The WONDER BOOK OF SCIENCE

J·H·FABRE

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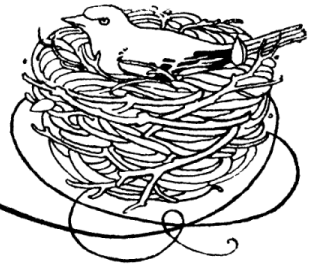

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Chapter I — *The Stag-Beetle*

ALL children take pleasure in insects, with their strange ways of life and their varied forms and colours. They follow the splendid butterfly from flower to flower; they keep the cockchafer on a bed of fresh leaves; they lure the cricket from its hole with a straw. But the insect not only affords amusement but also instruction, and we will spend a little while in considering it.

What is this clothed in strong brown armour? His big head, carved in projecting folds, is armed with two branching claws which open like pincers, and then close again, bruising the finger that has been caught between them. Woe to the careless boy who has been surprised! The trap holds fast and will not let go.

Yet, though its pincers are so strong, this insect is not to be feared as long as we avoid the claws. In spite of his threatening appearance he is quite a peaceful creature, and if you tie him by the leg he will fly round like a cockchafer. His name is *stag-beetle*, and the name explains itself; for the insect

has branching claws similar to the horns of a stag.

This strange insect did not always present the same appearance that it does to-day. In its young days—only a year ago—it had neither the claws, the six legs, the wings, nor the brown coat of mail, while its shape was as different as possible from what it now is. It was then a big portly worm, as fat as butter, with a fine white skin and legs so small and so weak as not to be worth mentioning.

The whole insect was scarcely anything more than a crawling, defenceless stomach, the head alone being fortified by a strong cap of horn, in addition to which it bore, right and left of its mouth, two short strong teeth, well adapted for crumbling the wood of the oak, which is its only food.

Such a completely naked worm cannot, of course, live in the open air, where the roughness of the ground would always be wounding its delicate skin. It must have a safe shelter, which it will never leave until it has become the strongly armoured insect of to-day. The worm of the stag-beetle lives inside the oak, which provides it both with board and lodging. It has a safe retreat in the depth of the trunk.

With its two teeth, as hard and sharp as a wheelwright's tool, it cuts out, bit by bit, the fresh wood, saturated with sap. Each morsel detached is a mouthful, and as the

food is not of a nourishing character, a large amount of it is required. So it never leaves off gnawing, and enlarging its dwelling, which soon becomes a labyrinth of galleries—rising, descending, crossing one another, going deeper into the trunk, or approaching the surface, at the pleasure of the inhabitant, as it chooses the bits that it prefers.

For three or four years the worm leads no other life. Its only business is to grow large and fat, and for this end it works hard. You may speculate as to what will become of an oak ravaged by a dozen of these feeders. Under the bark, which is scarcely touched, the trunk is one great wound, furrowed by galleries filled with rottenness, from which a brown juice oozes with the smell of a tan-yard. Unless the forester can apply a speedy remedy the great oak is ruined. But we will leave this care to him and go on with our story.

When it is big enough and fat enough, after at least three years of continual feasting, the worm prepares to change its shape. Near the surface, so that its future exit may be easily accomplished, the worm digs a large oval apartment, lined with a kind of down, procured by it from the finest fibres of the wood. By this means the tender new flesh will be protected from any rough contact.

When these precautions have been taken the creature changes its shape. The worm

splits open all along its back, strips off its skin, throws it away like an old rag, and is—so to say—born again, but in quite a different shape. It is no longer the worm—far from it; and it is not yet the stag-beetle, though the insect may already be recognised.

The creature is perfectly motionless, as though dead; and the legs, neatly folded under the belly, are as transparent as crystal. The claws rest on the chest, and the wings, as yet unspread, look like a short scarf surrounding the sides. All this, which is swathed in bandages finer than the skin of an onion, is resting as though deprived of life; and is white or crystalline and so tender that the least thing would wound it. The original common worm has been succeeded by the most delicate creature: a new individual is being fashioned from the material collected by the enormous appetite of the wood eater. The flesh, which is at first almost fluid, slowly becomes firm; while the skin hardens, takes on a brown colour and acquires the strength of horn. At last, when the hot weather returns, the insect awakens from this deep sleep, which was not death, although so much resembling it. It stirs, it tears away the bandages under which its second birth has been accomplished; it strips off its swaddling clothes; and at last we see the insect in its full perfection—we see the stag-beetle.

It leaves the natal oak—taking its flight

in the shelter of the woods; its place in the sunlight: flitting from tree to tree. The freedom of the open air and the joys of light are the supreme festival for which it has prepared by three or four years of persistent work in the gloomy galleries of an old oak.

Henceforth it grows no more. As it is when leaving its cell, so it will remain till the end, without any increase in size or weight. It is also now extremely temperate. As a worm the famishing creature gnawed the wood night and day; its life being one prolonged process of digestion. Now a few draughts of the sweet fluid oozing from the bark are enough to support it.

But its joyous days are limited: it has barely two months to spend happily on the oaks. At the end of this time the insect deposits its eggs, one by one, in the cracks of the trees to assure its posterity, and that being accomplished it soon dies. It has fulfilled its destiny. These eggs will produce worms, which will patiently make their way into the wood, excavate their galleries, and take up the life of their predecessors.

Most insects follow the same course as the stag-beetle, and pass through different states before attaining their final form. All—from the least to the greatest, without any exception—come from eggs deposited by the mother in selected spots, where the food, which is different for every species, may be easily found.

There issues from the egg, not the insect with its distinctive features but a preparatory creature—altogether unlike the creature that has preceded it or the one that will follow it. We called this preparatory form "worm," when speaking of the stag-beetle. The name would apply in this case; but in many others it would be incorrect, as not agreeing with the form of the creature. We shall therefore in future call it *larva*.

The larva is the insect in the shape which it assumes upon leaving the egg, its life being longer than that of the perfect creature. That of the stag-beetle lives three or four years, while the stag-beetle itself only lives a couple of months.

When large enough the larva constructs a retreat—that is, it digs a cell or spins a cocoon, where, in a motionless condition, the delicate work of transformation is to be effected. Then stripping off its skin, it becomes an inert body, with growing flesh, which is called a *nymph*, or *chrysalis*.

Last of all the nymph, having reached maturity, throws off its wrappings and becomes the *perfect insect*. Its eggs are laid and the same series of transformations begin again. Egg, larva, nymph, perfect insect; these are the four stages of the creature's life, which changes of form are called metamorphoses.

Chapter II Insects with Elytra or Wing-cases

HERE is the scarabæus, clothed altogether in black. A passionate lover of the sun, it will not go far from the provinces bordering on the Mediterranean. It belongs to the guild of the dung-beetles, a group of handsome insects which, as they feed on filth, are appointed to purify the grass soiled by the flocks.

Its special treat is the dung of horses and mules. With the notched end of its head it digs into the dung; with its great front legs, furnished with huge saw-like teeth, it cuts it out, kneads it, and fashions it into a ball about the size of an apricot. When the ball is finished it is a question of getting away from a crowd of guests, which for a mile round will be attracted by the smell. The booty must be transported to a safe place to be leisurely consumed, without the fear of being deprived of it by the envious.

