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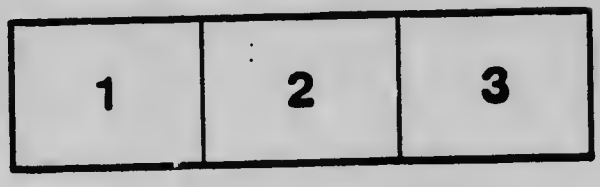

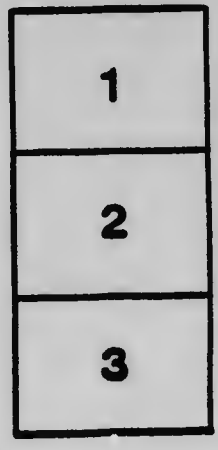

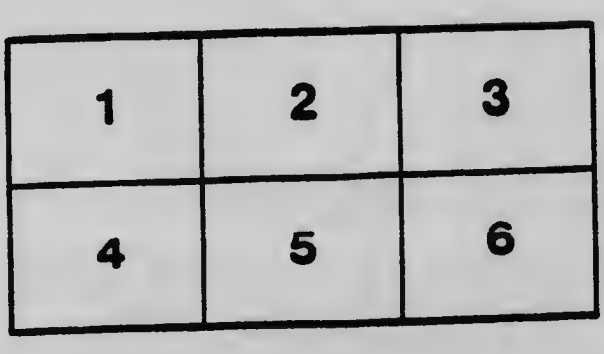

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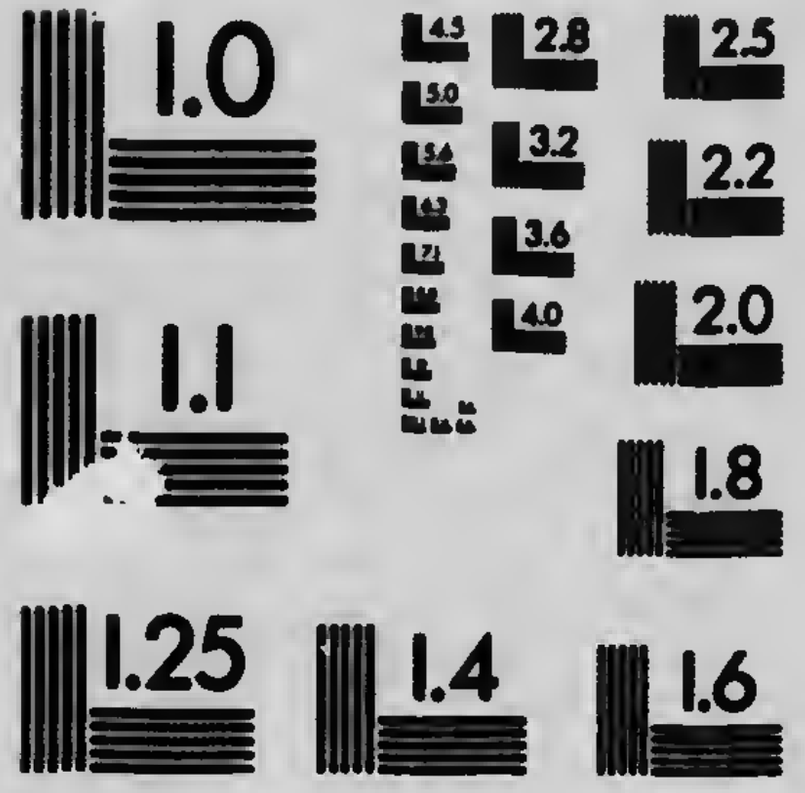

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ILLUSTRATED WITH PHOTOGRAPHS AND PHOTO-MICROGRAPHS TAKEN BY THE AUTHOR

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PREFACE

THE science of Entomology is one the importance of which has not yet been fully realized. Until quite recent times the man who went into the fields with a magnifying lens and a net was regarded as a more or less harmless crank. To-day that idea has become considerably modified, and man is learning that his own life is often menaced by the insignificant insects which buzz and move around him; likewise with his cattle and his crops, for these are even more threatened than he is himself.

The entomologists of to-day are rendering vast services to humanity, and those of the future will wield powers the significance of which we are as yet scarcely able to comprehend. Nevertheless, the study of insect life has yet to be made popular.

To assist in the later purpose the life-histories contained in this volume are designed. It is of growing importance that the public should be taught in plain and simple language the details in the lives of familiar insects—many of which are our valuable friends, and at the same time the deadly enemies of some of our worst insect foes.

The writer has made every effort in the various chapters to avoid that scrappiness of treatment so

often found in so-called Nature Study books. Some of the chapters deal with insects which may be regarded neither as friends nor enemies of man, but which present some exceedingly interesting aspects of insect life.

The photographs which illustrate this volume, and which the writer trusts will compare well with anything of the kind that has been published hitherto, have, with one or two obvious exceptions, all been photographed directly from living insects. No fine entomological pins have been used to secure the insects here depicted. Every insect is in its natural pose—a feature which often necessitated many hours of patient waiting with camera all in readiness.

I will therefore ask my readers to accept this volume in the spirit in which it is offered, namely, as an effort to popularize a science of enormous importance but which, in the public eye, is still unpopular. There will, of course, be the usual critics, for they, like the poor, are always with us. To these it may be mentioned that the author is fully aware that the cover of the volume is decorated with a spider's web, and that the chapter on Spiders contained in the volume is duly apologized for on pages 188 and 189.

J. J. W.

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CHAPTER I

THE LIFE-STORY OF THE LACEWING FLY
(*Chrysopa vulgaris*)

ON almost any evening during the summer twilight the charming Lacewing Fly may be seen; its curious flight alone will suffice to identify it. Between the hedge-rows of the lanes, in the garden paths, or along the woodland glades, it may be readily distinguished from the numerous moths that appear as the daylight declines. The flights of the moths are very varied in character; some of the larger and dark-coloured kinds sweep past at a tremendous pace, their movements leaving doubt in the mind of the observer whether his eyes have not deceived him, while many of the smaller and pale-coloured species flutter about like wind-tossed snow-flakes. Between these two extreme methods, every gradation of locomotion by flight may be observed.

Distinct from all, however, appears that of another insect. It is apparently travelling along a straight line, its pale silvery wings extended wide and rapidly vibrating, but its progress is so slow and laboured when compared with even the slowest-flying moth that we are reminded of a traction engine moving along a road on which motor-cars and cyclists are hurrying by. This slowly-progressing insect is the Lacewing Fly.

Although I liken its progress to that of the traction engine, the fly itself is by no means a clumsy insect. Indeed, it is one of the most delicate and charming amongst British insects. Its body is of a pale emerald green, while its lace-like, silvery-grey wings are iridescent with lovely hues, varying from pink to green in the changing light. Also, its eyes are veritable living jewels, sparkling one moment like burnished gold, the next becoming rubies of the deepest crimson, only to quickly change again in the shifting light to emeralds of the brightest green; hence it is sometimes called the Golden-eyed Fly.

The Lacewing Fly is easily captured

with a sweep of the hand as it toils past in its slow and apparently laboured flight; lest, however, my description of its æsthetic features should so tempt the inquiring observer, I must offer a word of warning. This lovely insect when captured in the hand almost immediately becomes offensive in the highest degree, for it can produce an odour so evil that, deceived by the insect's delicate form and pretty colours, its captor often fails to recognize in it the source of so vile a characteristic—so incongruous is the combination. This offensive trait probably protects the insect against the attacks of some of its foes; and how excellent a protective device it is those of my readers who inadvertently handle a Lacewing Fly will soon discover, for the smell is not removed from the fingers with one washing, and when gloves and clothes have become involved the unfortunate wearer is troubled with it for days afterwards. The Lacewing Fly is, indeed, the counterpart of the skunk amongst British insects.

When gardeners become more scientific, and learn to recognize that many insects

which they ruthlessly exterminate are their best friends, the Lacewing Fly will hold a very high place in their estimation; indeed they will find it extremely profitable to occasionally capture a few of them, or, even better, to collect their eggs for the express purpose of placing them in their greenhouses. The eggs may frequently be found on the leaves of various plants in the garden and fields. In illustration Fig. 1, a lilac leaf is shown on which may be seen eleven of these curious stalked eggs. Now, if a stem bearing such a leaf as this were transferred to a greenhouse during June, it is very probable that that simple action would entirely obviate the necessity for the use of tobacco paper and similar fumigating devices later on as a means of exterminating the aphides or blight; for the Lacewing Fly in its early stages is one of the natural foes of these troublesome pests.

In Fig. 2, an enlarged view of one of these eggs is shown, and it is interesting to investigate the significance of its curious form and also how it was produced. The Lacewing Fly when egg depositing presses

1. Stalked eggs of the Lacewing Fly—natural size.
2. A magnified view of one of the eggs.
3. An abnormal egg : two eggs deposited on one footstalk.
4. Larvæ of the Lacewing Fly capturing and devouring aphides or green-flies—natural size.

the end of the abdomen against a leaf and ejects a drop of glutinous fluid, which spreads into a tiny conical foot-stalk. The end of the abdomen is then quickly raised, and from the summit of the deposited gluten a thread is drawn out, which hardens with exposure to the air. On the top of the thread she then deposits an egg.

In from seven to eight days the larva emerges from the egg and the necessity for the long stalks on which the eggs are placed then becomes obvious. The newly-hatched larva is a most voracious animal, and its appetite increases prodigiously as it grows.

From one of a number of eggs which I had under close observation for the preparation of this chapter, in exactly seven days after it was deposited I witnessed the emergence of the larva. After it had burst through the shell it stood for several minutes on the broken part at the end of the thread. Then it proceeded to feel its way carefully along the egg-stalk towards the leaf, on which I had placed several aphides.

As soon as it reached the leaf an aphis

crossed its path, and, in spite of the fact that the aphis was double its own size, the larva immediately gripped it by means of the large mandibles with which it is armed. The aphis wriggled, but all in vain. At the end of twenty-five minutes the larva cast on one side the empty and shrunken skin of the aphis. Such was its first meal. When about ten days old it could, when hungry, devour aphides at the rate of thirty to forty per hour. Also, from experiments made, I discovered that aphides were not the only kind of food of which it would partake. It spent some considerable time amongst a batch of eggs of the common cabbage moth, inserting its sharp mandibles into their shells and sucking their contents. The juices of little caterpillars just emerged from the egg, it seemed to particularly relish. Furthermore, one of its younger brothers that I had confined with it, suddenly and mysteriously disappeared; the mystery, however, was explained by the finding of its shrunken skin amongst those of the aphides. Also, this larva had no objection to sucking the eggs of its own species when they were

offered to it. This latter fact probably explains the origin and use of the stalks, for if the Lacewing Fly's eggs were deposited on the leaf like those of the moths and other insects, they would doubtless experience the same fate when this ravenous larva came upon them, but it makes no attempt to climb the smooth stalk. Its only journey along that path is when it emerges from the egg; and if its movements are then watched through a magnifying lens, it becomes plain that this is a very difficult though necessary task that it has to perform.

The illustration Fig. 3 shows that abnormal eggs are sometimes deposited by insects. The Lacewing Fly that deposited this double egg evidently lost count, or else was in a great hurry. If the latter was the case, I fear that the mother insect sadly erred, for whichever larva emerged first would almost certainly insert its mandibles into the egg of the other, before making its journey along the stalk.

From what I have here stated it should be obvious, I think, that a leaf or stem

containing a few of these eggs, if conveyed into a greenhouse or placed amongst plants, will ultimately be the means of causing much destruction amongst the aphides and other injurious insects that the gardener well knows. In Fig. 4, several photographs are shown to illustrate how these active little larvæ move about the leaves and branches capturing and devouring their prey. When full grown they are only about half an inch in length, but their feeding powers are most astonishing. To properly appreciate the attack of one of them upon its prey, a magnifying lens should be used, and in the photograph shown in Fig. 5 the scene is depicted as it then appears. The larva is seen on the surface of a leaf holding the aphis and sucking its juices by means of its huge, sickle-shaped jaws. How efficiently these organs are adapted for that work I have endeavoured to show in Fig. 6.

