a special name to commemorate the fact); not very long ago it was found in great numbers in nearly every well-watered district of the northern continent, but it has been so mercilessly and unremittingly persecuted for the sake

WHAT A 'LODGE' IS LIKE

of its beautiful coat that its range is now greatly narrowed and its numbers are vastly reduced; the extinction of one of the most interesting of living animals cannot be long delayed.

The beaver is aquatic in its habits, and is a powerful and extremely graceful swimmer. It is a social animal, and the wonderful dams which the communities make by felling trees, cutting them up into logs, and building these across streams with the help of mud in order to form ponds in which the water will remain at a constant level and be deep enough for their needs, are familiar, by report at least, to everybody. A full description of the animals' method of cutting down trees and carrying out their great engineering schemes has been given by Mr. Selous in *The Romance of Animal Life*. Here we will merely give a short account of their famous huts, or 'lodges,' as they are called in America.

The beaver is a burrowing animal, and its skill as a builder probably arose from its habit of constructing a kind of rude porch to screen the mouth of a burrow where it opened in the river-bank and to prevent it from becoming blocked up by a heavy fall of snow. In shallow water, as Mr. Martin points out, it would be a great advantage to extend the porch-like covering further from the bank, and in time the animal would discover the convenience and additional safety of having a hut which was not connected with the shore at all and would thus be beyond the reach of many of its enemies.

The lodge is a large, dome-shaped structure, containing a spacious internal chamber lined with grass or other herbage, and is entered by at least two approaches which open at a depth of about four feet beneath the surface of the water. The outside of the hut has the appearance of a great pile of logs, branches, and twigs piled together in a disorderly heap and plastered up with mud. The plastering is done with the fore feet, and not with the flat, trowel-like tail, as is

HOW A LODGE IS ENLARGED

often supposed. One of the entrances is a winding passage, but the other is made straight, in order no doubt that the animals may more conveniently carry into their dwelling branches, the bark of which forms a considerable part of their food. Three kinds of lodges are distinguished—bank lodges, island lodges, and lake lodges. The island lodges are built upon the low islets in the ponds above the dams, while the bank lodges, as their name indicates, are situated upon the shore, the interior communicating with the stream not, as a rule, by means of arcades of branches, mud, and weeds as in the former case, but by subterranean tunnels. Many of them, however, are built partly in the water, the front wall arising from the bed of the stream except just where open tunnels are left for the animals to pass in and out. The lake lodges, owing to the shelving character of the shore, are built still further out, so as to reach a place where the water is deep enough for the entrances to be safe from any danger of being rendered inaccessible by thick ice during a hard frost. They are therefore not infrequently constructed for quite one-half, or even two-thirds, of their extent upon piles.

The size of the inner chamber, which is roughly circular or oval in form, varies according to the age of the dwelling, for the animals renovate their home from time to time by removing pieces of decaying wood from the inner wall and by adding fresh materials to the outside. In this way the whole structure becomes enlarged until the interior may measure as much as seven or eight feet across. Each lodge is inhabited by one pair of beavers and their offspring, but as the latter live with their parents until the third year of their life, the whole household may consist of as many as a dozen individuals, though there is generally only about half that number.

The Musquash or Musk-rat, (*Fiber zibethicus*), is also a

‘MUSK-RAT HOUSES’

North American animal, being found in the greatest numbers in Canada and Alaska. It is a massively built creature about a foot in length, not including the tail; its neck is short and thick, its eyes are small, and its little ears almost concealed under the fur. It frequents the grassy banks of lakes and slowly flowing streams, but it likes best of all to make its home in a large pond, the margins of which are grown with reeds, where it forms small colonies. In diving and swimming it is almost as skilful as the beaver, though it is scarcely as graceful as that animal in its movements under the water.

It is a burrowing animal, and its dwelling often consists of a large oval chamber at the end of a long tunnel in the bank of the stream; other galleries from the dwelling-room lead further inland, some of them being not infrequently used as storage tunnels for roots. Sometimes, however, these animals build what are known as ‘musk-rat huts’ or ‘musk-rat houses’ on a heap of mud which rises above the level of the water, or even in the water itself—though in that case it is of course only the foundation which is submerged. The huts are made by collecting immense masses of vegetation, which are piled up like haycocks; reeds, grass, and sedge being heaped together and cemented with mud. A few inches above high-water mark there is a spacious chamber which is entered by one or more burrows which penetrate the heap of weeds or mud on which the hut is situated and open some distance beneath the surface of the pond. Dr. Merriam says: “Many of the houses contain no mud or sticks, but consist wholly of balls and knots of roots and swamp-grasses. . . . The materials of which the huts are composed, it will be observed, are such as serve as food for the animals during the long winters; hence the musk-rat’s house is in reality a storehouse, which he devours piecemeal as the winter advances.” In this dwelling, even when it is

BRUSH-TAILED RAT-KANGAROOS

covered with snow, the musquash lives very comfortably during the severe weather, and by the time he has eaten himself "out of house and home" the return of spring brings a further supply of food. Sometimes the nest for the young is placed in this curious house, though it is more usually in a burrow in the bank. It will be observed that the musquash's habits in many respects resemble those of the beaver, and it is interesting to note that the Indians call this creature the beaver's "little brother," regarding the larger animal as the senior and more talented member of the family.

The kangaroos, which form the great bulk of the mammalian population of Australia, at all events as far as the number of species is concerned, are interesting not only on account of their peculiar structure and remarkable appearance, but also because of their curious habits. Few of them, however, can be regarded as coming within the scope of this book, but there is one group whose members make nests in a manner which is probably unique and is certainly as strange as any we meet with amongst the four-footed beasts. This group is composed of the four species of prehensile-tailed or brush-tailed rat-kangaroos, three of which are natives of Australia, while the fourth inhabits Tasmania. Some members of the kangaroo tribe are very large and powerful, the great grey kangaroo having the stature of a man, but the rat-kangaroos are never larger than an ordinary rabbit. The brush-tailed rat-kangaroos, or Jerboa kangaroos as they used to be called, are distinguished, as their popular name indicates, by having on the tail rather long hair which forms, especially towards the tip, a more or less distinct crest. The chief peculiarity of this member, however, is its prehensile character and the strange use which the animal makes of it. The Common Brush-tailed Rat-kangaroo (*Bettongia penicillata*) frequents

THE HAMMER-HEAD'S HUT

low grassy hills and dry ridges thinly dotted over with trees and bushes. There, usually beside a tuft of coarse grass, it constructs a little nest or hut, having previously scratched a slight hollow in the ground. The nest is completely roofed over, and is composed of grass and similar materials. It is not a very remarkable dwelling, but the process of building is extremely interesting, for the animal carries the materials in its tail, the extremity of which is curled downwards below the bundle, and one can readily imagine that its appearance as it leaps along towards its nest bearing a sheaf of grass in this manner is, as Mr. Gould states, exceedingly grotesque and amusing (*vide* Frontispiece). The nest never overtops the surrounding herbage and is very difficult to detect, especially as the animals conceal themselves completely by dragging grasses over the entrance. During the day the dwelling is usually tenanted by one or two animals, and the blacks are very well aware of this fact, for when, owing to their remarkably keen powers of observation, they detect a nest, they strike their axe into the midst of it and so destroy the sleeping inmates before they can escape.

A very remarkable hut is that built by the Hammer-head (*Scopus umbretta*), a bird allied to the cranes and the herons, which inhabits nearly the whole of Africa and Madagascar. Although this bird is no larger than a raven, it builds a nest of immense size, sometimes as much as six feet in diameter. The huge structure is placed either in the fork of a tree or upon a rocky ledge or cleft in the immediate neighbourhood of running water, often, indeed, on one which overhangs a torrent. It is very compactly built of sticks, rushes, roots, and grass, and has a flat-topped roof. The interior, which is well and neatly lined with clay, and according to Dr. Holub is generally found to contain a number of bones, is entered by a small aperture at the side, which leads into a kind of ante-chamber before opening into the main cavity. The

QUAINT BEHAVIOUR

architecture has been found still more elaborate in some cases, the interior being divided further into a living-room and a nesting chamber above this—making three distinct chambers in all, if we count the small entrance-hall. In South Africa, however, they are usually of simpler construction, though they are always very massively built, and sometimes contain quite a cart-load of materials. The outside, like that of many suburban villas, is often decorated with bits of crockery and other rubbish. The inhabitants of this interesting dwelling are creatures of striking appearance. Robed in earthy brown with a purplish sheen, they have long wedge-like beaks, while the feathers of the head and cheeks are prolonged into a large crest which is usually carried standing straight out in the opposite direction to the beak, thus giving to the head that remarkable hammer-like appearance from which the birds derive their popular name. Nor are their habits less peculiar. By day the bird displays but little activity, but at dusk it awakes from its lethargy and behaves in a very amusing manner. “He may then be observed for hours at a time,” M. Oustalet writes, “walking upon the river-bank like a peripatetic philosopher. Marching solemnly along with shoulders humped, and gazing earnestly upon the ground, he appears to be engaged in profound meditation; occasionally he shakes his head vigorously as if to drive away some importunate thought. But he is engaged in no more intellectual occupation than a careful search for his supper of small molluscs.” Suddenly he encounters some creature moving in the opposite direction and, looking up, he finds himself face to face with one of his fellows; in a moment he lays aside his air of serious contemplation, and the two birds, with wings outspread, join in a queer Pyrrhic dance, after which each of them solemnly proceeds on his way with the same sedate, philosophic demeanour as before, looking as incapable of frivolity as a dean or a Quaker.

CHAPTER XV

SILK-SPINNERS

SPINNERS OF NETS

The versatile spider again—A delicate rope—What a spider can do with its thread—A spider's hunting—The development of the snare—A telegraphic system—Eyes and no eyes—Beauty of a common web—How a garden spider works—A line thrown at a venture—A slender bridge—The framework completed—Putting in the cross lines—Testing the lines—Temporary scaffolding—A rapid worker—How insects are caught—The spider's biographer—An exaggerated view—The lurking-place—Alarm and agitation—A living whirligig—Competition and strategy—Remarkable mechanics—The house spider's den—Spider *versus* horseman—Bird-eating spiders—Trapping with a snap-net—A rope in reserve—In the toils—Why spiders rest head downwards—Falling a fine art—Scaling ladders—Co-operation and communities—A common hunting-ground—Immense nets—A nest as large as a hat—Giant and dwarf.

THE only spiders we have described hitherto are the members of that versatile group whose trap-door nests require for their construction the application and practice of a number of arts and crafts nicely adjusted to one another with great skill and cleverness. But the spiders are above all else expert spinners; silk-spinning is their national industry, their proficiency in other directions being largely dependent on their ability to produce at all times an almost inexhaustible silken thread. In the trap-door nests silk plays a most important part, for the doors, the hinges, and the walls of the tube could not be made without it; but

A SPIDER'S HUNTING

if we were to confine our attention to these, wonderful as they are, we should have a very one-sided view of what the spiders can do with their delicate material.

We need not trouble just now to inquire exactly how the spider produces its thread—what we want to learn is how it is used; so we will be satisfied for the moment to know that it is produced from a spinning organ consisting of two pairs of little protuberances called spinning mammillæ, which are situated at the hinder end of the spider's body, and that what appears to us to be a single thread of extreme fineness is really built up of a great number of even finer threads, which, being exposed to the air separately immediately outside the spinning mammillæ, dry more rapidly than a single thicker thread would do. Another advantage of having its slender rope made of a great number of strands is that when the spider wants to fasten the end of it to any object, and presses its spinning mammillæ against the surface, the minute threadlets are all stuck separately and over a comparatively wide area, giving a much firmer hold than would a single thread attached at one point only, just as you could glue the end of a piece of string more firmly to a board by first roving it out and separating the strands.

With the aid of the ever-ready thread spiders can go hunting, trapping, ballooning; make bridges, diving-bells, rafts, tents, tunnels, and warm bags to protect their eggs; can get themselves mistaken for living or dead leaves, and are able even to render themselves practically invisible. We will first see how they use the thread to spin nets and snares in order to furnish their larder; not that all spiders secure their prey in this manner—they show as much variety in their methods of hunting as in other things. Some species rely solely on sheer agility, and either stalk their quarry with cat-like strategy until they have crept near enough to

A TELEGRAPHIC SYSTEM

pounce upon it, or chase it in the open until they have fairly run it down; some lurk in flowers, so that the small insects which visit the latter find death in the cup instead of nectar; others lie concealed amongst leaves, or openly mimic leaf-buds, relying on the chance approach of a possible victim. The most noticeable, however, are those which construct snares.

The simplest snare consists of fine lines which cross one another in all directions, apparently without any definite plan in their arrangement. It seems very probable that this was the earliest kind of snare, and that spiders first discovered its use from their habit of attaching ties, like tent ropes, to the sides of their tubular retreats in order to keep them steady. From finding that insects became entangled in these "ropes," they would in time come to realize their value as an aid in providing themselves with food, and would gradually elaborate the snare—just as other spiders have gradually elaborated the simple tubular retreat until it has developed into the highly complex and ingenious trap-door nest. Many spiders still retain this system of threads attached to their dens or lurking-places, the other end of the threads being connected with various parts of the snares they make, for the threads may not only help to embarrass their prey—they also keep the spider in touch with the whole expanse of the web, and give warning, as if by telegraph, of any interesting events that are taking place in the most distant parts of its domain. For spiders depend far more than is generally realized on their sense of touch, which is very delicate and highly developed; although they have numerous eyes, their position on the front part of the top of the head does not, as you might at first imagine, enable the spider to take an extensive 'bird's-eye' view of all that occurs in the neighbourhood. Even when

HOW A GARDEN SPIDER WORKS

spinning she cannot keep her eyes fixed on her work; indeed, she cannot see at all what she is doing at the moment, and she has to rely entirely on judgment and the sense of touch in accurately placing her threads in position.

If we keep this fact in mind, what a wonderful thing the familiar geometric web of our common garden spider (*Epeira diadema*) becomes! Because it *is* so common, and familiarity to some extent blinds us to its beauty, we may pass it by a hundred times with scarcely a glance, until on some bright morning late in summer we come upon one with the dew still upon it, trembling in the lightest breeze, every slender thread sparkling with glittering points, and we are suddenly struck by the symmetry, the delicacy, the beauty of workmanship, the sheer wonder of it, and are ashamed to realize that we have associated ourselves so long with the great, unobservant "family of No-eyes."

As it would be impossible to find a better instance of the spider's skill in weaving nets, we will describe how one of these geometric webs is made. They are usually found amongst bushes and shrubs, stretched between the branches in a vertical position, that is to say, like a target, with one edge directed towards the ground. The spider's first care is to make a framework of silken cables, stout enough to bear securely the net she intends to stretch upon it. Where the nature of the situation makes it possible to walk from one point to another she does so, trailing her thread after her and fixing it here and there to the branches in the most convenient places. But she can seldom make a complete frame in this manner, unless she happen to have chosen the angle of a window, the doorway of a tool-shed, or some similar spot to spin her web. Amongst shrubs and bushes there are wide spaces to be bridged over and deep chasms to be crossed, and there the spider is obliged to have recourse

A SLENDER BRIDGE

to another method. She throws out a floating line and trusts to a current of air to carry it over the intervening space. By pulling on it with her legs, which are furnished with convenient claws which enable her to manipulate her slender line with the greatest ease, she is able to judge when her thread, thus cast at a venture, has come in contact with some solid object; she then hauls in the slack of the line and fixes it taut. In this way a rope bridge is established over the space—a bridge which is not yet strong enough to bear any great strain, but which furnishes the little engineer with the means of conveying to the other side of the gap a stronger cable, just as a steeple-jack sometimes gets his ropes into position by first flying a kite over the spot he wishes to reach until he succeeds in placing a string by way of a leader. But our spider is more daring than the steeple-jack, for she trusts herself to the first thin cord and, after attaching another thread to the branch she is about to leave, ventures confidently across the space trailing the second cord behind her. After strengthening her work, she subjects it to a series of tests, hauling upon it with her claws and even swinging herself down from it with her whole weight to ascertain whether it is capable of standing the strain which it will have to bear when the net is slung upon it. Proceeding in this manner, she makes an irregular framework; whether a triangle, a trapezium, a polygon, or a figure to which no name can be assigned, depends entirely on chance and the locality, and it is a matter of not the slightest importance. Wherever it may appear desirable to do so she attaches smaller lines to the main cables of the framework and draws them taut to steady the structure and make it more rigid. After these preliminary operations everything is in readiness for weaving the net. Starting from some point on the boundary of the 'claim' she has (if we may be per-

TESTING THE LINES

mitted the simile) pegged out for herself, the spider attaches the end of a thread to the framework and, letting out line as she goes, walks round to the opposite side. She is very careful to prevent her line from getting fouled by the way or stuck before the right point is reached, by holding it clear during her progress in the claws of one of her hind legs. On arriving at a point opposite that from which she set out she hauls in the slack with her claws in the usual manner and fastens the end of the thread to the framework, which is thus divided by a line passing across the middle. The mid-point of this first diameter becomes the base of subsequent operations, the object of which is to complete what we may call the scaffolding of the web by fitting in a number of radii, of which there are usually twenty or more, like the spokes of a wheel. These are all put in separately, starting from the point which is destined to become the centre of the web, and being trailed to points at short intervals along the framework, guided as usual by the claws.

When the radii have been filled in, the spider takes up her stand at the centre and tests the quality of her work by tugging at the lines. If any of them prove too weak to stand the test they are reinforced or replaced by others, until the spider is satisfied as to the stability of the structure as far as she has gone. Her next business is to fill in the circular meshes or ladder-rungs between the radii, and there seems to be some difference of opinion as to the exact way in which this is done. I suspect that the confusion arises from the fact that various species of geometric spiders differ a little in their procedure, and that people who have not taken the trouble to observe the operations for themselves, which they might do very easily, but have relied on vague impressions derived from what others have to say on the subject, have become 'boggled' in wading through the various accounts.

TEMPORARY SCAFFOLDING

It is also certain that spiders of the same species do not invariably finish their webs in precisely the same way, though there appears to be no want of uniformity in the general plan of the completed structure in each case, and I have known the *Epeira diadema* to omit the intermediate operation I am about to mention.¹ This consists in laying down a temporary thread which crosses the spokes of the wheel in the form of an open spiral, and which serves to steady the web while the permanent so-called "circular" meshes are filled in, being finally cut out when the rest of the work is done.

Lastly the rings of the web are spun—those meshes which appear to form a series of circles of gradually diminishing size one inside another, but which are really, speaking generally, not complete circles, but the coils of a long spiral which extends with occasional breaks from the centre to the circumference. The distance between the coils varies to some extent according to the size of the spider; a small spider makes a net with finer meshes than does one of larger size. This is just what we might expect, for the rungs of the ladder, being closer together, are better suited to the length of its legs; there is, however, an excellent reason for this beautiful adaptation, and I need only remind you again that the spider is guided in its spinning by the sense of touch, and not by sight, for you to guess what the reason is, for it is obvious that the spider's legs serve as natural callipers in measuring distances, and that the spaces depend to a certain degree on the length of the spider's stride and the 'spread' of its feet. When carrying out this portion of its task, the spider fastens one end of a thread to one of the spokes, takes a pace or two along the radius, and stepping over to the next spoke fastens the thread to that by pressing the spinneret upon it, and so on, proceeding

¹ J. L.

THE SPIDER'S BIOGRAPHER

with astounding rapidity and with scarcely a pause until the spiral extends from centre to circumference. The turns in the middle are set closer together than the peripheral ones, and all are of very fine, very elastic silk, which is of a far more sticky character than that which composes the framework, because it is beaded over at intervals with minute gummy drops. These tiny beads are of great importance from the spider's point of view, for there is no doubt that they play much the same part in entangling insects which come in contact with them as is played by birdlime in a bird-catcher's snare, and that a geometric web deprived of its adhesive drops would not be so very much more effective than, in the other instance, would be the twigs without any birdlime smeared upon them.

Mr. Blackwall—to whom we shall presently have to refer again, for it is almost impossible to discuss spiders without quoting from the writings of that renowned authority—was of opinion that the stickiness of the line depends entirely upon these little globules, “for if they be removed by careful application of the finger, a fine glossy filament remains, which is highly elastic, but perfectly inadhesive.” He goes on to say that an estimate of the number of sticky drops upon the spiral line of a net of average size made by *Epeira apoclista* shows that they amount to more than 80,000 while a large net fourteen or sixteen inches in diameter will be found to contain upwards of 120,000! “And yet,” he adds, “*Epeira apoclista* will complete its snare in about forty minutes, if it meet with no interruption”—the inference being, I suppose, that the placing of every drop is the result of a separate effort on the part of the spider—a rapidity of skilled movement that might excite even Paderewsky to envy! But this appears an unnecessary and altogether fanciful view to take, and there is, so far as I am aware, no reason to

ALARM AND AGITATION

suppose the beading is not produced to all intents and purposes mechanically as the thread is emitted from the spinnerets.

Some of the geometric spiders give the finishing touch to their nets by cutting a little piece out of the middle, where they make a neat round hole over which they stand astride and through which they can dart in a moment to the other side—that is to say, to the other surface—of the web. But our common garden spider is not one of these; she leaves her web intact, merely trimming off the little bunch of silk formed by the ends of the converging radii. She also, however, usually stations herself in the centre of the snare, where she is in touch, by means of her eight feet, with the lines passing in as many different directions towards the circumference of the web, and is thus kept in telegraphic communication with the outlying parts of it, and warned of the approach of a wooer or a meal. Sometimes the spider prefers to lurk at the edge of the snare, often under the shelter of a leaf—always, however, keeping her sensitive paws upon the delicate cords, ready to investigate matters when they give her the signal that a visitor has, whether willingly or otherwise, “walked into her parlour.”

When alarmed, many of the web spiders have a way of violently shaking their nets, often with great rapidity. This proceeding may serve several purposes: the sudden movement is calculated to startle an enemy and perhaps drive him away; or the swinging of the net may embarrass his movements and cause him to become hopelessly entangled; or it may ward off attack, because a spider which is rapidly ‘bobbing’ up and down is obviously a far more difficult object to strike than one that is stationary. Some spiders have improved on this system of defence; *Pholcus phalangoides* will serve as an example. This spider is not uncommon in

A LIVING WHIRLIGIG

the south of England, where it spins tangled, irregular webs in sheds and outhouses. It has very long, slender legs, like a "daddy long-legs," but they do not appear to give it any exceptional advantage in walking—indeed, it moves over the ground in a slow and clumsy fashion, and would stand but a poor chance if it were a case of *sauve qui peut*. But a spider may be trusted to make up in cleverness what it lacks in physique, and this species has turned its long, weak shanks to advantage in a very ingenious fashion, for when alarmed it gathers its feet together, hangs from the middle of its web by the tips of its toes, and spins round like a top with such astounding rapidity that it becomes practically invisible as a material body, looking rather like some vague, ghostly presence obscurely haunting the snare. I do not know whether the English *Pholcus* has yet learnt a clever trick which Mr. Hudson states that its relatives in the Argentine practise on occasion ; perhaps it is not necessary that it should do so, for the genus is not of such frequent occurrence here, and the trick has been developed under the stress of competition. When a fly is captured, the spider approaches it with caution and marches around it in a narrowing circle, spinning a web meanwhile, until the captive is swathed in a silken shroud. The fly, aware of the peril of the situation, makes a fuss in the way flies have, and as the agony is long drawn out its noise attracts other spiders, who come to tourney for the prize. But where competition is very keen the proprietor avoids the trouble of doing battle by finishing the winding-sheet as quickly as he can and then cutting the precious packet away from the web and lowering it by a long line so that it hangs in mid-air some feet below the web, where it remains suspended until the freebooters have gone away again, when it is hauled up and enjoyed in peace. This reminds me of another point which illustrates the wonder-

THE HOUSE SPIDER'S DEN

ful ingenuity with which spiders often act on an emergency. In rough weather a web may be shaken so violently as to be in considerable danger of being torn to pieces, for the mass of a web is infinitesimal, while the surface exposed to the wind is comparatively enormous. In other words, its 'inertia' is small, and the force acting upon it is great, so that it is tossed hither and thither in a manner that strains the delicate threads to a dangerous degree. The poor spider sees—or feels—her precious snare threatened with destruction. How is she to ward off the misfortune? As she can neither control the wind nor "furl sails"—she cannot even "take in a reef"—the only course open to her is to try to steady the web by weighting it with something. I have never observed a spider actually doing this, but cases are recorded in which they have hauled up fragments of wood, many times their own weight, on the end of a silken cord, and attached them to the web—on exactly the same principle that fishermen weight their nets in rough weather.