This is the work of two. The one fixes himself in front of the ball and drags, with uplifted head; the other pushes behind, with its head bent down. Well done! it travels, it rolls, by the combined effort of the two

partners. Every now and again on the slopes, the burden carries away the team, which turns a somersault, gets up again, and resumes the transport with unwearied energy. Under the rays of a burning sun the provisions are hustled across sand, greensward, and ruts of the path. Perhaps the scarabæi think that their ration is not close enough and try to make it firmer by rolling it on the ground. There is no accounting for taste.

At last a suitable spot is chosen in sandy ground. One of the proprietors hastily digs a dining-room; the other keeps guard on the ball outside, ready to defend it vigorously if any thief should arrive. When the room is ready the food is brought in; after which the partners seclude themselves from tiresome visitors by closing the door of the apartment with sand. Now they are face to face before the heap of food. Now let us enjoy ourselves! When everything is finished the two companions will abandon their underground dwelling to collect another ball, and to renew the feast.

The scarabæus is not found everywhere, and it is a pity, for its mode of life is very curious. Yet though this particular ball manufacturer is lacking we find everywhere other dung-beetles that work almost in the same way. They make balls of dung the size of a cherry; they roll their booty for some time like the scarabæus, after which they bury it underground and feed on it.

Let us take another. This one is called the *calosoma*, and owing to its elegant shape and rich colouring it is one of the most beautiful insects of our country. The back shines like a jewel such as no jeweller ever possessed. You would take it for gold, but a special gold—far more splendid than ours—with red, green and purple reflections. This dazzling garment has no equal. If taken in the hand the insect gives out, in defence, a strong smell like the unpleasant drugs of the chemist.

The calosoma does not follow the peaceful customs of the scarabæus. It is a keen hunter, and lives by slaughter. Its prey is the caterpillar, as large as possible, whether smooth-skinned, or bristling with tufts of hair. If you should happen to find one, you should put it in a large bowl with a strong caterpillar, the size of your finger. The fierce blood-drinker will tear open the poor wretch with grim satisfaction, in spite of its struggles, and feed on its green entrails.

The *carabus*, also a fierce hunter, is as smart and brilliant as the calosoma, but of a much smaller size. Some are bronze, some gold, copper or black with a splendid violet edge. They all keep a careful watch on our pastures, and pursue their small prey—larvæ, caterpillars or maggots. The most common one is all golden green, and frequents the gardens, where it wages war on every kind of vermin. It is the little watchman of our vegetable and flower beds.

The carabus and the calosoma cannot fly, but are made for running. This is shown by their long legs, their agile motion, and elegant shape. They run after their game, or wait for it in ambush behind a leaf: they never fly after it. On the other hand the scarabæus, the common cockchafer and many others, fly very well.

Look at a cockchafer. It has two kinds of wings. On the top there are two large, strong, horny scales, and underneath two delicate membranous wings, which are extended when flying, but carefully folded and concealed when no longer in use. The exterior scales are called *elytra*, and serve as a sheath to enclose and protect the fine membranous wings, which alone are good for flight. It is true that the carabus and the calosoma have splendidly brilliant elytra, but under these elytra there are no membranous wings extending in flight, and folding up again when at rest: so these two insects are unable to fly.

The *dytiscus* and the *hydrophilus*, of which the former name means diver and the latter water-lover, both frequent the water of deep ponds, ditches or pools. With their legs flattened like oars and their very smooth bodies arched on the top, and shaped underneath like the keel of a ship, they are first-class swimmers and divers. It is a pleasure to the eye to follow the graceful agility of their oars as they row quietly on the surface, or float under water.

At the least alarm they descend quickly to the bottom of the pond, among the weeds. As they dive their bellies shine like a sheet of polished silver. This borrowed brightness results from a thin layer of air, which they carry with them, adhering to their bellies. Thus provided they are able to breathe under water until the danger is past, when they return to the surface.

These two master swimmers are modestly clothed. They are both very dark olive-green, and the dytiscus has a trimming of dull yellow on the elytra. If the pond should dry up, or no longer suit them, they can reach another quickly: not on foot; for their flat legs, which make excellent oars, are no use for walking; but by flight with the membranous wings protected by the elytra, where the water cannot touch them.

The larva of the *longicorn*, another spoiler of the forests, lives in the old oaks like the worm of the stag-beetle. Very large, and all black shaded with brown, this insect is remarkable because of the enormous size of its knotted horns, which are longer than its body. What is the use of this cumbersome decoration? Is it worn on the forehead to inspire terror in the enemy? It may be so—I cannot tell. But I do know that these outrageous horns frighten the inexperienced schoolboy, who dare not touch it and calls it the devil. The longicorn does not deserve the bad reputation given by the timid, as it is quite inoffensive.

The horns of insects are called *antennæ*. They all have them, longer or shorter, fashioned in various ways. In some they are flexible filaments, or chaplets of knots; in others they are short stalks, ending either in a number of knobs or in a group of leaflets folded one against the other. Let us, for instance, examine the large and splendid insect which browses on the foliage of the pines in the hottest summer evenings. It is known as the cockchafer of the pines, and has white spots on a brown ground. The antennæ have at their ends a collection of leaflets, which open and close and recall the leaves of a half-opened book.

Here should also be mentioned the common cockchafer, which like the cockchafer of the pines has foliated antennæ. But its history will be related with more detail; for while it is the delight of the young, it is also the dread of the agriculturist. Now to sum up briefly our short study on the elytra-bearing insects. Their number is immense. Almost all of them have membranous wings under the sheath of the elytra, and these are able to fly. Others, which are comparatively rare, have no membranous wings and are therefore not adapted to flight. They are collectively known as coleoptera, which means sheathed wings, and every insect possessing elytra is a coleopter, whether it flies or not.

Chapter III — *The Cockchafer*

LIKE every insect the cockchafer is first of all a larva. This lives in the earth for three years, while the perfect insect has only a life of ten to fifteen days on the trees. When it has attained its full growth it constructs an oval shell of earth—rough on the outside and smooth within. There it becomes a nymph and then a perfect insect.

The grub is a large pot-bellied worm doubled in half, slow in motion, and white in colour, with a yellowish head. It has six legs, which it uses, not to walk on the surface but to crawl underground, and strong jaws, fit for cutting the roots of plants. Its head is covered by a cap of horn, so that it may be strong for digging. Its belly is distended by the food which shows black through the skin. As it is too fat to stand on its legs, the animal lies lazily on its side.

The grub lives for three years, always under ground, digging galleries in every direction like a mole. Nothing comes amiss to it: roots of herbs and trees, of cereals and grass, of vegetables and ornamental

plants. In the winter, to avoid the cold, it goes down deep underground and hibernates. In the spring it returns to the upper beds, chooses its place among the roots, and passes from one plant to another as the damage is completed.

You have in your garden a fine bed of lettuces. One day, without any apparent reason, it is all faded. You pull one up and the faded plant comes up without a root: it has been cut off by the grub. You have a nursery of shrubs—the hope of your orchard. The horrid grub passes that way and your nursery is only good for firewood. You have sown some acres of wheat or colza upon which you have spent considerable sums in manure and labour; but the harvest promises to be good and to compensate you amply. The grub comes up from the ground and good-bye to the harvest: the stalks wither as they stand, having no root left.