For twelve days the larva proceeds with its destructive work amongst the aphides, mites, and other plant parasites, becoming more ravenous every day, until on the twelfth day it may, after fasting, often be

5. A unique magnified photograph of the larva of the Lacewing Fly attacking a green-fly.
6. Head of the larva, showing its mandibles.
7. The curious cocoons formed by the larva.
8. The Lacewing Fly depositing eggs on a lilac leaf.
9. Another view of the Lacewing Fly.

seen to destroy aphides at the rate of one per minute.

About the twelfth day, however, it gives up feeding and prepares for the next stage of its existence. It draws itself up in ball-like fashion, usually on the edge of a leaf, and slowly envelops itself in silk which it spins for the purpose. A few hours later it has changed into an almost circular cocoon about the size of a sweet pea; three cocoons are shown on bramble leaves at natural size in Fig. 7.

Sixteen days later the cocoons are cut open from within, a circular lid opening at the top of each, and, like a Jack-in-the-box, the fully-developed insect emerges. It is surprising how so large an insect can develop in so small a cocoon, but, immediately it appears upon the surface of the leaf, its wings begin to shake out their folds, and a few minutes later we see the insect developing in all its charming hues. Its bright green body, its gauzy and iridescent wings, and its sparkling eyes (together with its abominable characteristic of producing a most vile odour), have all been acquired in some mysterious way

during the sixteen days while it was crushed within its little cocoon upon the leaf. How the magic was performed is a secret hidden deep within the pages of Nature's book.

The perfect insect is shown in Figs. 8 and 9, where it is seen to have been depositing its eggs upon a lilac leaf. Allowing seven days for the egg stage, twelve for the larval period, and sixteen for the pupa or chrysalis stage, it is seen that the whole development from the egg to the winged insect occupies about five weeks. It follows, therefore, that several broods of these insects appear during the summer months. The last brood of larvæ remain in their cocoons throughout the winter, appearing early in June just as the aphides are becoming plentiful.

Réaumur estimated that a single aphis may become the first parent to no fewer than 5,904,900,000 individuals during the few weeks of its life, while Prof. Huxley computed that the descendants of a single aphis, if allowed to multiply unchecked for ten generations, would then produce a bulk of organic matter equivalent in weight to

that of five hundred millions of human beings, each of which could turn the scale at twenty stones.

With these computations in mind we have only to think of the vast number of aphides that may infest a single branch or leaf of a plant, and to remember that each aphis possesses this same marvellous power of multiplication, to realize that the existing vegetation of the earth is always in serious danger of becoming converted into living aphides, unless some efficient agents are always employed in the work of their destruction.

Conspicuous amongst the most important of these agent are the larvæ of the Lacewing Flies, of which there are some fourteen or fifteen species in this country; while in America these insects are equally abundant.

The female of the species here described will deposit as many as forty eggs in the course of one night. This progeny of forty larvæ feeding during the twelve days of their larval stage in a greenhouse containing plants infested with aphides, would, I think, prove more effectual as

aphide destroyers than several pounds spent in fumigating devices. Also it would probably be possible to produce a second or third generation, if the greenhouse was large, and provided sufficient aphides for the larvæ to prey upon.

CHAPTER II

THE TRANSFORMATIONS OF A SWALLOW-TAIL BUTTERFLY
(*Papilio machaon*)

THE butterfly was an exquisite and marvellous creature, an aristocrat amongst British butterflies. Larger than any other of the native species, its arched and clean-cut wings terminating in the sharp tails from which it derives its popular name (Fig. 10) their bright yellow artistically contrasted with edgings and veinings of velvety black, relieved here and there by spots of silvery-blue and orange-red, one needed only a glance to realize that the insect came of butterfly nobility. As it rested amongst the umbelliferous flowers it exposed its delicate and handsome wings to the sunlight with an air of proud dignity, providing, of course, that you did not approach it too closely; for then it instantly soared

into the air, and the utility of its wondrous organs of flight became apparent.

Its aerial movements were the more astonishing when it was espied by an amorous mate: for the butterfly was a virgin female. The headlong onrushes of her suitor were now encouraged and now avoided by almost hair-breadth distances, and that she was a born coquette not a shadow of a doubt could remain. So dancing through the air on light wings, the insects curvetted here and there, she coyly inviting and then capriciously turning aside, while he followed her capricious course on untiring wings.

Such picturesque butterfly frivolity may often be witnessed on sunny days in the fen districts of the eastern counties, and whenever it is seen it must always appear as a miracle; especially a miracle when one realizes the processes through which the fairy-like butterflies were evolved. It is hard to believe that these same insects, seen so gaily disporting themselves in the sunlight, were once

hungry caterpillars, crawling about the stems of the wild carrot or the marsh parsley, and whose sole occupation was to gorge themselves with the green leaves of those plants. Even as caterpillars, though, they were handsome; their pale green bodies marked with black bands studded with orange spots (Plate II) gave them a striking appearance.

From early June and well into July the caterpillar continues to feed, moulting its skin from time to time as the latter fills up, and then eating the cast skin before again resuming its green food. At last it has had enough, and its appetite suddenly declines. From that hour, throughout the remainder of its life period, it never again eats green food.

The caterpillar then proceeds to attach itself by a silken thread at its tail end to the stem, and also by a silken girdle just above the centre of its body. So attached to the stem, it awaits the assimilation of its final meal of green leaves, and, in the course of a few hours, it moults its last caterpillar skin. In this way it is transformed into the next stage of its

existence, for it is then no longer a caterpillar, but has become a chrysalis, or pupa (Fig. 11).

At first the chrysalis is of a bright green colour, but as the vegetation become yellowed, the pupa also assumes similar hues, probably gaining a measure of protection by this simulation of its surroundings. In very favourable seasons the butterflies may appear in August, but more often they do not emerge until the following May or June.

Frail though the chrysalis is, there it remains on the reed or stem to which it is attached, subjected to all the vicissitudes of the winter months. Though it may be frozen and thawed many times, yet within it the broken-down organic substance of the caterpillar is slowly reconstructed, almost every distinguishable organ being dissolved into a greenish liquid, in readiness for the moulding of a butterfly with wings of lovely hues.

Strange legs, long antennæ, or feelers, a body divided into three parts, and marvellous wings clothed with innumerable scales of wondrous colours, all appear

10. The Swallow-tail Butterfly resting with its wings expanded.
11. The Chrysalis.
12. The Butterfly just emerged from its chrysalis.

within the magic chamber of the chrysalis. More wonderful, too, are the new instincts developed there. The caterpillar could not recognise a butterfly of its own species, so different are their lives and habits. Yet the butterfly, only a few hours after its emergence, will recognise its mate on the wing, and without instruction will seek flowers from which to sip nectar by means of its long, coiled proboscis, or sucking-tongue, which it has exchanged for the biting mandibles of the erstwhile caterpillar.

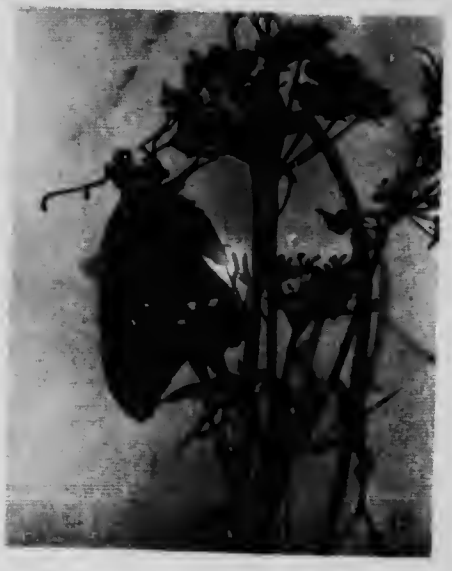
As soon as spring days come the work is completed, and all is in readiness waiting for Nature to give the command. Then almost instantly the chrysalis is expanded from within to its utmost limits, until the frail covering skin bursts asunder, and from it crawls a dowdy and crippled-looking butterfly (Fig. 12).

It is not a pleasing insect that emerges. Its wings are dumpy, wet, and distorted. Hey presto! though. Something wonderful is happening. At almost the first step the butterfly makes,

its wings swell outwards, and lo, in a moment they have increased to double their original size (Fig. 13). Then do we realize that the wings are unfolding and expanding, and we ask ourselves how it was possible that a moment ago they were pressed into the chrysalis together with the legs and body of the butterfly, and yet thus emerge without a defect on their surface; the process becomes an insoluble mystery to us.

In a period of less than one minute, the chrysalis has burst and the butterfly has shaken the folds from its wings (Fig. 14) and greets the eye as a picture of dainty loveliness. It rests and suspends its wings in space while they dry and harden. Then this creature, of but a few sunny days, ascends to the topmost point of the branches, and there exposes to the warm sunlight (Fig. 15 and *frontispiece*) its exquisitely coloured wings.

Flight, until then, could never have entered its head; yet the sight of a mate overhead was sufficient to instantly fill it with the joy of life, and in a moment it was soaring on its untried



13. Its wings unfolding and expanding.
14. The wings extended and drying.
15. Ascending the stem into the sunlight

wings. Soon the same mysterious instinct would guide it to deposit its eggs on those plants so dearly loved by the caterpillars of its species, and this in spite of the fact that the butterfly has no taste for, nor can it ever eat, green food.

CHAPTER III

THE LIFE-STORY OF THE PUSS MOTH
(*Dicranura vinula*)

THE two main factors in the struggle for existence are, necessarily, to eat and to avoid being eaten. The Puss Moth, in the course of its evolution, has had to resort to some most extraordinary devices to escape the latter contingency. Its colours, its habits, and its anatomy, throughout all its stages, clearly indicate that it has had to fight persistently against the attacks of formidable foes, and that only by extreme defensive methods has it been saved from extermination. The history of this insect is, indeed, a most wonderful chapter in insect evolution.

This moth may be found from May to July. It deposits its eggs on the leaves of poplar and willow trees, and after about nine days the little caterpillar

emerges, often taking eight or ten hours to bite its way through the strong egg-shell. When the head, which is the largest part of its anatomy, is through, the rest emerges quickly. It is of a velvety black colour, and on its head are two curious, ear-like structures (Fig. 16) which disappear as it gets older; while at its tail-end it possesses a forked appendage from which, when it is irritated, issue two delicate pink threads, the function of which will be considered later.

The young larvæ make no attempt to hide themselves, but feed boldly on the surface of the leaf (Fig. 17). And now we observe what is probably the first selective device for their protection—viz., their black colour, for the little holes in willow and poplar leaves bear a resemblance to black spots and markings, while bruised parts also turn black. Therefore the black larvæ feeding on them are not conspicuous.

Later on, when they begin to develop to a conspicuous size, they moult their skins and change colour, gradually

becoming green, assimilating then with the leaves of the food plants; their upper surface, however, retains a brown hue speckled with grey. In Fig. 18 two half-grown larvæ are shown feeding in their characteristic attitudes.

At this stage, when about a month old, a curious change takes place. The caterpillar again moults its skin, and it then appears in still more brilliant greens, while its dorsal parts have developed more grey colour, giving its body a shaded effect. Also two white wavy bands run from its face to the hump at the back of its head, and from there down the sides of its body to its forked tail. What strikes the observer most, however, is its face, for there a most remarkable mask has developed of a rose-red colour, shaded with greyish-blue, and bearing what look like two staring black eyes.

The change after moulting the skin is so extraordinary, that one can scarcely believe it is the same caterpillar. In Fig. 19 is a photograph of three larvæ at this stage, showing their masks. On

16. Egg of Puss Moth with the caterpillar just emerging—magnified 20 diameters.
17. The caterpillars, when three days old, feeding on a poplar leaf—natural size.
18. Half-grown larvæ before they develop their "eye"-spots.

comparison with Fig. 18 it will be seen that now, in the place of the two ear-like organs which were so conspicuous when the caterpillar emerged from the egg, have developed the eye-spots that give to the caterpillar such a striking and terrifying aspect.