Many spiders make little shelters for themselves on the outskirts of their snares, where they lie in wait until business calls them out. If you examine the untidy and generally unattractive web of a common house spider (*Tegenaria atrica*) you will find a neat little circular opening in one corner, which is the entrance to its den. *Agalena labyrinthica*, another spider which is abundant in Britain, and spreads its large sheet-like web in shrubs and hedges, spins a rather long tube which leads from one extremity of the web down to the bush or undergrowth. This spider is very agile, and can run at a great pace; when it is alarmed it darts swiftly into the tube, and pursuit is not then likely to be successful, for before it can be traced it escapes at the other end and disappears amongst the herbage. Swift as it is, however, its speed is utterly insignificant when compared

BIRD-EATING SPIDERS

with that attained by a giant *Lycosa* found on the Pampas in La Plata—a monstrous grey spider with a black band round its middle. Mr. Hudson, who calls this creature “the king of the spiders of the Pampas,” states that it is so aggressive that it will give chase to persons who chance to pass within several yards of its lurking-place and pursue them for thirty or forty yards; and so swift that on a certain occasion when he was riding at an easy trot he noticed one keeping up with his beast, and on cutting at it with his whip, it ran up the lash, and was within a few inches of his hand when he flung the whip away from him! An angry bulldog would seem an attractive creature beside a spider which is capable of attacking a man on horseback. That spiders can and do kill small birds is common knowledge, though the statement was long discredited, until Mr. Bates verified it during his travels on the Amazons. He says: “The species was *Mygale avicularia*, or one very closely allied to it; the individual was nearly two inches in length of body, but the legs expanded seven inches, and the entire body and legs were covered with coarse grey and reddish hairs. I was attracted by a movement of the monster on a tree trunk; it was close beneath a deep crevice in the tree, across which was stretched a dense white web. The lower part of the web was broken, and two small birds, finches, were entangled in the pieces; they were about the size of the English siskin, and I judged the two to be male and female. One of them was quite dead, the other lay under the body of the spider not quite dead, and was smeared with the filthy liquor or saliva exuded by the monster. I drove away the spider and took the birds, but the second one soon died.” It is not a pleasing picture: let us turn to the more attractive arts of another tree-dweller, the little *Hyptiotes*. This spider lives on pine trees, and its

TRAPPING WITH A SNAP-NET

specialty is a snap-net. It spins a three-cornered web, which is anchored by lines which pass from each angle to surrounding objects. The threads of the net are arranged for the most part parallel with the shortest side, and are crossed by a line which runs down the middle of the triangle from base to apex. The spider stations herself upon the long anchoring line of which this is a continuation, and hauls it in until the net is drawn taut, gathering the slack of the line under her body. Then she awaits events, and the moment an insect comes in contact with the net she lets go the line, the snare springs forward with a jerk, and the unfortunate captive is thus entangled more effectually by having other meshes of the net flung upon it. To make quite sure of her prey the spider often snaps her net a second time, and when she is satisfied that all is safe she proceeds without undue haste to the enjoyment of the feast.

A species of *Epeira*, found in Madagascar, makes a web which was at one time a great puzzle to naturalists. This web is in general structure not unlike the common garden spider's, but it is peculiar in having near the centre a very stout silvery-white cord—a cable for thickness compared with the other threads—arranged in a zigzag manner. It is not easy to conjecture what the use of this line can be, and you may watch the spider a long time without ascertaining its purpose; yet it is obviously of importance, for if it be removed she hastens to make a new one. Dr. Vinson states that he was one day patiently observing one of these spiders for the hundredth time, when a large grasshopper got entangled in the web. Under ordinary circumstances—that is to say, when she had to do with small insects—the spider had always dealt with them in the ordinary manner adopted by *Epeiras*, by enveloping them in a few light threads; but this was evidently an exceptional occasion, calling for a

FALLING A FINE ART

different method of procedure, for she made a dash for the cable and proceeded to imprison the struggling grasshopper. The prey was too bulky to be easily rendered helpless with the ordinary threads, and the rope appeared to be held in readiness for such an emergency. Darwin mentions a large *Epeira* of Rio de Janeiro which generally makes its web among the great leaves of the common agave, and sometimes *strengthens* it near the centre by two or four zigzag ribbons which connect two adjoining rays. In this case, however, the spider does not appear to make the same use of them as that described by Dr. Vinson, for Darwin says: "When any large insect, as a grasshopper or wasp, is caught, the spider, by a dexterous movement, makes it revolve very rapidly, and at the same time emitting a band of threads *from its spinners*, soon envelops its prey in a case like the cocoon of a silkworm." This *Epeira* always stands with its head downwards near the centre of the web. The head-downwards position is a favourite one amongst spiders which spin vertical webs, the probable reason being that they are in the habit of trailing a safety cord behind them, just as a man about to descend a precipitous rock might fasten a rope round his body for security in case of accident; and as the spinning organ from which the line is produced is at the hind end of the spider's body, it is obviously more convenient to keep that end uppermost, for in such a posture the line is free of the legs and is less likely to embarrass the spider's movements. Speaking of the same spider, Darwin goes on to say that "when disturbed it acts differently according to circumstances: if there is a thicket below it suddenly falls down; and I have distinctly seen the thread from the spinners lengthened by the animal while yet stationary, as preparatory to its fall."

The art of falling at the end of a thread has become

SCALING LADDERS

developed in some cases, according to Mr. Hudson, in a manner that is extremely interesting. He noticed in La Plata certain vividly green *Epeiras* which frequent green-leaved bushes, and others of the same family that are of a faded yellowish-white colour, resembling that of a dead, dried-up leaf, which are found in the same situations as the bright green kind. When the bush is shaken it is the habit of both these spiders to drop to the ground and lie there simulating death; but they do not both fall in just the same way, for while the bright green spider "drops just as a green leaf would drop, that is, not quite so rapidly as a round, solid body like a beetle or spider," the faded-looking, yellowish-white one falls more slowly, as a faded leaf falls more slowly and gently than a green one! The thickness or the elasticity of the line, or the rate at which it is given out, has become so nicely adjusted, that the resemblance to a falling leaf is perfect, and it furnishes us with as pretty an instance of mimicry as one could hope to meet with.

What a piece of rope was to a sailor of the old school in the days when steamships were unknown, its silken thread is to the spider: there are few practical problems it has been unable to solve with its aid. A spider's feet are clawed, but they are not furnished with anything of the nature of 'suckers,' so the animal is unable to obtain any foothold on a perfectly smooth, upright surface. Why, then, can a spider escape when placed in the bottom of a clean wine-glass? The answer is, that with its spinner it can not only make a rope wherewith to let itself down from a height, but also a scaling ladder which enables it to climb up a perpendicular surface. Standing on its front legs, the spider raises the hind end of the body as far as possible against the surface to be scaled—in this case the side of the glass—and attaches thereto a few strands of silk. These serve as a foothold for

A NEST AS LARGE AS A HAT

a further advance, and become the first rung of the silken ladder which before very long leads to the rim of the glass and liberty.

The spider is the very type of a solitary animal, pugnacious, unsociable, mistrustful, never sharing a meal with a comrade, never calling upon one for assistance. It is seldom indeed, however, that we find a rule to which there is no exception, and a few instances are known in which spiders co-operate, or at least tolerate each other's society, for the common welfare. There are some which form small colonies under the glass of greenhouses, where their webs, instead of being kept distinct from one another and jealously preserved from intruders, form a continuous sheet; when an insect becomes entangled in any part of the common snare, several spiders sometimes advance simultaneously to take possession of the prey; but the one which gets there first is left to enjoy it without molestation.

In other species, for the most part tropical, this tendency to a modified sociability is still more marked. Darwin mentions that he found near St. Fé Bajada many large black spiders with ruby-coloured marks on their backs, which were gregarious if not social in their habits, for they attached their webs at intervals of about two feet to common lines, of great length, which extended to all parts of the community, so that large bushes were encompassed by the united nets. These spiders were a species of *Epeira*, and other members of the same family have been described as living a communistic life. Azara observed in Paraguay a kind of small blackish spider, the *Epeira socialis*, about the size of a dwarf-pea, which formed colonies of a hundred or more individuals, and constructed a common nest as large as a hat. The nest was suspended in a sheltered position from some large tree or the ridge of a roof, and had a large number of stout white

1.

1. Compound web of "republican" spider. These spiders are gregarious in their habits, large numbers of them attaching their webs to common lines.

2.

2. Nest of "social" spider. A hundred or more individuals construct a common nest as large as a hat, from which a large number of very long threads extend on all sides. The small object in the corner is a single cocoon.

GIANTS AND DWARFS

threads, fifty or sixty feet long, extending from it on all sides. Darwin also gives an instance of two very different species living together in apparent harmony, the one a huge *Epeira* whose strong yellow webs barricaded the forest paths in Rio de Janeiro, and the other "a small and pretty kind of spider, with very long fore legs," which lived as a parasite on almost every one of the vast webs of the *Epeira*. "I suppose," says Darwin, "it is too insignificant to be noticed by the great *Epeira*, and is therefore allowed to prey on the minute insects, which, adhering to the lines, would otherwise be wasted."

There are many other instances, and more will no doubt be recorded as our knowledge of these interesting creatures is extended. The sociability—such as it is—is of many degrees; in some cases it is merely temporary, lasting only during the breeding season, while in others it is permanent; in one instance all the work is carried out in common by the republic as a whole, in another the common task does not exclude a certain amount of individual enterprise.

CHAPTER XVI

SILK-SPINNERS

AËRONAUTS AND DIVERS

Spiders 'skylarking'—The pleasures of ballooning—Long journeys—Thirsty travellers—Restless beings—An unsolved problem—Various theories—An island prison—A possible explanation—A-tiptoe with expectation—Why the spider's aeroplane rises—What gossamer is—A "flying" spider—The diving-bell—A fairy dwelling—Clothed in air—Weaving the diving-bell—Filling the bell with air—A strange nursery—Sea spiders—A canoe-spider—Rowing himself ashore.

IT is hardly to be supposed that the talented spider family would rest content for all time with triumphs achieved on land when there were other worlds waiting to be conquered. Nor have they done so; they have invaded both water and air, and their doings in both of these are well worth recording.

Do you, too, remember watching a skylark one golden summer morning, and wondering what it is like to rise up, up, up, until you become a speck of pure joy floating amongst sunbeams? And did you feel that on such a perfect day there was really nothing left to wish for—except wings? I suppose that is, more or less, how the little spiders feel, for it is on just such a day that they go ballooning; not one here and there, but thousands and thousands of them, all overcome at once by the same desire. You see them on all sides, tiny, delicate, ethereal creatures, climbing up blades of grass, gates, posts—anything that will enable

LONG JOURNEYS

them to get away from the solid earth—shooting out slender, almost invisible threads, and then sailing away upon their adventurous journey. And when one has gone another takes its place, and another, until in the evening when the sunbeams fall aslant you see that the air is full of these delightful little creatures, floating lightly back again to earth.

Naturalists have given learned explanations of this pretty habit of the gossamer spiders, some thinking that they are impelled to it by an insufficiency of food, and that hard necessity makes it desirable that they should go far afield in search of happier conditions; others are of opinion that they migrate just as the swallows migrate; but I believe that it is nothing more than a roving spirit and a desire to go “skylarking” amongst the sunbeams. Whatever it may be that sends them upon their journey, they are sometimes carried to immense distances before it comes to an end, as we may judge from the fact that they have been known to come aboard ships sixty miles away from land. It was Darwin who observed them on such an occasion during his famous voyage, and this is what he relates: “On several occasions, when the *Beagle* has been within the mouth of the Plata, the rigging has been coated with the web of the Gossamer Spider. One day . . . I paid particular attention to this subject. The weather had been fine and clear, and in the morning the air was full of patches of the flocculent web, as on an autumnal day in England. The ship was sixty miles distant from the land, in the direction of a steady though light breeze. Vast numbers of a small spider, about one-tenth of an inch in length, and of a dusky-red colour, were attached to the webs. There must have been, I should suppose, some thousands on the ship. The little spider, when first coming in contact with the rigging, was always seated on a single thread, and not on the flocculent mass. This latter appears

AN UNSOLVED PROBLEM

merely to be produced by the entanglement of the single threads. The spiders were all of one species, but of both sexes, together with young ones. These latter were distinguished by their smaller size and more dusky colour. . . . The *aëronaut* as soon as it arrived on board was very active, running about, sometimes letting itself fall, and then re-ascending the same thread; sometimes employing itself in making a small and very irregular mesh in the corners between the ropes. It could run with facility on the surface of the water. When disturbed it lifted up its front legs in the attitude of attention. On its first arrival it appeared very thirsty, and with exerted maxillæ drank eagerly of drops of water; this same circumstance has been observed by Strack: may it not be in consequence of the little insect having passed through a dry and rarefied atmosphere? Its stock of web seemed inexhaustible. While watching some that were suspended by a single thread, I several times observed that the slightest breath of air bore them away out of sight, in a horizontal line. On another occasion, under similar circumstances, I repeatedly observed the same kind of small spider, either when placed or having crawled on some little eminence, elevate its abdomen, send forth a thread, and then sail away horizontally, but with a rapidity which was quite unaccountable. I thought I could perceive that the spider, before performing the above preparatory steps, connected its legs together with the most delicate threads, but I am not sure whether this observation was correct."

Since such an acute and accurate observer as Darwin could not be sure about the exact proceedings of a gossamer spider about to go a-sailing in the air, we need not, perhaps, be very much surprised that nobody since his time has succeeded in being 'sure'—at all events not as the result of carefully watching the spiders, and without the aid of

ESCAPE FROM AN ISLAND PRISON

imagination, though there are of course plenty of theories on the subject, and their authors have usually been pretty sure that they offered the only correct explanation of what is still, in my opinion, an unsolved problem.¹ I have a theory myself that is based upon the observation that Darwin was not "sure" about, and being but mortal I am rather inclined to believe in it. But it is quite a modest little theory, and not at all revolutionary, so I offer no apology for it, but merely hope to succeed some day in proving or disproving it by direct observation. In the meantime if you are possessed of plenty of patience and a good magnifying-glass you will perhaps succeed in deciding the question for yourself. Now what is this troublesome problem about which naturalists are unable to come to an agreement? It is nothing more than the precise means by which a spider produces a thread, one end of which is connected with its spinner and the other end of which floats freely in the air, and is not connected with anything whatever. It seems such a very simple matter to decide, that you might think anybody—anybody, that is to say, who is not foolishly afraid of spiders—could settle it once and for all without very much trouble, for gossamer spiders are common enough, and it is not even absolutely necessary to have one of those, for other spiders are certainly able to produce similar floating threads, otherwise they could not escape as they do from the awkward situations in which they are sometimes placed by way of experiment. Mr. Kirby placed, as others have done, a common garden spider on the top of a stick which was set upright in a vessel of water, yet the spider succeeded in making a bridge by which to escape. He thought it did so by attaching one end of a thread to the top of the stick, letting itself down and so spinning a

¹ J. L.

A POSSIBLE EXPLANATION

thread as long as the stick, and then cutting the thread thus formed so that it was carried along by a current of air and, by coming into contact with some object in the room, produced the necessary bridge. The objection to this explanation, as he himself admitted, is that lines a yard or two long are often found fastened to twigs of grass not a foot in height; also in the stick and bowl of water experiment, bridges have been made between the stick and articles of furniture separated from it by a much greater distance than the length of the stick. Some people have thought that a spider can shoot out a thread forcibly in the same way as water can be squirted from a syringe; but the force with which the silk is extruded must be very insignificant, for in perfectly still air the line cannot be thrown through the space of half an inch even, as Mr. Blackwall proved by placing a lot of gossamer spiders on a twig with the end immersed in water and covering them over with a bell-glass, when he found they remained on their island prison for seventeen days without being able to produce a single line by which to escape. As soon as he removed the glass and exposed them to the air they escaped in the usual way by emitting threads and making bridges. "They emitted from their spinners a small portion of glutinous matter, which was instantly carried out in a line, consisting of four finer ones, with a velocity equal, or nearly so, to that with which the air moved."

Everything goes to show that a current of air is absolutely necessary for the production of a line, though the current may be so slight as to be imperceptible to us; the difficulty is to know how the thread is started—what it is upon which the current of air gets a purchase at the very beginning. If, as Darwin thought he perceived to be the case, the spider first connects its legs together with delicate

WHY A SPIDER'S AEROPLANE RISES

threads, these threads being stretched across the direction of the wind would present something appreciable for its force to act on and would give the thread a fair start. It seems as if some such method must be resorted to ; but a gossamer spider is a very tiny creature, and the action is so swift, so seemingly instantaneous, that the thread is a foot long before you can perceive what is going on.

It is not one particular kind of spider that practises aëronautics ; the young of many species indulge in the sport. As a preparatory measure they always appear to take note which way the wind is blowing, and turning their thorax towards the quarter from which it comes, they stand on tip-toe and raise their body. Darwin has further observations on the subject which are as follows :—“ One day, at St. Fé, I had a better opportunity of observing some similar facts. A spider which was about three-tenths of inch in length . . . while standing on the summit of a post, darted forth four or five threads from its spinners. These, glittering in the sunshine, might be compared to diverging rays of light ; they were not, however, straight, but in undulating lines like films of silk blown by the wind. They were more than a yard in length, and diverged in an ascending direction from the orifices. The spider then suddenly let go its hold of the post, and was quickly borne out of sight. The day was hot and apparently quite calm ; yet under such circumstances, the atmosphere can never be so tranquil as not to affect a vane so delicate as the thread of a spider's web. If during a warm day we look either at the shadow of any object cast on a bank, or over a level plain at a distant landmark, the effect of an ascending current of heated air is almost always evident : such upward currents, it has been remarked, are also shown by the ascent of soap-bubbles, which will not rise in an indoors room. Hence I think

A "FLYING" SPIDER

there is not much difficulty in understanding the ascent of the fine lines projected from a spider's spinners, and afterwards of the spider itself; the divergence of the lines has been attempted to be explained, I believe by Mr. Murray, by their similar electrical condition."

Mr. Murray went further; he stated that the aëronautic spider could propel its thread in any direction either in motionless air or in the wind, and that electricity was the one and only explanation. But we must not devote too much time even to such an interesting subject as this is.

The irregular white webs of beautiful ravelled silk which are seen floating in the air or covering the fields and hedgerows are formed of tangled masses of myriads of the gossamer threads of which we have been speaking. Some are perhaps formed as the threads come together in the air, but most of them are formed at earth's surface from threads which have become tangled before the spiders could sail off.

The *Saltigradæ*, or Jumping Spiders, stalk their prey like a cat, gradually approaching it with great caution and finally pouncing upon it with a well-judged spring. One spider of this family, an Australian species named *Attus volans*, has acquired the power of prolonging its leaps in a curious manner. Attached to its body are little flaps of skin, by raising which the spider is able to convert itself into a miniature aëroplane and thus extend its leaps into short flights.

No spider can live without atmospheric air, but several species have become more or less amphibious or aquatic in their habits. We shall have occasion to mention one remarkable instance in the next chapter; the best known of all, however, is the Water Spider (*Argyroneta aquatica*), a dull-looking brown-and-olive creature about half an inch in length, which frequents quiet waters in the British Islands

WEAVING THE DIVING-BELL

and the central part of Europe. It prefers slow streams, canals, and ditches, where it makes a remarkable sub-aquatic dwelling which may best be compared to a diving-bell. In shape this structure resembles a thimble, or an egg-shell with one end cut off, and it shines in the water like a globe of silver. It is woven entirely of silk, the threads of which cross one another in all directions, forming a strong but delicate tissue of a very close, fine texture. The bell, though nearly always entirely submerged, is seldom far from the surface, and is anchored to neighbouring water weeds by a number of irregular threads. The opening is directed downwards, and the cavity is filled with air which, glistening through the white silken walls, gives the beautiful silvery appearance to the structure. In this curious chamber the spider dwells. When she feels hungry she leaves her retreat and swims about freely in the water, where she is far more beautiful than she is on land, for the fine hairs which grow closely all over the abdomen retain a layer of air, so that the spider also has a curious silvery appearance. She hunts about under the water or at the surface for insects, and having secured her prey she devours it either within her bell or in the open air. It is not difficult to keep these spiders in an aquarium or even in a large tumbler of water, where they can readily be observed making their bells, but it is by no means easy to perceive exactly how they do it. You can see that a great number of threads are first attached to the water plants in such a way as to form a sort of irregular network, and that as soon as the work has proceeded far enough the spider carries down a small bubble of air from the surface and releases it under the web; what you feel you cannot be quite sure about is the precise manner in which the spider obtains and conveys the bubble. It is sometimes stated that it is merely a portion of the layer of air en-

SEA SPIDERS

tangled in the spider's hairy coat ; some think that the hind legs, which are curved round the end of the body, have something to do with holding the bubble until it is set free in the bell ; but the most general opinion appears to be that it is obtained in some way by the help of the spinning mammillæ. Certain it is that the extremity of the body alone is protruded when the spider rises for its bubble, and both Brehm and Clerck mention certain movements of the mammillæ at this moment. They are very tiny structures, and I was not able to observe that anything of the kind took place when I watched these spiders myself ; but I am inclined to think this view is the correct one, and that the capture—if I may use the term—and conveyance of the bubble may be aided by a thread or threads extending between the mammillæ.

When a number of bubbles have been placed under the web it begins to shape itself, and the spider then proceeds to strengthen the walls of the bell by the addition of more threads until at last it assumes the appearance already described. When full of air the bell, which is about half an inch in diameter, has, of course, a tendency to rise to the surface ; it strains at its cables like a captive balloon. As the oxygen is consumed the air is renewed in the same way as it is introduced in the first instance. The eggs are laid in the upper part of the bell, and in course of time the young are born in this queer nursery. In winter the spider closes the mouth of the bell and stays quietly at home, resting head downwards. The male water spider also makes a bell for himself. He has the distinction, unusual amongst spiders, of being stronger than the female, and—no doubt it is a mere coincidence—they do not quarrel.

The other aquatic spiders are the *Desidæ*, and are marine in habit, being found about the coasts and coral reefs of the

THE MARGIN OF A QUIET STREAM

The glistening object under water is a silken air-bell, made by the common water-spider ; its owner is seen comfortably ensconced within. Another spider is represented diving with a captured insect ; the silvery appearance of its body is due to the air entangled amongst the hairs with which it is covered. Crawling upon the bottom of the stream and the stems of water-plants are several larvæ of caddis-flies in their "cases," which are covered with sand, dead leaves, or snail-shells—often with the living snails still occupying them. The caddis-flies themselves are shown amongst the reeds above the surface. The birds are reed warblers.

ROWING HIMSELF ASHORE

Australian, South African, and Indo-Malayan seas, above low-water mark. They are excellent swimmers, and their food consists of small crustaceans, etc. When the tide rises they retreat into holes and crannies in the rocks, where they surround themselves with a strong layer of silk to keep out the water.