When the terrible larva swarms in a country, ruin appears with all its misery. Taking one year with another, in France alone, it causes in a single year destruction to the value of millions and millions worth of francs. One year in the department of the Sarthe the destruction was so widespread that they had recourse to extermination on a large scale. Three hundred million insects were collected. To count this number a man would take more than twenty years, spending ten hours a day on the work.

Some years ago in several parts of France, especially in Normandy, the number of cockchafers reached proportions that spread terror in the country. The amount of damage done by these insects is almost incredible. In most of the communes the trees were entirely stripped of their leaves; and in the evenings the air was filled with cockchafers to such an extent, that locomotion was almost impossible.

Almost everywhere bands of destroyers were organised, and large sums of money were paid by the municipalities, according to the number of cockchafers collected. All these insects were transported in wagon loads and thrown into the sea. In many places the number collected was so great that it was not possible to dispose of them, and the whole atmosphere was infected. In 1668 the cockchafers destroyed all the vegetation of an Irish county, so that the country presented the appearance of winter. The sound of their mandibles browsing on the foliage of the trees resembled the sawing of a large piece of wood; while in the evening the buzzing of their wings might be taken for the distant rolling of a drum. Enveloped by the clouds of insects, blinded by this living hail, the inhabitants could hardly find their way about. The famine was terrible; and the unfortunate Irish were reduced to eating the cockchafers.

Now what shall we say to the following?

It is less distressing than the Irish famine, but it will help to show us the prodigious legions of cockchafers in some years. In 1832, near Gisors, a stage-coach was surrounded one evening by a cloud of cockchafers. The horses, blinded and terrified, obstinately refused to advance and they had to turn back: the buzzing cloud had stopped the team.

When swarming to this extent the cockchafer is a formidable enemy, with which we must reckon seriously. There is but one way of getting rid of this disastrous brood and that is by destroying the grubs and the cockchafers. To a certain extent moles, hedgehogs, ravens, magpies and crows help this extermination by hunting the larvæ in newly ploughed land; a host of birds, shrikes, sparrows and others, which eat the cockchafers, also give their assistance; but the number of our enemies is so great that destruction by these natural means is altogether insufficient.

We must intervene energetically ourselves. Which of the two shall enjoy the fruits of the earth—man or the cockchafer? It will be man, if he will take the trouble—that is, if he will undertake and carry on a constant war against the insect and its larva.

Chapter IV *Caterpillars and Butterflies*

OF all insects the most beautiful and the most worthy of our young affection are the butterflies. How lovely they are! When resting on a flower they seem to form part of it and to bring it to life with the gentle flutter of their wings. We approach carefully, we stoop, extend our hand, and—the butterfly has departed. It is waiting on another flower, regardless of pursuit. We will leave it to wander from one bunch of lilac to another, while we learn something of its history.

All butterflies have four wings adapted to flight; two upper and larger ones and two underneath, half concealed beneath the others. There are no tough elytra like those of the scarabæus and the cockchafer; no protective sheath in which the membranous wings are folded, so that they may not be crumpled or torn. The scarabæus is a rustic pedestrian, which goes on foot and only flies in exceptional circumstances. The butterfly is a delicate aerial creature, scarcely ever walking, only using its feet to rest on the flower. It

has, therefore, four large wings, widely spread and always ready for flight.

And what wings these are! There are no words to describe them. Some are floury white, others sky-blue, sulphur yellow, fiery red or dark crimson; some have round spots, like eyes which seem to watch you with their great pupils encircled with azure, mother-of-pearl or gold, and some are spotted with black, edged with silver and fringed with carmine. When touched they leave on the finger a bright dust, beside which the filings of precious metals would seem dull.

This dust might be called the butterfly's plumage. It consists of extremely delicate scales placed evenly side by side like the tiles of a roof and fastened by one end in the membrane of the wing, just as the feathers are fixed by the quill in the skin of a bird. When held by the fingers the wing is stripped; it loses its garment of scales and is left bare. It is then a fine transparent membrane, traversed by nerves which extend and strengthen it.

When at rest all butterflies do not hold their wings in the same way. Those which fly in the daytime, and flutter from flower to flower in the sunlight, keep them upright and leaning against each other. These are also known by their bright colours, their easy flight and their beautiful shape. Those which fly by night, or in the twilight, keep the wings outspread, or slightly bent into an

arch. These are thicker and heavier than the former and exhibit darker hues in their costume.

Whether loving the light or the dark, whether diurnal or nocturnal, all butterflies are very abstemious and a drop of sweetness oozing from the depth of the flower suffices them for food. As many flowers are long with a narrow mouth, no head could penetrate such a vessel to drink the syrup. The butterfly has therefore a special instrument for the purpose.

This instrument is the trumpet, which is as fine as a hair and long enough to reach the delicious drop at whatever depth it is hidden. When not in use the insect keeps the trumpet tightly rolled up in a spiral close to its mouth. When it finds a suitable flower it unwinds this spiral and extends the trumpet in a straight thread, which enters the long-necked vessel and draws out the desired drop. If we should wish to drink from a vessel too small for our lips, we should make use of a straw or reed. The trumpet is the straw with which the butterfly quenches its thirst at the bar of the flowers.

Like other insects the butterflies are first larvæ which, as you know, are very different from the later form of the creature. The larvæ of butterflies are caterpillars. So it is that caterpillars, objects of our dislike, are transformed into the splendid butterflies which excite our unwearied admiration.

Some caterpillars, which show a bare skin striped with different colours, are not unpleasing. They may be touched, or even handled, without fear on account of their inoffensive appearance. But there are others, and these are some of the largest, that carry behind, on their back, an alarming horn—a kind of hook, liable to excite a reasonable suspicion. But this fear is unfounded; the horn is inoffensive and is not a weapon, but an ornament. The caterpillars which possess it produce great butterflies that fly about in the waning evening light.

Others are still more repulsive in appearance, bristling with tufts of prickles and bunches of long hairs. Some of the most beautiful butterflies come from these ugly things, the mere touch of which would be unpleasant to us. Such is the caterpillar that feeds on the leaves of the nettle, and becomes the Vanessa or peacock butterfly. This caterpillar is black, spotted with white, with a strong armour of toothed prickles. The butterfly—the Vanessa—has bright brick-red wings, all adorned with a large eye of black, violet and blue. Who could imagine unless they had seen it or been told, that such a delightful creature could have had such a beginning?

Notwithstanding their hairs and prickles, caterpillars are by no means formidable. There is nothing in them to justify the fear that they often inspire. Not one of them is

poisonous, or will hurt the hand that touches it. It is, however, advisable to use some precaution with regard to the hairy caterpillars; for their hairs sometimes come off, adhere to the fingers and cause considerable itching.

Every larva eats greedily, because it has to grow and to store up a reserve for future transformations. The caterpillars do not fail in this serious duty. The prosperity of the future butterfly depends on it, and being adapted solely for eating, they gnaw and feed incessantly. Each one has its special food and plant, and nothing else will do for it. That of the Vanessa loves nettles and loathes everything else; that of the Pieris, or Cabbage Butterfly, only likes cabbage; and the Machaon, a butterfly whose large wings end in a spike, feasts on fennel. It is the same for others.