When the larva again moults its skin and reaches its full growth, (generally during August or September), its extraordinary mask is still more conspicuous, and its colours are brighter than ever; indeed, the full-grown caterpillar when seen isolated from its surroundings, presents a most startling appearance, both in colour and form. Two of the larvæ are shown peacefully feeding in Fig. 20 at natural size.

Such, then, are the various changes which the caterpillar undergoes during the six weeks of its life, and one naturally asks the meaning of these curious metamorphoses and the object of this extraordinary mask. I use the word "mask" advisedly since it is not the caterpillar's real face that is exposed to view. Its flat head is withdrawn into

the first ring of the body, and it is this ring, so curiously coloured and bearing conspicuous spots appropriately placed for eyes, that produces the startling caricature of a face. It remains, then, to ascertain what is the object of this singular pretence.

I have mentioned that, when isolated from its surroundings, the caterpillar is a very striking animal; however, when feeding amongst the leaves and branches, in spite of its bold colouring, it is not at all conspicuous. When so situated, its broken masses of green and brown, and their soft shadings, harmonise so closely with the moving leaves and brown branches that it becomes very difficult to detect it by ordinary methods of observation; hence, its apparently conspicuous colouring serves in reality to make it inconspicuous, and so protects it from the eyes of its enemies.

It sometimes happens, though, that the caterpillar is discovered by an enemy, and it is then that the object of its strange disguise becomes apparent. At the slightest touch when feeding on the

tree, the larva instantly turns its repulsive mask towards the source of irritation, and, so to speak, glares wildly at the enemy, the ring of the body bearing the eye-spots being distended to its fullest extent. At a touch from the opposite side round goes the "face" in that direction, bearing the same terrifying aspect, which, by its fixed glare, seems to plainly imply some considerable danger to the enemy if it is further molested.

How effective this quick movement of the head and the sudden presentation of a facial monstrosity are as a protective device may be readily appreciated by the effect it has upon a human being who touches one of these larvæ for the first time; rarely will he touch it again without an assurance that no harm will come from the venture. Let us imagine, then, that some bird or small animal meets one of these caterpillars resting or feeding amongst the branches, and, on account of its colouring, is doubtful whether it would make a toothsome morsel. It approaches carefully, and probably gives

the suspicious object a preliminary prod, just as man himself would do. Then the caterpillar suddenly faces round with that apparently outraged stare, as if to say, "Who dares?" and the terrified foe probably takes to flight.

When a healthy larva is feeding, a sudden touch may often produce a further surprise for the enemy. At the moment the terrifying mask is presented to view the forked tail is raised, and from its two prongs the pink threads previously referred to are suddenly protruded to a great length, and lashed like whips over the caterpillar's head and back. In Fig. 21 is shown a caterpillar employing both these artifices.

Now, it happens that the worst foes with which the larva of the Puss Moth has to contend are ichneumon flies —parasitic flies which boldly attack the caterpillar and deposit their eggs upon it, usually behind its head. From the eggs of the ichneumon little grubs emerge, which are parasitic upon the caterpillar, sucking its juices from the moment they break through the egg-

19. Three larvæ after they have moulted their skins and the "eye"-spots have appeared. *Note.*—This photograph will be better appreciated if viewed upside down.
20. Full-grown caterpillars feeding.
21. The parasitic Ichneumon Fly approaching the caterpillar, which the latter is endeavouring to drive away by means of its inflated "face" and its tail-whips.

shell, and adhering firmly afterwards. The caterpillar feeds ravenously, but the appetites of its boarders increase also. Eventually the larva attains its full growth and spins its cocoon, yet it is never destined to become a moth, for the ichneumon grubs then completely devour the soft parts of their host, and attain their full growth, making their own cocoons within that formed by the caterpillar, thus utilizing the caterpillar's home as their own.

The ichneumon-fly is, therefore, a formidable enemy that has to be dealt with promptly when it appears. Whether the caterpillar's remarkable simulation of a face has any influence on the ichneumon-fly is a doubtful point; probably that feature is only of service in scaring larger foes, including man. Its tail whips, however, have probably been developed purely as a means of reaching the back of its head, where the ichneumon-fly usually makes its attack; for these organs are really the caterpillar's last pair of clasper legs modified and evolved into tube-like structures and endowed with

delicate muscles, which allow of the sudden protrusion and contraction of the pink threads. It is curious, too, that these whips should be of a colour similar to that of its mask, a fact which seems to imply that that colour may have some influence on the particular enemies which the insect has to combat. In this connection, too, we have to remember that colours and forms which we may regard as merely curious or quaint may affect other animals in a very different way, and have a significance which they have not for man. Especially is this true of insects, the structure of whose eyes is so very unlike our own. We should never overlook the fact that peculiarities in an organism that appear to us useless, and sometimes absurd, may be of great practical value to the creature possessing them.

So far as is known, the tail whips are perfectly harmless to the ichneumon, and only serve to drive it away, just as a cow removes flies from its back by the switch of its tail. Nevertheless, the parasitic ichneumon takes considerable risk in making its attack upon the caterpillar.

In the lower part of the red mask is a transverse slit, connected with a gland in which a strong solution of formic acid is stored. Professor Poulton, who has made many interesting experiments with this species of caterpillar, states that this solution, in a mature larva, contains a proportion of acid "as high as forty per cent.," which is a much greater percentage than that found in the stings of nettles, wasps, hornets, bees, etc.

This irritant fluid the larva is able to eject as a fine spray when it directs its "face" towards an enemy. I would suggest that the mask may be a means of holding the attention of the enemy in the right direction to receive this shower of acid. Of the effect of this liquid, we have Professor Poulton's statement that he has "seen a marmoset and a lizard affected by it," and has himself "twice experienced sharp pain as the result of receiving a very small quantity in the eye."

It follows, therefore, that the ichneumon fly has also a formidable foe to contend with while carrying out the

natural functions of its species; indeed, it is a life and death struggle between the caterpillar and the fly, for Professor Poulton's experiments revealed the fact that the ichneumons collapsed immediately when a little of the acid was placed upon them, "and either died or took many hours to recover."

Such then is a page in the incessant warfare between living creatures that may be enacted unseen beneath the green leaves of a poplar or willow tree; a warfare which has been going on throughout the history of this quaint caterpillar, and has brought such an influence to bear upon it during its struggle for existence as to produce those extraordinary modifications in its anatomy which we have noticed, such as its colour simulation of its surroundings, its startling mask, its tail whips, and its poison-secreting gland.

The ichneumon-fly is the natural foe of the caterpillar, and only those caterpillars have survived that have inherited features that would best serve as weapons of defence against the attacks of this

wily enemy. On the other side, the ichneumon has concurrently developed quickness of movement to avoid the acid shower, and a daring in attack, together with such structural details as sharp claws for holding on and an ovipositor highly adapted for securely placing and fixing its eggs upon the caterpillar.

Should the larva successfully reach maturity, it then prepares for the next stage of its existence. Here, again, the precautions it takes obviously point to much persecution in the past history of its species. The larva selects a suitable crevice in the bark of a tree, into which it withdraws itself. It then proceeds to spin some glutinous threads over its body, attaching them to the bark on each side, afterwards gradually filling up the interstices. While doing this it bites small portions from the bark and weaves them into the substance of the cocoon. When complete and dry the caterpillar is entirely obscured from view, and as the cocoon dries it becomes identical in colour with the bark, looking simply like a rugged portion of it; also, it is then

as hard as horn. In this position the developing insect spends the winter.

This mimicry of the bark, combined with so much strength, distinctly indicates that the caterpillar has found it necessary to hide itself from the eyes of its enemies, and even then to put on armour. But notwithstanding all this self-protective care, cocoons may frequently be found torn open and empty, for hungry tits know well how to seek out such choice morsels as the cocoons contain.

Just what is inside is shown in Figs. 22 and 23. Also the photographs show how strong and well-made is the cocoon. The chrysalis is produced when the caterpillar moults its last skin within the cocoon. The thinnest portion of the cocoon is that part where the future moth will emerge the following summer.

In Plate III. two cocoons are shown in their natural position, from one of which the moth there seen has just emerged, the cocoon then being broken open to reveal the empty chrysalis skin left behind.

In the ordinary way the moth makes its appearance from quite a small round

22. Cocoon removed from the bark of a poplar tree.
23. Internal view of the Cocoon, showing the chrysalis.
24. Puss Moth resting on the bark.

hole near the top of the cocoon, the chrysalis being provided with a kind of cutting tool for breaking a way through the weak part. When the moth emerges from the chrysalis it secretes a fluid, which moistens and softens that part of the cocoon to be broken open, and by this means it is enabled to make its way out on to the bark, where its wings develop. Shortly afterwards the moth appears as shown to the right in Plate III. and in Fig. 24.

Its hairy body and legs, and the peculiar softness of its greyish-white wings streaked with black, give it a handsome appearance as it rests upon the bark until nightfall, when it will take to its wings and find a mate.

The meaning of the wavy markings upon its wings is a problem that remains to be solved. These, doubtless, have some significance amidst its surroundings, and although the moth is conspicuous to us as it appears upon the bark, it may not be so to the enemies that attack it at this stage of its development. On the other hand, it may be more con-

spicuous to them than it is to us, and its bold display may be a warning to birds and other insectivorous foes that it has now become unpleasant to the taste; for there are many British moths of a white and greyish colour streaked with black and brown, that rest with exposed wings upon the dark-coloured bark of trees.

The moth is found in most parts of the British Isles, and this feature shows how far the extraordinary developments in its caterpillar stage have proved successful; for it does not follow that a highly evolved insect is necessarily successful in the struggle for existence. Such developments only show how keen has been its struggle, and to what devices it has been driven to hold a place for itself —sometimes a place that it may be hourly losing.

CHAPTER IV

THE "DEATH WATCH" BEETLE
(*Anobium domesticum*)

"THE patient, after suffering long, had fallen into a deep sleep; and the nurse, in the still hours of the night, was, with anxious forebodings, critically watching her charge. Intently she listened to his weak and irregular breathing, and, while she listened, a weird ticking commenced. Five gentle but distinct taps—a pause—five more taps, but this time from a different direction; then a dead silence. The old and superstitious nurse hopelessly raised her hands and shook her head. All now was of no avail. It was a 'warning'! She had heard the 'death watch.'

"Two hours later the patient died."

Such a passage as this was common enough in the pages of novels not very many years ago.

In earlier days the "death watch" was heard much more frequently than now; indeed, was quite a popular terror amongst the superstitious and ignorant, who believed in "omens," "warnings," and such presages of future events. However, like most of the superstitious fancies of bygone days, this supposed prophetic and mysterious "augury," when investigated with ordinary scientific methods of observation, proves to be entirely fallacious and a delusion.

The "death watch" that produces the weird tickings formerly so much feared is nothing more or less than a mischievous and destructive little beetle madly in love and very desirous of finding its mate. Thus is the fallacy of our ancestors regarding this mystery dispelled.

Let us review the circumstances more closely and endeavour to see how this erroneous idea came to have such a hold.