While speaking of water spiders we may as well mention the *Tetragnatha*, a genus of small geometric spiders that spin their webs over the margins of streams. They have long, slender bodies shaped something like a boat, and in one South American species the ends of the long legs are flattened so that they rather resemble oars. When the spiders fall into the water—an event which is not uncommon, for they are quarrelsome creatures—all they have to do is to stretch out their legs, dip the extremities, and row themselves ashore.

CHAPTER XVII

RAFT BUILDERS

An interesting encounter—A spider buccaneer—Hunting from a raft—A redoubtable pursuer—Fishes' rafts—Wedding attire—Blowing bubbles—An inverted nest—Retrieving the eggs—A watchful parent—The rainbow-fish—A coat of many colours—Floating the raft—Making a dome—Sinking the nest—Another careful father—The violet sea-snail—Building with air.

SOME years ago, on an occasion when I was hunting for plants in the fen districts of Cambridgeshire, I happened to notice while peering into a ditch a large spider resting on what I took to be nothing more than a small tangle of leaves and drift-weed floating upon the surface of the water.¹ Perceiving, from its size and its more handsome appearance, that it was not a common water spider, I imagined that some accident had turned it adrift, and promptly reached with my stick to rescue it from an uncomfortable situation. The spider, however, misinterpreted what was really a perfectly amiable intention on my part, and greatly to my astonishment disappeared promptly over the edge of the bunch of weeds into the water. As far as I could judge, however, it had not left its asylum altogether, so I persisted in my attempts to bring it to land; but before I could succeed in doing so, the surprising creature darted out again, and running with apparent ease along the surface of the water, vanished amongst some reeds. I then remembered having somewhere read of a spider which makes a raft for itself and starts out in search of adventures, like some terrible pirate who is able to step overboard at a

¹ J. L.

HUNTING FROM A RAFT

moment's notice and pursue his wretched victim even after he has made him "walk the plank": a circumstance which, until that moment, had quite escaped my memory. To make quite sure that I really had met with one of these solitary buccaneers, I examined the little bunch of weeds, and found that the leaves and debris of which it was composed were slightly bound together with a few threads of silk.

The name of the Raft Spider is *Dolomedes fimbriatus*, and it frequents the margins of lakes, marshes, and other stagnant waters, along the surface of which its raft is wafted by the wind. On catching sight of a drowning insect it leaves its floating dwelling, retrieves the prey, and returning with it to the raft, devours it at leisure. It does not depend for food entirely on insects which have fallen into the water, however, but is always prepared to venture beneath the surface and explore the submerged stems of aquatic plants in search of booty. After laying her eggs, the female carries the cocoon about with her in her mandibles for a while, until the time of hatching approaches, when she attaches it to some plant at the water's edge.

I cannot recall any other animal which makes a true raft for the purpose of navigation, but amongst the fishes there are two species which construct something of a similar character. You may see both of them in aquariums sometimes; one is the Chinese *Macropus*, or Paradise-fish, and the other is the Indian Rainbow-fish.

The Paradise-fish is a domesticated variety of a fish which has been named *Polyacanthus opercularis*, and his own distinguishing name is *Macropus viridi-auratus*. That is because the male fish, when he is preparing for his wedding, turns a bluish-green colour, which is varied with bands of red. Over his gills there is a patch of bright orange with a dark-blue spot in the middle. His unpaired fins, which

FISHES' RAFTS

are always uncommonly long, grow still longer at this time, and develop a thread-like fringe on the edge, so that altogether he looks a very remarkable fellow, and it was on account of his striking appearance that people began to keep him as a pet in the first place. But it is not only because of his good looks that he is so interesting; at certain times he busies himself in a very curious manner.

In the first place, the male fish begins to construct an odd sort of shelter, and the way he sets about it is this. He rises to the top of the water and sucks in a mouthful of air, which he retains for a little while; then he lets it escape, and it remains on the surface in the form of a bubble. He does the same thing again, placing a second bubble by the side of the first, then a third and a fourth, and so on, until there are hundreds of bubbles, which together form a little mass of froth. This does not burst or disappear, because while the air is in his mouth he makes a kind of bladder to contain it out of the slime or 'mucus,' by which it is surrounded, and the bubbles are thus prevented from running one into another, the cavities remaining quite distinct although the sacs are stuck closely together.

What can be the purpose of this curious little fairy-raft, which measures about three or four inches across? We shall see.

As soon as it is completed, the male fish brings a female *Macropus* to it, and she deposits her eggs beneath the shelter. Now, the eggs are very light indeed, and very buoyant, so that they rise in the water instead of sinking to the bottom, and they stick to the under side of the raft. If some of them go astray and float outside, the male fish swims after them in a moment, like a dog after a ball, and brings them back in his mouth. When several females have deposited their eggs in this manner and there are about five hundred of them collected together beneath the raft, it

THE RAINBOW-FISH

is the male fish which remains beside them to keep watch, the female giving them not the least attention.

Not for one instant does he neglect this duty. Now and then he rearranges the eggs, putting the middle ones outside and moving those which were outside towards the centre, his instinct telling him that they will develop better if they are changed about in this way.

When the eggs are hatched he still guards his offspring, keeping the fry together underneath the raft and bringing back any that wander away. He continues to do this until the young ones can swim freely, when they at last leave the nest, which is destroyed and abandoned.

Now you may observe these wonderful things for yourself quite easily, because there is no difficulty whatever in keeping the fish. The only thing you have to be specially careful about is the temperature of the water, which should not be allowed to fall much below 70° F. Indeed, if you wish to be successful in keeping Chinese or Japanese or other foreign fishes, you should always try to provide for them as nearly as possible the same sort of climate as that to which they are accustomed in their native country.

Although the nest we have just described is a very strange one, it is not nearly so curious as that made by the Rainbow-fish, which is perhaps more like your idea of what a nest ought to be.

This beautiful little fish frequents the rivers of Northern India, and is plentiful in the Ganges and Jumna. At Calcutta, where it is quite common, it is often sold alive in bottles of water, and it thrives fairly well in aquaria.

The name *rainbow-fish* would lead you to expect the brightest of colours, and you would not be disappointed. The body is resplendent with upright bands of scarlet and light blue, one-half of each scale being of either colour, and the fins are barred in scarlet dots. No fish is more

FLOATING THE RAFT

gaily attired. The ventral fin—that is to say, the fin just beneath the throat—consists of a single, long, hair-like filament, and on this account the fish has been given the imposing title of *Trichogaster*, a long name for a little fellow who never measures more than two inches from nose to tail!

The nest of this little fish is made to hold eggs which float on the surface like those of *Macropus*, but it is not built of air-bubbles. The rainbow-fish makes his raft of plants, and the plants he chooses are those thin, delicate green threads called *confervæ*, which you may find growing in almost any pond. Now these threads are just about as heavy as the water which surrounds them, or if anything a little heavier, so that they do not under ordinary circumstances rise to the surface, but remain suspended in the middle or sink slowly to the bottom. But it is necessary for the eggs to be kept at the surface; if, therefore, the nest which is to contain them be built of materials which will not float of themselves, something must be done to make them more buoyant. How is the fish to overcome this difficulty? Well, he deals with it in a way as simple as it is ingenious: he uses air-bubbles to make the little plants lighter, and this is how he sets to work. First he takes a mouthful of air, just as the paradise-fish does, but instead of forming it into one large bubble he breaks it up into a number of very tiny ones, and expels them in such a manner that a great many of them become entangled with the filaments of *confervæ* and carry them up to the surface. He repeats this several times, and then he begins to weave the plant-threads together so as to form a little raft. When he has made one about an inch in diameter, he takes another mouthful of air and without enclosing it in a sac of mucus like *Macropus* he sets it free under the raft, which now remains afloat and forms a foundation for the nest. After that he looks about for other bits

ANOTHER CAREFUL FATHER

of weed and puts them alongside the first until the whole forms a circular patch four inches across, under which he proceeds to collect more air until the middle part of the raft gradually rises up about two inches above the water and becomes rounded like the top of an open umbrella. Around the edges of this the fish places more confervæ, which he weaves and interlaces with some force, so as to make a strong border to the central dome. The nest now appears more like a hat than an umbrella, with a middle part curved like the crown, and a broad, flat brim all round.

As soon as the male rainbow-fish has completed his nest he, like *Macropus*, escorts the female fishes to it and places their eggs beneath the rounded middle part or dome, whereupon he makes the entrance to this a little narrower. At first he takes care of the eggs after the same fashion as the paradise-fish, keeping watch over them and changing them about from one place to another. But after a while his instinct leads him to do a very curious thing. If the eggs were permitted to remain too long in the air under the dome of the nest they would not develop properly; in order that they may do so it is necessary for them to be completely surrounded by water. To bring this about, the fish makes a hole in the top of the nest and so lets the air escape; the dome falls in and both nest and eggs sink to the bottom.

This happens about the end of the third day, just when the young are about to hatch out of the eggs. After their escape the parent fish still cares for their welfare. We have seen how *Macropus* keeps his family at home by swimming after any that attempt to wander away and bringing them back again. The rainbow-fish avoids all this trouble very cleverly. He undoes the firmly woven rim of the nest and roves it out until it forms a fringe which hangs down all the way round like a curtain and prevents the little ones from getting out as easily as they would otherwise do.

BUILDING WITH AIR

In about ten days, however, the young fry are strong enough to lead independent lives, and then their parent permits them to go where they will.

Among the raft builders we must also mention a mollusc which lives in the sea and has a spiral shell of a delicate violet colour. On this account it is sometimes spoken of as the Violet Sea Snail; but we will call it by its proper name, which is *Janthina*.

This little creature can only keep itself on the surface of the water by the help of a float which is attached to its foot and is composed of a stiff gelatinous mass containing air-sacs. The outer sides of these sacs are rounded, but where they are in contact with one another the walls are flattened. I will tell you how *Janthina* adds a little piece to his float when he finds it necessary to make it larger.

The foot is divided into two distinct parts, and it is the foremost of these which does the work. This part is capable of very free movements. First of all it becomes longer and spreads out at the end; at the same time the animal raises it out of the water so that it stands up like a little club. Just at this moment the end of the club becomes hollowed out in the form of a shallow cup, the edges of which come together in such a manner that a bubble of air is enclosed. *Janthina* now obtains with the aid of his foot a result similar to that which *Macropus* produced with his mouth; he encloses the air-bubble in an envelope of slime. The foot continues to move forward until it reaches the front end of the float, against which the bubble is pressed into position.

The same movements are gone through time after time, and thus more and more air-bubbles or vesicles are accumulated. The slime which surrounds them is at first quite soft, but when exposed to the air it gradually becomes much tougher, until it forms an almost gristly mass.

CHAPTER XVIII

POTTERS

Pelopæus—A gay little workman—Carafes and jars—Glazed ware—
Economical methods—The vases of *Eumenes*.

UNDER the title of potters we may group together a number of animals so skilful in the art of moulding mud or clay that their nests resemble true pots turned on a potter's wheel.

Amongst them we ought perhaps, by courtesy, to include some of the *Pelopæi*, a family of insects to which we have already had occasion to refer under the heading of Masons. Mr. Bates gives a brilliant account of the many kinds of bees and wasps that he found frequenting the shallow clay-pits from which the people of Santarem obtain material for the manufacture of their coarse pottery. "The most conspicuous was a large yellow-and-black wasp, with a remarkably long and narrow waist, the *Pelopæus fistularis*. It collected the clay in little round pellets, which it carried off, after rolling them into a convenient shape, in its mandibles. It came straight to the pit with a loud hum, and on alighting lost not a moment in beginning its work; finishing the kneading of its little load in two or three minutes. The nest of this species is shaped like a pouch, two inches in length, and is attached to a branch or other projecting object. One of these restless artificers once began to build on the handle of a chest in the cabin of my canoe, when we

A GAY WORKMAN

were stationary at a place for several days. It was so intent upon its work that it allowed me to inspect the movements of its mouth with a lens whilst it was laying on the mortar. Every fresh pellet was brought in with a triumphant song, which changed to a cheerful busy hum when it alighted and began to work. The little ball of moist clay was laid on the edge of the cell, and then spread out around the circular rim, by means of the lower lip guided by the mandibles. The insect placed itself astride over the rim to work, and on finishing each addition to the structure, took a turn round, patting the sides with its feet inside and out before flying off to gather a fresh pellet. It worked only in sunny weather, and the previous layer was sometimes not quite dry when the new coating was added. The whole structure takes about a week to complete. I left the place before the gay little builder had quite finished her task: she did not accompany the canoe, although we moved along the bank of the river very slowly. On opening closed nests of this species, which are common in the neighbourhood of Mahicá, I always found them to be stocked with small spiders of the genus *Gastracantha*, in the usual half-dead state to which the mother wasps reduce the insects which are to serve as food for their progeny. Besides the *Pelopæus* there were three or four kinds of *Trypoxylon*, a genus also found in Europe. Their habits are similar to those of the *Pelopæus*: namely, they carry off the clay in their mandibles, and have a different song when they hasten away with the burthen, from that which they sing whilst at work. *Trypoxylon albitarse*, which is a large black kind, three-quarters of an inch in length, makes a tremendous fuss whilst building its cell. It often chooses the walls or doors of chambers for this purpose, and when two or three are at work in the same place their loud humming keeps the house in an uproar. *T.*

CARAFES AND JARS

aurifrons, a much smaller species, makes a neat little nest shaped like a carafe; building rows of them together in the corners of the verandahs."

Amongst the cleverest of the insect potters we must certainly count the *Agenias*—fragile creatures scarcely larger than a common gnat, black-coated and unpretentious, but so skilful in the practice of their craft that they are surpassed by few, if any, of the workers in clay. The pots they make are delicate and symmetrical, like the pieces of a tiny set of china. *Agenia punctum* fashions little oval jars, while *Agenia hyalipennis* shapes its ware in the form of a primitive drinking-cup, the antique cyathus. But it is not only in the graceful curves of their fragile vessels that the *Agenias* display their genius as potters; in that respect they show themselves to be good artists, but in another direction they have made an important advance as craftsmen, beyond the limits attained by most of their fellows. The outside of their pots, though even in curvature, is rough in texture; there we find no particular attention given to the nature of the surface, which is simply that produced by the building up of a multitude of tiny pellets of clay, uneven and porous. Placed in water, the vessel softens and falls to a shapeless mass. But the inner surface is carefully smoothed, and not only so, it is watertight: a drop of water introduced into one of these jars does not penetrate into its substance, but remains within the cavity. The *Agenias*, then, have learnt the art of glazing their ware—of making it watertight with the least possible expenditure of material, by spreading their waterproofing substance in a thin film over the inside of the pot, just as our common earthenware is glazed inside while the outer surface is left in the rough, unglazed condition. It would obviously be a still greater advantage if the whole substance of the cell could be made impervious to water; it

THE VASES OF *EUMENES*

would be more durable, and less likely to come to harm if by any accident exposed to inclement weather. But the glazing is secreted by the *Agenia* itself, and as the cells are of large dimensions compared with the size of the insect it would be beyond the power of its minute glands to pour out a sufficient quantity of the precious liquid to mix with all the clay, or earth, or dust, or whatever other substance it employs: the process would be too expensive, and the production of pottery would not be rapid enough for the insect's needs. So the dust or clay is tempered with water, and the saliva is held in reserve for the inner coating—a perfectly admirable instance of animal economy! The cells, being liable to injury by rain, are always placed in a situation which affords a certain amount of shelter. The *Agenia* appears to be quite indifferent in its choice of a cavity for this purpose, and its cells may be found in all kinds of places—under a loose fragment of bark, in the tunnel made by a beetle larva, or the burrow of a large earth-worm, a crevice in a sunny wall, an empty snail-shell—in any hole or corner that offers a convenient asylum to the busy and ingenious little potter.

The solitary wasp known as *Eumenes coarctata* is also a potter. It is commoner than the species *E. Amedei*, described in a previous chapter; it is also less particular about choosing a warm, sunny spot for its nest, and is content to build on the stems of various small plants. In England it often chooses the ordinary heath for this purpose, so that a heather-clad common is a likely place to find specimens. Its nest is about the size of a small cherry and, unlike that of the *E. Amedei*, is made of earth alone without any admixture of little stones. It is spherical in shape and encloses a single cavity which the wasp provisions with the caterpillars of small butterflies or moths. These serve as

THE VASES OF *EUMENES*

food for its larva, only one of which is found in each cell.

Another species, called *Eumenes pomiformis*, builds a very similar nest, the opening of which is curved out like the mouth of a vase. The walls are as thin as paper and slightly ridged outside where the different layers of clay have been joined, so that the whole structure has the appearance of a Lilliputian water-jar of porous earthenware, showing the grooves made by the potter's thumb. Sometimes these cells are fixed to walls, stones, shutters, or other broad surfaces, and they are then formed with much wider base so that they are shaped like a marble with a large piece cut off one side at the point of attachment.

CHAPTER XIX

PAPER-MAKERS

Wasps as paper makers—Varieties of wasp-paper—Sizing—Making the pulp—Architecture of a wasp's nest—An air-jacket—Founding a colony—Mother and queen—Defending the home—Nests of *Polybia*—A fortified dwelling—Variety of Polybian architecture—Fine paste-board—A beautiful product—Termites as paper-makers—Tree-dwellers—A stupendous structure—The destructiveness of termites.

IT is not long since paper was made almost exclusively from rags, which, as you know, consist mainly of fibres of cotton or flax. Nowadays, however, wood is very largely used for the purpose: it is first ground to dust and then made into a pulp, which is spread out and dried, thus forming either thin, flexible sheets of paper or the thicker and more rigid cardboard.

The insects which we group together under the name of wasps carried on this industry long before it was invented by man, and the paper which they produce will bear comparison in many respects with ours, for they know as well as we do how to make both blotting-paper and paper which is rendered tougher and less porous by means of size. When placed in underground cavities, where it is sheltered from the rain, their paper is simply composed of wood fibre reduced to pulp; on the other hand, in situations where it is exposed to the weather the wasps cover it with a protective varnish—or in other words, give it a coat of size—in order that it may not be damaged by rain, while some

MAKING THE PULP

species make a sort of tough card of admirably fine texture.

Wasps employ both paper and card to make their nests, which usually consist of an outer jacket or protective covering, enclosing a number of regular hexagonal cells such as one finds in an ordinary honey-comb. Let us see how such a nest is made. It is in the springtime, about April, that the female or queen wasps are to be seen busily looking for a convenient place to build a nest, or seeking materials for its construction. Both they and the workers have strong jaws, the edges of which are serrated or toothed and work into each other; they are the principal implements with which the nests are made and food is provided for the grubs. With these mandibles, then, the wasp gnaws off fibres of seasoned bark and wood, works them into a little ball, and flies back with it to the spot she has chosen. You may often see wasps and *Polistes* at work in this manner on an old fence or window-ledge, opening their jaws, pressing the sharp edges into the wood, and tearing up tiny splinters about a twelfth of an inch long; biting and gnawing them into fine fibrils, and at last making them into pulp with saliva so that the little bundle may be carried more conveniently to the nest. On arrival it is thoroughly kneaded once more and then spread out into a layer, to which the finishing touches are given by the insect's tongue, which smooths the surface and glazes it over with a coat of saliva, thus rendering it to a certain extent waterproof.

Wasps' nests—those, at all events, with which we are most familiar in England, the nests of *Vespa vulgaris*—contain a number of separate cakes or combs sustained by pillars, and each nest has three main constituents:—

(1) The combs or cakes, one or more in number, composed of a single layer of hexagonal cells placed side by side with the openings directed downwards.

AN AIR-JACKET

(2) Pillars or columns by which the cakes are attached to one another and the uppermost comb is fixed to the top of the nest or to the under side of a branch, rafter, or other support.

(3) The outer envelope, which at first consists of only a single layer ; to this, however, others are usually added afterwards in small sheets shaped very much like oyster-shells, with the convex side outwards. Now these little sheets, or lamellæ, are attached to each other by their edges, which overlap, just as the tiles on a roof overlap. The outside is sized over with saliva, which gives it for a while a glistening, almost silvery appearance, and helps to make the covering waterproof. But this jacket of many layers serves another purpose besides that of protecting the combs from moisture. Owing to their shell-like shape, the lamellæ do not fit closely together over their whole surface ; spaces are left between them, filled with air, and this arrangement produces a covering of the sort best calculated to retain heat. Consequently, the temperature inside a thickly populated wasps' nest may be as much as 25° F. warmer than the outside air—a matter of great importance for the development of the brood.

Most of our wasps make their nests in holes in the ground, often taking possession of the deserted burrows of moles, field mice, and the like. Old walls have also a great attraction for these insects ; while some choose hollow trees, or build under thatches, beams, or rafters. Cases are known in which wasps' nests have been found in old barrels, and occasionally a colony establishes itself in a bee-hive, where the intruders not improbably grow fat on the store of honey. Several species nest in the open air, and attach their dwellings to the branches of shrubs or trees.

The first cells are always made by a female wasp, who,

MOTHER AND QUEEN

unlike the bees, works in solitude. She places an egg in every cell, from which, in course of time, grubs are hatched. These helpless creatures have to be supplied with food by their parent, who thus has a hungry family to add to her cares. But after a while these, the first of her children, become worker wasps, and after their transformation they at once take upon themselves the labour of building and hunting for food. Henceforward the mother wasp leads the life of a queen, whose duties mainly consist in supplying an egg to every cell constructed by the workers. If the nest be underground, the wasps often have to do a lot of excavating to make room for its growth. At such times you may frequently observe them appearing at the entrance carrying in their jaws little lumps of earth with which they fly away to some distance. In chalky ground their labour is often increased by the presence of little stones; the insects will carry off the smaller ones—any in fact that are not more than twice their own weight; but those of larger size, which can only be dragged over the ground, are heaped up outside the entrance of the nest, which is often completely hidden by the débris. Stones of still greater size are undermined and by this means gradually sunk to the bottom of the hole; while the largest of all, which cannot be dealt with in any other way, are either avoided or embedded in the substance of the nest.

As the nest becomes larger, additions are made to the outside envelope, which may ultimately be from half an inch to an inch or more in thickness, and contain as many as ten layers of 'paper' in its walls. At the same time the inner skin of the shell is cut away in order to enlarge the cavity and make room for the construction of new cells. The combs are not attached to the envelope all the way round, but only here and there by means of little pillars, which

NESTS OF *POLYBIA*

leave ample space for the insects to pass easily from one story to another. At the bottom of the envelope there is an opening, or sometimes two, by means of which the wasps pass in and out. This hole is just about large enough to admit your finger; and if the nest be underground, it opens into a gallery of varying dimensions, but often more than half a yard in length. The burrow which leads to the outer world is seldom straight, and it serves to discourage any hostile insects which might otherwise be disposed to adventure into the nest, as do also the vigilant sentinels who, during the day at all events, remain on guard about the entrance.

The envelope which encloses the nest is not in actual contact with the walls of the cavity in which it is situated, being separated therefrom by an interval of about half an inch, and held in position by a varying number of pillars constructed around the sides and over the top.

Another class of hymenopterous insects, to which naturalists have given the name *Polybia*, make nests which consist of a number of cakes encased in a single covering of a material which resembles cardboard, and are often attached by means of a stalk or ring to a reed or a branch of a tree. The nests exhibit a great deal of variety in shape, which approaches more or less in different examples to that of a cylinder, a cone, a ball, or a pyramid, and some are bell-shaped. One small hole gives admission to the nest, and there is no other opening of any kind in the covering. Sometimes the outside wall is slightly grooved at the level of each story of the dwelling.