When they have reached their proper size the caterpillars, like other larvæ, prepare for metamorphosis. Some are enclosed in a shell fashioned by a silken thread issuing from their mouth; others are satisfied with gluing together, with the small amount of thread at their disposal, bits of earth, morsels of wood or the hairs stripped from themselves, thus procuring a strong dwelling, at small expense. Others, again, especially among the butterflies that fly by day, only take refuge on a wall, or a tree, and hang there by a silk band.

When these precautions have been taken the caterpillar strips off its skin and changes into a nymph, which is quite different from that of the stag-beetle. In that case we were able to recognise the coleopter with its branching claws, its legs folded on its belly, and wings contained in a sheath. This is not the case with the butterfly. Its nymph, with a skin as hard as parchment, is an indefinite object which, far from resembling some creature, would rather suggest the kernel of some strange fruit. By reason of its form, so different from that of other nymphs, it has received the special name of *chrysalis*.

This name means "golden." Some chrysalids, especially that of Vanessa, are adorned with gilding. But in the great majority of cases this gorgeous epithet is undeserved, the usual colour of chrysalids being plain light or dark brown. When matured by a long rest, this species of animal shell breaks open down the back and the perfect insect, with all its attributes, comes forth. The butterfly spends a few days feasting on the flowers and, before dying, lays the eggs from which the caterpillars that are to carry on the race. will be born.

Chapter V — *The Phylloxera*

You must have heard of the plant-lice, which are milked by the ants. These strange herds have, instead of nipples, two little tubes from which a sweet fluid oozes. The ant milks them by stroking them with its antennæ; drinks their milk, filling its stomach for a bucket, and swelling out, and returns to the ant-hill to discharge the exquisite liquor into the mouths of the nurslings. The ants watch the nurslings with jealous care, if necessary enclosing them in folds—the terror of would-be robbers. So far all is well; the flocks of the ants amuse us for a time and there is no serious fault to be found with them. If, however, we inquire further we shall take a far more serious view of the lice.

We will first examine those which inhabit the rose-tree. We wish to gather a rose. Its scent perfumes the air, while its form and colour delight the eye. We pick it, and what have we in our hands? At its base, and over the whole twig that bears it, the splendid flower is infected with a host of green lice. Odious vermin have taken possession of it:

the eye is disgusted; the fingers draw back from this living bark which, at a touch, dissolves into a sticky liquid. We will gather the rose all the same and examine the lice for a few minutes before getting rid of them.

They are light green, big-bellied, and without wings. With a little attention the two small posterior horns may be detected, from which the liquid dainty of the ants oozes. They have under their body a straight and very fine sucker—a kind of probe which they fix in the soft bark, in order to draw out the juice which is their food. When once the sucker is fixed in a convenient spot the creature does not move. If it changes its place ever so little, it is because its well is dried up and it must pierce another close by. To travel round the twig would be an adventure only attempted by the boldest. The rule is for the louse to remain definitely on the very spot where it was born.

The lice increase very quickly; for each of them, without exception, however many there are, is able to produce a family after a few days. The newly-born settle by the side of their mother and are themselves soon surrounded by their offspring. Soon afterwards these produce their own offspring, and this goes on as long as the hot weather lasts. The twig, the branch, the whole plant is then covered with lice so closely pressed together that the bark quite disappears under this cover of vermin.

Have you seen a bed of beans attacked by black lice? The rapidity of the propagation is there seen at its worst. A small black spot is seen on the green expanse and announces that the attack has begun. This is a family of lice settled at the top of a stalk, the tenderest part, where the suckers can act most efficiently. The gardener hurriedly cuts off the top and crushes it under foot. He hopes to get rid of the nuisance by destroying this nest of vermin.

His hope is of short duration. A few days afterwards, instead of one plant, there are dozens attacked. He again cuts off the heads and turns over the leaves and examines them one by one, crushing them so that none shall escape extermination. Is it all right now? Not in the least; the black population reappears more numerous than ever: the infected plants exceed computation. A few lice that escaped the slaughter have infected the whole bed of beans. The leaves hang down, unsightly and withered; the young fruit, riddled with wounds and wrinkled with scars, shrivels up, having lost the power of growth. Remedy there is none: the harvest is ruined.

The gardener pulls up everything and throws it on the dunghill. His care and vigilance have been unable to subdue the invasion. In vain has he crushed legions beneath his angry heel. In a few days the scanty survivors established a family more

numerous than before. Man is not in a position to struggle successfully against these tiny vermin, which by their infinite number defy destruction.

We have seen that the plant-louse does not like to change its place. It plants its sucker in the spot where it is born and does not stir, drinking the sap and surrounding itself with a family. This love of rest explains how the branch of a rose-tree, or the top of a bean-stalk is gradually covered, but it does not account for propagation at a distance.

With its stay-at-home habits this insect should be confined within strict limits—on one leaf, but not on all; on one rose-tree, but not on its neighbours. On the contrary it is everywhere. When one bed of beans is attacked, all those in the vicinity suffer alike; when one rose-tree is infected, the same thing happens to all the rest. No suitable plant will escape the invasion. How then can this fat little insect, which totters with fatigue after one step forward, pass from one rose-tree or one garden to others? How can it take possession of unlimited space?

If we examine a few rose-trees we shall find a speedy answer to this question. Besides the wingless, pot-bellied lice, assembled on the tender twigs, we shall find others, also green, but more elegant in shape, more slim in figure and possessing four very beautiful, diaphanous wings, exhibiting the colours of the rainbow. These are not the lazy drinkers

of the sap, always crouching over the spring exposed by the sucker. We see them coming and going, moving about cheerfully among the motionless flock, inspecting the leaves, transporting themselves from one branch to another, and even taking their flight to a distance. These are the travellers of the family. Their function is, by the help of their wings, to propagate their race in the neighbourhood, or even at a great distance when carried away by a puff of wind.

Thus, among the green lice of the rose-tree, the black lice of the bean, and many others, there are two kinds of insects—unlike but related. Some have no wings, and live on the spot where they were born, to multiply there in crowded legions. The others, relatively few in number, are provided with wings. Without settling anywhere, carried by the wind and their wings, they deposit in a suitable place the germs, each of which will produce a flock of wingless lice. The former increase on the spot with inconceivable fertility; the latter desert the immovable family and found new centres of population elsewhere. The former swarm to excess; the latter colonise.

To spoil the stem of a rose with a family of lice is not very dreadful; to destroy a field of beans is a more serious matter. This is nothing compared with other crimes of the lice. One of them lives underground on the roots of the vine. That hateful louse!

Agriculture has never known such disasters; neither floods, droughts, nor bad seasons have caused such distress. It is said that its terrible sucker has already cost France the fabulous sum of ten thousand million francs. What a mouthful for wretched, almost invisible vermin! And to think that the common effort of nations cannot exterminate this louse. Alas! how weak is strength when opposed by that which is very small and infinite in number!

This destroyer of the vine is named *Phylloxera*, a word foreign to our language, but impressive when its meaning is known. "Phylloxera" means *leaf-witherer*. The louse bearing this name does really wither the foliage of the vine, not directly it is true, but by attacking the roots. These pierced and wounded, can no longer draw the food of the plant from the ground; the stem dies, and with it the leaves, which turn yellow and fade.