The Death Watch Beetle (Fig. 25) is a worker in wood. Nearly the whole of its life is spent hidden amidst the woodwork of old houses, or old furniture. There are few houses, indeed, but contain some

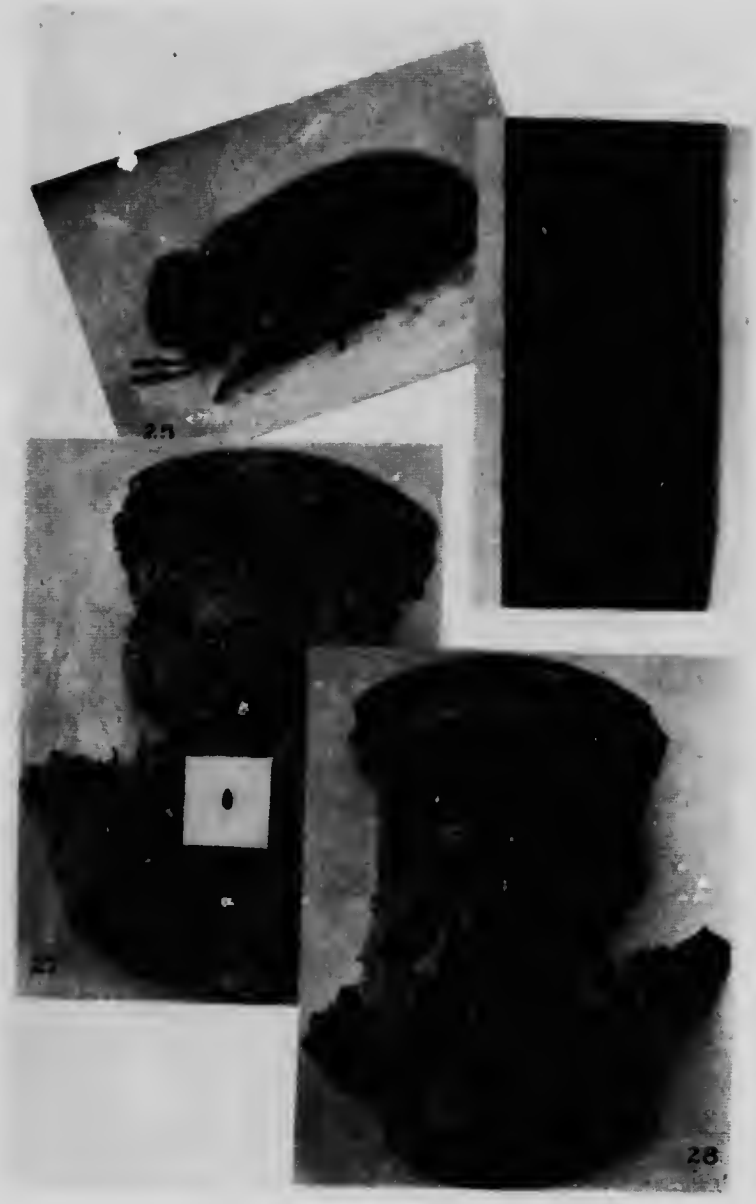
articles upon which the ravages of this most destructive insect may be observed; such articles are spoken of as being "worm-eaten." Neatly-drilled, round holes, irregularly scattered over some wooden article, giving it the appearance of having been riddled by fine shot, are the outward and visible signs that *Anobium domesticum*, or the Death Watch Beetle, is an inmate of our home, and warn us that, under favourable conditions, its "death-watch" tickings may be heard.

It is obvious that in old houses, where wooden rafters and panels are much in evidence, these mischievous insects would be more abundant than in modern buildings; hence the frequency of such "visitations" in olden times. Furthermore, superstitious minds are far more prone to explain all mysterious occurrences as supernatural "omens," or "warnings," than to seek for a natural cause, and so simple an explanation as a tiny beetle being the source of the weird tickings, would be regarded as absurd, especially as the beetles are scarcely ever seen away from their burrows amidst the wood.

It may be that the tickings emanated from the very chair on which the nurse attending a sick patient was sitting, or even from the wooden bedstead on which her charge was resting. In Fig. 26 is shown another source from which it may have originated. The illustration shows part of the edge of an old gilt picture-frame seen from behind, with its significant perforations. A picture bearing such a frame might hang above the patient's head, and then, in the stillness of the sick chamber, the mysterious tappings would be distinctly heard.

Near the centre of Fig. 27 one of the beetles is shown natural size, and one may naturally ask how so small an insect can tap sufficiently loud to be heard by human ears. As already explained, the ticking is most often heard at night and in a sick room, because then, owing to the quietude and suspense, a slight noise is greatly intensified. A glance at Figs. 27 and 28 will throw more light on this point.

The photographs show a common wooden gas-bracket block of four inches diameter. The front, it will be observed,



25. The "Death-watch" Beetle—magnified 20 diameters.
26. Part of the edge of a picture-frame attacked by the "Death-watch."
27. A wooden gas-fitting block destroyed by the "Death-watch"—one of the beetles is shown near the centre at natural size.
28. The front of the same block showing the shot-like perforations.

bears the familiar shot-like perforations, and the sides have completely crumbled away as yellow dust or powder in the process of removing it from the wall to which it was attached. On the back (Fig. 27) the wood is seen to be penetrated in all directions by the burrowings of the larvæ of the beetles; for it is in their early stages, as larvæ, while feeding on the wood, that they carry on their destructive work.

It is obvious, then, that the beetles in the block would be surrounded by more or less hollow tunnels, and that these would tend to increase the sound of their tappings as they communicate with each other. In Fig. 25 one of these beetles is shown magnified twenty diameters. It should be observed that the thorax, or portion of the body next the head, has developed in a curious fashion, forming a kind of horny hood which covers the beetle's head. In making its tappings the beetle raises itself on its fore-legs, tucks in its head, and then brings down this horny and helmet-like thorax in contact with the wood. Thus results that regular

interval between the beats which has given rise to the expression "death watch." The hollowed and cowl-like thorax may also serve to increase the sound that it makes.

In this manner the insect is enabled to call to its mate, and often, after its four or five taps, responding taps may be heard from a different direction; and as the communications sometimes go on at intervals until the couple have met, it is not surprising that a superstitious nurse, sitting alone in a sick chamber and hearing these weird noises that arise without apparent cause and come from all directions, should be scared. The ultimate death of the patient is, under such circumstances, of course, offered as culminating evidence which there can be no disputing.

I have previously stated that these insects are but rarely seen away from their borings amidst the wood. However, when the wood in which they have developed shows signs of having exhausted its resources for providing food material and shelter for the rearing of the young, the old beetles make their way out, taking to

their wings at night, to seek more favourable quarters; but they quickly disappear from view, as they are essentially of nocturnal habits and prefer darkness to light.

It is, nevertheless, an easy matter to see them if an infested article of furniture can be obtained. All that need be done is to select a part of the wood where the holes are not too numerous, and then to drop a little turpentine into a few of the holes here and there. As the spirit finds its way into the borings and is absorbed by the dry wood, the beetles will be seen making their way out into the open through the holes down which no turpentine has been poured. A complete immersion in turpentine will kill them in the borings; although paraffin would prove more effectual for this purpose.

It is also interesting to observe that the moment the beetles are touched they immediately feign death, drawing their legs together and lying on their backs, or in any position they may be, and remaining perfectly motionless, often for five minutes or more. This is a defensive feature which

they share with many other classes of insects and some familiar species of spiders. Probably at first this action would be due to paralysis of the limbs produced by fright, but as it served to protect them from the further attacks of their enemies the movement would become exaggerated and evolve into a defensive habit.

There are several species belonging to this genus of destructive beetles that prey upon household furniture, and also some nearly related kinds with similar habits, but the species here considered is probably that most commonly met with. In view of the fact that even the smallest of living things has its place and function in the natural world, the question may be asked: What good purpose can these household pests serve to justify their existence.

In the home of man, where they destroy beams, floors, tables, chairs, cupboards, etc., they, of course, cannot serve any good purpose. Nevertheless, their action even when engaged on such destructive work has its place in Nature's economy. As Darwin has so vividly shown, long before man used the plough, the earth was

regularly ploughed by earthworms, the whole soil of this country having to pass and repass through the bodies of these lowly-organised creatures every few years. A similar work is also carried on by the termites, or the so-called white ants, in Africa and other places where earth worms are not prolific; fallen trees and broken and decaying branches are quickly reduced to dust with the soil excavated from the "ants'" underground galleries; thus they serve as natural scavengers and fertilizers of the soil. Likewise with submerged and decaying timber, the mollusc known as the shipworm eats its way through and through such woodwork until it has become once more converted into organic material.

So it is with the Death Watch beetle. Our chairs, tables, and furniture are nothing more than dead and decaying organic material; material, too, that is ever needed in the organic laboratory for the re-modelling of other life forms. Nature is the theatre of incessant change, and the existence of dead and decaying matter is strictly prohibited in natural economy. Although we may for a time

bar the doors against the entrance of natural scavengers, yet it is but for the moment; immediately the doors are opened they will reappear.

CHAPTER V

TREE-WASPS AND GROUND-WASPS
(*Vespa britannica and V. vulgaris*)

EARLY in September wasps were so abundant that they became a veritable plague. In the house they appeared to be everywhere. In the kitchen area, when cooking was in progress, they became positively dangerous. Everything sweet or tasty that was placed upon the table was immediately surrounded and attacked, even a cloth that savoured of gravy or fruit juice, if laid down for a few moments, became a source of danger and the hand that next touched it risked a painful sting. Some few particularly enterprising individuals that escaped the eye of the cook have, indeed, quite recently reappeared amongst certain choice preserves, and although all danger from their stings was past, yet they seemed just as potent to cause a scare as if they were alive.

Later on, at the end of the month, only an occasional wasp caused annoyance, even in the kitchen. In early October a few still found their way into the house, but these behaved very differently from the early September ones. They seemed to have no hostile intentions regarding the cook or even her commodities; their object in life appeared confined to a careful scrutiny of the window frames, the openings where the sash-ropes worked being especially attractive to them. Also the folds in the curtains round the windows offered a further attraction for these October wasps; so pleased were they with these quarters that they would often stay there for days together—until, indeed, there came a cry of "Another wasp!" after which their career was brief.

At the end of October wasps had become almost entirely forgotten, when (doubtless in a moment of inspiration) the cook, obsessed by the wasp topic, suddenly propounded the question: "Where have all the wasps gone?" For a time there was silence. Then the suggestion came that the cold had killed them all. Every-

one seemed satisfied with this answer until the cook (who only on very rare occasions thinks with a scientific mind) further remarked: "If that is so, where do the first wasps of summer come from?" That question presented a stumbling block, and the discussion consequently became confused and was left in a very hazy and unsatisfactory state.

Around the two questions propounded by the cook there hangs a tale—a story wonderful and marvellous, though its interest centres on facts and not on fiction.

The October wasp that hides in the curtain in a warm room is one of the marvels of creation. It is a queen wasp. Queen in name only, for there is probably no animal on the earth that works harder or is able to perform so many and such varied kinds of labour, and withal carry on her work with such devoted energy.

In the early stages of the wasp city there are only two kinds of individuals. There is first the queen, which is the only perfect female of the community. Then appear the numerous workers, or neuters,

which are really imperfect or undeveloped females. At a much later stage other queens appear, and finally the males or drones. In Fig. 29 the three classes of individuals are shown. The males may be distinguished by their slim bodies and their longer antennæ, or feelers; the queens by their large size; and the workers are the smaller active wasps seen everywhere during the summer and autumn months. It is rare that the original queen is seen after the worker wasps appear; her duties then confine her within the walls of the city of which she was the foundress.

How comes it, though, that the late wasp must always be a queen? Why may it not be a worker, or even a drone? Well, the so-called "nest" of wasps—which is really a wasp city with several thousand inhabitants—is only a very frail structure; indeed, it is built of paper. In the process of manufacture the pulp from which the wasp-paper is made has to be moistened and kneaded, and, as the numerous workers employed are continually adding their contributions, the combs hang heavy. Consequently, their growth is necessarily limited,

29. Three species of Wasps—in the top row are the males, in the middle row the queens or females, and lowermost the workers.
30. The Queen Wasp tearing off fibres of wood.
31. A nest of the Tree-wasp with two entrances.
32. Section of nest of Tree wasp, shewing the first comb.

since the safety of the structure has also to be considered. Hence it follows that, the more the wasp city thrives, the greater the vitality of the swarm, and the larger its combs become, so the end and destruction of the fabric are hastened.