In Uruguay and the Argentine there is a species called *Polybia scutellaris*, whose nests are often over two feet long and measure more than a yard in circumference. In shape they are not unlike huge sausages slightly narrowed, in some

SOUTH AMERICAN HONEY-WASP'S NEST BROKEN OPEN BY A JAGUAR

The outer surface of these strange nests is covered with stout spikes, which no doubt serve as a means of protection against the smaller members of the cat tribe, whose fondness for honey would tempt them to tear open the combs. The Jaguar, however, has extremely powerful claws, against which the wasps' fortifications are of no avail.

A FORTIFIED DWELLING

cases, towards the middle. The cardboard covering is coarse in texture and very tough, but its surface is smooth and sized over, so that it is quite possible to write on it. It is brown in colour, and it is said by the natives to be manufactured from the excrement of the tapir.

The nests are penetrated by stout branches, which contribute to their strength. A few of the upper cakes are globular and arranged in concentric spheres; but those below are only segments of spheres, that is to say, they are shaped like a skull-cap; while the lowest of all are shield-like. At the side of every comb there is a single opening. This little wasp is remarkable for storing up honey, like the bees; but the most curious thing about its nest is the peculiar character of the envelope, which, so far as we know, is quite unique. Numerous stout knobs and spurs of cardboard project in irregular horizontal rows from the outer surface, each series roughly corresponding with one of the combs within. These projections are built up of layer upon layer of very dense card, and are exceedingly strong. They probably serve to protect the nests to some extent against various members of the cat tribe, such as jaguars and cougars, which are in the habit of detaching them from the branches and breaking them open to get at the honey, of which they are very fond.

Another species, called *Polybia liliacea*, which is common in Cayenne, builds a nest which is still larger than that made by *P. scutellaris*, for it sometimes attains a length of forty inches by the addition of successive compartments to the lower end. The envelope is thick and strong and has a shiny surface, but it is too rough and coarse to write upon very readily. The nest is flattened and oblong, and hangs from a stout bough by a ring at the top. It contains a large number of flat oval combs placed one above another; these

FINE PASTEBOARD

are manufactured with greater care than is devoted to the envelope, for though they are rather brittle, they are denser and of a finer substance.

The holes by which the insects pass from one story to another are situated about the middle of the combs, and are large enough to admit several at one time.

The nests of another species, *Polybia sedula*, found in the province of Bahia, are notable because their shape is adapted to that of the objects to which they are fixed. For instance, when the nest is built on the under surface of the leaf of a reed or other monocotyledonous plant, it is long and narrow in form; but if it be attached to the broader, more rounded leaf of a dicotyledon, it is similarly rounded. In this wasp's nest the layer of six-sided cells is protected by a jacket of material almost woody in texture, not unlike the bark of a tree, which follows their outline somewhat closely.

There seems to be no limit to the variety and originality of Polybian architecture. In another type the whole nest is composed of a series of globes, one within another, and the insects enlarge it by covering the outer wall with cells and then constructing a new roof over them, so that the roof of one comb becomes the floor of the next.

The insect known as *Chartergus chartarius*, a native of Guiana, Brazil, and Mexico, and, like those already named, one of the Hymenoptera, makes its nest of a material which rivals the finest pasteboard in toughness and beauty of texture. It is whitish in colour and elongated in form, becoming gradually wider towards the lower end, to which new combs are constantly being added, so that although the nest is always complete and self-contained after the building of a story, it still remains capable of enlargement without any alterations being made to the existing structure. It is

TERMITES AS PAPER-MAKERS

suspended from the branch of a tree by a broad ring of cardboard at the upper end. The interior is divided into chambers by a series of partitions stretching across from wall to wall, with whose substance they are continuous. The partitions bulge downwards, and bear a single layer of cells on their under surface. Each of them has in its turn formed the lower end of the outside shell, and they all have an opening near the middle, through which the insects can pass from chamber to chamber, and so to the outside world. In this beautifully constructed nest the qualities of lightness and strength are admirably combined; the surface is hard and polished, and perfectly waterproof, and the material is so durable that the insects are able to inhabit the same nest for several successive seasons.

We have perhaps said enough about the wasps to show that they have raised the art of paper-making to the level of a national industry, in which they all engage with more or less happy results. But they have no monopoly; the same industry is carried on by other groups of insects, notably by the Termites.

Termites are popularly known as "White Ants," though they are in reality not ants at all, but more nearly allied to grasshoppers, crickets, and cockroaches, and belong, with the dragon-flies, May-flies, stone-fles, and ant-lions, to the great family of Neuroptera. Some of them dwell in trees, and are very skilful in the manufacture of a sort of paper, which is different from that which the wasps make, because after the woody fibres have been reduced to pulp, the latter is mixed with some adhesive substance—generally with the insect's own dejections, a kind of cement which animals employ but seldom.

The best-known species of tree-dwelling termite is the *Termes arborum*, which is common at the Cape and in West

TREE-DWELLERS

Africa and in some other parts of the world. These insects construct their nest on trees at a great height—often eighty or a hundred feet—above the ground, sometimes placing it between two branches, sometimes around one only. The nests are rounded or oval in shape, black in colour, and occasionally of enormous size, some of them being as large as a sugar cask. They are composed of particles of wood mixed up with various gummy substances into a paste, and fashioned into a multitude of irregular cells. They are so strongly constructed, and fixed so firmly to the trees, that it is impossible to remove them without cutting off the branch to which they are attached. On the Guiana coast, where hurricanes of great violence occur, trees are often hurled down by the tornadoes, yet the termites' nests upon their branches escape injury. The number of insects in a single nest may be prodigious, for they are packed as closely as herrings in a barrel. They shun the light, and make covered galleries of clay in which they can pass at their ease from one place to another. Such covered roads form an irregular network of black lines which may be observed winding along the under side of the limbs of a tree in which a nest is situated, often to the very topmost branches, and down the trunk to the ground, where they frequently communicate with subterranean passages; they form convenient avenues by means of which the workers can bring provisions to the nest. These insects sometimes make their nest on the roof of a house, and do an enormous amount of damage to the interior unless they are immediately destroyed; on other occasions they find their way into a packing-case, make a nest, and eat at their leisure everything the case contains. They attack dead trees which are still standing, entering the lower part of the trunk and devouring the wood until nothing but the bark remains. In doing this they often

DESTRUCTIVENESS OF TERMITES

exhibit much ingenuity in strengthening the hollow part as they proceed with a mud wall; but when a strong wind arises, the tree comes to the ground and is broken to fragments. It is of course dangerous to attempt to climb a tree thus attacked by termites, and accidents have before now occurred to unwary travellers from this cause.

When the insects take possession of a tree which is already lying on the earth, they are spared the labour of building up a mass of cement to replace the wood that has been hollowed out, such a precaution being unnecessary.

CHAPTER XX

WEAVERS, SEMPSTERS, AND WORKERS IN COTTON

Weaver-birds—Variety of nests—A stocking-nest—The golden weaver-bird—Elaborate structures—A lively scene—An Indian weaver—Social habits—Division of labour—The baya's firefly lantern—Ballast—A native legend—The Baltimore oriole—The influence of climate—Cassiques—A tough material—Spider-catchers—A nest sewn to a leaf—The tailor-birds—Making bags—Different kinds of thread—Neat and clumsy sewing—How the stitches are put in—Another tailor-made nest—A neglected industry—Disadvantages of vegetable down—Ideal nests—Dyed eggs—Cotton-wool nests—Young birds glued to their cradle.

THE ancient and respectable craft of weaving is practically carried on only by the bird family, many members of which follow this industry in the construction of bag-like nests which are marvels of lightness, grace, and comfort. These dwellings—the cradles of their young—are so various in form that in order to convey a true idea of them it would be necessary to describe many different kinds. To give at once some indication of their variety, we need only say that the sides of the nest may in some cases be an inch or two in thickness, while in others they are so delicate that you would imagine the fine network woven out of spiders' webs, through which you can see the nestlings being fed.

The "Weaver-birds" (*Ploceidæ*) derive their name, of

THE GOLDEN WEAVER-BIRD

course, from this habit of actually *weaving* their nests out of fine branches, roots, and more especially of very flexible grasses. They interlace them in such a way that the whole structure is very firm, the materials in some cases being further united and consolidated by means of clay or the birds' saliva. The shape of the nest varies both according to the species and with the birds' individual taste, but it nearly always resembles to some extent a bag so suspended that the opening is directed either downwards or to one side. One well-known variety has been aptly compared to a stocking hung up by the toe, with the nest in the heel and the entrance through the leg.

Weaver birds are very common in Africa, and are represented also in Australia and some parts of Asia.

According to Brehm, the Golden Weaver-bird (*Ploceus galbula*), which is found in the Eastern Soudan, goes to work as follows. It begins by constructing a framework of long braids of grass, suspended from the end of a slender branch. This framework is a sketch in outline of the completed nest, the form of which can already be discerned, and when it is finished the walls receive attention, straws and grasses being woven in from above downwards, so as to form a water-tight roof; in one side, usually that which faces south, a little round hole is made. At this stage the nest resembles a cone with the point cut off, placed upon the half of a ball. The bird next directs its energies to the construction of an entrance corridor; starting from the round opening at the side, it weaves a long tube, which is firmly attached to the wall of the nest and hangs downwards, the entrance being at the lower end. The bird completes its labours by lining the interior with the finest and softest grass stems; very often, however, the work of construction goes on even after the eggs have been laid. Of these there are from three to five,

A LIVELY SPECTACLE

white or green in colour and speckled with brown. Heuglin accounts for this variety in colour by saying that the eggs when first laid are white, gradually turning to a reddish tint, and lastly becoming green.

The male bird is the actual craftsman, and he often commences a nest as if in anticipation, and at a time when he has no immediate use for it. On the other hand, the female, as far as could be ascertained, takes upon herself the entire care of brooding, but she is tended and fed in the most charming manner throughout this period by her mate.

During the nesting season a colony of these birds presents a very lively spectacle, especially when the young are hatched and growing up; scarcely a minute elapses without the arrival of one or other of the parents with supplies for the nestlings, and they cling to the lower part of the nest while they thrust in their heads to place the food in the hungry mouths of their greedy offspring. When the nests are numerous and placed closely together upon the tree, as they frequently are, the scene strongly suggests the activity of a hive of bees, for the birds are continually flying backwards and forwards, to and fro, with the appearance of incessant hurry and confusion.

The inside of every dwelling is furnished with a sort of special compartment or inner nest for the reception of the eggs.

The Golden-fronted Weaver-bird (*Oriolinus icterocephalus*) suspends to the branches of mangroves, or to the leaves of palms or cocoa trees, a nest composed of various flexible stems and grasses woven into the form of a chemist's retort, the rounded swelling of which constitutes the nest chamber proper. Sometimes the rounded part is double, and gives the structure a very singular appearance. Beside these large, bulky nests there are often others of a less elaborate

AN INDIAN WEAVER

form, which were at one time supposed to be the home of the male birds ; we now know, however, that they are merely half-finished dwellings. A great number of these nests are frequently found suspended from one tree, the branches of which are devoid of foliage—for the reason, doubtless, that the birds themselves strip off and eat the leaves ; perhaps they do so partly with the intention of permitting the sun to shine freely upon the nests and so assist by its warmth in the process of incubation.

The Baya (*Ploceus baya*), or common weaver-bird of India and Ceylon, is equally remarkable for the nest it makes. Jerdon has given us a very interesting account of the habits of this bird. Its food, he tells us, consists of seeds of various kinds, but more especially of rice ; it is popularly supposed to be an inveterate robber of fruit trees, but there is no reliable evidence in support of this belief, and its evil reputation appears to be quite undeserved. It is a cheery, good-humoured little bird, and even when at rest the whole colony keeps up a continual lively chirping. It is often on friendly terms with other birds, associating freely with sparrows.

The bayas breed during the rainy season, that is, sometime between April and September, according to the locality. Their long retort-shaped nests are hung from palms or other trees, and are usually attached to branches which overhang a stream. In India this rule appears to be without an exception ; but in Burmah they are often suspended from the eaves of houses, as many as twenty or thirty in a row ; and on one occasion Jerdon observed a colony of more than a hundred nests all attached to one house. The bayas do not always seek human society in this manner, however ; in some parts of the country they seem just as anxious to shun the neighbourhood of man, and retire to the most secret and

THE BAYA'S FIREFLY LANTERN

inaccessible spots, or frequent solitary trees in the midst of outlying rice fields.

The baya's nest is made of various grasses, gathered while still green, or of strips of palm leaves. In the latter case the little craftsman appears to be quite well aware that he is using a material far stronger than grass and that a smaller quantity will suffice, for such nests are always less bulky than the others. There is, however, in all cases much variety in the form and appearance of the different dwellings. As soon as the chamber intended for the eggs is completed, the bird constructs a strong partition wall a little to one side, thus dividing off a second compartment which some naturalists have regarded as a special sanctum for the male bird, but which is in reality nothing more than an ante-chamber dividing the nursery from the entrance passage. This part of the nest is very firmly constructed, since it is destined to be used as a sitting-room by the parents and ultimately by a whole family of turbulent youngsters.

At first both birds work together at the construction of the nest, but when the ante-chamber is completed the hen retires to the inner compartment and gives the final touches to the home by weaving in fine grasses brought to her by the male bird, who for his part undertakes to finish the outside work.

This long and arduous task is followed by a period of comparative repose, in the course of which the bayas carry into their nest little lumps of clay, concerning the use of which many and varied opinions have been expressed. The natives say that fire-flies are fastened into the clay while it is still soft, like candles into a candlestick, for the purpose of illuminating the interior of the nest or of frightening away rats, snakes, and other enemies, on the same principle that hunters and explorers take care to keep their camp fire burning

NESTS OF THE BAYA WEAVER-BIRD

In India these birds usually suspend their nests from branches of palms or other trees which overhang a stream, and weight them with lumps of clay which prevent them swaying about at the mercy of the wind. The natives state that fireflies are fastened into the clay for the purpose of frightening away rats and snakes. The curious compound nest in the foreground is drawn from a specimen in the Natural History Museum at South Kensington.

THE BAYA'S FIREFLY LANTERN

brightly at night to scare away beasts of prey. This opinion has met with some support from competent European observers. Thus Mr. H. A. Severn writes in *Nature*: "I have been informed on safe authority that the Indian bottle-bird protects his nest at night by sticking several glow-beetles around the entrance by means of clay; and only a few days back an intimate friend of my own was watching three rats on a roof-rafter of his bungalow when a glow-fly lodged very close to them; the rats immediately scampered off." It must be borne in mind that the tropical fire-flies give out a brilliant light beside which the faint, soft glimmer produced by the glow-worms of our English lanes would be utterly insignificant. On the authority of M. Dutertre we learn that the earliest missionaries to the Antilles, having no oil for their lamps, would on occasion read matins by the illumination produced by fire-flies; and in more recent times we find the natives in South America fastening one of these insects, the cucujo, to their great toe to light them on their way at night and to protect their feet from snakes. Still, until we have more trustworthy evidence we had perhaps better not be too credulous concerning the baya's extraordinary sagacity in converting its nest into a lantern. Layard imagines that the bird sharpens his beak upon the clay; Burgess, that it is used to strengthen the structure of the nest. Others have suggested that the bird is born with the instinct of a collector, and that it finds pleasure in accumulating lumps of clay, just as the bower-birds delight in gathering together gaily coloured objects such as shells, bits of rag, pebbles, feathers, and even flowers.

But from the position in which the clay is placed, the manner in which it is distributed, and its mass (amounting to as much as half a pound in a single nest), it appears most probable that it serves merely as a means of steadying

THE BALTIMORE HANG-NEST

the structure and preventing it swaying about at the mercy of the wind.

The eggs of this weaver-bird are white, but as to their number there are many conflicting statements; some naturalists give two as the number in a 'clutch,' others as many as ten. It seems likely that two eggs commonly form a clutch, but that several females sometimes deposit their eggs in the same nest, like the anis and some other birds of sociable habits.

According to a native legend, whoever succeeds in opening a baya's nest without breaking a single straw will find inside a ball of gold; but as the nest is very compact, and cannot possibly be opened without considerable damage, nobody as yet has been so fortunate as to discover such a treasure!

One of the best-known weavers, though not a "weaver-bird" in the stricter sense, is the Baltimore Oriole, or Baltimore Hang-nest (*Icterus baltimore*), a bold, handsome bird with a melodious voice. As a craftsman it is peculiarly interesting, because it has learnt to adapt its nest to suit the climate of the particular region which it inhabits. Thus in the hot countries of the northern portion of South America it makes a nest entirely of lichens, which are woven very loosely together so that the air can circulate freely through the walls. The structure is placed where it will be sheltered from the midday sun, and the absence of any sort of lining contributes to the general coolness. In the Northern States, on the contrary, it is exposed fully to the rays of the sun, and is provided with closely woven lining of the finest and warmest materials.

The nest is pocket-shaped, and rather deeper than it is wide. It is hung by the rim at several points to some slender bough, and is very skilfully woven, mainly or entirely of vegetable substances which are picked up from the

A TOUGH MATERIAL

ground. In the nesting season these birds are apt to become somewhat troublesome in their eagerness to gather suitable materials, and the women of the country are obliged to keep a careful watch over the threads they put out to bleach, which are especially attractive to the little weavers.

The Cassiques (*Cassicinæ*) are almost as remarkable for their wonderful power of imitating various sounds as for their curious nests, which may be seen hanging in great numbers from the same tree, like fruit. Each nest is pocket-shaped, but very much longer than the Baltimore oriole's, and of a far looser texture. The walls, indeed, are so openly woven that it is often possible to discern the parent bird brooding or feeding the nestlings within the nest. They are composed of fibres and strips of bark, which the bird itself tears from the tree in a very curious fashion. It perches on a branch and pulls up a little tag of the outside bark with its beak; then, seizing the loose end, it flies with it to one side in a peculiar manner until it has succeeded in detaching a long strip. The nests are five or six inches in diameter, and often as much as three and four feet in length. The opening is in the upper part, and the same nest may be used, after trifling repairs, for several consecutive seasons, for though so loosely woven, the walls are very strong, and can only be torn open with the greatest difficulty.

A tree decked out with forty or more of these nests, with the large, handsome birds hurrying to and fro in noisy flight, presents as beautiful a picture as a naturalist could wish to see. The males spread their tails, half open their wings, and with lowered head and distended crop sound their curious call; but there are no cries of alarm, for they appear to be quite indifferent to observation.

The *Arachnocestra longirostris* (one of the birds known as

TAILOR-BIRDS

Spider-catchers), which frequents banana plantations, weaves its nest after a very different fashion. It is an oval structure about seven inches in length by five in width, but the cavity of the nest is shaped like the half of a pear cut lengthways. It is attached to the tip of one of the large pendulous banana leaves by cotton fibres piercing the leaf, which itself forms the hinder wall of the nest. A slit-like opening in the upper part gives access to the interior, and is placed so high that the brooding bird is quite hidden from sight. The lining is composed of dry leaves and fine fibres, with a few grass stalks; the outer wall is of similar but coarser materials, with the addition of a number of skeleton leaves, which are carefully collected by the bird, and give a fine web-like appearance to the structure.

The spider-catcher's habit of attaching its nest to a leaf in the manner described above brings us to one of the most interesting groups of 'craftsmen.' Of the many surprising things we meet with when studying animal industries, few are more wonderful than the craft of the sempster as practised by the tailor-birds, for with no other needle than their thin beak, these little creatures by sewing leaves together form bags or pouches to contain the actual nest.

The common Indian Tailor-bird (*Orthotomus sutorius*) is the most famous of the tribe, and it is found throughout the whole of India and Burmah, on hills and plains alike. It has a bright green back and a chestnut crown, and the under part of its body is white. The cock bird has two long feathers in the middle of his tail, but his mate is wanting in this mark of distinction. The curious nest, which is most often found about June or July, consists of a soft, deep cup contained in a pocket of leaves, sometimes high up a tree, but generally only a little distance from the ground. The outer covering is fastened together by threads which pass

THE INDIAN TAILOR-BIRD

This bird sews leaves together by their edges and thus makes a little pointed bag, in which a nest of cotton-wool and other soft materials is afterwards constructed.

MAKING BAGS

through holes near the edges of the leaves and are often knotted at the end to prevent them slipping out. Nobody knows exactly how the bird ties these knots so cleverly, or how it makes some of the threads which it uses for sewing, which are often composed of cobwebs or cotton—though various other materials are used, such as wool, silk from cocoons, and vegetable fibre of many kinds. As you might expect, the tailor-birds are not all equally skilled in their craft, and there is a great difference in the quality of the work done by different individuals; one bird will sew his leaves together neatly from stalk to tip, while another seems to have put the stitches in at haphazard, just anyhow, without any care at all for appearances. The number of leaves used in making a nest is not always the same in every case, but two or three, arising from the same point on the branch, are generally employed. The bird sews them together by the edges, lengthways, so that they form a little pointed bag, like the end of a knitted purse such as our great-grandfathers used. He appears to bring the margins of two leaves together with the aid of his claws and beak, and after piercing them with the latter, to pass the thread through the hole and pull it tight; the process is then repeated until the thread, which is usually rather short and only suffices for two or three stitches, is used up, whereupon he takes another piece and starts afresh. Inside the bag the real nest is constructed of fine cotton-wool and other soft materials, to which the bird adds a few horsehairs or very fine grass stems to keep everything in place. When finished it is about two and a half inches deep inside, and may contain three or four white or bluish-green eggs with reddish-brown spots, mostly collected about the larger end.

Besides the tailor-birds proper, there is in India and Ceylon another species which practises the same craft. This

ANOTHER TAILOR-MADE NEST

bird is the Rufous Fantail Warbler (*Cisticola cursitans*), and it appears to be identical with a bird called *Cisticola schænicola* which is found in the south of Europe. In India, the little *Cisticola* makes its home in the paddy fields or in guinea-grass plots about bungalows, choosing for its location a patch of fine-stemmed grass about two feet in height. In the midst of this tuft the bird begins to construct its nest by sewing together stems and blades of the grass as it grows, and at no great height above the ground, with cobwebs and delicate vegetable fibre. It thus makes a kind of tube two or three inches long and about an inch and a half across the inside, and this is afterwards converted into a pouch by the addition of a bottom, which the bird constructs by bending a few of the grass blades across and fastening them together with fine threads as before. Towards the top of one side the stems are left loose so that the bird can pass in and out of the nest. This framework or sheath is finished in one or two days; a neat little lining of fine strips torn from grass leaves is then added, and the whole of the interior is carefully filled with silky down plastered together with the bird's saliva. The eggs vary both in number and colour, but usually there are from two to four.

If we were asked to name among nature's products some material remarkable for its lightness and warmth, and for delicacy and softness of texture, probably one of the first we should think of would be cotton, by which, of course, we mean cotton-wool. That being so, it would seem to be peculiarly well adapted to form a lining for the nests of birds, and yet when we come to inquire into the matter it is surprising to find how few of them make use of this substance. Scarcely any birds think of constructing a nest entirely of cotton, although it is an ideal material from which to make a luxurious bed.

A NEGLECTED INDUSTRY

In England that is easy enough to understand, for it is only on a few plants that hairs or down are developed to any considerable extent, and it would be a very troublesome matter to gather a sufficient quantity of these materials; but in warmer climates such plants are far more common, and there are some kinds which appear quite white from the thick growth of down with which they are completely covered. Under such circumstances the only explanation which seems to account for birds avoiding its use is the difficulty of joining these fine and delicate threads together to form a structure strong enough for their needs: they are too smooth to form a substantial felt-work in the same way as hair or wool.

There are, however, in warm countries a few birds which specialize in the use of cotton either by itself or mingled with other materials for the sake of rigidity.