The Phylloxera is not satisfied with withering the foliage; it withers and kills the whole vine. Moreover, the name that it bears was not made on purpose for it; another possessed it before the destroyer of vineyards was known. The louse first named Phylloxera lives at the expense of the oak; it settles on the leaves and draws out the juice. This is really the leaf-witherer. The vine louse has merely inherited an old name, which is inadequate to represent the gravity of its destruction.

The latter is a small, plump, yellowish louse, hardly to be seen by an unpractised eye. It lives in hosts, on the fine branches of the roots, wherever the bark is soft enough to allow it to plunge its sucker. The ranks are so crowded that the infested rootlets are covered with a continuous sheath of vermin, which stains the fingers yellow. All, however many there are, lay in the crowd, little heaps of oval-shaped eggs, which are sulphur yellow at first, but turn brown as the time of hatching approaches.

From these in a few days fresh layers are born, which settle near the first and augment the innumerable family with their offspring. As long as the favourable season lasts, myriads of generations succeed one another, until the filaments of the roots disappear under the accumulation of the layers and their eggs.

Riddled with wounds, the rootlets swell out at intervals and look like chaplets of long beads. When thus deformed, with their delicate suckers injured, they can no longer extract the nourishing juices from the earth. The starving vine languishes for a time, and sends out a few poor shoots, which cannot produce grapes. At last it withers and dies—the louse has murdered its nurse.

THE yellow root-louse is not fond of travelling : wingless, slow and pot-bellied, it is ill-adapted for locomotion. Wherever its little drill is fixed it likes to remain as long as possible. But when the dying rootlet turns to corruption it is obliged to change its dining-room and to seek a better furnished table elsewhere. The louse must then change its lodging. A persistent explorer, with time and patience, it can pass from one root to another through the cracks in the ground. It even dares to come to the surface, and travelling in the open air, it moves from the exhausted stock to its neighbour, which has plenty of sap and the roots of which may be reached by some opening in the ground.

One of our steps would be an enormous journey for this slow walker, and its further distribution would be very slow if it were not assisted by other means. The green louse of the rose tree has already shown us this method of colonisation at a distance. The phylloxera also has a special guild of winged travellers to be spread abroad in the vineyards.

In the hottest days of summer, among the hosts of yellow lice covering the roots, some will be noticed of a longer shape. These soon cast their skin and then show two pairs of black projections on each side, which are the sheaths of four wings to come. These are the nymphs intended for emigration. These nymphs abandon the depths and come up to the base of the stock sometimes even to the surface of the ground. Then there is another change of skin and the winged insect appears, larger than its underground kindred.

It measures rather more than one twenty-fifth of an inch, without the wings. These are transparent and iridescent, and much longer than the body. The upper ones are wide, round and slightly smoky at the end, while the lower ones are narrow and shorter. They are traversed by strong nerves—the sure sign of a powerful flight. With its large diaphanous wings, its broad head with big black eyes, its belly ending in an obtuse point and its yellow colour, the travelling insect looks like a very small cricket. This is the phylloxera, entrusted with the duty of propagating the race at a distance.

This is no longer the slow, fat little insect, the strength of which is exhausted by passing from one root to its neighbour. This is an agile, aerial creature, able to traverse a distance of several miles with the speed of an arrow, especially with a favourable wind. During the hot days of July and August the

winged phylloxeræ take flight and settle in swarms on the vineyards, which have been respected until then. Settling on the foliage, their suckers draw up a moderate subsistence.

They have no intention of feeding with insatiable greed, like the lice that are settled on the roots; and the damage done by them is of no importance. Unfortunately they have a mission which is most disastrous: the mission of infesting the neighbouring vineyards and filling the still healthy regions with underground destroyers. All set to work; every one, without exception, begins to lay.

It is true that the eggs are few in number; for each layer deposits ten at the most in the cottony down of the young leaves and shoots. Nevertheless, this produces an enormous number, for in this strange family there are so far only mothers. We have seen that all the wingless root phylloxeræ lay eggs, and now all those on the leaves do the same.

This outrageous fertility must end in the exhaustion and extinction of the insect if there were no truce for renewing the vitality of the race. The eggs of the winged phylloxeræ are yellow, like those that are produced underground; but they are of two kinds—some larger and other only half the size. The former give birth to females, the latter to males, and at last we have the two sexes, whose co-operation will assure lasting prosperity.

But what strange little creatures. They are yellow, wingless, squat—resembling the root lice, but still smaller than these. This third form of phylloxeræ are the dwarfs of a dwarf family. They have no stomach for digestion, no sucker for piercing the leaf and drinking the juice. They have no need of food. Their short existence is limited to laying eggs, which will renew the strength of the race, and to depositing them in a safe place. When this is accomplished they at once die.

These male and female dwarfs wander about the stocks for a few days; and then, in the cracks of the wrinkled bark, each mother lays a single egg—huge in contrast with the small size of the layer and green and marked with black spots. This egg, which is called the *winter egg*, will spend the cold weather fixed to the bark of the plant by a small hook. When this is finished the layer contracts into a reddish spot and dies.

When summer returns the winter eggs are hatched and give birth to lice like those on the roots. Each one goes down its native stock, seeks the ground, finds a crack, enters and settles on a rootlet, on which it fixes its sucker. At peace in the ground and in the lap of abundance it does not remain alone for long, but deposits its heap of eggs at its side, which soon produces a new generation. Each member of this family surrounds itself with offspring of its own, and this process is

repeated until the root which had originally only one inhabitant is covered with a legion of destroyers. To this recent population we must not forget the former subterranean inhabitants, which live through the winter and begin to lay again as soon as the hot weather returns.

Let us sum up these strange customs. The race of the phylloxera comprises three forms of insects, each of which has its special structure, mode of life and function. We have thus three different insects grouped in a single species.

The *sedentaries* are wingless and live on the roots. All of them lay eggs and are followed by several generations equally adapted for laying. The vineyards perish through the wounds of their countless numbers. This is the real enemy, the marauder whose scarcely visible sucker has already cost such fabulous sums.

The *migraters*, which have large wings, live on the leaves and deposit a small number of eggs in the down of the shoots. Like the sedentaries they are all layers, but their office is to propagate the race from one vineyard to another.

The *sexuals* conform to the general law; being male and female. Without wings, sucker or stomach, they wander over the plants without taking any food. Each mother lays a single egg, the winter egg, which produces a sedentary phylloxera in

the spring. This goes down to the roots, settles there and starts a fresh colony.

How can we fight this enemy which defies our attempts at extermination by its numbers and its underground existence? Three principal methods are in use. In low ground the vineyards are flooded in winter and a deep layer of water is retained. The root phylloxeræ are killed by this submersion. Secondly, by means of boring holes down to the roots an asphyxiating liquid, *carbonate of sulphur*, is injected into the ground and the vapours at once kill any insect in contact with them. The difficulty is to avoid leaving survivors. In the third place, wild vines are brought from America, which are far more robust than the European ones but the grapes of which are of very poor quality. These American plants resist the wounds of the phylloxera when attacked and prosper when others would succumb. The European vine is, therefore, grafted on to this well-rooted wild stock, whereby plants are obtained, the strong roots of which resist the attacks of the phylloxera, while the shoots afford the incomparable grapes of the old vineyards.