Just as the community has reached the zenith of its glory and is most flourishing some strange things happen within the city, and afterwards everything seems to go wrong, and the end speedily comes. The diligent and persistent workers seem all at once to realize that more work on their part is useless, and then to lose heart and purpose in life. Some of them simply cling to the cells on which they have laboured so long, and there starve. Others (probably the younger ones) wander away from their home to return no more. Guided by their keen sense of smell, many of these discover the nearest warm kitchen where savoury foods are being prepared, and there they become freebooters and give themselves over to orgy ; for now they have no longer need to carry food to the nursery for the developing grubs. They appear to be ravenously hungry and attack

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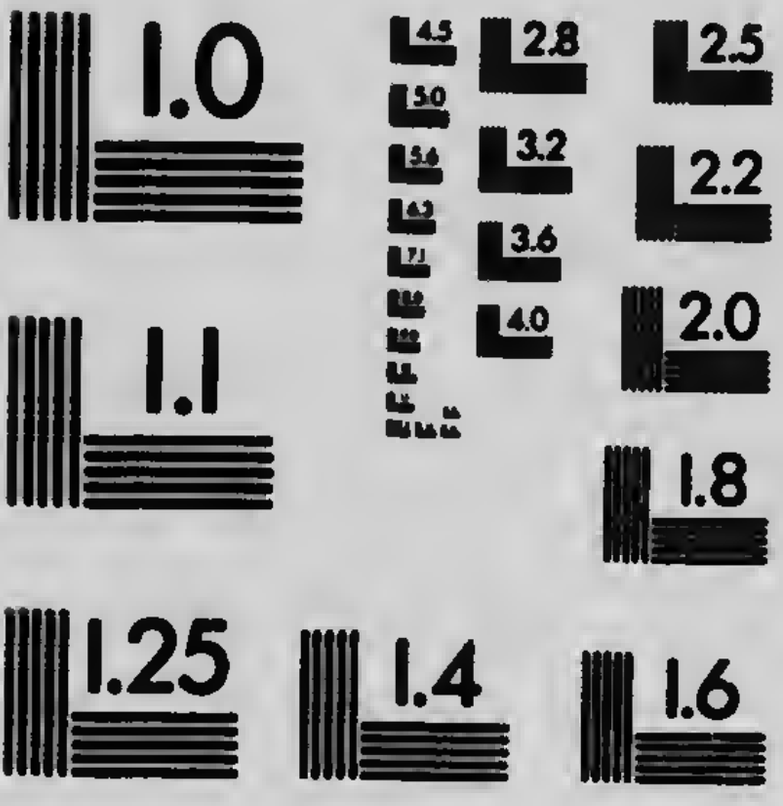

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almost every kind of sweet or meat food that appears, although their habit of pouncing upon flies and carrying them off is no longer indulged in.

Their orgy, however it may revive their spirits, does them but little good, even though they may escape from the kitchen—for their hour has come. As night approaches cold, or perhaps frost, overtakes them; for their home is no longer a home for them. So they rest beneath a leaf or in some similar situation and there become chilled and numbed. Next day the warm sun may revive them for an hour or two, but later on it comes cold again, and so they may linger on for a day or two, ill-tempered and always ready to sting at the slightest provocation, until at last an extra chill spells their doom. Such is the normal end of the worker or neuter wasp, after its several weeks of laborious life.

The lordly and lazy male wasps fare much the same, although they succumb to cold and wet much more readily than the hardy little workers. Probably, too, the exhausted queen meets the same end. I

have, however, previously stated that young queens are produced later in the year. This event occurs when the fabric of the city has reached such proportions as impose a limit to any further expansions, having regard to the safety of so fragile a building in a precarious and uncertain climate. It may be climatic warnings that first awaken the workers to the fact that the edifice on which they have laboured is becoming unstable.

How the young queens come into being is difficult to understand. All through the early part of the season the eggs deposited in the cells by the queen produce the grubs of common workers, but almost as soon as chilly nights make themselves felt some special large cells begin to appear (some of these may be seen in centre of Fig. 36 and also in the lowest tier of Plate IV.), and from these develop the queens of future colonies. Whether the queen deposits a different kind of egg, or whether the difference is brought about by special feeding of the grubs by the workers, is a debatable question.

Almost contemporary with the advent

of these queens, other special cells begin to produce males. When, in this way, the sexes have appeared, those strange happenings to which I have previously referred then take place.

Suddenly all the machinery of the city stops, as it were. The builders of the cells give up work; the busy workers that return laden with material to build new cells, or with food for the developing grubs, seem to become stupefied and inactive. Even those wasps that remain active seemed to lose all their orderly movement and to be continually in the way of each other; in fact, confusion has taken the place of orderliness throughout the whole city.

Amongst the combs, around which the stupefied worker-wasps are continually congregating, numerous slim-bodied wasps suddenly become extremely busy. These are conspicuous on account of their long antennæ, or feelers, which are continually quivering in a very excited manner. They are the prospective bridegrooms for the young queens. From careful observation, I am inclined to think that

their mates are selected within the nest, and that then they leave their home together never to return. However, the honeymoon appears to be spent in the immediate neighbourhood of the nest. In the case of a tree-wasp I observed no fewer than six young queens accompanied by their male suitors within the space of a yard on the ground beneath the nest. Some of these I returned to the nest, but they immediately left it again; strange to say, also, they seemed to possess the power of finding each other again when separated.

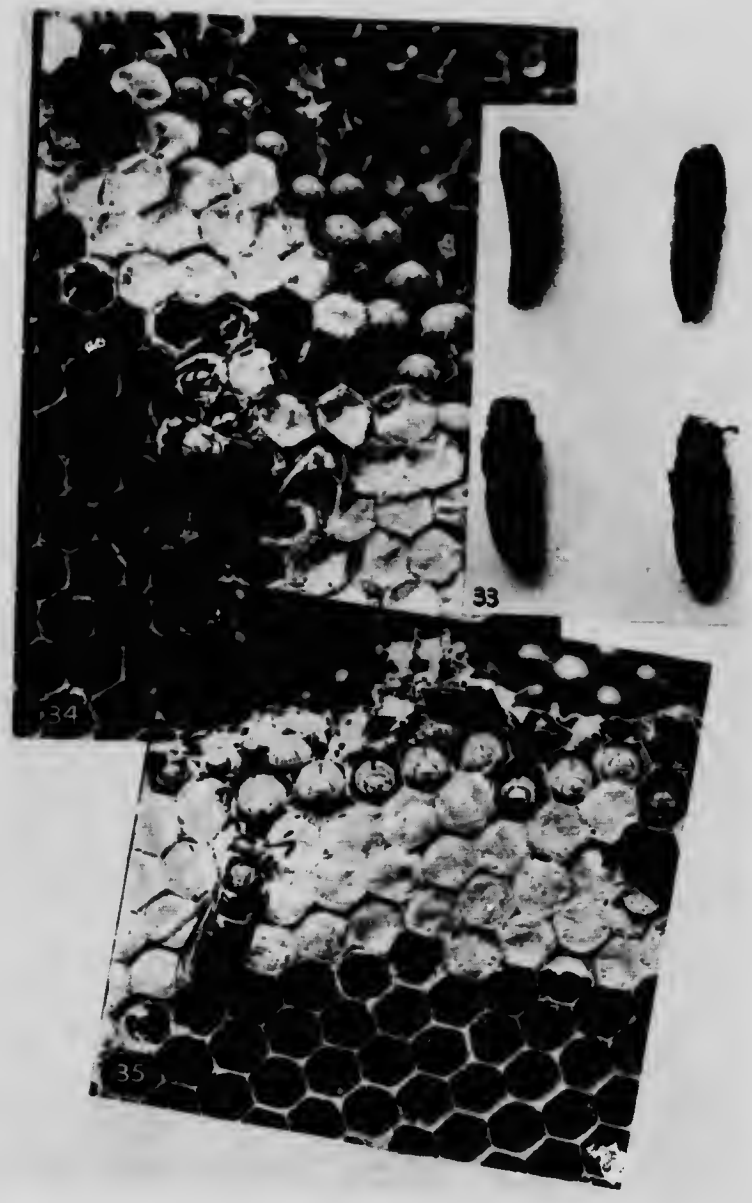
When the queens and males have left the nest, some of the more active workers appear to become strangely possessed; they seem, indeed, to have gone mad. Instead of tending and feeding the young grubs with that jealous care so characteristic of them, they now commence to undo their work in an extraordinary manner. The developing larvæ are set upon, dragged from their cells, and carried outside the nest, where they are left to perish on the ground.

The significance of this proceeding pre-

sents a problem to which no satisfactory answer has, to my knowledge, as yet been advanced. On the face of it, it appears that the workers realize that they will not be able to rear their charges, and so, rather than let them slowly starve within the nest, they mercifully remove them outside, where they will quickly die. However, a little study of the actions and habits of wasps scarcely encourages one to credit them with so much forethought; indeed, one soon discovers that their movements are most automatic.

To explain the matter, one has to ask: What benefit does the wasp community derive from this strange behaviour? It may be said that an instinctive impulse to clear the nest of decaying matter guides them to remove the starving grubs, but then comes the question: Why should they clear a nest which they are then deserting?

There is only one way, I think, in which the economy of the wasp race can benefit by this action, and therein lies a probable explanation of the extraordinary conduct of the workers during their last hours within the nest.



33. Larvæ above and pupæ below—removed from their cells.
34. Cells containing larvæ and the closed ones pupæ: some of the fully-developed Wasps are seen biting their way out, while one has almost emerged.
35. Cells with larvæ, pupæ and eggs, together with a Worker Wasp that has just emerged.

No matter how late in the season it is when the wasp community disperses, there are always signs that the wasps were till then still extending the structure of the nest. Empty cells are always ready slightly in advance of those which contain eggs. Also, when the end comes, some of the cells always contain larvæ and pupæ. The city seems to have suddenly come to a dead stop in the midst of its development.

It follows that the tiny larva that hatch from the eggs would soon perish. The fat and half developed larvæ would, however decay in the cells. If this happened, the undeveloped pupæ in the closed cells (which would be most probably queen or male individuals, and therefore important to the community) would, as they matured in the deserted nest, emerge amidst most unhealthy surroundings. The workers, therefore, as a last labour for their race, instantly remove the grubs, which can not mature in the nest, for the benefit of the developing pupæ of the males and queens, which, may mature. Furthermore, if the grubs

were left to decay, the result would be to attract such enemies into the nest as would probably be injurious to the pupæ that remained. That, I think, is the true explanation of the apparently wonderful forethought on the part of the worker-wasps.

When the work of removing the grubs from the cells is finished the worker-wasps then forsake their home, or a few may idle about its vicinity until cold or wet overtakes them. A few late queens or males may afterwards develop in the nest, but they quickly leave it; and then, while the structure holds together, it becomes a prey to all sorts of animals—snails, slugs, earwigs, flies, beetles, woodlice, etc

By that time, the mating of the queens has taken place, and, like the workers, the male wasps have also perished. Out of all the inhabitants of the wrecked city none now remain except the young queens. These are the only individuals destined to live over the winter. Not all of them, by any means, will survive to become the mothers of a vast generation in the future; nevertheless, a few will maintain the race.

In the ordinary way the fortunate queen will shelter in some crevice in a stone wall, under the bark of a tree, or, not infrequently, in the fittings of a window frame, to which I have previously referred. If left undisturbed, the folds of a curtain in a not too warm room provide a favourite spot; but as I have already hinted, that selection is positively dangerous for the wasp community. In some such situations then, clinging firmly by her legs, and often holding by her strong jaws, the queen sleeps away the winter months.

Some bright day at the end of April the dormant queen awakes and crawls sleepily out into the sunlight. Her first thought is her toilet. Her wings, body, antennæ and face are briskly brushed by means of her bristly legs; and then, having removed all dust and dirt from her limbs, she takes to her wings. She has not travelled far, perhaps, before she alights and carefully investigates an old tree stump; but she is soon off again. Then the corner of the roof of a thatched cottage occupies her attention for a few

minutes, and afterwards a hawthorn and holly hedge. In the latter place she was occupied for the rest of that day and for many days that follow. In short, this queen had discovered a suitable site on which to commence operations for the building of a new wasp city.