The birds which engage most largely in the cotton industry are the Humming-birds (*Trochili*). They make little gems of nests, using chiefly the down of plants, mixed or covered with mosses or soft lichens and spiders' webs. These nests, says Burmeister, "all resemble one another so closely that it seems to me useless to give a separate description of each kind, notwithstanding a slight difference in the choice of materials. Such differences must be regarded as purely local, depending merely upon the materials which the bird finds at hand. The groundwork consists of a layer of cottony substances, mingled with lichens, blades of fine grass, and the scales of ferns; all these substances, or one only, may be found in a single nest. The lichens are of various kinds, and each humming-bird seems to have its own favourite species.

"The most curious nest of all is that of the *Phætotornis*, which ends at the bottom in a long point and is made of sprigs of moss, bound together with orchela lichen (dyer's

BIRDS GLUED TO THE NEST

moss), the whole presenting a very beautiful appearance. But that is not all. The warmth developed during incubation causes the lichens to set free their colouring matter, with the result that the eggs are dyed a lovely carmine colour. The tint is wonderfully even all over; there are no spots, no darker patches, and yet the lichens do not completely cover the eggs; they are disposed horizontally among the mosses, and in contact with one side only."

There are a few other birds which use cotton alone without any admixture whatever, and gum the filaments together with their saliva.

The Dwarf Swift (*Cypselus parvus*) is one of these, and it nests in a peculiar manner. Brehm states that during one September, when he was travelling in the vicinity of the Blue Nile, he was attracted by the cries of a great number of these birds, circling around a group of tall palm trees. His curiosity was aroused, so he went nearer and then perceived some little white objects attached to the green palm leaves, on which the swifts settled from time to time. Wondering what they might be, he climbed one of the trees, and was astonished to find that they were nests of a very singular kind. They were shaped like the bowl of a deep ladle and measured two and a half inches across. The palm leaf itself, hanging straight down, formed the back of the nest, the sides and bottom of which were composed of cotton-wool stuck together with saliva and glued against the surface of the leaf, beside the middle stalk, by the same means.

Not only is the nest attached to the leaf in this way; the parent bird takes the precaution of fastening its eggs, and even the young birds, to the nest in a similar manner, so that they cannot fall out when the leaf is violently shaken by a strong wind.

Two pure white eggs are laid and are placed in the nest end upwards—a position which is extremely uncommon.

CHAPTER XXI

CLOTHIERS

The hairless caterpillars—A delicate race—Self-preservation—The clothes-moths family—The importance of clothing—"Robbing Peter to clothe Paul"—Style of garments—A leafy robe—Careful feeding—An interesting experiment—A disconcerted caterpillar—Making the best of it—Cutting out a new garment—Making the seams—Silken linings—A curious pattern—Furbelows—A modern "Psyche"—Inhabitants of a pear tree—Robes of silk—Doublet and cape—Elaborate materials—The housewife's pest—An elusive intruder—Silk and shoddy—Lengthening a garment—*Volte face*—'Letting out' a garment—Motley—Colour preferences—The white-robed infant—Going into retreat—Caddis-cases—Coat of mail—The strangest garment of all—Eviction without violence—Fancy dress—How to secure a perfect fit—Careful adjustments—Strictly utilitarian—Barricades—'Housebuilder' moths—A complete outfit—Disguises—A living fleece—Accident or intention?—A popular material—*Trop de zèle*—Instinct at fault?—*Dorippe* and *Dromia*—Compulsory patriotism—The result of habit—Sea-urchins and their clothing—An unappreciated race—Timid beauties—Uncommon methods—A waterproof garment.

THERE are few animals whose bodily structure affords them less protection against the inclemency of the weather or the attacks of foes than that of the smooth caterpillars. Naked and unarmed, their extreme vulnerability places them at the mercy of numerous enemies and—fortunately for the rest of the world—countless millions perish every year, unable to offer even passive resistance when attacked. Their enormous number gives some chance of survival to the individual, whose only hope, except for this fact,

THE CLOTHES-MOTHS FAMILY

usually lies in concealment. Hence we find caterpillars lying hidden on the under side of leaves ; developing protective colouring, so that they are inconspicuous by being in harmony with their surroundings ; burrowing amongst the food on which they live ; or even tunnelling into its substance and thus escaping observation. We shall see that some species have acquired considerable skill in rolling and folding single leaves, or binding several leaves together with silken threads, and thus constructing habitations for themselves in which they pass their lives.

Besides these, however, there is another class of craftsmen amongst the caterpillars, the members of which are remarkable for making little sheaths or garments for the protection of their bodies. The most notable of these are found in the vast family of moths called *Tineidæ*.

The caterpillars of most of the *Tineidæ* share the common habit of dwelling upon plants, but there are—unfortunately so in the opinion of humanity in general—some few species which have acquired a taste for animal food, to the great detriment of furs, tapestries, carpets, clothing, leather, and so forth. The *Tineidæ* are the family of “clothes-moths” in more senses than one.

The moths themselves are all of small size, but many of them, unlike the too familiar little grey or silvery clothes-moths, are endowed with very beautiful colouring which often shows a metallic lustre. When examined under a lens some of them appear extremely gorgeous and are amongst the most brilliant of living creatures. In another group known as *Adela*, many of the males have antennæ of enormous length, like silken threads, which look very distinguished but incommode the insects not a little when flying.

Now the clothes-making caterpillars attach a great deal of importance to the possession of a garment. It is their first

“ROB PETER TO CLOTHE PAUL”

concern when they are born, and their chief care all through life, for there is much truth in Pliny's remark, with reference to clothes-moths, that they will die of hunger rather than feed unprotected. They are as punctilious in the matter as the greatest dandy ; but with them it is a question of self-preservation.

When but recently emerged from the egg, the little caterpillar makes its covering of silk, the product of its own body ; but it soon begins to look about for some material at once less conspicuous and less extravagant. Like most animals, it shows a ready adaptability to the circumstances into which it is born, and it takes whatever material there may be at hand. Thus the leaf-dwellers garb themselves like wood-fairies in garments of leaves ; those which find themselves upon our old coats “rob Peter to clothe Paul,” as an ancient saying has it, and make themselves warm wrappers of wool ; while they who are born to the ermine are content to wear robes of fur.

We will first consider the leaf-dwellers, whose home is upon various trees, such as the oak and elm, apple, pear, and thorn. These caterpillars are very tiny, scarcely discernible when first hatched, and seldom exceeding half an inch in length ; and as their garments are correspondingly small they may readily be overlooked, or mistaken by the inexperienced for scales which have been cast off by an opening bud, their colour being the same as that of a dead leaf of the tree upon which they are found. The caterpillar is usually entirely hidden, and you might very well be unaware of its presence if it were not for the occasional movements of its garment. The latter is long and narrow, as you would expect it to be on account of the form of its owner ; but the shape is not in all cases the same. Indeed, these garments exhibit considerable variety in style ; they may, how-

A LEAFY ROBE

ever, be divided roughly into two main types—those which are more or less cylindrical, and those which, as Réaumur pointed out, are rather like a gold fish, having a fin-like frill along one side, and a flattened end where the fish's tail would be. What we may call the front end of the garment is nearly always curved, so that the round opening does not look in a straight forward direction, but towards one side—that side, namely, which is turned towards the leaf, and which corresponds to the under side of the caterpillar.

Now if you take one of these tiny garments—one, let us say, fashioned by a *Tinea* which makes its home upon elm trees—and examine it carefully with a magnifying glass, you will not have much difficulty in deciding that it really is made of a bit of leaf; you can perceive the same kind of network as that which is formed by the fine veins of the leaf itself, and other similar indications. But it is not so easy to imagine how it has been formed, for a leaf is a stubborn thing for so small a creature to shape and mould, and the little garment is fashioned and joined with the utmost neatness and delicacy. We can only solve a problem of this kind by closely observing the animal itself and studying its ways.

Dwelling on the under surface of a leaf, the caterpillar can retire at will into its cloak and thus be entirely concealed from sight; and under ordinary circumstances it always does so when not actually engaged in eating or in changing its pasturage. Even when moving about from one part of the leaf to another only its head and a small portion of the front of its body are extruded, the rest remaining within the garment, which it carries about as a snail carries its shell—not lying flat against the surface of the leaf, but sticking out at an angle, which varies in different cases according to the extent to which the front end of it is curved out of the straight. The caterpillar obtains its food, of course, from

AN INTERESTING EXPERIMENT

the leaf substance, but it does not bite through the entire thickness like its larger brethren. A silkworm, for instance, will devour a small lettuce leaf until nothing of the soft parts remains ; a cabbage which has been attacked by the larvæ of the common "garden white" butterfly is often reduced to a mere skeleton ; but the little *Tinea* caterpillar acts quite differently. Having chosen its pasturage, it bites through the membrane covering the leaf and proceeds to eat its way into the soft substance within, leaving the outer covering of the leaf intact but for the minute opening through which its entrance was effected. As its meal—or series of meals—progresses, the caterpillar extends its body further and further into the leaf, until only the extreme end of it remains within the garment, which all the while rests, of course, on the outside of the leaf. Now you would suppose that, in its eagerness to reach more food, the caterpillar might, in a moment of forgetfulness or by some accident, lose its hold upon the little cloak and permit it to fall to the ground. To guard against the occurrence of anything so inconvenient, however, it takes the precaution of connecting garment and leaf together by means of a few silk threads spun around the opening. It then proceeds to eat its way into the leaf substance, and as the green pulp is devoured its movements can be seen quite clearly through the thin, transparent membrane which stretches unbroken over the surface. In this ingenious way it contrives to keep its body entirely under cover all the while it is eating.

On the slightest alarm the caterpillar withdraws hurriedly into its cell ; but supposing we watch our opportunity and, choosing a moment when it has mined some distance into the leaf and is busily feeding, quickly remove the little cloak before its owner can regain possession of it, what will the caterpillar do then ? This simple experiment has been per-

A DISCONCERTED CATERPILLAR

formed by many naturalists, from Réaumur downwards, with the object of compelling the caterpillar, if possible, to make itself another garment. It is the only way of discovering the secret of its industry, and you may think it worth while to observe the process for yourself, as we have done. Usually what happens is this. First of all the caterpillar feels about vaguely in all directions for its missing property, and then, not finding it, draws as much of its person as there is room for into the cavity of the leaf. If removed and placed upon a fresh leaf, it wanders over the surface as though making a careful search, and at last appears to make up its mind to replace the stolen garment by a new one. Now let us observe the little creature very closely ; to see the nature of its various movements satisfactorily, however, a fairly strong lens will be required.

Its first proceeding is to begin to eat its way into the leaf, leaving, as before, the outside membrane intact except at the point of entry. Its great concern is to get under cover, yet this takes some time, for all the material which has to be dug out is swallowed, and not merely excavated and cast out of the way. In this respect the mining of a *Tinea* larva differs from that of various other animals we have described, such as the ants and trap-door spiders, and resembles rather the burrowing of an earth-worm. Having at last fairly eaten its way under cover, that is to say, between the membranes of the leaf, its subsequent proceedings are of a very interesting nature, for it begins to fashion a new garment. Now if a plain tube, straight from end to end, would meet its requirements, this would be a simple matter ; but as we have already seen, there is a peculiar curvature to be allowed for at one end, and in addition to this—a point we have not hitherto mentioned—the hinder part of the tube is usually almost twice the width of the front portion. The garment

MAKING A NEW GARMENT

has therefore to be cut out on a very elaborate pattern, and Réaumur remarks that the curvatures are as complex and difficult to imitate as those of the pieces of cloth which compose the back of a coat. The caterpillar's 'new suit' is, however, made to fit very loosely; it allows for growth, and as its bearer is an excellent contortionist, we cannot suppose that the exact curvature is a matter of great importance so long as the general shape is satisfactory. Its cloth consists of the thin leaf membrane, and using its 'jaws' as scissors, it sets to work industriously to separate two pieces which, being joined together above and below, will compose a garment of the required form. There is no difficulty about making both pieces equal in size and similar in shape, for they appear always to be cut out both at the same time; but how are they joined along the edges? The caterpillar undoubtedly uses silk for this purpose; but all observers are not agreed as to whether it makes the seam—which is so wonderfully neat that it is not easy to detect even with the aid of a lens—before or after the little pieces of membrane are separated from the leaf. However that may be, it is certain that the edges are stuck together with tolerable firmness from the first; to me it appeared that the caterpillar had previously fastened them here and there with little ties of silk, on the same principle that a seamstress runs together two pieces of cloth before making a seam.¹ Our little workman then gives the garment the necessary roundness by moving about within it, pressing out the sides and, where needful, opening them out and smoothing them with his head. When the moulding is completed, it adds a lining of silk which strengthens the whole structure and makes it opaque. Its task is then at an end, and it is free to walk away in its new garment to another part of the leaf, where it anchors it to the surface and once more devotes its whole energies to feeding.

¹ J. L.

A MODERN PSYCHE

As to the garments which bear such a curious resemblance to minute fishes, we cannot do better than quote the following remarks by those famous entomologists, Kirby and Spence: "Some of this tribe, whose proceedings I had the pleasure of witnessing a short time since upon the alders in the Hull Botanic Garden, more ingenious than their brethren, and willing to save the labour of sewing up two seams in their dwelling, insinuate themselves near the edge of a leaf instead of in its middle. Here they form their excavation, mining into the very *crenatures* between the two surfaces of the leaf, which, being joined together at the edge, there form one seam of the case, and from their dentated figure give it a very singular appearance, not unlike that of some fishes which have fins upon their backs." In other respects these garments are made in the same way as those we have already described.

The cloak of another species of caterpillar which lives upon a kind of *Astragalus* has several pieces of leaf membrane overlapping each other at the front end in such a way that the garment resembles the furbelows which were once in fashion.

The whole process of preparing the cloth, cutting out, moulding, and lining a garment occupies the caterpillar about half a day—a considerable portion of its brief life.

The larvæ of another family of moths, distinguished under the name of *Psyche*, also make clothes for themselves, but of a rougher build than the garments of the *Tineidæ*. One of them, *Psyche graminella*, which lives on grasses, cuts out little square pieces of grass leaves and fastens them on its coat by one end only, so that they overlap one another like the tiles of a house.

So far we have only spoken of garments made chiefly of material cut from leaves and with a silken lining; but some

DOUBLET AND CAPE

of the *Tineidæ* make their clothes entirely of silk. There is, for instance, a small brown moth with long hind legs (*Phalæna Tinea serratella*) whose larva has this extravagant habit. Its abode is on pear trees, and if you examine the leaves fairly early in the spring you are pretty sure to find some with little brownish objects sticking straight out from the under surface. They are very tiny, seldom more than a quarter of an inch long, and no thicker than a stout pin, so that you would hardly suspect that every one of them contains a caterpillar; yet such is the case, and if you carefully remove one and squeeze it very gently you will see the grub emerge from the end. Sometimes these insects are very numerous, and then the leaves of the pear trees become covered with minute withered specks, for in feeding, the caterpillars fix their garment upright upon the leaf with silken threads and then eat the pulp of that portion which is immediately beneath the opening—no more; having exhausted the supply in one spot, they move on to another and thus produce the characteristic speckled appearance of the leaf.

The silken garments made by some of the *Tineidæ* have a peculiar shape, much like that of a shepherd's crook. A curious feature about them is that the bent portion, which is at the hinder end, is split down the middle, so that the two halves of it can be forced open in case of necessity and afterwards spring together again by their own elasticity.

Some larvæ, such as that of *Tinea palliatella*, are not content with a single covering, but appear to want an overcoat as well, for they attach to their silken doublet a voluminous cape of the same material, open on one side, and not unlike an Italian cloak. The young caterpillars have quite short capes, but those which are almost full grown wear them very long, reaching, not to their heels, but to their head, for the

THE HOUSEWIFE'S PEST

cloaks are put on the reverse way to that you would expect. A very remarkable thing about these cloaks is that instead of the silk being woven smoothly and evenly into one uniform tissue, it is formed into minute transparent scales arranged like those of a fish, and when the caterpillar wishes to enlarge its cloak it adds a few fresh scales to the edge.

Larvæ which clothe themselves in silk cannot afford to cast aside their garments when they outgrow them, for the material is produced from the animal's own body, and frequent renewal would be too expensive a process. In order to avoid such needless and ruinous expenditure, the caterpillar proceeds to let out its jacket when it becomes too small, in a very skilful manner. We shall describe exactly how this is done when speaking of the clothes-moths proper, which constantly practise a similar economy.

It is not one particular kind of moth that is responsible for the destruction of clothing, furs, and furniture; the larvæ of several species are equally mischievous. The moths themselves are incapable of injuring the most delicate fabric, but the housewife is right in waging war against them all the same, because their serious business in life is to deposit their eggs where the larvæ will find an abundant supply of food—that is to say, from our point of view, where they will do an abundant amount of damage. The moths are well fitted for carrying out their purpose, for they are so small and slender that they can dispense with open doors—a minute chink or a keyhole is all they need to effect an entry into our wardrobes and drawers. Once inside it is a difficult matter to get rid of them, for they can lie hidden in the smallest crannies, and are so active that even when disturbed they elude pursuit and disappear in a moment into some fresh fold or crevice.

The lesser clothes-moth (*Tinea pellionella*) is a typical representative of its family. The caterpillars are of course

AN IDEAL FABRIC

born naked, but they are very well able to look after themselves, for they begin at once to provide themselves with garments to cover their tender, unprotected bodies. There is nothing elaborate about the shape of their clothes, which are always made in the form of a tiny tube open at both ends, and usually a little wider towards the middle. The tube is made of wool cut from our furniture or clothes and artfully woven with silk into a stout felt-like cloth, the inside of which is finished off with a soft lining of pure silk. This little caterpillar seems to have surpassed us in inventing an ideal material for clothing: a material composed of wool outside and silk within—the perfect combination for affording warmth and comfort! The colour of its garment is the same as that of the stuff from which it is taken.

Now the caterpillar wears the same coat all its life, and as it is made to fit its body when it is quite young, it of course requires enlarging from time to time. This is accomplished very cleverly. If the garment merely requires lengthening it is a simple matter, for all that is needful is to add a ring of similar material to each end. You may see the little occupant looking around for suitable hairs or filaments of wool, selecting one here and there, cutting it off, and applying it to the end of the tube, where it is fixed in place with fine fibres of silk. After attaching a few fresh hairs to one end, the caterpillar withdraws into its tube and a moment afterwards its head appears at the opposite end. This manoeuvre is executed so rapidly that it is quite startling; it almost appears that the creature has two heads, one at each end of its body! The same process of addition is gone through again, and the tube is thus lengthened at both ends.

But the caterpillar does not only grow in length; with advancing age it becomes fatter, and its coat grows too tight. That is a more serious affair, for the coat will not stretch.

‘LETTING OUT’ A GARMENT

What is to be done? Clearly there is but one plan to adopt, and the caterpillar not only carries it out, but does so in the best possible way.

The remedy is obviously to slit the garment down the sides and insert new pieces of the requisite size. This is done very neatly; a clean cut is made—that is to say, the material is bitten through in a straight line—and the new piece is added. The larva carefully avoids cutting open the case from end to end all at one time, however, for the edges might become displaced too far, and the occupant would be too much exposed. It therefore slits only one-half of one side at a time, and when the opening has been filled up, proceeds to divide the other half, or a half of the opposite side, and so on, until the enlargement has been completed in four separate operations.

Now we have already said that the garment has the same colour as that of the stuff from which its material is taken. Thus a caterpillar living upon red cloth will have a red coat. If it be removed and placed on a piece of green cloth, then on the next enlargement the rings at each end and the two strips at the sides will be green. By placing it at various times on cloth of different colours the larva can be made to wear a harlequin garment of many hues, which will show very clearly the form and extent of successive enlargements. This happens not infrequently in the natural course of events, as the caterpillar moves about from one place to another on a multi-coloured cloth. There is another curious point about these cases which is worth mentioning. We may often be surprised to find that a caterpillar has a garment of a certain colour, although there are clear indications that it has been obtained from cloth of a different tint. Thus one which lives on grey or brown cloth may have bands of pure blue or red in its coat. But on looking very closely

CADDIS-FLIES

at the brown or grey cloth you will find that it is made of wool of various colours woven together. It seems, then, that the caterpillar has displayed a preference for some particular tint, and has carefully picked out hairs of that one colour in making or enlarging its garment. According to Réaumur, the very youngest grubs often choose only those filaments which have not taken the dye at all, or have been left white; at any rate, minute white-robed larvæ are not uncommonly found on dyed stuffs of different sorts.

When the time comes for retiring awhile from active life and entering the chrysalis stage, the creature seeks for some firmer, more fixed support than that offered by the loose materials on which it has wandered as a caterpillar. Some choose the angle of a wall, others the ceiling, or the under side of a shelf, where they fix their tube either by one end or both, and at almost any angle; then after sealing up the openings with silken web they remain quiescent until they turn into moths.

If you look closely into any clear and shallow stream or pool of water in which plants are growing, you will almost certainly see moving about the bottom a number of small, oblong masses which seem to be alive and yet are apparently made of bits of stick, stones, sand, straw, and other débris. They are strange-looking objects, and at first one is puzzled to imagine what they may be, until the secret of their movement is revealed and one notices the heads and legs of a small insect protruding from the end of each.

The curious little masses are "caddis-cases," and the inhabitants, called "Caddis-worms," are very well known to anglers, who frequently use them as bait. They are not true worms, but the larvæ of a tribe of four-winged insects, the Caddis-flies. These flies are dull-coloured insects, usually brown or grey, with long, slender legs and antennæ. They

COAT OF MAIL

are of moderate size, the largest British species measuring only about an inch and a half across the wings, and in appearance and structure they bear much resemblance to certain moths, especially to the *Tineidæ*. Their wings, however, instead of being covered with scales like those of a moth, are clothed with hair, and on that account the order to which these insects belong is called the *Trichoptera*, or hairy-winged insects. When the fly is at rest its hind wings are folded like fans, close to the body, and the front wings cover them over like a roof. Like many moths, they are most active in the evening and are then attracted by light, so that in the summer-time they often enter houses at night by the open windows.

The larva has a long body which is divided, like that of a caterpillar, into a number of segments. The first three of these, to which the legs are attached, are hard and of a brownish colour, but the others are of a very delicate nature, soft, white, and translucent; to protect them from injury, therefore, the caddis-worm surrounds itself with a stout garment or case. These cases are in the form of little cylinders, open at both ends, and covered with all sorts of materials. Some larvæ seem to gather together whatever comes handiest and to make their cases quite roughly of bits of stick and stone, shells, sand, leaves, or straw, all fastened on without any attempt at arrangement; but others select their materials very carefully and build them up with great neatness and skill. The substances employed are very various, and depend not only on the particular species of the larva, but also on the circumstances in which it finds itself. Perhaps the commonest kind of case is one made of numerous short pieces of stick, straw, or grass stem, all placed transversely. Some larvæ employ four or five pieces of grass blade cemented together into a

THE STRANGEST GARMENT OF ALL

rectangular or polygonal case; others use bits of twigs and leaves cut into almost equal lengths and placed side by side in such a way that they form a ribbon-like spiral band passing round the case from end to end. Many prefer grains of sand, coarse or fine, and their cases are often fashioned with the most beautiful regularity into a graceful tapering horn-shape. Another species uses entire leaves and thus makes a case which is wide and flattened. Others build cases of small stones, which are fitted together very skillfully, and these are found more frequently in rapidly flowing streams—a fact which may be accounted for in two ways: it may either be for the reason that such streams more commonly have hard, stony beds than the sluggish or stagnant waters, or because the larva finds it necessary to make a heavy case which will not readily be swept away by the current. The strangest cases of all, however, are composed of shells of various small water snails, more especially of *Planorbis*, often with the living occupants still inside. Fastening a number of these around his body the larva drags them about with him at his pleasure, and as Réaumur remarks, it is a covering as singular as if a savage, instead of clothing himself with skins, should make a garment of living musk rats or other small animals (see illustration p. 250).