Chapter VII — *The Ant-lion*

By the waterside, fluttering from reed to reed, there are insects with great transparent wings and a long, thin body like a piece of string. Some are bronze-green, some splendid indigo, and other larger ones, wearing a costume of mingled black and yellow. They are called *libellula* or, more commonly, *dragon-flies*.

Do you know them? Do you recognise them? Have you never followed one? On the end of a reed that quivers in the running water; it seems to be asleep and waiting for you with outspread wings. You stretch forward your hand to grasp it. Good-bye, dragon-fly! It is ten steps farther away.

Not all of them frequent the reeds of the brook. There are some that avoid the cool spots and prefer the sandy ground scorched by the sun. Their colour is a modest grey; but they compensate for this lack of splendour by their strange mode of life while still larvæ.

It is a strange and somewhat alarming creature and we should not care to meet it at

the corner of a wood if it were large enough to attack us. Its fierce pointed claws, opening and shutting like pincers, seem to proclaim a murderous appetite. Indeed, this insect only lives by slaughter, its sole quarry being the ant; for which reason it is called the ant-lion.

Such prey can offer no serious resistance when once seized by the terrible claws: but first it must be caught, and that is the difficulty. The agile ant flies quickly, and if hard pressed climbs up a blade of grass and avoids the danger. The ant-lion, on the contrary, with its heavy body and short legs, drags along awkwardly; and should it happen to use its legs, which is seldom the case, it can only go backwards—not the best way to make speedy progress or to keep sight of the quarry.

Direct hunting being impossible, there still remain the trap and the ambush. The hunter must seize by cunning the prey that it cannot overtake, because of its heavy obesity. We will look into this stratagem.

Let us seek at the base of walls and rocks exposed to the sun. If there is some shelter to which the rain never penetrates, some small grotto with a floor of very fine dry sand, the ant-lion will hardly fail to be there. Its dwelling may be recognised by regular funnels dug in the sand. But the creature itself is invisible, being hidden at the bottom of the excavation.

If we raise this floor by obliquely introducing the blade of a knife, the ant-lion will appear, bewildered at first by the disturbance of its dwelling, but soon recovering and trying to bury itself in the sand by a backward retreat. We must make haste to catch it and place it in a glass, on a bed of sand similar to that from which it was taken. Here we can see it digging its funnel—the trap to catch the ants—or practising the stratagems of a hunter in ambush.

Resting on a bed of sand, recovered from its recent shock, the ant-lion buries half its body, and using it as a ploughshare and moving backwards, traces a circular furrow. When it has returned to the starting point it ploughs another just inside the first, a third inside the second, and a number of others—becoming smaller and smaller, so that the whole forms a spiral line winding round and round as it approaches the central point.

As this living plough goes deeper at each turn, and throws out the excavated sand, the final result is a funnel about two inches in diameter, and rather less in depth. This is the trap, the treacherous pit in which the ants are to be caught.

A hunter in ambush must not be seen, and as the ant-lion is too expert in its business to disregard this elementary principle, it hides under the sand in the centre of the funnel. Only the claws are seen, resting on the ground and ready to transfix anything which

may fall into the precipice. Although exposed the horrid claws inspire no distrust: from the top of the pit they would be taken for being fragments of a dead leaf.

When these preparations have been made the creature waits, quite motionless. Its patience and hunger are subject to lengthy trials; for hours and days elapse without any prey falling into the trap. It is difficult, in this world, even for an ant-lion to earn its mouthful.

At last an ant comes along. Going about its business and being so busy it does not notice the pit. It has hardly touched the edge of the abyss, however, when the sand slips away from beneath its feet. The slope of the funnel runs away and carries with it the careless insect. Half-way down, with a desperate effort, the ant stops and tries to ascend. With its frail claws, trembling with terror, it clings as well as it can to any inequality in the side; but as soon as they are touched the supports give way and the irresistible glissade is resumed.

The fall is arrested by a grain of sand, more stable than the rest, and safety may result from this support if it holds good. It does. The ant goes up a little way with very careful steps, for fear of disturbing the dangerous ground. It approaches the edge of the abyss: it will reach it; it will escape.

Not at all; the hungry creature watching at the bottom of the funnel has no such idea, but has every intention of dining on the ant.

If things had followed their proper course and the imprudent insect, having entered the crumbling trap, had slipped as far as the claws, it would have been seized without further formality; but since the prey is escaping the hunter must have recourse to a manœuvre reserved for difficult cases.

The head of the ant-lion is flat and shaped like a navvy's shovel. The insect fills it by plunging it into the sand, and then with a rapid movement of its neck throws the load into the air on the top of the ant. Other shovelfuls, very quickly and better aimed, fall like hail on the exhausted ant.

No resistance is possible to this shower of sand, on treacherous ground which falls away at every attempt to escape. The poor beaten insect is dragged down and falls to the bottom of the funnel. The claws promptly seize it, and it is all over. The hunter will dine; not by gnawing the prey which is too tough for it, but by sucking it—greedy epicure that it is.

As soon as nothing is left of the ant but a dry skin, the ant-lion places it on its own head and throws it out of the funnel, so as not to disfigure its den with a useless carcass, which might excite the suspicion of the passer-by. Then the sandy trap will be restored by careful ploughing; the slopes of the precipice will be as slippery as before, and the hunter will wait patiently for another ant—the victim of a careless step—to slip into the den.

Chapter VIII — *The Bat, the Hedgehog*

SEVERAL creatures, carrying on an independent existence, help us by fighting the caterpillars, larvæ, insects, and other destroyers of our harvests. What can man do against the insect, which is renewed every year in incalculable numbers? Will he have the patience, skill and eyesight, necessary for waging war against the smaller species, while the cockchafer defies us, despite its larger size? Can he undertake to examine every sod of his fields, every blade of his wheat, every leaf of his fruit-trees?

The human race would not suffice for this prodigious work, if it concentrated all its strength on this occupation alone. The greedy brood would starve us unless others were working on our behalf; others, gifted with unwearied patience, with skill which overcomes all stratagems, with vigilance from which nothing escapes.

The only care of these others, their incessant occupation is to watch the enemy, to seek him out in his hidden retreat and to exterminate him. They are eager and

pitiless; impelled by hunger for themselves and their families. They live on those who live at our expense, and are the enemies of our enemies. The bat, the hedgehog, the mole, the owl, the swift, the swallow and all small birds, the lizard, the adder, the frog, and the toad, are among the chief of those that share in this great work.

The *bat* feeds exclusively on insects. None come amiss to it; beetles with hard wing-cases, skinny gnats, plump butterflies, and, in particular, moths—those destroyers of our crops, our vines and our fruit-trees, which, attracted by the light, come to burn their wings in the lamps of our houses. Who could tell the number of insects devoured by the bats while they circle round the house? The prey is so small and the hunter's appetite so insatiable.