Afterwards, you can almost always find her round that particular part of the hedge. It is her custom, however, to make little flying journeys between the hedge and a dry tree-stump in the field close by. From this stump, by means of her strong jaws, she will tear off fibres of the wood (Fig. 30) and then carry them back to her building site amongst the holly leaves. After masticating the fibres into a pulp she will then plaster it to a branch, and so she continues until a short suspended pillar is formed. More pulp is then applied to this footstalk (or rather headstalk, for the wasp, unlike man, commences to build the uppermost story of her house first), in the form of a little cap, and under this four small cells, with their mouths opening downwards, are placed,

these also being formed of the same material.

Such is the beginning of the nest, and immediately the four cells are formed eggs are deposited in them. Outside these cells others are soon added, and, by the addition of new layers of paper, the cap-like covering is extended to cover these, and to fall below, the edges of the covering layers then being joined beneath, so that the comb is completely hidden from view, a single round opening being left as entrance to the nest (Fig. 31). In Fig. 32 an example of a nest at this stage is shown in section, where the first comb will be seen suspended inside.

The eggs that were first deposited then begin to hatch out their grubs, and these have to be fed on chopped insects and vegetable food. So the wasp-mother's labours increase, but still she perseveres and keeps pace with the work. As the larvæ grow, she has to increase the height of the walls of their cells to accommodate them. At last, however, those larvæ that hatched first become full-fed and proceed themselves to spin a silken cocoon within

the cell, closing the latter with a cap of the same material, and in which they change into pupæ (Fig. 33). Ten days later, or thereabouts, from these cells emerge the first worker-wasps.

The wasp city then grows apace, new workers continually emerging—Figs. 34 and 35. These worker-wasps are soon ready and willing assistants of their mother, and are just as capable as she in paper-making and in the building of cells. Later on, the time of the queen mother is entirely occupied in depositing eggs in the cells made by the workers. The latter not only extend the cells and walls of the city, but also collect food for the young, tending and feeding them with motherly instinct. Sometimes, too, in the case of the loss of the queen, they will also deposit eggs; but these only produce male brood, and, consequently, without the queen the swarm eventually fails, and the nest is deserted.

In due course, the workers suspend a second comb, or terrace, by short pillars from the first one, and finally several others, each being attached to the one immediately

36. Nest of Tree-wasp with outer covering removed. Eggs can be seen in some of the lower cells.
37. The above nest viewed from beneath.

above it; and so the nest increases in size until it becomes externally like that shown in Plate V, and internally as seen in Figs. 36 and 37. It will be observed that the larvæ in the cells are suspended upside down, and that the worker-wasps tend them in that position, as shown in Plate IV. Everything in waspland is topsy-turvy, from the very moment when the queen commences to build her home until its dissolution after the advent of the males and the young queens.

Such is the method adopted in building the several species of British tree-wasps and ground-wasps. The common wasp, so familiar in summer-time, in its nest beneath the ground (Fig. 38), often extends its combs to much larger dimensions than the tree-wasps. In Fig. 39 a comb is shown containing over 4,000 cells, and this comb was the largest of ten. In this nest there would be, at the lowest estimate, 20,000 cells, and it should be remembered that the worker-cells are sometimes used two and three times over for the rearing of larvæ. With these facts in mind one may readily understand why fruit-growers

advocate the killing of the queen wasps that may be seen at any time from October to May, for each one that lives may become the parent of a vast community by the autumn.

To distinguish between the six different kinds of British social wasps requires an expert; the nests of the several species, however, differ somewhat in their external covering. Three species are illustrated in Fig. 29, the central one of which is the common ground-wasp, and the rows on the right and left are two of the commonest species of tree-wasps. In Fig. 40 is shown a sample of the paper manufactured by each of these three species. The texture of each is seen to differ, but in all appear the tiny bands of varying colours showing where additional material was added by the numerous workers. In the central example of the common wasp the paper is seen to be formed in shell-like patches, while the tree-wasps make theirs in more or less continuous bands.

In concluding this brief outline of wasp life, I may add that, from what has been written here, it will be obvious that the

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38. Nest of Common Wasp beneath the ground, with covering walls broken open

39. A comb from the nest of the Common Wasp, containing 4,000 cells. Its size may be appreciated by observing the postage stamp placed in its centre, which has been reduced proportionately in photographing.

40. Three samples of Wasp-paper.

discovery of a wasp in winter is nothing unusual, because such a wasp will be an hibernating queen. Also, though one's sympathy may lean towards the wasps in the hour when the wonderful fabric of the queen and her labourers [illegible] doomed to be wrecked, yet we [illegible] ask: What if it were not so? Wha[illegible] the workers lived through the win[illegible] and commenced their work early in spr[illegible] together with their guiding queen mother? What, indeed! By autumn there would be a plague upon the land, and wasps would be reigning supreme.

CHAPTER VI

THE LIFE-STORY OF A HOVER-FLY
(*Catabomba pyrastri*)

WE have already seen in the case of the Lacewing Fly that not all the insects we find in the garden must be regarded as enemies. To distinguish between our insect friends and foes, however, is not an easy task. The average gardener kills indiscriminately when insects cross his path, especially if they happen to assume a grub-like form. Nevertheless, a little time devoted to discrimination between them, would be time well spent, for his wholesale killing often results in the destruction of his greatest friends; indeed, he often kills much better killers than himself.

My friend the Hover-fly has perfectly protected my sweet-peas from the ravages of the "green-flies" or "blight" during the

past summer, for like the Lacewing Fly, its mission in life is to deal death and destruction amongst the aphides, and consequently it is an insect which everyone who owns a garden ought to know.

Although at first the green-flies existed in more than usual abundance, and their attacks were even more persistent than ever, yet this particular species of Hover-fly, together with its near relatives, acted so promptly, and supervized things so thoroughly, that, later on, I could scarcely find a single green-fly.

It happened like this. By the side of my sweet-peas there was a bed of mint which quickly produced its flowers. Now of all things in the garden on which Hover-flies love to feast, probably mint flowers stand first. So these black-and-pale-yellow-banded flies came in large numbers to the banquet, poising themselves above the flowers in their characteristic manner, held there by the rapid vibrations of their wings, and then suddenly swooping down in hawk-like fashion to feast as opportunity occurred.

There was merry-making and love-

making amongst them during every hour of sunlight; in due course, too, there was marriage, and also families. It was then that my sweet-peas had become badly attacked with the "green blight," which, like the Hover-flies, were thriving apace during the hot weather. It was then, too, that some of the female Hover-flies became deeply interested in my sweet-peas.

Day after day they were hovering before the flowers and leaves, alighting upon them and carefully searching them over. The moment they met with a green-fly, they would deposit one of their eggs near to it, and then fly to another flower or leaf for the same purpose.

Now, as everyone who has tried to cultivate plants will know well, green-flies possess extraordinary powers of reproduction. A single green-fly will bud out twenty or more young in one day, and these are all females, which quickly develop to maturity, and are at once able to produce young in the same manner as their parent, and which are again all females. Also, this budding process of

reproduction continues for twenty or more generations during the summer months without any males appearing. Males are eventually forthcoming in the late autumn broods, and after their appearance eggs are produced instead of living young. When winter has passed, these eggs provide the first brood of budding females.

It is obvious, then, that every "green-fly" seen during the spring and summer months can become a mother, and I have previously referred to Réaumur's estimate, that a single green-fly may be progenitor to no fewer than 5,904,900,000 individuals during the two or three weeks of its life.

The mother Hover-fly seems fully acquainted with this state of things, for the moment that she detects a green-fly on a leaf or stem, she is content to place an egg there; probably she is instinctively satisfied that the sight of a green-fly is a sufficient guarantee that ample provision will be forthcoming to give her offspring a good start in life.

In Fig. 41 the egg is shown as placed by the parent insect amongst the green-flies, and more in detail in Fig. 42. Three

days later a tiny, yellowish-white grub (Fig. 43) emerges from the egg, which when fully extended is not more than one-sixteenth of an inch in length; but its courage and strength are as marvellous as its voracity.

The grub under observation, when hatched, travelled down the stem until it came to a leaf, on whose surface it met with its first green-fly. One of the legs of the latter touched the grub as it moved towards it. Instantly the grub thrust its head forward, and a moment later it was standing upright on the tail-end of its body with the green-fly elevated in the air—a magnified photograph of the actual incident is shown in Fig. 44.

In this attitude the little grub held the green-fly for over an hour while it sucked its juices, and this in spite of the fact that its victim was much larger than itself and continually struggling to escape. It then cast away the empty skin of the green-fly and rested for a while. During the first day of its existence it captured and ate two half-grown green-flies and two smaller ones; and day by day, for ten

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41. Bud of sweet-pea with Green-flies and egg of a Hover-fly upon it.
42. An enlarged view of the egg.
43. The grub of the Hover-fly photographed soon after its emergence from the egg—magnified.
44. The young grub on the surface of the leaf, sucking the juices of its captured Green-fly—magnified 12 diameters.

days, its appetite increased in an astonishing manner.

It grew rapidly, and by the end of the second day had become quite an expert in manipulating green-flies (Fig. 45). It is interesting to note that the grub is blind; it finds its prey by rapidly thrusting its head here, there, and everywhere as it travels. Sooner or later its nose comes in contact with a victim, when a three-pronged fork, or trident, at its mouth is immediately thrust into the green-fly's body; so it is elevated into the air.

The method of feeding of the full-grown grub is clearly shown in Figs. 46-49. The grub is of a green colour, with a white stripe down the centre of its back, which is tinged with purple at the base. When hungry, after searching for prey, these grubs are very ravenous, consuming green-flies at the rate of more than one per minute. As they feed during the night as well as the day, the enormous amount of destruction they work amongst these garden pests is incalculable; indeed, man's insecticides and fumigating devices

scarcely count against the persistent onslaughts of these grubs.

The grub's method of locomotion is curious. It is not provided with feet, but adheres to the leaves by means of the rough edges of the skin at the sides of its body. It, consequently, has some difficulties to overcome when on the move; nevertheless, it travels at a remarkable pace.

It stretches out its head—which is little more than a tapering proboscis bearing at its apex the trident previously referred to—as far as it can reach, then grips the leaf by means of its trident and immediately draws up its hinder parts until its tail-end almost touches its nose—appearing as if it were about to turn a somersault. Just as you expect to see it perform that movement, however, its head is suddenly thrust forward again; so it moves along in this loop-by-loop fashion. Also, it always appears to be in a big hurry, both when travelling and in making its thrusts around in search of prey.

Many kinds of these grubs may be

45. The grub when two days old, with a Green-fly larger than itself—magnified 2 diameters.
46. A full-grown grub spears a Green-fly.
47. Elevating it into the air.
48. Extending its body—see 46.

found amongst the leaves of garden and field plants, some of which are of a whitish-yellow colour, while others are marked with pale brown. These are the larvæ of the smaller species of Hover-flies, and their habits are much the same as the species here described, which may be readily identified by its green and white colouring and its larger size.

At the end of the ten days' feeding period, the grub's enormous appetite declines, and it attaches itself to a leaf or stem by the trident at its mouth. There it hangs for another ten or eleven days, its skin hardening and becoming of a golden brown colour (Fig. 50). After that time has passed, this pupa or chrysalis is suddenly burst open, and we find that the voracious grub has been transformed into a shining black-and-yellow-banded Hover-fly (Figs. 51 and 52).