As the larva increases in size it is obliged to construct new and more spacious cases, for it has not the faculty, like the *Tinea* caterpillar, of enlarging its garment. Some larvæ invariably make their cases of the same materials, but others either display a varying fancy or are satisfied with any material that is most convenient, for the fashion of their garment varies with each successive change. They show a remarkable ability for adapting themselves to circumstances when the necessity arises, for a larva which has been accustomed all its life to make its cases of straw or leaves very

EVICTIOŒ WITHOUT VIOLENCE

soon learns to use little stones if placed in a vessel where it is provided with nothing else.

If you wish to see one of these little creatures making new clothes for itself, all you have to do is to remove it carefully from its tube and supply it with fresh material. If you try to remove it by pulling you are almost sure to do it serious injury, for it clings tightly to its garment with a pair of horny hooks at the end of its body and strongly resists any attempts to dislodge it. The best way is to push it gently from behind with the end of a match or a grass stem, and patiently coax it out without violence. Having removed the larva from its case, place it in a vessel of water together with a handful of small stones, clean gravel, splinters of sodden wood, or any similar material that your fancy may suggest. By supplying it with bits of coloured glass or other small glittering objects you can obtain very curious results. It is necessary, however, that the material should not be too small or too regular in shape; beads, for instance, are not regarded with favour by the little workman unless they are broken, and he always seems to prefer objects of a rough, angular form.

His task is to make a tube which is smooth inside and about as wide as an ordinary straw—a problem which seems to be one of no small difficulty with such roughly shaped materials to build from. His skill, however, is equal to his task. He begins by fastening two or three fragments together with threads of silk, and before long succeeds in making a sort of girdle round himself. Having fairly established a foundation in this manner, he constructs the rest of the case by adding further material to the front of it, remaining inside the growing garment all the while until it is completed. It is interesting to see how he examines whatever object he has selected, and turns it about on every side until he finds the best way to apply it to the structure.

CAREFUL ADJUSTMENTS

A point to which the larva pays special attention is the specific gravity of the case. Though he spends his whole life under water he is unable to swim, so it is essential that he should not be carried off his feet owing to the excessive buoyancy of his garment; on the other hand, if it were too heavy he would have difficulty in dragging it about with him. His object, therefore, is to hit upon a happy medium, and make a case which, being neither too light nor too heavy, can be moved about freely in the water with little effort. In order to compensate for defects in either direction we often find him fastening on a bit of stone as ballast, or a leaf or a fragment of wood to add to the buoyancy of the whole—an ingenious but strictly utilitarian proceeding, which frequently results in the disfigurement of an otherwise neat and symmetrical structure. I have in my possession a case to the upper side of which its occupant had attached a grass-stem over five inches in length, an arrangement which must have caused him considerable inconvenience when moving about the uneven bed of the stream from which he was taken.¹

The inside of the tube is smoothly lined with silk, and before entering the pupal stage many caddis-worms spin a sieve-like plate of the same material across each opening of the case; this arrangement permits constant renewal of the water necessary for breathing, but affords them some protection against their enemies, to whose attacks they would be especially liable during that helpless period of their life-history. Other species place small stones loosely over the openings, with a similar object.

We will now return for a moment to the caterpillars. Others besides those of the *Tineidæ* clothe themselves, and of these we have already mentioned the larvæ of the moths of the genus *Psyche*; but the most interesting are those of

¹ J. L.

A LIVING FLEECE

the *Oiketicus* (or house-builder) genus. Many of the structures made by the *Oiketici* look very much like giant caddis-cases hanging in a tree. A very remarkable suit of clothes is made by one species. It consists—starting from the outside—of a complete mantle of greyish silk, covering a regular coat of mail composed of a multitude of leaf-stems and bits of stick, the ends of which project on all sides and show through the silken mantle. Under the armour there is a jacket made of leaves cut into little pieces, and last of all, next to the body of the caterpillar, a silken lining, which we may call its shirt. Protected by these four wrappings, the caterpillar clings to a leaf by its feet, ready at any time, if alarmed, to bury its head in its clothes and wait until the danger is past, with the comfortable conviction that not even the tip of its nose is visible.

We find some indications of the making of garments—primitive clothing which we may regard as the product of the first rudiments of this industry—in several other instances, but it is not always very apparent that the animal's will enters into the matter to any great extent.

Amongst the crabs, for example, there is a tribe called *Oxyrhyncha*, which includes the Thornback and Spider-crabs, some of which are found on our own coasts. These animals are remarkable for their untidy appearance, their shells being often covered with a dense growth of all sorts of algæ and hydroids, to such an extent that it is sometimes very difficult to detect them under their disguise. Such a covering not only forms an efficient protection to the animal by concealing its presence, but is no doubt of great service to it when it goes a-hunting, by preventing it from being recognized except at close quarters. Seen but dimly under its living fleece, the crab may easily be mistaken for a fragment of rock amongst the surrounding stones. Such being the case, the interesting question arises as to how far these advantages are the result

A POPULAR MATERIAL

of chance and how far they are due to active intervention. At first sight the animal appears to play merely a passive part; it seems as though protection had been forced upon it and that it had no choice in the matter. Careful observation has proved, however, that the crab is the master, and not the slave, of its strange roof garden.

The carapace in this family is usually covered with rough spines, tubercles, or hooked hairs, while the pincers are very flexible—two facts of great importance to the animal in its manœuvres. Some examples of *Hyas* were stripped of their covering and placed in an aquarium, upon a layer of sponge. They appeared to be much disturbed by their exposure; but in a short time they began to tear off fragments of sponge with their pincers and to place the pieces upon their backs, applying them with a rubbing movement until they remained in position, so that at last their disguise was complete. Others were provided with algæ and various zoophytes instead of sponge, and they behaved in a similar manner. Sponge clothing, however, seemed to be regarded with most favour, for it is stated that specimens clad in seaweed stripped off their covering in order to exchange it for a coat of sponge.

Speaking of another of these crabs, *Maia*, M. Houssay states that when the algæ which flourish upon its back become inconveniently long and interfere with the freedom of its movements, the crab tears them off with its claws, shred by shred, until it is stripped clean. It then finds, however, that it has been rather too zealous, for being quite naked it can be distinguished too easily from surrounding objects; so it attempts to remedy the defect by taking up some bits of weed and planting them out like ‘cuttings’ upon its back, where in a short time they take root and produce a new growth.

DORIPPE AND DROMIA

The culture, then, is clearly intentional, for the crab exercises control over it, interferes when it is necessary to do so, and even takes steps to acquire a growth when none is present. It shows a preference for one sort of covering rather than another ; but there we reach the limit of its intelligence in the matter, for it will as readily plant out paper upon its carapace as sponge or seaweed, if it finds nothing else at hand. Through successive generations these crabs have acquired the instinct or habit of covering themselves, and we cannot help recognizing a certain amount of ingenuity in the means they adopt for their concealment.

The thornback and spider-crabs are not the only members of their race which have developed this instinct ; others that behave in a similar way are *Dorippe* and the common *Dromia*, but the means they adopt are different. *Dromia*, for instance, seizes a large sponge and places it upon its carapace, where the object is held in place not by hooks, spines, or hairs, but by the two hind pairs of limbs, which constantly grip it and keep it firmly in position. The sponge continues to live and grow, so that in course of time it completely covers the carapace of its proprietor ; but the two beings seem never to be definitely attached to each other, and a heavy wave may divide them at any time. No sooner are they separated, however, than the crab scrambles after its precious covering and restores it to its place. A story is related of a *Maia* which was a favourite pet in the Concarneau laboratory. A little white cloak with the arms of Brittany worked upon it was made for this animal, and he caused great amusement by putting on his fine overcoat when all his other clothes were taken away from him.

The long-established habit of clinging to their garments has produced a curious effect on the structure of the *Dromia* and *Dorippe*, in which the four posterior legs have become

SEA-URCHINS

strangely modified. They are quite small, and grow upwards over the animal's back, so that they are no longer of any service for walking or swimming, but beautifully adapted for holding a sponge or other covering firmly in its place. If you could imagine a race of men whose well-being depended on them keeping always on their heads ill-fitting, awkwardly shaped hats, constantly liable to be knocked or blown off unless held in place, and if you supposed that those individuals fared best who always took great care to hold their hats on, and that gradually one arm, in this queer race of people, came to grow upwards instead of hanging down from the shoulder, and became quite small and of no use whatever for anything except holding their hats on, you would have a pretty fair idea of what has happened in the case of the *Dromia* crabs.

It is surprising enough to find crabs putting on clothes, but it is still more astonishing to learn that those queer, hard, unyielding, bulbous, thorny creatures the Sea-urchins are also capable of personal adornment; as you find them sometimes lying on the seashore, cast up by the tide, inert globes apparently incapable of the slightest movement, you would as soon expect it of an egg. Yet the sea-urchin at home is by no means helpless or inert. If you happen to find a shell of one of these creatures empty and bleached, as you sometimes do find them, and hold it up to the light, you will see that it is pierced by a multitude of little holes arranged in bands. Through these holes, when the animal is alive, an equal number of feet can be protruded—what naturalists call *tube-feet*, things like slender 'feelers' with a sucker at the end. Now many sea-urchins walk about by means of these tube-feet, but some species prefer to move about on the tips of their spines, and they have in some instances found another use for their tube-feet. If you place one of the

AN UNAPPRECIATED RACE

urchins called *Strongylocentrotus* in an aquarium with bits of shell, seaweed, and pebbles, it will probably before long raise some of these things upon its back and hold them there by means of its tube-feet. There are urchins which clothe themselves all over—a most inappropriate thing for a sea-urchin to do!—in this manner, and are thus able, like the thornback crabs, to move about unobserved.

When speaking of the intelligence of insects one's thoughts naturally turn to the orderly industry and wonderful organization of the bee-hive or ant-hill, and to the constructive skill and ingenuity of wasps and other members of the Hymenoptera. We then recall the varied labours of caterpillars and "caddis-worms," and the gigantic structures built by termites. Beetles, on the other hand, occupy but a small place in the popular estimation; we are accustomed to regard them as dullards, poor creatures which sprawl helplessly in a dusty roadway, or force their clumsiness on our notice by an unpleasant way they have of coming into violent collision with our faces in the twilight of a summer evening. Such a reputation is quite undeserved, for these insects are constantly carrying out works that call for no small amount of ingenuity, and the fault lies in our powers of observation rather than in their skill. We have already seen how cleverly certain weevils roll up leaves into neat little cylinders, and what expert trappers the larvæ of the tiger-beetles have become; but in other respects besides these the activities of beetles are often of a high order, and we have now to give an example of their skill in the making of garments for their own protection whilst still in the soft, vulnerable grub stage of their existence.

It will suffice to mention two families in this connexion, the *Clythrina* and the *Cryptocephalina*. The *Clythrina* are beetles of massive build with rather elongated bodies, and wing-cases marked with black patches or bands on a coloured

TIMID BEAUTIES

ground. Our British species, *Clythra tridentata*, with long front legs, and *Clythra quadripunctata*, which has four black patches upon its back, occur in woods, but they are by no means common.

The *Cryptocephalina*, which look rather as though they had been beheaded, are brilliant, gay-coated little creatures, which are to be seen in fine weather during the hottest part of the day upon various trees, such as the hazel, oak, birch, or willow; that is to say, they may be seen upon the trees if you approach very cautiously and quietly, for these timid little beauties have a habit of dropping from their leafy perch and simulating death when disturbed, and as they often take alarm at the mere passing of a shadow, it is not always an easy matter to become acquainted with them. Now the larvæ of both *Clythra* and *Cryptocephalus* live in curious leathery cases, which they carry about with them as a snail carries its shell. When the larva is born, it finds a little thimble-shaped cap over one end of the egg from which it emerged, and it uses this as its first garment. In a certain sense it has no other garment all through life, for it never casts it off or leaves it for a moment; but the tiny thimble is barely large enough for its needs even in its early days, so it begins almost immediately to make it more roomy by adding fresh material to the edge. The material it uses is made by mixing earth with the glutinous excretion of its own body, and the larva moulds it with its jaws into a beautifully symmetrical form until, by repeated additions, the thimble-like structure comes to resemble a graceful amphora with an oblique opening, and with low sloping ridges symmetrically arranged on either side, marking the extent of each successive enlargement. In this case it lives. When it wants to walk about, it protrudes its head and the three leg-bearing segments of its body and, tilting the case upwards at an angle, marches slowly along under its swaying

A WATERPROOF GARMENT

burden. When alarmed it withdraws completely into the amphora, the aperture of which is closed by its flattened head. In course of time, as the grub grows fatter, it is clear that additions to the length of its case will hardly meet the situation; the garment must be let out. Its substance, however, is hard and unyielding, and it is not easy to see how this is to be accomplished; indeed, probably very few people would find a satisfactory solution of this difficult problem.

The way it is done is extremely ingenious and almost unique, though wasps adopt a similar proceeding in some instances in order to enlarge their nests. It consists merely in this: the larva takes the lining of its case and puts it outside; what was before the outer part then becoming the lining! Of course it cannot do all this at once; it removes it piecemeal, in tiny pellets, which are mixed with a little of the glutinous substance and spread thinly and evenly over the outer surface—so thinly and so evenly that the original slight grooving of the surface, which is scarcely more pronounced than the mark of the potter's thumb on an ancient vessel of clay, is never lost. The layer is spread from end to end, and, by reason of its great extensibility, the grub is able to carry out this process without at any time exposing its whole body. There is another point to be considered: if the case were constantly enlarged without any addition to the material of which it is composed, the walls would become proportionately thinner and weaker. Material, however, is always at hand, and fresh portions are added from time to time, as the need arises. The larva thus keeps a tough waterproof coat upon his back until, in the natural course of his development, he acquires the hard carapace which is characteristic of his race and is able to dispense with any artificial means of protection.

CHAPTER XXII

ROCK AND STONE BORERS

An arduous task—The piddock—An old problem in a new form—A natural file—Ways of boring—"Dogged does it"—The use of the file—Interesting evidence—Each for himself—Habits of limpets—More cave-dwellers.

TO bore a hole in hard rock is a difficult matter, or at least a matter which requires a large expenditure of energy and not a little patience. Even with the help of good tools, I imagine that you or I would find it by no means easy to make a neat, round hole, though only a few inches in depth, in any really hard stone such as granite; so you might very naturally suppose that an animal capable of accomplishing this feat must necessarily be exceptionally strong and perhaps more than ordinarily intelligent. It is a little surprising, then, to find that the stone-borers are neither remarkably powerful nor remarkably intelligent—that they are, in fact, comparatively lowly creatures of small size, and of a nature that appears at first glance but ill adapted to the work they have to do. The most notable of the rock-borers are what are popularly known as "shell-fish," those little animals with fleshy bodies enclosed in a shell which does not, so to speak, give them room to turn round, and with about as much brain development as a maggot. Yet, unlikely as it might appear to any one unacquainted with them, they contrive in some way to form deep cavities

THE PIDDOCK

in the solid rock, and even in the very hardest of rocks ; and it is our business now to try to understand how they perform this seemingly impossible task.

Most people who go to the seaside are familiar with the *Pholas*, or Piddock, the tips of whose double shell may be seen within the round opening of its hole in the rock, and there are probably few who have not attempted to pull it out of its snug retreat, only to find that the shell was too large to pass through the opening, and that it was therefore impossible to extract it without breaking the stone—or the shell. In other words, the crypt in which it lies is bottle-shaped and is almost filled by its occupant. The question as to how the *Pholas* ever got there rather resembles the problem of the apple in the dumpling, and, as Carlyle remarks, “there have been minds” to which that “presented insuperable difficulties.” It is of course pretty evident that the rock has not been formed round the living animal, however, so the only alternative is that the latter must have increased in size since its first entry into the rock ; which is precisely what has taken place.

The *Pholas* is a bivalve—a mollusc, that is to say, with a shell consisting of two parts connected by a hinge—though in the *Pholas* there is no true hinge. The shell is white and thin, hard but brittle, and is roughened or prickly on the outside, like a rather coarse file. The animal’s body is prolonged into a siphon, like that of its near relative the ship worm, but very much shorter. Many species are highly phosphorescent.

Now how does the *Pholas* make the flask-shaped crypt in which it lies ? For a long time it was thought that it did so by the secretion of some acid which gradually dissolved the rock, an explanation which would seem not improbable if only limestone or chalk were attacked. That, however, is

WAYS OF BORING

by no means the case, for no stone appears to be capable of resisting the entrance of the *Pholas*, which attacks limestone, granite, or gneiss, if not with equal ease, at all events with equal success. We must therefore seek some explanation which will apply to every kind of rock, and not to limestone alone, and we seem to find one in the peculiarly file-like surface of the shell and the behaviour of the animal at certain times. On some occasions a *Pholas* may be observed to contract its siphons, open its valves, and taking a purchase on the rock with its foot, to rub its shell to and fro against the walls of its crypt. Here again, however, we meet with a difficulty, for there are other rock-boring molluscs which have shells that are not at all like a file; the Date-shells (*Lithodomus*), for instance, have thin shells which are not only devoid of prickles, but are covered with a kind of yellowish-brown membrane, so that their smooth surface would be practically incapable of making any impression on the stone. In all probability the principal boring instrument, if not the only one, is the foot, which is far more powerful and effective than you would suppose it to be. It consists of a fleshy mass not unlike a tongue, and is composed of muscle which can be contracted and made quite firm on occasion. If you open the shell of a common freshwater mussel and take the foot between your finger and thumb, you will realize how hard a bivalve mollusc can make this organ. The surface appears to be absolutely smooth, but on examining it carefully under the microscope we find there a number of extremely small crystals, so that it rather resembles very fine glass-paper. By rubbing away for a great length of time with this living file the animal succeeds in wearing down the surface of the rock until it ends by piercing a deep hole in it. There is little doubt, however, that the *Pholas* takes advantage of its prickly shell by using

INTERESTING EVIDENCE

is as a file to enlarge its retreat and make room for its own growth.

The burrows of the rock-borers are peculiarly interesting on account of the evidence they furnish concerning changes which have taken place in the level of the coast at certain places on various occasions within historic times. At Puteoli there is a cliff the face of which is pierced at a height of nearly twenty feet above sea-level with a multitude of holes, the burrows of a species of *Lithodoma*, a member of the edible mussel family. On the small plain which lies between this cliff and the sea are the ruins of the temple of Serapis. Three tall columns of white marble are still standing, and these also are perforated in the same manner as the cliff. Now the temple was certainly built on dry land, so it is evident that at some time—perhaps about the end of the fourth century—there must have been a subsidence of the earth's crust at this spot, whereby the plain on which the building stands was plunged beneath the level of the sea to a depth of almost twenty feet, and that at a later period, probably in the sixteenth century about the time when Monte-Nuovo was formed, the surface was raised again to its present level.

Saxicava is another rock-borer, and is usually found in colonies which honeycomb the rocks with burrows which are sometimes six inches deep; but although this creature is gregarious in its habits, it does not seem to have much regard for the rights of its neighbours, for should it encounter any of the latter in its course through the rock, it does not hesitate to drill through them rather than turn aside from the direct line.

The common Limpet (*Patella*), whose tenacity in clinging to rocks and stones has become proverbial, at last produces at the spot which it has appropriated as its own a small

MORE CAVE-DWELLERS

hollow around which the edge of its shell fits closely to the surface of the stone. Few people are aware that when the tide is up these animals go on little expeditions in search of food, returning again to the same spot as the tide goes out again.

We have already had something to say concerning sea-urchins and their unexpected habit of decking themselves out for purposes of concealment with any unconsidered trifles they happen to come across. It is not less surprising that these queer creatures are capable of making cave dwellings for themselves—neat round holes in the solid rock, just large enough to lie in comfortably. The common Purple Sea-urchin (*Strongylocentrotus lividus*) is a well-known example, and is found in large colonies on various parts of our coasts, especially in Ireland. Like the Molluscs, they do not bore their holes by an acid secretion; but their structure being very different, they cannot adopt the same method as *Lithodoma* and its relatives. The sea-urchin has extremely hard teeth and sharp spines, and it is by the continuous movement of all these hard points that the rock is gradually cut away until a cavity of sufficient depth has been formed. Then when the waves wash over him, all the urchin has to do is to set his prickles firmly against the sides of the hollow and hold fast.

CHAPTER XXIII

‘CIGAR’ MANUFACTURERS

Superficial resemblances—Weevils—A brilliant family—Arm-chair observations—Preparing the leaf—A skilful operation—Subsequent proceedings—Tireless efforts—Sealing the edge—A mother’s forethought—A lazy partner—Vine weevils—Other methods—Leaf-rolling caterpillars—More arm-chair observations—How it is done—Applied mechanics—A simple model—Food and shelter—A serious pest—Leaf-folders.

THE industries of animals are nearly always directed, as we have seen, towards providing shelter or protection for themselves or their offspring, storing up food, or capturing prey—just as was the case amongst the primitive races of mankind, and is still the case with certain savage races of to-day. Beyond those we have named, animals have no other needs, and when we compare their activity with the more varied occupations of civilized man the similarity lies in very many cases not in the purpose of their labours, but in their general character, the means by which they are carried out, or in a certain superficial resemblance in the result.

When we speak of animals as ‘cigar’ makers, therefore, we mean no more than that they roll up leaves more or less into the form of a cylinder, rather like tobacco leaves are rolled in making a cigar or cheroot. This is done by certain insects and caterpillars—which, as everybody knows, are the larvæ of insects.

WEEVILS

The most remarkable exponents of this industry are found amongst the Weevils—those little beetles which are such a pest to fruit-growers and agriculturists on account of the enormous amount of damage they are responsible for. They vary considerably in shape and appearance, but you will seldom have any difficulty in recognizing one, because the head is elongated so that it looks like a snout, and the antennæ or feelers on each side of it have a sharp bend or elbow about the middle. The wings and body are covered by a very hard case which often shows brilliant metallic colours; the well-known “diamond beetles” are weevils. Mischievous as they are, few of our insects are so beautiful, and some foreign species, on account of their hardness and brilliant lustre, are employed in various ways as ornaments.

The weevils form an exceedingly large group, but they are not all leaf-rollers, this interesting habit being peculiar to the females of three genera known to naturalists as *Apoderus*, *Attelabus*, and *Rhynchites*. These insects live on various trees and plants, such as the oak, poplar, birch, and vine, and many species are named after the tree on which they are found. Let us see how they carry on their industry. How, for instance, does the little Poplar Weevil, *Rhynchites populi*, which is not nearly half an inch in length, manage with feet and snout to make a neat roll out of a stiff leathery poplar leaf, better than a child could do it? You may watch these insects at work yourself, for they seem to prefer the lower part of the tree to the high branches, where they would be more exposed to the wind and might easily be sent tumbling head over heels to the ground. As they go about their task very deliberately, it is more convenient still to cut off a branch, place the end in water to keep it fresh, and observe the insects at home at your leisure. You will not be dis-

A SKILFUL OPERATION

appointed, for they are industrious little creatures and they will go on working assiduously.