We will observe what goes on during a quiet summer evening. Attracted by the mild temperature and the twilight the insects leave their retreats in crowds, and come out to play in the air, to seek their food and to find their mates. This is the time when the great night butterflies are flying hastily from flower to flower, plunging their long trumpets into the corolla and sucking the honey; when the gnat, greedy for man's blood, sounds his war-song in our ear and chooses our most tender spot to insert his painful lancet; when the cockchafer quits the leaves, spreads his humming wings and strolls

forth to meet his kin. The midges are dancing in merry bands, scattered by the least breath like a pillar of smoke ; the moths, with wings powdered with silvery dust, are gambolling or looking for a favourable spot to lay their eggs ; the little wood-eating beetles leave their galleries and prowl on the bark of the old tree-trunks ; and a host of butterflies, whose caterpillars live on our fruit, are exploring the apple trees, pear trees and peach trees—all occupied in securing board and lodging for their disastrous progeny.

In the midst of these joyful crowds the spoil-sport suddenly appears. It is the bat, with its twisting, tireless flight, that comes and goes, rises and falls, appears and disappears, turns its head from side to side, and every time catches an insect in its flight, which is at once crushed and swallowed by the great mouth spreading from ear to ear.

As long as the fading evening light allows, the eager hunter carries on his work of extermination. When at last satisfied the bat will seek its gloomy retreat. On the morrow, and all through the hot weather, the same pursuit will be resumed, always as keen and always at the expense of insects alone.

The *hedgehog* feeds chiefly on insects. He despises the tiny vermin as being too small ; but the larva of the cockchafer is a fine prize. If the grubs are not too deep in the earth he digs with his feet and nose to extract them.

He wanders about all night—prowling, seeking and devouring numerous enemies, without any appreciable preference. He seems to attack all kinds of prey indifferently to satisfy his greedy appetite. Even the viper is eaten without any fear of its poison.

The prickles with which the hedgehog is covered are just hairs—very large, stiff and as sharp as needles. They cover all the upper part of the body, mingled with other fine, soft, silky hairs, which form the fur. The lower part has only the silky hairs, otherwise the animal would wound itself when it rolled up.

When the hedgehog, which is always very cautious, is aware of danger, he bends his head under his body, draws his feet together and rolls himself into a ball, which presents to the enemy an armour of thorns everywhere. It was said by the ancients that while the fox had many tricks, the hedgehog had but one—but that one was always effective.

Where is the champion bold enough to seize the animal in this posture of defence? The dog will refuse obstinately, after some ill-advised attempts which have covered its muzzle with blood, and will only bark. Sheltered by its cover of needles the hedgehog remains deaf to these empty threats, and keeps quiet. As soon as the enemy has departed the hedgehog warily unrolls and hastens to reach some safe retreat.

WHAT does the mole that lives underground live on? On all kinds of small game—beetles, larvæ, caterpillars, chrysalids and other marauders that live in the earth. Moreover the animal has a starving appetite, a frenzied stomach which in twelve hours requires an amount of food almost equal to its own weight. The mole will die of starvation after a few hours' abstinence.

What can the animal rely on to appease the torment of such a stomach, through which the food only passes, dissolves and at once disappears? It relies on the larvæ that inhabit the earth and, above all, on the larvæ of the cockchafer. These are small things for such hunger, but their number compensates for their size. So what a clearance of grubs will be effected by the mole, when the ground is full of them! There is no animal as useful as the mole.

It is only a pity that, in order to reach the vermin on which it feeds, it is obliged to dig among the roots occupied by the prey. A number of roots that interfere with its work

are cut through; the plants are uprooted and lifted up, and the earth from the excavated galleries is piled up outside in little mounds or mole-hills, which hinder the play of the scythe when the hay of the meadow is cut. No matter, the grubs would do far more serious damage and there is nothing equal to the hungry hunter for ridding the field of these.

Everything in the mole is fitted for the rapid extension of the galleries, which are prolonged for hundreds of yards. The body is thickset and round, almost cylindrical from end to end, so as to slip easily through the narrow passage. The fur is short, thick and carefully polished, so as to give no hold to the dust and to remain perfectly clean in the most crumbling and easily disturbed earth. It resembles a kind of black velvet.

The tail is short and the external ears are lacking, though the sense of hearing is extremely acute. These various appendages, often highly developed in animals that live in the open air, would be inconvenient underground and an obstacle in the narrow gallery.

Widely opened eyes, exposed to grains of dust from earth continually disturbed, would be a source of constant torture to the mole. Besides—how should they be needed in the absolute darkness of its dwelling? The mole is not quite blind; it has eyes, but they are very small and buried in the thickness of the fur.

It is guided by its sense of smell, as keen as that of the pig, and it has a similar snout to unearth the morsel revealed by its odour. The pig with its snout tracks and finds underground the scented truffle ; the mole tracks and finds the plump grub in the same way.

In order to reach it through the mass of roots, it has its front feet, which are enlarged into enormous hands, armed with exceptionally strong nails. These hands, which are strong shovels, able to force a passage through stiff ground, are the special tool of the mole.

As the animal advances, digging with its snout, and clearing with its hands, the earth is thrown backwards in the gallery by the hind legs, which are much weaker but good enough for this easier work. If the mole intends to return by the same way the road must be kept open : so the rubbish is pushed outside and forms mole-hills at intervals.

I am not about to discuss whether the toad is ugly or not—every one has a right to his own opinion—but whether it is dangerous is another matter. The toad is an extremely inoffensive animal and also a most meritorious helper, being a greedy devourer of snails beetles, larvæ and every kind of vermin. Discreetly hidden by daylight under the shelter of some stone or in some dark hole, at nightfall he leaves his retreat and goes his rounds, lamely dragging himself along on his great belly.

A snail is hurrying towards the lettuces; a mole-cricket is chirping on the threshold of its burrow; a cockchafer is depositing its egg—the toad approaches quietly, opens a mouth like the door of an oven, and in three mouthfuls swallows up all three, smacking its throat as a sign of satisfaction. How good! How very good! Let us have some more.

The game goes on. When it ends at dawn you may imagine what vermin of every kind is contained in the glutton's great belly. And there are some who kill this precious animal and stone it to death because it is ugly, thus depriving the fields of their vigilant guardian! Leave him to carry on his work in peace; he will destroy so many insects, snails and worms, that you will find that he is not so ugly after all.

Chapter X — *Nocturnal Birds of Prey*

THE owl, the screech-owl, the horned owl, and other similar species, have received the name of *nocturnal birds of prey*. They have received this name because they live by hunting, in particular the rats and mice of our houses and those that live in the fields. They are among birds what the cat is among quadrupeds—fierce slayers of that small game of which the mouse is the most familiar example.

They are cats in their mode of life—flying cats, hooting cats, uttering cries like piteous howls. They are nocturnal, which means that in the daytime they remain hidden in some dark retreat, and only come out in the evening, to hunt in the twilight or by the light of the moon.

Their eyes, which are very large and round, and are both situated in front instead of being placed at either side of the head, are encircled by a large wreath of fine feathers. The need of these enormous eyes is caused by their nocturnal habits. Because they have to find their food in a very dim light, in

order to see clearly they must receive as much light as possible, and this calls for widely opened eyes.

But these large eyes, which are so useful at night, are a serious trouble in the bright light of day. Dazzled and blinded by the rays of the sun, the bird of darkness remains in some hiding-place which it dares not leave. If it is obliged to move it does so with extreme circumspection—its flight being undecided, short and slow. The other daylight birds vie with each other in insulting it. The redbreast and the titmouse are the first, and these are followed by the chaffinch, the blackbird, the jay, and many others.