It is obvious that the Hover-flies are amongst the gardener's most valuable allies. When we recognize the enormous rate of increase of which the green-flies are capable, together with the knowledge that, if their multiplication remained unchecked,

every green plant or tree on the surface of the earth would soon become converted into living green-flies, and that, in consequence, the food supplies of all terrestrial animals would quickly terminate, we can only marvel at the efficiency of Nature's sentinels which are ever on guard and ready to strike when one organism becomes dangerous to its fellows. When the green-flies become too abundant, Hover-flies and other natural foes of the green-flies quickly appear, and the work of destruction then goes on persistently until the normal balance is again established.

Many species of Hover-flies may be met with in the gardens and fields, but the species whose life history I have here described is one of the largest and commonest members of the family. Should my readers desire to encourage these insects to visit their gardens, it is only necessary to cultivate some of the old-fashioned garden flowers such as poppies, sweet-williams, thyme, mint, cornflowers, ox-eye and other daisies, etc. The parent insects visit these blooms for

49. Sucking the juices of the Green-fly—natural size.
50. The Pupa or Chrysalis.
51. The Hover-fly just emerged from its chrysalis.
52. Another view of the Hover-fly—natural size.

their nectar and pollen; for, as previously explained, the flies themselves do not feed on green-flies. Therefore, the garden with such flowers arranged amongst its rose and fruit trees, is least likely to suffer from the attacks of the green-flies, for the Hover-flies which come in search of food will soon detect their presence and place their eggs amongst them.

CHAPTER VII

WINTER BUTTERFLIES

WHEN damp days come and icy-cold winds commence to blow, man quite naturally seeks a closer companionship with his fireside, or resorts to other artificial means of raising the temperature of his surroundings to comfortable conditions. In wild nature, however, such artificial devices for obtaining warmth are, of course, impossible. As a consequence, at the approach of frost and cold temperatures Nature shuts up shop, as it were; leaves fall rapidly; many birds and small animals disappear as if by magic; while the myriad forms of insect life that were so abundant on every hand, seem, by some mysterious means, to have been suddenly and completely swept from the districts where perhaps only a few hours before they revelled in the sunlight.

Man is so busily occupied at such times in attending to his own creature comforts that he rarely gives a thought to what is happening to the frail life-forms that appear summer after summer and whose surprising habits ever prove a source of entertainment for him during his summer and autumn rambles. For instance, there is the familiar Large White Butterfly (Plate VI) which the Londoner may sometimes see even in the busy thoroughfare of the Strand; or, indeed, in almost every spot in the British Isles, so abundant is this insect in both town and country; yet how few of those who know the insect well could tell how it spends the winter!

In this chapter, therefore, I propose to consider how winter is passed by some of the more familiar butterflies of summertime. I would say, furthermore, that each of the butterflies illustrated here has been photographed from life, *i.e.*, in its natural pose, just as my readers might see it in its wild state. This class of photography is beset with many difficulties, as those who have attempted it will well know.

It may interest readers of this volume to learn that, to secure some of the pictures shown here, the writer had often to spend four or five hours of careful watching with camera all in readiness, so rarely could the insects be caught in a pose that would show their characteristic features and at the same time sufficiently at rest for a life-size photograph to be made.

It is not at all surprising that the non-entomologist should find a difficulty in stating how the butterflies with which he is familiar pass the winter season, for even expert entomologists cannot speak with any certainty regarding some of the most common species. The butterflies shown in Figs. 53, 54, and 56 present examples of such doubtful character.

The Red Admiral is one of the commonest and most striking of British butterflies; its velvety, black forewings, striped boldly with scarlet and heavily spotted with white, together with its large size, readily distinguish it as it feasts amongst the autumn flowers. Likewise, the Clouded Yellow Butterfly, with its

53. The Red Admiral Butterfly with closed wings.
54. The Red Admiral expands its wings.
55. A Clouded Yellow Butterfly.
56. Small Tortoiseshell Butterfly.
57. Comma Butterfly resting on a tree-stump with wings open.

orange-coloured wings broadly edged with black (Fig. 55) is equally striking, and sometimes even more abundant, although some seasons it is quite scarce.

Now, both these butterflies may abound in late autumn, but at the first signs of frost they entirely disappear. Late in the following spring both species are often seen again, but as isolated individuals or, at all events, in small numbers. From these facts it was concluded that the butterflies hibernated for the winter and that the cold killed off most of them. There is, however, good reasons for thinking that the butterflies seen in spring are not the same as those that showed in autumn. The spring butterflies are, most probably, immigrants from the Continent blown here by suitable winds; and it is the offspring of these immigrant species that develop into the larger broods seen at autumn; but even some of these may be new arrivals. In the same manner, too, the large autumn broods at the approach of cold, drift with warm winds to more congenial climes.

This theory of immigration certainly is

more plausible than that of hibernation, as it would account for the fact that the butterflies are never found hiding during winter, and also that remains of the perished individuals of the large autumn broods are never met with. Another point which lends colour to the immigration theory is that the Painted Lady Butterfly (see Chapter X), which is a first cousin to the Red Admiral, has an established reputation as a notorious migrant. Furthermore, the two species are often found associating on the slopes and summits of hills.

It may be said, then, of these handsome species that they do not "spend the winter" anywhere, but evade it; or, rather, they winter abroad.

Although only some sixty-seven or sixty-eight butterfly species are found in the British Isles, yet they have solved the winter problem in quite a variety of ways. Though some of our most handsome butterflies have to winter abroad, other species, more hardy in constitution, are able to survive throughout the months of frost and snow.

That such a frail creature as a butterfly, whose life activities are essentially associated with warmth and sunlight, should be able to endure several months of damp and snowy weather alternating with periods of freezing temperatures, and then, at the first approach of mild weather, take to its wings as if it had only rested in its flight awhile, seems a remarkable fact; nevertheless, this is true of several of the most familiar British butterflies.

In Plate VII, and in Figs. 56, 57, and 58, some of these hibernating species are shown. The familiar Peacock Butterfly (Plate VII) is readily distinguished by its bold "eyes" (resembling those of the tail feathers of the peacock) glittering on the upper surface of its velvety brown wings as it moves amongst the thistle flowers in autumn. There is always the possibility that this insect may be seen flying on any day in mid-winter. Even during a walk on a snowy Christmas Day that possibility exists, for it has been observed on more than one occasion flying over snow-covered pastures.

Likewise the Small Tortoiseshell (Fig. 56),

one of the prettiest and perhaps the most familiar amongst all our British butterflies that bear red and orange-coloured wings. This insect is easily recognized by its orange and red hues, together with the pale blue splashes that decorate the edges of its wings. On any mild day throughout the winter this butterfly is likely to be tempted from its hiding-place to stretch its wings with a short flight in the sunlight. Often that flight results in disaster in winter's fickle sunshine, which may disappear as quickly as it came, and leave the butterfly numbed and cold before it can find its hiding-place again; nevertheless, sunshine is irresistible to this merry little insect, and of all the butterflies that hibernate for the winter this is the one most likely to be observed.

In the spring the Tortoiseshell is always one of the earliest butterflies abroad, and it is this insect, therefore, that provides the crop of newspaper paragraphs that invariably turn up about February or early March, stating that a butterfly has been seen on the wing, attesting the "abnormal mildness of the weather."

There is, of course, in this nothing abnormal; the butterfly might have been seen in December or January for that matter. Before one can be justified in describing as "abnormal" any phenomenon connected with insects, he should first be fully acquainted with the habits of the insects themselves; but more on this point later.

A somewhat similar insect to the Tortoiseshell is the Comma Butterfly (Fig. 57). This insect is not nearly so common as the former, and may be readily distinguished by the edges of its wings being much more jagged, and by the absence of the blue spots at their edges. Sometimes on a winter's day this insect may be seen sailing along like a bit of tattered leaf; its cut wings, however, are perfectly natural.

Now, in the case of the Peacock, the Small Tortoiseshell, and also in the Comma, while the upper sides of the wings are brilliantly coloured, the lower sides are dull and dingy. The Peacock, illustrated in Plate VII, presents a good example of this. One moment the insect is a gorgeous display of colour; it closes

its wings, and instantly its colours are obliterated. The advantages that these hibernating species derive from this characteristic are obvious.

With wings open the insects are most conspicuous, but it would need keen eyes to distinguish them when, with wings closed, they rest against the dark roof of a barn or beneath the ledge in a hollow tree, where they have retreated for their winter sleep. The curious wavy and irregular markings of the lower wings harmonize so perfectly with the dusty thatching of the roof, or the fallen and shrivelled leaves that lodge in the crevices of the tree, that the insects become completely lost amidst their surroundings.

How efficient this protection is I have endeavoured to show in Plate VIII. The photograph represents two Comma butterflies resting in their natural attitudes (for the insects were living when photographed) on a branch bearing shrivelled leaves. I wonder how many readers of this chapter would have observed these butterflies had they seen the branch amidst ordinary surroundings?

Even their pale-coloured legs and the conspicuous white comma-like marking in the centre of the lower wings have their meaning, and, as the photograph shows, appear only like damaged parts and insect-eaten spots in the tissues of the apparent leaf. Probably, too, the contrasting whiteness of the legs and the comma-like marking serve to momentarily distract the eye of an approaching enemy, and divert it from the general contour of the insect, but as they remain immovable, the eye of the foraging mouse or bird is soon turned in other directions. Thus it would neglect to give its usual close scrutiny to that particular spot. It is from the comma-like marking referred to that the butterfly derives its popular name.

Then there is the Brimstone Butterfly (Fig. 58), the male of bright daffodil yellow and the female of primrose hue. This is another insect that may surprise the country rambler any sunny day during winter. Its colours are very striking, and one naturally wonders how with such colours it can remain unseen during the period of its hibernation; however, a

little thought will recall to the mind that this yellow colour is found amongst many evergreens, as variegated laurels, barberries, privets, and hollies, and as such bushes would serve as good shelter, these shrubs probably offer suitable hiding-places; also the leaf-like aspect of the wings tends to suggest such a probability.

About a dozen of British butterfly species select the chrysalis stage as a means of solving the winter problem. This particularly applies to the various species of White or Cabbage butterflies. so familiar throughout the summer months. The Large White (Plate VI), may be taken as an example. That insect generally spends its winter under the coping of the garden wall, or between the angles of the palings and fences, fixed in a horizontal position; although summer broods sometimes attach themselves to leaves, as shown in Fig. 59, where two chrysalids are seen held by their silken girdles to a lily-of-the-valley leaf; in this form the insect awaits an atmosphere more congenial for its destructive work amongst the cabbages.

58. Brimstone Butterflies love-making.
59. Two chrysalides of the Large White Butterfly.
60. Four Orange-tip Butterflies, showing how they become inconspicuous amongst the umbels of green and white flowers when their wings are closed.
61. Chrysalis of the Orange-tip Butterfly.
62. The Speckled Wood Butterfly—see 63.

In Fig. 60, some Orange-tip Butterflies are shown. These are familiar insects in May and June, and easily recognized by the mottled-green and white underwings (shown in photograph) which are white above, the forewings being tipped and spotted with black. In the male insect the forewings bear a bright patch of orange colour at their tips, hence the popular name "orange-tip." In July the caterpillar of this butterfly gives up feeding and attaches itself to a stem, often that of the lady's-smock, on whose seed-pods it feeds. Then it moults its skin and changes into a chrysalis like that shown in Fig. 61. The chrysalis in shape resembles the seed-pods amongst which it is not infrequently placed, and possibly by this means it is protected from the eyes of its enemies during this longest period of its life; for it continues in the chrysalis stage from the end of July until May of the following year. During all this time the tender chrysalis remains exposed; it is subjected to drenching rains, and becomes frozen and thawed many times, but at the end of it all the

delicate butterfly breaks from its frail protective shell and greets the sunlight. It is interesting, too, to note that at the first the chrysalis is green like the seed-pods; later in the autumn, when the pods become browned, the chrysalis likewise assumes that colour; thus the chrysalis remains inconspicuous.

The famous Swallow-tail Butterfly (see Chapter II) also remains throughout the winter in the chrysalis state; the chrysalis is attached to the stems of the reeds in an upright position, as shown in Fig. 11. This insect, however, is now only to be found in the Eastern counties in a few districts amongst the undrained fens. Drainage and cultivation seem to have driven it from many of its old haunts; it is, nevertheless, a familiar insect on the Continent.