In the first place, it is quite evident that if the leaf were allowed to remain crisp and fresh, the tiny insect would wrestle with it in vain. Its first concern, therefore, is to make the material on which it has to work soft and plastic, and in the means which it adopts for this purpose the weevil shows that it is endowed with instinct of the highest order. You know that when you break the stem of a flower or the stalk of a leaf, the part which is separated from that portion of the plant which still remains connected with the root withers and dies. If instead of breaking the stalk you merely bend it sharply at an angle, or crush it between finger and thumb, so that the tissues are damaged to some extent but are not altogether destroyed, a certain amount of fluid can still find its way along the stem past the injured spot to the part beyond, which does not then lose its vitality completely as in the former case, but merely droops and becomes limp and flaccid. Well, the instinct of the poplar weevil leads her to act as if she were perfectly well aware of this. Having made her choice of a leaf, she takes up a position on the stalk and commences operations. With her snout she begins to bore into the tough tissues; she works away patiently, until she has made a tiny hole in the stalk. " 'Tis not so deep as a well, nor so wide as a church-door; but 'tis enough": the aqueducts of the leaf are injured, the supply of nourishing fluid is permanently interfered with, the forces which were constantly at work to keep its broad expanse crisp and fresh are interrupted. Very soon the leaf begins to droop under its own weight until it hangs straight down from the wounded point; it becomes limp, soft, and plastic. This is all that was necessary; with one dagger thrust, as it were, and with the least possible expenditure of energy, the weevil

TIRELESS EFFORTS

has attained her purpose. What she required was a supple, half-living leaf, whose forces were paralysed; one which would offer but little resistance to the operations of modelling and rolling, and which, when moulded, would retain its form; and having obtained this, the insect proceeds without delay to her further labours.

A poplar leaf, as everybody knows, presents a sort of four-sided figure; that is to say, it is shaped like a lance with the two sides of the blade spread out into broad, pointed wings. It is invariably at one or other of these points that the roll is begun. Standing on the upper surface of the leaf in a fore-and-aft direction, with one side of her body turned towards the roll and the other towards the unrolled portion, three of her feet resting on each, the weevil pursues her occupation. The end of each leg is furnished with minute claws and stiff, spiny projections which afford a firm grip, and by means of these she pulls steadily first on the one side, then on the other, so that the roll gradually moves over the free surface of the leaf until it reaches the middle, after which the other half of the leaf is similarly rolled round the first half. That, in a few words, is the principle on which one of these little 'cigars' is made; but as that distinguished naturalist M. Fabre remarks, it is only by watching for hours at a time the ceaseless, untiring labour of the weevil as she drags upon the leaf with quivering limbs, never loosing her hold with one claw for a single moment except when the other five are firmly anchored, never making a careless movement lest the roll should spring open and all her work come undone again—it is only by observing all this that we are able to realize how great is the undertaking and what difficulties are overcome. The coils of the leaf are held in position by the effort of the insect alone; no sort of cement is used, no thread binds them in place or prevents them springing open. If the weevil works

SEALING THE EDGE

very slowly, it is with the object of preserving the form of the roll until it has had time to become moulded into shape, and will of itself retain the curl which has been given to it.

As the roll is of much greater length than the weevil, it follows that the latter cannot manipulate it along its whole extent at once; she must move gradually from end to end, working as she goes, and as a rule she works backwards. On arriving at the edge of the leaf, she does not leave the fold which has just been completed and return to the starting-point before beginning another, for if she relaxed her grip too soon the portion last rolled would open out again and become too loose. The insect therefore retains her hold and begins to work her way back again in the opposite direction patiently and without hurry, and the new fold adds to the security of that which preceded it. Thus she moves to and fro and from end to end, just as a plough is driven over a field.

At length, at the end of a day or thereabouts, the whole leaf has been rolled into a neat cylinder; but even then the work is not complete. The edge of the leaf must be sealed down in order to make it quite secure, and in doing this the weevil continues to show the same ingenuity that has characterized her labour from the beginning. With her snout she presses firmly on the edge of the leaf, rubbing and smoothing it in all directions until it sticks to the rest of the roll. The cement which fastens it is not secreted by the insect, but by the little glands which are found in the edge of the leaf itself, and from which it is made to flow by the pressure of the weevil's beak.

Having given the finishing touches to one roll in the way we have described, the industrious insect passes on to another leaf and performs a similar series of manœuvres, from the

A LAZY PARTNER

piercing of the stalk to the soldering of the edge of the roll.

Now we may reasonably inquire, what is the use of all this labour? It is hardly to be supposed that so much energy and ingenuity would be expended on rolling leaves unless some important object were to be attained; yet when once the edge of a roll has been sealed down the weevil appears to lose all interest in it. The explanation is precisely what we should expect it to be; the weevil works with the same motive as the dauber wasp or the mason bee, *Eumenes*, *Osmia*, or *Odynerus*, that, namely, of providing board and lodging for her helpless offspring. We have all along spoken of the worker as "she"; it is, indeed, the female weevil alone who works, and as she does so she places here and there an egg between the folds of the leaf—sometimes one only, sometimes as many as four, in a single roll. When in course of time larvæ are produced from these, they find themselves surrounded by an abundant supply of food and at the same time hidden from the sight of the numerous insects and birds that are always on the look-out for such delicate morsels.

As for the male weevil, he is an idle fellow who spends most of the day watching his partner work. Now and then he takes hold of the coils of the leaf and makes some slight pretence of "lending a hand," but it is the merest courtier's trick to win her favourable opinion, for he soon goes away again and resumes his life of lazy contemplation.

Species of *Rhynchites* whose home is on plants which have leaves less simple in shape than poplar leaves are confronted with greater difficulties, and the rolls they make are not so neat and regular as those of the poplar weevil. The vine weevil, for instance, which gives so much trouble and inflicts so much loss on wine-growers, has to deal with a leaf which

VINE WEEVILS

is both large and deeply cleft, and whose shape makes it practically impossible that it should be rolled into a regular cylinder by so small a creature. In this case, therefore, we find the leaf bent in sharp folds which run in various directions and leave sometimes the back, at others the front of the leaf on the outer side. These rolls differ from those seen on poplar trees in another respect; the edges are not fastened down with cement from the leaf glands, but by means of the interweaving of the cottony hairs which cover the surface of the leaf.

Some weevils of the kind known as *Apoderus* go to work on a different plan from that followed by the *Rhynchites*; instead of boring a hole in the stalk in order to make the leaf flaccid before rolling it up, these insects divide the leaf by a straight cut which extends from one edge across more or less of its expanse, and by this means they achieve the same object. On alder trees you may sometimes see leaves cut across in this way, only a small portion at one side remaining intact. From this point a neat little cylinder hangs straight down, swaying and quivering with the lightest breeze. If you examine one of these rolls, you will find that it is double; that is to say, the leaf has been folded lengthways down the middle before being made into a coil. The weevil which makes these structures never places more than one egg in each.

The pretty *Attelabus curculionoides* is equally skilful, and, like the last named, also has its own peculiar method of working. It is found on oaks and evergreen oaks; but few leaves are so stiff or stubborn as to resist the manipulation of these clever 'craftsmen.' They divide the blade of the leaf on each side throughout its whole width, leaving only the middle vein untouched, and they roll it up from the tip towards the stalk. These insects are said to work only

LEAF-ROLLING CATERPILLARS

during the night, when the leaves are less crisp and offer less resistance than in the daytime.

In England the "leaf-rollers" with which we are most familiar are the caterpillars which are popularly known by that name. Nobody who has walked through an oak forest late in spring, when the foliage is fully developed, or who has access to a country garden where lilac trees grow, can have missed observing—especially in a mild, damp season, when all the herbage is soft and succulent—that many of the leaves are coiled up in the form of a hollow cylinder, some lengthways, others crosswise, or at any angle between these two directions. It may be that only part of a leaf is rolled up in this way, or the whole of it, or even several leaves together; others again are merely folded edge to edge, or from tip to stalk; almost every conceivable variety is to be met with.

If you strike a branch which bears a number of such leaves a smart blow with a walking-stick, a strange thing happens. A multitude of tiny caterpillars suddenly appear suspended in mid-air, hanging from delicate silken threads, and descend with short jerky movements towards the ground. If not alarmed further, they soon stop in their downward course and presently begin to climb up their slender ropes towards the branch, where, on arriving, each hurriedly dives into one of the rolled-up leaves, as precipitately, almost, as it had previously left it.

These, then, are the caterpillars which make their homes in the leaf rolls, and their homes are, if we may be permitted the expression, their own handiwork. The caterpillars which construct them are of many species, but all are small, and some are very tiny indeed—so tiny that it is difficult to imagine by what means they succeed in producing any curvature whatever in a crisp, springy, living leaf. For these

ARM-CHAIR OBSERVATIONS

little creatures do not, as a rule, make their material more workable by first interfering with its vitality as the weevils do; they take it as they find it, and mould it to their use without any previous preparation. It is quite clear that they could not hope to do this by 'brute force' alone—they who possess so little strength. Let us see, then, how they solve the problem.

If we take one of the curled leaves and examine it carefully, we find that its form is maintained by a number of short silken bands or ties, which are attached at one end to the outside of the roll and by the opposite extremity to the flat, unrolled portion of the leaf. As seen under a lens, each of these ties is found to be composed of a multitude of filaments of the finest silk, and as a single filament is capable, as we know, of supporting the weight of a caterpillar, the entire bundle is strong enough to resist a fairly considerable force. Now there are often as many as ten or twelve such ties placed at more or less regular intervals about a line or two apart, so there is no difficulty in understanding how the leaf is kept in curl; that, however, does not explain by what means the curl is produced which requires so many cables to prevent it springing open. The best plan for solving any problem in nature is that of direct observation, whenever it is practicable, and in this instance, as with the weevils, it is quite a simple matter. All you have to do is to take a branch, remove a few caterpillars from their homes on the tree, place them upon the fresh leaves, and watch them closely. Exposure appears to be very distasteful to them, and they quickly set about making new shelters for themselves. It is most interesting to see them at work, and well worth the small amount of trouble that is necessary, even if you are not a naturalist; though for that matter every healthily constituted boy is a naturalist in some

A SIMPLE MODEL

degree, and takes a keen delight in observing the ways of animals.

Well then, let us suppose that we have our leaf with our leaf-rolling caterpillar placed upon it ; how does he act ?

If you take an oak leaf, or a leaf of almost any kind, and examine it closely you are almost sure to find that however flat it may seem to be as a whole, the extreme edge of the leaf is curved slightly towards the under side at some part of its extent. It may be ever so little, but if there be *any* curvature it is all that is needed to give the caterpillar a 'purchase,' as the phrase is, on that part of the leaf. Choosing such a spot, he attaches a thread close to the margin, and swinging his head and the front half of his body as far as he can reach in the opposite direction, he fixes the other end to the flat surface of the leaf. His head swings to and fro like a pendulum as he spins thread after thread in this manner until there are, perhaps, a hundred or more which together form a stout little band, stretching from point to point like, let us say, the hairs on a fiddle bow. The threads are straight, but there is no particular tension in them ; they have not increased the curvature of the leaf, and if you were to divide them at this moment the leaf would not spring back in the smallest degree, but would remain exactly as before. Take a piece of stiff paper, curl one edge of it upwards, and stretch a piece of cotton across the curvature, fixing the ends of it in place with gum or wax so that it just remains in position without exercising any 'pull' on the paper, and then you will have on a large scale a simple representation of the first stage in the process of rolling a leaf. With the help of this simple apparatus, the mechanical means by which a caterpillar overcomes a force far too great for its own unaided strength can readily be demonstrated. A very slight pressure on the middle of the

FOOD AND SHELTER

cotton thread of our model is sufficient to produce an angle at that point; at the same time it will be seen that the distance between the two points of attachment is lessened and the curl of the paper is increased. If without releasing the tension on the first thread, another and shorter piece of cotton be attached to the same two spots on the paper so that it extends straight and taut between them, it is clear that the increased curvature which has been given to the paper by pressing on the first thread will be maintained when that pressure is removed. Now this is precisely the principle on which the caterpillar acts. After spinning a certain number of threads from point to point he begins to spin another series which crosses the first at a sharp angle, and in doing so he presses upon the former with his body at each swing of the head, thus pulling upon the edge of the leaf and curling it over, the new thread, when attached, holding it in this position. Having carried out this manœuvre in one place, he moves on to another a short distance away and repeats it; and so on, until a definite curl is imparted to a certain portion of the edge of the leaf. Then the whole series of manœuvres is gone through a second time, the silken bands on this occasion being attached by one extremity to the outside of the roll already formed, and by the other to points slightly nearer the middle of the leaf, which is thereby rolled a little more. This is repeated as often as may be necessary, that is to say, until the roll is completed. Here and there it may happen that one of the stouter nervures of the leaf offers too much resistance; the caterpillar nibbles off a little of its substance at one or more places, and thus makes it more pliable. When the roll is finished it has the form of a hollow cylinder, into the cavity of which the caterpillar retires to enjoy well-earned seclusion, sheltered from the sun and wind, and hidden from the sight

AN INSECT CIGAR-MAKER

A caterpillar's method of rolling up an oak-leaf. By an ingenious device a small caterpillar succeeds in rolling up a crisp, living leaf into a neat cylinder, within which it lives under cover.

A B C D show the successive stages by which a leaf is rolled transversely.

E A leaf rolled lengthways.

F The arrangement of the silken strands in one of the short cables.

G Caterpillars of the little green Oak-Tortrix.

A SERIOUS PEST

of possible enemies. Even when threatened by the intruding beak of a too-inquisitive small bird, he can tumble out at the opposite end of the roll and remain suspended on his silken cord until the danger is past. For nourishment he devours the inner coils of the rolled leaf; if you open a number of rolls, you will find some of which only the outside coil remains, all the rest having been eaten by the inhabitant. Some species of caterpillars are so short lived that a single leaf is enough to supply them with nourishment until they reach the pupal stage; others, however, have to repeat their task once or more before they arrive at maturity.

The commonest species of leaf-roller in England is the larva of the Oak Tortrix (*Tortrix viridana*). In some seasons it becomes an absolute pest in districts where oak trees abound, and it occasionally happens that a whole plantation may be almost entirely stripped of its foliage by these little creatures. In June, under such circumstances, myriads of moths may be shaken out of the trees, their wings glimmering green and grey as they flutter about in uncertain flight.

The leaf-folders are even more numerous than the rollers, and they may be found from time to time on almost every kind of tree. A convenient place to seek for them is on apple trees. The folded leaf forms a kind of shallow box in which the caterpillar lives. As the walls of its home consist of only a single layer of the leaf, it is quite clear that if the caterpillar were to eat, as the rollers do, the entire thickness of the leaf, it would literally "eat itself out of house and home." But it avoids such a disaster by nibbling only a part of the thickness of the leaf, and I cannot recollect having ever found a folded leaf whose inhabitant had, by inadvertence or tempted by a specially succulent morsel, penetrated the outer cuticle and so made a hole. When feeding—and this occupies the most of their life—they bite

LEAF-FOLDERS

out the soft tissues from the meshes formed by the larger veins of the leaf, which remain intact, so that the network is far more distinct on those parts of the leaf which have been eaten than it is elsewhere.

Many caterpillars are not content with rolling a single leaf; they fasten several leaves together in a bundle. Of these the most remarkable are found on willows, whose long, narrow leaves, growing, as they do, almost parallel to one another when not quite fully developed at the end of a branch, are readily bound into a little sheaf. The caterpillar performs this operation exactly as we should do it ourselves, by winding a thread round and round the group of leaves from end to end. In the space which remains along the middle of the bundle he takes up his abode and without delay begins the all-important business of feeding. A happy instinct prompts him to eat first of all the bud at the tip of the branch, for if this were allowed to develop it would in all probability burst open the packet of leaves and expose the occupant to all the dangers and mischances of a merciless world.

CHAPTER XXIV

WORKERS IN SECRETORY AND EXCRETORY PRODUCTS

Nature's cement—"Edible swifts"—Birds'-nest soup—A weird company—Laying the foundations—Birds'-nesting in Java—Deceptive architecture—An inadequate cradle—Nest-building shrimps—Praying insects—A saintly appearance—The soothsayer—A wolf in sheep's clothing—The soothsayer's true character—A deadly weapon—Coming to grips—The perils of courtship—An elaborate egg-case—Arts of peace—The mother cockroach's little bag—Nature's economy—Beetle hunting—The initiation—An unattractive covert—A busy scene—Fighting with prejudice—The sacred scarab—Shovel and rake—How the scarab lost his feet—Important news—Hastening to the feast—"The immortal Fabre"—The beetle's callipers—Shaping the ball—Feverish activity—The journey—The beetle's "mate"—Highwayman and diplomat—Fighting for the spoils—Lending a hand—Travelling extraordinary—A perplexing situation—Ways and means—Calling a halt—Preparing the banqueting-hall—An unscrupulous guest—A Gargantuan feast—The scarab's nursery—A chip of the old block.

WE have already seen that many animals make use of saliva in their building operations in order to bind the materials together and give strength and solidity to the whole structure. It is employed by mason bees to make cement from dust; wasps utilize it in forming the paper of which their nests are composed; many birds when building glue together shreds of vegetable substances by the same means, and it adds to the hardness and coherence of the mud and clay of the swallow's nest. It appears also in the form of silken threads, of which caterpillars make such

BIRDS'-NEST SOUP

ingenious use in a variety of ways. But the most striking instance of all is furnished by the "Edible Swifts" (*Collocalia*), some of which build up entire nests of nothing else.

These birds range from the Indo-Malayan countries to Australia, frequenting especially the Sunda Islands, Ceylon, and the mountains of Assam; and their nests, which are commonly but inaccurately known as "swallows' nests," are in China regarded as a great delicacy and made into birds'-nest soup. For this purpose they are classed according to their colour and texture; the whitish ones, which are the most highly esteemed, fetch very high prices, but those of a brown colour are considered hardly worth gathering. For a long time there was much discussion as to their nature, the most common opinion being that they were made from some gummy substance which the birds obtained by the seashore—probably from some kind of seaweed. It is now known, however, that saliva is the principal, and in the first quality nests the only, constituent.

The nests are found attached to the face of steep rocks, sometimes on cliffs by the seashore. Usually, however, the birds frequent dark caves, where great companies of them build close together and often join their nests in clusters. So populous are these colonies that Colonel Legge, in describing one he visited in Ceylon, says that the hundreds of frightened little birds, as they screamed and whirred in and out of the gloomy cave, made in their flight a sound like that of a storm in a ship's rigging. Owing to the inaccessibility of their haunts but few people have been able to observe these swifts closely when making their nests. Dr. Bernstein, however, studied them carefully in Java, and has given an interesting account of their manner of working. In shape each nest is not unlike one-quarter of an egg-shell which has been divided lengthways. It is open at the top, and the rock to which it is

LAYING THE FOUNDATIONS

attached serves to form the back of the nest. The upper part extends over the rock at each side into a wing or spur, which greatly strengthens the attachment. The wall of the nest is thin and often translucent; it has a horny look, and is marked with wavy ridges running from side to side.

In the nesting season the glands under the bird's tongue become much enlarged and form great quantities of saliva, which collects in the front part of the mouth. It is a viscid and stringy fluid, not unlike a thick solution of gum, and when exposed to the air it rapidly becomes dry and hard, sticking firmly to any surface on which it is placed.

When beginning to make a nest, the bird flies to the spot it has chosen and places saliva on the face of the rock with the tip of its tongue. It continues doing this until it has marked out roughly in the form of a half-circle a foundation for its nest, which soon dries and makes a firm base on which the rest of the structure is built in layers, thus producing the wavy lines which may be observed running across the nest when completed. Sometimes a feather becomes stuck in the mass during construction, and some nests have moss embedded in the walls. Mr. Hose has discovered that distinctive nests are built by the various species of the genus, and that the white nests of pure saliva, which are so valuable, are made by the bird known as *Collocalia fuciphaga*.

The nesting season lasts from March until June. Two is the usual number of eggs, which are of a pure, dead white and about three-quarters of an inch in length. According to the account given by Colonel Legge, the partially fledged young roost on the exterior of the nests in an upright position, with the bill pointing straight upwards.

The nests are not gathered for the market without great risk, for the only way to reach them is to be lowered down

BIRDS'-NESTING IN JAVA

the precipitous face of the rock by means of a rope or bamboo ladders. Nevertheless in Java considerable numbers of the coast population engage in this perilous industry, which is certainly a profitable one, for nests of the finest quality are very valuable.

The edible swifts are by no means the only interesting members of the family, for many of their near relatives display nesting habits which are equally strange. The Common Swift (*Cypselus apus*), which is a familiar summer visitor to Britain, is fairly orthodox in this respect, making merely a slight structure of straws, cobwebs, and a few feathers, under the eaves of buildings, in hollow trees, or in the crevices of rocks; but other species call for special attention. One which is found in Guatemala, and is known as the San Geronimo Swift (*Panyptila saucti-hieronyni*), makes an enormous nest, of which there is a remarkable specimen in the Natural History Museum at South Kensington. Like the edible swifts of the Old World, this bird attaches its nests by means of saliva to the rocky walls of caves. It is a remarkable structure, with the form of a great hanging tube more than two feet long and about six inches in diameter, an opening at the lower end permitting the birds to pass in and out. Inside the tube, at the upper end, there is a ledge, slightly hollowed on top, for the reception of the eggs. One of the most interesting features of this strange nest is, however, a kind of portico built out at one side about half-way down. The portico has an opening below, but no communication with the interior of the nest: it is in fact a sham entrance, and appears to be placed there to deceive some enemy, such as a snake or a lizard, to the attacks of which the parent bird or its offspring would be more exposed during the time of incubation. Mr. Salvin, who first described it, observed a similar structure in other nests—prob-

COLLECTING "EDIBLE BIRDS' NESTS"

In Java many of the coast population engage in this perilous occupation. The nests are those built by some of the swifts; when of fine quality they resemble isinglass in substance, and are the delight of Chinese epicures, who have them made into soup.

AN INADEQUATE CRADLE

ably those of some Australian bird. Now the whole of this elaborate piece of architecture is composed of the downy seeds of a plant, thousands of which are stuck together by means of the bird's saliva. The result is a sort of tough grey felt, and in no other way could so firm and durable a structure be obtained.

The Tree Swifts, or Crested Swifts (*Macropteryx*), constitute another division of the family, and range from India through Burmah and the Malay Archipelago to the Solomon Islands. They make small, exposed nests on a branch or tree stump, not in the forest, but in scattered jungle on low, stony hills. The nest, which is scarcely larger than the half of a large walnut shell, is glued to the side of the stem so that the edge of the nest is on a level with the upper surface of the branch, which forms one side of the shallow, saucer-like cavity. It is composed of thin flakes of bark, with occasionally a few small feathers, the whole being gummed together with saliva. The walls are extremely thin, and the little cup is not capable of containing more than the single egg which this bird lays. So small and fragile is the structure that the bird when incubating supports itself upon the branch and sits *over* rather than *on* the nest, which it entirely conceals. It is curious to observe how the young bird conducts itself in such a tiny nursery, for it is evident that after a few days' growth it must find itself as badly off for "elbow-room" as was Alice after she had drunk from the magic bottle in the Rabbit's little house. It overcomes the difficulty, however, by scrambling out of its narrow quarters and taking up a position across the branch just as its parent did when sitting. You might think that in such an exposed situation it would prove a tempting object to birds of prey; but Dr. Bernstein states that on the slightest suspicion of danger it immediately ruffles its feathers and

NEST-BUILDING SHRIMPS

remains perfectly quiet ; its mottled plumage then harmonizes so well with the lichen-covered bough upon which it is perched that it is a very difficult object to detect.

The nest of the palm swift has already been described. We must now take leave of this interesting family and briefly consider the animals which make use of secretions other than saliva as materials in their constructive work.

Such instances are numerous, and amongst the most notable are the "spinners," of which we have already given some account.