Perched on a branch the bird of night answers its assailants by grotesque motions of its body, turning its head from side to side in an absurd fashion and rolling its bewildered eyes. These threats are of no avail. The smallest and weakest birds are most active in tormenting it. They attack it with their beaks, they pull out its feathers, and it dare not defend itself.

Because of their large eyes the birds of prey need a dim light—that of dawn or twilight. So they leave their retreats to hunt their prey at the beginning or end of night, when they carry out a successful pursuit ; for they find the rats and mice, either of the houses or the fields, either asleep or just falling asleep. Moonlight nights are most favourable to them, and during these

fruitful times they hunt for a long time and effect numerous captures.

We will follow the owl in his nocturnal progress. The time is propitious; for the air is calm and the moon is shining. He leaves the wood and skims over the bare plain, the ploughed fields and the meadows. He examines the furrows and grassy lawns where the field-mouse hides and the hovels where the rats and mice are running.

Its flight is silent, its soundless wings cleaving the air without the slightest noise which might warn its victims. This silent flight is due to the structure of its feathers, which are silky and finely divided. Nothing betrays its sudden approach, and the prey is seized before the presence of the enemy is suspected. On the other hand its wonderfully keen sense of hearing informs it of everything that happens in its vicinity; for its great, deep ears will notice the mere rustle of a field-mouse under the grass.

The prey is seized by two strong claws, warmly clothed with down as far as the root of the nails. These claws are composed of four digits—three directed forwards and one to the back. But by an advantage possessed by nocturnal birds of prey, one of the front digits is movable and can be turned backwards, so that the claw is divided into two pairs of equal strength should the bird want to grasp, as in a vice, the branch on which it perches, or its struggling victim.

The head of the captured rat is smashed by the beak, which is short and hooked. The two mandibles are moved very easily, so that by striking against each other they emit a rapid chattering or rattling by which the bird expresses its anger or its terror.

During the action of swallowing they expand, showing a large opening passing into an enormous throat. The prey is first moulded by the claws and then disappears as a whole, with bones and fur. Nothing is left of the rat or field-mouse—not even a hair.

When digestion is finished a shapeless mass is left in the stomach, composed of skins inside out, and retaining all their hair, and bones as clean as if they had been scraped with a knife. The bird gets rid of this troublesome mass, which is of no value as food.

Grotesque motions indicate the work of deliverance ; something is travelling up along the distended neck, the beak opens, and it is all over. A ball rolls to the ground containing skins, bones, wing-cases, hair— everything that is unaffected by digestion. All nocturnal birds of prey clear their stomachs in this strange way. They throw up in balls the refuse of the prey which has been swallowed whole.

Chapter XI — *The Small Birds*

ALMOST all small birds help us to preserve the goods of the earth from the ravages of the insect. Their service deserves a long story, but time is lacking, and we can only mention a few of these brave caterpillar-hunters.

The tits are lively, impetuous little birds, constantly in motion. They flutter from tree to tree, carefully inspecting the branches ; they hang at the end of the weakest twigs, remaining there in any position often with their head downwards—following the swaying of their flexible support without losing their hold, and never ceasing their examination of the worm-eaten shoots, and opening them to get at the vermin and eggs that they contain.

It has been calculated that a tit consumes three hundred thousand insects' eggs in a year. It is true that it has to supply the needs of an exceptionally numerous family, yet to feed twenty nestlings and more at a time is not too hard a task for its activity. It is then that the shoots and the cracks in

the bark must be inspected, in order to catch the larvæ, spiders, caterpillars and maggots of every kind, and to feed twenty beaks always gaping hungrily in the nest.

The mother arrives with a caterpillar. The brood is excited and twenty beaks are opened. Only one receives the morsel, and nineteen have to wait. The unwearied tit goes off again, but by the time that the twentieth beak is satisfied the first has long been gaping with hunger. Only consider how much vermin is consumed by such a family.

Whole families of birds are addicted, like the tit, to the patient pursuit of seeking for eggs in the wrinkles of the bark and the folds of the leaves; for larvæ in the scales of the shoots and in rotten wood, and for insects in the depth of the cracks where they remain hidden. In this kind of hunting the bird has not to pursue the game, or to rival it in speed, but only to discover its dwelling-place. For this a keen eye and a sharp beak are needed; the wings are only of secondary importance.

But other families practise the great chase in the air, and pursue in flight midges, moths, gnats and beetles in the plains of air. They need a short beak very wide open, which will securely catch the midges as they pass, despite the uncertainty of their motion which is often not under control; a beak into which the prey will plunge of its own accord, without the bird slackening its flight for a moment; a beak sticky on the inside,

so that a little butterfly cannot graze it with its wing without being caught by the glue.

Above all, there must be indefatigable and rapid wings, unwearied by the desperate flight of the game at full speed and not deceived by the crooked course of a moth at its last gasp. A widely opened beak and very large wings are necessary to make the bird fitted for hunting in the air on a large scale.

These conditions are fulfilled to the utmost by the swallow and the swift, which both pursue flying insects. Following them tirelessly—going and coming, crossing and recrossing in a thousand ways—they gulp them into their great sticky throat and pass on without stopping for a moment.

The granivorous bird, which lives on grain, has a strong beak, broad at the base, and stiff in proportion to the hardness of the seeds that it is intended to split open.

Such are the chaffinch, the greenfinch, the linnet, the goldfinch and the sparrow. The *insectivorous* bird has a slim, thin, delicate beak, but less robust because the vermin that it catches are softer. Among these are the nightingale, the warbler, the fallow-finch and the dishwasher.

Agriculture has no more efficient protectors from the ravages of vermin than these little birds with their fine beaks, eagerly devouring the larvæ and insects. But the granivora certainly have their faults.

There are some that plunder the cornfield, that are able to extract the wheat from the ear, and impudently share with the poultry the oats scattered in the yard. Others prefer the juicy flesh of fruit and know, before we do, if the cherries are ripe or the pears are melting.

These misdeeds are amply compensated for by their services. The granivora gather from the fields an infinite number of seeds of every kind, which would choke the harvest with weeds if they were left to grow up.

With this character of weeder they unite another which is more meritorious. It is true that grain is their natural food, but they do not despise insects by any means, and devour them in large numbers when they are plentiful and easily caught. Better still, when young, weak and naked, they receive their beakful from their parents, many of the granivora are fed with insects.

We will take the sparrow as an example. He is certainly a grain-eater. He plunders the dove-cots and poultry yards, stealing food from the pigeons and fowls. He anticipates the harvest of the cornfields near our dwellings. Many other misdeeds are laid to his charge. He strips the cherry trees, plunders the gardens, forages among the growing seeds, and refreshes himself with the young lettuces and the first leaves of the peas. But when the time of eggs comes the

impudent thief is converted into a quite exceptional helper.

Twenty times in the hour at least the father and mother by turns bring their beakful to the little ones; and every time the bill of fare consists of a caterpillar or of some insect large enough to be divided into quarters, or a plump grub, grasshopper, or any other game.

In one week the brood will consume about three thousand insects—larvæ, caterpillars, grubs of all kinds. The remains of seven hundred cockchafers have been counted near one sparrow's nest besides innumerable small insects. This is the food required to bring up a single brood. Let us then keep friends with all the small birds which defend us from the destructive insect.