Amongst the animals which the majority of people would least expect to find building nests are, I suppose, the shrimps ; yet these little creatures make quite an interesting variety of structures, and one could easily devote a whole chapter to the description of their dwellings and the way they are made. We must, however, be content to mention one or two species only, and our first choice rests on *Microdentopus grandimanus*. This tiny animal has unfortunately no simple, familiar name, so we must resign ourselves to speaking of him as *Microdentopus*. We choose him because he has been observed at work with particular care by Mr. S. I. Smith, from whose record the following account is taken. Mr. Smith found *Microdentopus* a particularly favourable subject for observation, for when captured and placed in a small trough with little pieces of branching seaweed the individuals almost always proceeded at once to construct their tube-like nest. A few slender branches of the alga are pulled towards each other by means of the animal's antennæ and limbs, and are then fastened by threads of cement spun from branch to branch. The spinning is performed by certain of the limbs, which are in the tube-making shrimps peculiarly adapted to the purpose, one of the 'joints' being greatly thickened owing to the development within it of a

THE SHRIMP AT WORK

large cement-gland. In the nest we are describing, the branches are not usually at once brought near enough together to serve as the framework of the tube, but are gradually brought together by being pulled in and fastened a little at a time until they are in the proper position, where they are securely fixed by a thick network of fine threads of cement spun from branch to branch. When the tube is almost completed it consists of a transparent network of cement threads woven amongst the branches of the alga; but the animal then begins to work little bits of weed into the wall until he is quite hidden from view, the spinning of cement over the inside of the tube being kept up all the while. In making the threads, the tips of the spinning-limbs are touched from point to point over the framework in a way very like the movements of the hands in playing upon a piano. The cement sticks at once wherever it touches, and spins out from point to point in delicate, uniform threads which appear to harden very quickly, and do not seem ever to adhere to the animal itself, even immediately after they have been produced. *Microdentopus* takes about half an hour to make a complete tube.

According to Mr. Bate, another species, the beautifully variegated little *Podocerus capillatus*, builds its nest in a very bird-like manner in submarine forests. The nest is not a tube like that of *Microdentopus*, but is somewhat oval in shape, with an opening at the top, and is used as a place of refuge for the animal, and for the protection of its young until they are old enough to look after themselves. In one nest Mr. Bate found a parent and a swarm of young of two distinct broods, "demonstrating, we think, tolerably clearly that the instinct of maternal love hovers over the young long after they are born." These extremely interesting little creatures are found on various parts of our coasts,

PRAYING INSECTS

from Plymouth in the south as far north as the Shetlands, and possibly beyond.

Many animals make cases from materials secreted by their own bodies, in which they pack their eggs for purposes of protection, and as an example of these we may take the "praying insects."

The *Mantidæ*, or Praying Insects, are near relatives of the grasshoppers, locusts, and crickets. They are found chiefly in warm countries, and though none of them are British, a few species are found in the south of Europe. They are generally green, brown, or yellow, some of them exhibiting very pretty colouring with curious markings. They are rather large insects, with long, slender bodies and limbs, and two pairs of wings. When at rest upon a tree or shrub they assume a peculiar and characteristic posture. The front part of the body is elevated, the legs of the first pair are held forward like hands raised in prayer, the wings cover the body as with a long filmy robe, the head is moved continually from side to side, and the whole attitude is irresistibly, if somewhat grotesquely, suggestive of earnest invocation. This peculiarity accounts for the names by which the insects are commonly known, as well as for the legends and superstitions which have been woven around them in most countries and from very early times. Wherever they occur their popular name has some reference to their pious attitude, and the Greeks called them Μάντις, prophet or soothsayer, just as we to-day call them praying insects or praying mantis and apply the title of *Mantis religiosa* to the species which is best known in France and Southern Europe. The insect has also a habit of stretching out one or other of its front legs and keeping it a long time in this position, as though pointing; and it used to be said that children who had lost their way had only to inquire of a mantis, which would

PRAYING INSECTS AND THEIR EGG-CASES

In the upper part of the illustration a Mantis is shown with its legs extended in the characteristic attitude, suggestive of pious invocation, from which these insects derive their name. The Mantis is, however, a "wolf in sheep's clothing," for the front legs are in reality deadly weapons by means of which other insects are captured and killed.

A WOLF IN SHEEP'S CLOTHING

immediately point out the direction to them, never deceiving them and seldom making a mistake !

It is somewhat disappointing, then, to find that this seemingly pious and benignant creature is really one of the most bloodthirsty of beings, with propensities that would discredit a tiger—fierce, predaceous, and at times a cannibal. The movements of the head indicate constant watchfulness, while the supplicatory fore legs are in fact powerful and deadly weapons ever ready to be turned upon some unhappy victim. The form and structure of these legs is peculiar. The middle joint is broad and flattened, and has a groove below, upon which the third joint, or tibia, with its row of strong curved spines, can be closed like the blade of a knife. The whole limb is thick and powerful, and is attached to the fore part of the body ; and as the first joint is of exceptional length, the insect has a long reach, which is of great advantage to him in his combats. Some species are further favoured by nature in being so coloured that when at rest upon a plant they resemble flowers ; other insects are attracted by their appearance, but no sooner do they approach than the terrible legs are shot forward and come to grips—there is a cracking of limbs or chitinous sheath, and the mantis is in possession of a meal.

When confronted by a powerful opponent, such as a large cricket, the mantis, according to M. Fabre's account, first terrorizes its prey before proceeding to the attack. It 'strikes an attitude' with wings half spread, body held upright, and the killing-legs stretched out so that two spots resembling eyes, ordinarily not visible, are disclosed. Its appearance at such times is full of menace and is apt for a moment to startle even one who is accustomed to observing these strange creatures. Over an insect it seems to exercise a peculiar fascination, for a cricket, instead of leaping at one

ARTS OF PEACE

bound out of harm's way as it might do under ordinary circumstances, remains motionless or even slowly approaches within striking distance; the legs fall, and the tragedy ends as before.

The female mantis is larger than her mate, as is frequently the case amongst insects, and the latter has to conduct his courtship warily and in imminent danger of having his head snapped off. In this the mantis is not altogether exceptional; some spiders and other animals are apt to give way to a sudden impulse of like kind.

The egg-cases which these strange insects make are large structures more than an inch and a half in length and about three-quarters of an inch in diameter at the widest part. They taper away towards the extremities, one of which is more pointed than the other, and the curved upper surface has a well-marked rounded ridge running down the middle. They are usually of a pale yellowish tint, and are found attached to the branches of trailing plants, fine twigs, dry stalks of vegetation, or even on stones. The middle ridge is composed of layers which overlap like the tiles on a roof, and through the cracks between these sections the young insects emerge when they leave the egg. The eggs themselves are embedded in the same horny-looking yellowish material of which the case is composed, and a cross cut shows that they are arranged in concentric layers. When first produced by the insect the material of the case is in the condition of a thickish fluid, which is beaten and mixed with air into a frothy mass resembling lather. It is the air, in the form of tiny bubbles, which accounts for the nest being so much more bulky than the body of the insect, and its use is to protect the eggs against extremes of heat and cold. In the midst of this foam the eggs are rapidly deposited in layers from side to side; in a very short space of time the

MOTHER COCKROACH'S LITTLE BAG

mass hardens, and the nest acquires the appearance already described.

The eggs of the common Cockroach (*Periplaneta orientalis*), which belongs to the same order of insects as the mantis, are also arranged in a horny case, in this instance shaped exactly like a purse with an opening at the top. It is, however, quite a small affair, and the insect carries it about with her for some time.

The more carefully we inquire into the vast, intricate scheme of nature, the more fully we realize that nothing is absolutely wasted; even the so-called "waste products" of one process are made good use of in carrying on another. And there is nothing in the world that is incapable of unfolding an interesting story—providing there be some one who is willing to be interested.

One day I was wandering through some fields in the south of France with a young friend who had asked me to take him out insect-hunting.¹ Perhaps he had expected me to show him some wonderful secret valley, unknown to all save myself, where beetles (for beetles were to be our special quarry) flaunted themselves in the sunshine in great multitudes, and where we should have nothing to do but fill my collecting bottle as a sack might be filled with gems in a story from the *Arabian Nights*.

When we came to the familiar pasture land, therefore, and I told him that there was no necessity for us to proceed any further, my companion's disappointment was evident. Glancing around with a dissatisfied air he protested: "But there are no beetles here? I can't see one!" "O, yes, there are," said I, "there are beetles everywhere. Did you bring the forceps I gave you? Then we will see who makes the better 'bag.'" Evidently he half suspected I was making fun

¹ H. C.

AN UNATTRACTIVE COVERT

of him, but I continued: "Now, how will it be if, in this one field, I show you as many beetles as you are ever likely to find in a single day, even when you have graduated as a first-class beetle-hunter?"

He looked round the field: there was not a beetle to be seen—or so he thought. Had he caught me tripping? or was I going to perform some queer conjuring trick? Either would be good fun, and his face brightened as he said: "O, please do! that *would* be jolly good sport!" "Very well," said I, "draw forceps, and have at 'em! Here's a fine patch of dung; we could not find a better hunting-ground if we searched all over the country." His enthusiasm had all disappeared in a moment. Dung! He wouldn't go near it, not he! Thrusting his hands into his pockets he said: "I think I'll watch *you*, if you don't mind." "All right," I replied, and with the forceps I carefully raised a flake of the dry outside crust. What a busy scene was brought to view! Crowds of tiny creatures, frightened by the sudden removal of the roof from over their heads, were hurrying about in excitement and doing their best to get under cover again. One after another they were seized and dropped into the bottle. "Here's a beauty! see the red glow on his wings! he's an *Aphodius fæstens*; and this little black fellow, like a bit of jet, is named *Aphodius fossor*, because he often goes digging in the ground. Look at this *Onthophagus taurus* with the queer horns on his head—and at this fat fellow with the violet waistcoat, you know him? he's a 'dumble dor,' *Geotrupes stercorarius*."

"And there's another of those diggers, what's their name?" said my companion, "he'll get away! have you got him?" He was quite eager over the chase, pointing out hurriedly any beetle which appeared likely to escape and following every movement with intense interest. Very soon he had completely forgotten his previous objections and was himself

FIGHTING WITH PREJUDICE

seizing the little fugitives with his forceps, becoming every minute more enterprising in his search and exclaiming gleefully over each fresh capture.

When at length every corner of the covert had been beaten and no more beetles could be found, he stood up flushed with excitement, and it was then my turn to smile. "Hullo!" I said, "what has become of all your objections? I thought they would not last very long, and now I see you are a born naturalist, so in the presence of our red-robed Dr. Aphodius I admit you to the brotherhood of Entomologists."

I tell this little anecdote in the hope that it may encourage other boys to overcome their repugnance to the unattractive aspects of nature for the sake of the wonders that are to be seen by anybody who has the good sense to get the better of his prejudices. The world is full of interesting things which nine people out of ten scarcely dream of, or at all events would not dream of looking for.

Often shall we find
The sharded beetle in a safer hold
Than is the full-winged eagle.

And certainly many boys would welcome an opportunity of climbing down a cliff to an eagle's eyry who would not have the courage to dig out an *Onthophagus*; yet *ce n'est que le premier pas qui coûte*, and it is worth doing.

Of the dung beetles met with in Great Britain, those belonging to the genus *Aphodius* are the most numerous; but there are several *Geotrupes*, the one which is the best known being the common 'dumble dor.'

The most famous of these creatures, however, is the big *Scarabæus sacer*, one of the sacred beetles of the Egyptians, as we shall have occasion to explain presently.

Though abundant in Africa, in Europe these beetles are found only in the warm districts bordering on the Mediter-

THE SACRED SCARAB

anean ; but where they do occur they are usually fairly numerous. Clad entirely in black, the body is large and flattened and the wing-cases are marked with distinct grooves from end to end. There are two remarkable characters which you notice at once when you compare the Sacred Beetle with most other kinds. Its head is very broad and flat, and has a number of tooth-like points along the margin; it resembles at the same time a shovel and a rake, and it serves the purpose of both those implements. The second and third pairs of legs, like those of most insects, end in a row of tiny, slender joints, called the tarsus or foot, which is often tipped with two claws, but the sacred beetle has no feet on its front legs. That is a curious thing! How shall we explain it? It is a question which has given rise to much discussion amongst naturalists. In years gone by they used to think that through this insect continually using its legs for digging its delicate tarsi were broken off, and so were never found in a fully developed beetle. But nowadays naturalists take a different view of the matter: the scarabs, they say, have probably been accustomed to dig for ages past; their delicate tarsi were of no use for such rough work—in fact, they only got in the way and hindered them, and the smaller the beetles' 'feet,' the better they could dig. So those individuals with the smallest tarsi were most successful in life; they got more food, laid more eggs, and had more descendants than their brethren, so that gradually, in the course of time, the scarab-folk have become a footless race as far as their front legs are concerned.

This, however, though very interesting, is at present hardly more than conjecture; let us turn to the facts.

In the pasturage a browsing animal leaves in its trail a mass of food material to gladden the hearts of all the dung beetles that chance to be in the district, and news of it is

SHOVEL AND RAKE

borne to them by the breeze in a moment. Afar off there, a scarab is wandering over the ground longing to satisfy the gnawings of hunger, when, almost with the rapidity of wireless telegraphy, it learns what has happened. Its antennæ twitch with eagerness, and it hurries off to the feast, moving awkwardly indeed across country, up hill and down dale, but never losing its sense of the right direction; there is no danger of that. Straining every effort, at last it arrives; surely now it will feast right royally at the plentiful table, devoting itself wholly to the satisfaction of its craving for food? No; the sacred beetle has other, wiser plans. In a few hours all the best morsels will be gone, for already a great multitude of insects are revelling in their good fortune and are eating like gluttons. In a few hours they will be satisfied; but fortune may not favour them again, for it may chance that no animals will pass that way, and then for days, perhaps for weeks, they must endure a long fast. The sacred beetle is a provident creature. With its head, spade and rake in one, and its stout rake-like fore legs, it gathers up a store of the choicest food; the less desirable portions are cast aside, and what is retained is heaped together and passed on to the hinder limbs.

M. Fabre—"the immortal Fabre," as Darwin styled him—has written a brilliant description of the life of the sacred beetle, and this is the account he gives of the way in which the operation is concluded: "The hind feet are planned for the turner's trade. The legs, especially the last pair, are long and slender, slightly bowed, and end in a very sharp claw. You see at a glance that they are adapted like a pair of callipers to reach around a globular object, to test and correct its shape. They are, in fact, used to shape the ball. Little by little the material accumulates under the insect, where it is held by four legs, which, pressing

SHAPING THE BALL

it lightly, give it their own curve and roughly shape it. Then, from time to time, the half-formed ball is set in motion between the arms of the callipers, turned underneath the worker, and rolled into perfect shape. Should the outer layer lose its plasticity and be in danger of scaling off, or should there be at some spot a fibrous portion which refuses to be moulded, the faulty part is retouched by the fore feet; little taps of their broad, flat surfaces cause the fresh layer to adhere, and embed the troublesome fibres in the general mass. On a bright, sunny day, when the work is urgent, it is amazing to see the feverish activity of the turner. He makes rapid progress with his task; a little while ago there was only a tiny pellet, now there is a marble as large as a nut, by and by it will become a ball the size of an apple. I have seen some greedy beetles make one as big as my fist." But it is not enough to gather provender; he must store it in some safe place, where he will be free from the intrusion of other beetles anxious to share his feast. He sets out immediately, stretching his long hind legs around the ball and digging a sharp claw into each pole of the sphere, or two points as near the poles as his claws will reach, in such a way that it revolves between them, like a wheel; then, leaning on the middle pair of legs and pushing sturdily against the ground with his fore feet, he sets the ball rolling and travels backwards with his load, up hill, down dale, towards the unknown goal. From time to time he takes a fresh hold with his claws in order to make the ball roll on a different axis, for without this wise precaution it would soon lose its globular shape and become pressed into the form of a cylinder. For some reason unknown to us the scarab takes delight in rolling his ball along the sides of the sloping banks instead of keeping to the valleys, which would make his task very much easier. The consequence is that

THE BEETLE'S "MATE"

time after time he tumbles head over heels in the course of his journey; if the ball come into collision with a little stone or a projecting root, or if the insect lean a little too far to either side, down they roll, ball and beetle together. But he is not readily discouraged; taking a fresh hold upon the globe, he makes another attempt to mount the dangerous hill, though often he meets with no better fortune, for, like Sisyphus, just as he seems on the point of surmounting the difficulty and rolling his burden safely to the summit, it tumbles down to the bottom of the slope and all the labour has to be begun over again.

Near the shores of the Mediterranean, where the sacred beetle is found, it is no very uncommon thing to come upon two scarabs pushing against the same ball. Are they partners who have combined their resources to furnish the family larder? It is a great temptation to suppose that a couple is behaving in this amiable manner, but unfortunately this gentle idyll has been destroyed by M. Fabre, who finds that the two beetles are frequently of the same sex. Perhaps, then, one is helping the other in quite a friendly way to take his provisions home, or the two are boon companions who share their rations and take their meals together? For a long while people thought that it was a case of one insect helping another with a burden too heavy for his strength, out of sheer good nature. But M. Fabre will not leave the sacred beetle a single shred of its reputation for altruism; according to him it is no better than a highway robber—indeed it is sometimes a great deal worse—it is a sneak and a hypocrite. Under the pretence of giving a helping hand, the intruder all the while means to carry off the ball at the first opportunity, in order to save the trouble of making one for itself at the heap. Should the owner fail to keep a good look-out, he will hurry away with the booty; but if he be

HIGHWAYMAN AND DIPLOMAT

too closely watched—why then he can at least claim a share of the feast as a reward for his services. In either case he is the gainer and the proprietor suffers, so that the profession of highwayman is a very popular one amongst the sacred beetles. They force their attentions upon those who have no need of assistance, fully determined to satisfy their greed at another's expense; or they go straight to the point at once and make a bold attempt at robbery by main force, overturning the unfortunate proprietor and, before he can recover from the fall, taking up an advantageous position on top of the ball, there to await events. The owner regains his feet and lays siege to the property of which he has been so brutally deprived. He walks round it, inspecting it on every side and seeking for a favourable spot for attack, but the party in possession faces him at all points. At length by some movement the robber is brought to earth, and it becomes a wrestling match, a duel at close quarters, body to body, until at length one has to admit the superior strength of the other and yield at discretion.

On another occasion a beetle approaches his toiling comrade with the greatest composure; there is no hustling, no attempt at depriving the owner of his booty by brute force; he adopts different tactics. He leans against the rolling ball, but in an attitude which is the opposite of that adopted by its proprietor—that is to say, he stands on his hind legs and grips the moving mass with his arms, pulling it towards him and hastening its progress over the ground. He appears to be a willing helper, but his assistance is not long continued. Very soon he draws up his limbs, clings tightly to the coveted goods, and remains motionless, holding on with the tenacity of a limpet. The unfortunate owner pushes with all his might, rolling ball and beetle along the road together. From time to time, however, the intruder

A PERPLEXING SITUATION

arouses himself; there is difficulty in surmounting a steep portion of the ground—the ball scarcely moves; then he may perhaps lend a hand once more until the difficulty is past, when he again becomes a passenger and allows himself to be wheeled along, though very often he does not budge from his position for anything. On the whole, his presence is not helpful; and we may now inquire whether these beetles are ever really inspired with a willingness to help their comrades except to their own obvious advantage, or whether they ever invite assistance.

M. Fabre has tried to solve this question by a number of experiments. While two beetles were travelling along with a ball in the manner just described, he fixed the mass firmly to the ground with a long pin. It came to a sudden standstill. The beetle thrust with all his strength, as he would have done had it been some ordinary obstruction in his path, a pebble or a twig, but all in vain—the wheels would not go round. He then released his hold and made a tour of inspection, walking around and climbing over the pellet; but he discovered nothing except his lazy companion. This was surely an occasion for demanding help. Whether the beetle did so or not it is of course impossible to say, but at all events if the request were made it met with no practical response, for the passenger made no sign. After a while, however, wondering perhaps what the matter was that they remained so long in one place, he aroused himself and took a look around. In the course of their inquiry one of the beetles tried to creep underneath the ball, and then he found the pin. That, then, was the obstacle. Evidently it must be removed—but how? It might be supposed that they at once set to work to excavate the earth and dig it out; but they hit upon a simpler method. Forcing themselves under the ball, they thrust it up a little higher on the

WAYS AND MEANS

pin. They continued the same manoeuvre by raising themselves on their legs and pressing upwards with their broad backs until they could reach no further; but still the ball was not free. The next step was more difficult, for they got into the usual position for rolling a ball, and pressed against it with their hind or fore feet, until at last it was raised completely off the pin and tumbled to the ground, whereupon they proceeded on their journey. On other occasions, when the pin was so long that the top of it could not be reached by these means, if little flat stones were placed in a suitable position, after a while and apparently quite by chance the advantage offered by the scaffolding was discovered; the beetles mounted upon the convenient platform thus provided for them, and continued to raise the mass until their efforts were crowned with success. Without such assistance, however, they gave up the problem in despair, and flew away to return no more. The precious ball was abandoned once and for all, and it never occurred to the beetles that by mounting upon the shoulders of a comrade the loss might be avoided.

Instead of harassing the poor insects in this manner, however, let us permit them to go peacefully on their way and observe what they will do. After travelling for a certain distance, the beetle at length arrives at a spot suitable for the purpose he has in view. He calls a halt, gets on all sixes again, inspects the ground, and begins to dig a hole in the sand. We must not forget that there is a passenger still on board, for presently he will awake from his lethargy and once more appear upon the scene. The proprietor then starts making a hole in the ground with his fore legs and his rake-and-shovel head. The pit quickly grows deeper, and in the meantime the beetle climbs out of it every now and then to cast away the refuse and to make

A GARGANTUAN FEAST

sure that his property is quite safe. "However," says Fabre, "the underground hall becomes wider and deeper, and the excavator appears more rarely, occupied as he is with the extent of his labours. Now is the time! The sleeper arouses himself; the crafty fellow makes off with the ball, pushing it behind him hurriedly, like a thief who does not wish to be caught in the act. . . . Already he is several yards away when the owner comes out of his burrow, looks around, and finds nothing there. He knows what that means, for he has himself had a hand in similar proceedings before now. He is soon on the scent—in sight—alongside the robber; but that 'artful dodger,' when he finds himself caught, promptly changes his position; he gets on his hind legs and clasps the ball with his toothed arms in the same manner as when he is acting helper." The good-natured owner cheerfully trundles the ball back to the hole and goes on with his digging. When the hole is big enough he rolls up the pellet (unless the other beetle has got clean away with it in the meantime) and pushes it over the brink, with his companion still clinging tightly to it. Then he blocks up the entrance and is lost to sight; but if you open the chamber a few days later, you find both beetles, the labourer and diplomatist, enjoying their retirement "far from the madding crowd," and in the peaceful recesses of their banqueting-hall giving themselves up entirely to the pleasures of the table. For many days—perhaps for a whole fortnight—they feast without a pause, without a rest, until the cake has been devoured to the last crumb; then they emerge once more into the light of day and stagger away to seek material for a fresh orgy.

It must not be imagined, however, that these insects devote the whole of their energies to laborious gluttony; they toil with equal zest to assure a peaceful and prosperous

A CHIP OF THE OLD BLOCK

entry into the world for their offspring, but in this instance they work more secretly. At one time it was believed that an egg is deposited in each of the balls of dung rolled by *Scarabæi*; but, as we have seen, they have quite another use. What the beetle does is this. Somewhere in the ground it sinks a shaft to the depth of about four inches, which it then continues as a winding horizontal gallery which terminates in a spacious chamber large enough to admit your closed hand. Into the underground nursery it carries, a little at a time or all at once, a quantity of sheep-dung, which it fashions into a pear-shaped mass; in the thin end of this there is an oval cavity, and there a single egg is placed. The burrow is then stopped up with earth, and in a few days a grub emerges from the egg, finds itself in the midst of plenty, and quickly devotes itself to the congenial occupation of eating the supply of food provided by its parent, so that, in course of time, it also becomes a beetle, ready to carry on the useful occupation of cleansing the earth's surface of impurities.

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