Now it is obvious that if either the Large White butterfly, the Orange-tip, or the Swallow-tail were seen flying in February or March, that fact might then reasonably be put forward as evidence of the "abnormal mildness of the weather," for these butterflies rarely emerge until

winter is well past. Thus, as I have previously mentioned, the writers of the weather paragraphs should first look to the butterfly before offering its advent as proof of a mild season. Even then mistakes may be made, for it sometimes happens that a caterpillar forms its chrysalis against a greenhouse chimney or in some similar warm quarters, and so its butterfly arrives prematurely into a cold and desolate world, only to perish quickly. However, when, in the course of a ramble early in the year, a few butterflies of a species known to spend the winter in the chrysalis stage are seen, then it is a true sign of winter's retreat. The sexes necessarily must appear together, and when several butterflies are seen moving about it is at least evidence of a milder temperature.

The most general method of wintering amongst British butterflies is in their caterpillar stage; more than thirty of our sixty-odd native species so spend the winter. The Speckled Wood Butterfly (Figs. 62 and 63), however, varies its proceedings, and is sometimes a caterpillar

and at other times a chrysalis (Fig. 64) during the winter period. Probably, when the autumn is mild the caterpillars continue their development and complete their feeding, and thus attain the chrysalis stage before winter.

When the caterpillars hibernate they are usually very small, and hide amongst the leaves low down on the ground. The familiar Small Copper Butterfly, shown in Fig 65, presents a good example. The caterpillars are like tiny green slugs (Fig 66), which conceal themselves beneath dock-leaves; early in the year they continue their feeding, and by April or May complete their development and become butterflies.

The same method is adopted by most of the species of the charming little blue butterflies that flit from flower to flower and make gay the grassy roadsides at midsummer. The Chalk Hill Blue (Plate IX) is a very familiar example, being found in most of the Southern counties. The species known as the Silver-studded Blue, however, spends its winter in the egg stage. The eggs are deposited amongst

63. The Speckled Wood Butterfly with open wings.
64. Chrysalides of the Speckled Wood Butterfly amongst grass blades.
65. Small Copper Butterfly.
66. Slug-like caterpillars of the Small Copper Butterfly.
67. Eggs of the Silver-studded Blue Butterfly—magnified.
68. Eggs of the High Brown Fritillary Butterfly—magnified.

the stems of heather during July and August and remain through the winter, the young caterpillars hatching from them in April of the following year. In Fig 67, two of these eggs are shown as they appear when magnified twenty diameters, or four hundred times.

There are some eight species of British butterflies that pass the winter in the egg stage, but most of these are familiar only to entomologists; four of them are known as Hairstreaks, and three of them belong to the Skippers; the eighth is the more familiar Silver-studded Blue just mentioned. There is also a ninth species which seems to compromise the matter of egg and caterpillar stage. This is the High Brown Fritillary, which deposits its eggs in July, and although these do not hatch out their caterpillars until the following April, yet the young caterpillars are perfectly formed within the egg before winter. In Fig 68, some of these eggs are shown magnified about three hundred times, and from one of them I have removed the young caterpillar. The time of its removal was the [illegible] the

illustration, therefore, gives positive proof that the young caterpillars are fully formed eight or nine months before they appear.

Thus it is clear that it is not an easy matter to state definitely how British butterflies spend their winter. It is obvious, though, that the various methods adopted by the different species have a direct connection with the timely development of the insect; each species appears in its due season—when its food-plants are to be found.

CHAPTER VIII

AN INTERVIEW WITH A DEVIL'S COACH-HORSE BEETLE

(Ocypus olens)

OUR meeting was quite impromptu. He had just come from under a heap of stones and was travelling at a rapid pace along the dusty road, when I approached. I do not think that he heard me coming, but probably the vibration from my footsteps warned him of my presence, and, being a warrior bold who knew no fear, he instantly halted. He set his legs wide apart and gripped the ground firmly with his feet, while his jointed feelers quivered excitedly for a moment, and then became still—as shown in Fig. 69.

Now a Devil's Coach-horse Beetle that is not prepared to meet a foe and fight until death, if need be, is no credit to his race. This fellow was no coward,

he evidently had no intention of running away; indeed, his attitude seemed to distinctly invite a quarrel.

While he was awaiting events, there was ample opportunity of viewing this gentleman of the road, and it did not take long to decide that he was undoubtedly the ugliest insect that one could expect to meet on an English roadside. He looked somewhat like a large and exaggerated earwig without tail-pincers, and with a big head bearing a pair of cruel-looking eyes. His colour, too, helped his hideousness, for, quite unlike, I think, any other animal in the British fauna, he was a funereal, dead black from head to tail.

I pushed the toe of my boot towards his tail-end. That was more than his irritable and aggressive nature could tolerate, and in an instant he turned completely round, fully prepared for battle. He held his head low down and half raised his tail, and seemed all ready to make a sudden and ferocious charge—as shown in Fig. 70. Probably

that manœuvre scares away many of his foes; his tactic, however, is to invite the charge rather than to make it.

He, therefore, adopted his usual procedure and once more became motionless in his changed attitude. Another movement of my toe instantly produced another and more desperate posture. He rapidly changed the position of his legs, raised high his tail in scorpion fashion, opened wide his huge jaws (which, as in all biting insects, open sideways), and positively glared with his cruel-looking eyes in a most savage manner—as shown in the photograph (Fig. 71). Then from a pair of glands at the tip of his tail he discharged two globules of a volatile fluid with a horrible odour.

Brave would have been the insectivorous foe that dared to tackle such a meal. Doubtless, in the course of his life he had scared away many birds, hedgehogs, toads, lizards, and similar enemies by these same manœuvres, but he had never before met a wandering naturalist bent on seeing what fighting powers a Devil's Coach-horse Beetle really possessed.

Here, therefore, was a new venture for this fellow of menacing attitudes.

After the one discharge of the evil fluid, that means of defence was for the time being exhausted. Its next defence was its jaws, for although its tail assumes a stinging posture, yet it is quite incapable of stinging. So its wide-opened mandibles would be the foe's next consideration. Can it really bite? the unsatisfied attacker would naturally inquire.

A small folded portion of coarse brown paper would probably represent a fairly tough natural foe. So with that object in one hand and the camera release-ball in the other I made some experiments. I gently pushed the folded paper towards him. He at once savagely seized it, much after the manner of an angry bull-dog, attacking it not only with his mandibles, but also with his legs. He held it so firmly that I was able to lift him up from the ground (Fig. 72), but that movement only made him still more desperately angry, causing him to hold on literally with "tooth and nail"—as shown in Fig. 73.

69. The Devil's Coach-horse Beetle scenting danger.
70. Showing fight.
71. Raising high its tail and opening wide its huge jaws.
72. Attacking a bit of coarse paper with which it was touched.
73. Getting desperate.
74. A savage attack upon a leaf-stalk.
75. Holding on by its jaws while the leaf-stalk was held up
76. Biting and holding on to the author's finger.

After a few minutes I laid him and the paper down, and when the latter had been quiet sufficiently long to justify its release, he let go; he, however, made no attempt to move away, but doggedly waited for the paper to move again.

When he had rested for about five minutes I laid a leaf-stalk beside him. His blood being up, and apparently having laid one enemy low, he was quite ready for the next, for he instantly pounced on this, taking the end of it firmly in his jaws. My touching the other end of it made him very angry, causing him to get his legs well over it (Fig. 74).

I then lifted the leaf-stalk, when to my great astonishment he raised his tail and slowly turned half a somersault, and in that attitude he held firmly on, his mandibles bearing his whole weight (see Fig. 75) until I laid him and the leaf-stalk down again.

An examination of the folded brown paper showed that his mandibles had neatly pierced it. Were those jaws strong enough to pierce the human skin?

Many stories have been told of people being bitten by these insects, and of the various ill-consequences thereof, but perhaps such stories were, as is so often the case with little-understood creatures, founded on superstition and ignorance. To definitely decide the point, therefore, after he had rested, I offered him the tip of my forefinger. Again he was ready to attack, and time after time he endeavoured to get a grip, but the roundness of the finger prevented this. I could distinctly feel the nip of his little jaws, and the amount of pressure which they exerted was really astonishing. Suddenly I felt that he had accomplished his purpose, when I instantly withdrew my finger. The skin was firmly gripped and he was holding on, as the photograph (Fig. 76) shows. He had, however, made a mistake in biting so hard on this occasion, for his wedge-shaped jaws had penetrated only the surface skin; but so thoroughly had they been driven in that he was not strong enough to withdraw them again.

It was obvious, then, that on occasion

this beetle will attack a human being, and although its little mandibles can only penetrate the surface skin of the finger, yet on the face, or neck, where the skin is more tender, they might enter more deeply. Also, should the insect make its attack in a dusty cellar, or after preying upon some carrion material, it might result in some poison being conveyed to the wound, and so set up blood-poisoning in the case of an unhealthy person.

Since the attack in my own case was provoked, I bore no ill-will against the beetle, and having performed his part so well, I carefully released him and placed him on the ground. After cleaning up his mouth-parts and waiting sufficiently long to see that no further enemies were abroad, he pursued his path on the roadside, quite ready to attack his prey in the same fearless manner that he had dealt with his supposed foes. In spite of his hideousness and readiness to attack foes both great and small, he is a most useful insect, and should never be killed; his

prey consists of almost any insect with which he happens to meet, and a slug or a worm does not come amiss to him; he will even attack a young toad. Also, he has ample wings, is a bold flier, and is common throughout the British Isles.

CHAPTER IX

THE LIFE-STORY OF THE LUNAR HORNET-MOTH

(*Trochilium crabroniformis*)

THE woodman had been busy for several weeks past in the copse-wood, and the young trees and saplings which the previous autumn had occupied all the available space between the older trees were now so much short-cut under-wood, the new wood of their cut ends standing out conspicuously above the sheets of nodding blue-bells and fresh green of the spring herbage.

Here and there the cut boles of some of the older tree-tenants of the wood showed that the gleaming axes had carried out the bailiff's decree. Now, however, the great tree trunks and brushwood had been carried away, and Nature was tidying-up things and rapidly repairing

the damage done; and, in spite of the havoc wrought, everything looked bright and hopeful in the morning sunlight.

Sitting on a tree-base listening to the music of the birds, and endeavouring to picture in the mind's eye how the damaged branches will shortly be clothed and hidden from view by the fresh green leaves of the now conspicuous new shoots, the eye is suddenly attracted by a neatly-cut round hole in the lopped stump of a branch of the sallow or goat-willow tree. The hole is just about large enough to receive the end of a lead pencil, or the tip of one's little finger, and apparently it has been cut by means of an auger (Fig. 77). One naturally wonders what purpose the woodman had in boring that hole, especially as other willow stumps similarly bored may be found here and there throughout the coppice.

It was indeed a strange "woodman" that drilled those holes, but how they were formed need not trouble us for the moment, for just at present there is a more important matter for consideration.

The sun's rays are falling directly into the hole under observation, partly illuminating its interior, and while we are wondering what function the hole could serve, we suddenly become aware of the fact that there is something moving inside it. What can it be? Some inquisitive insect, maybe, that has entered and is now returning. Whatever it is, it is moving but slowly!

Presently the forepart of a shiny brown body appears, gradually advancing by little bunts as if pushed from behind, until at last it is distinctly protruding from the hole (Fig. 78). Still it continues to advance, and just when we expect to see the curious object fall on the ground a most extraordinary transformation scene takes place.

The brown skin suddenly breaks open, and from it a wasp-like insect with a black-and-yellow-banded body crawls on to the bark (Fig. 79). Its wings at first looked soiled and crumpled, but in a few minutes they unfold from their creases, and the insect at once commences to travel up the branch, continuing until

it reaches the cut end left by the woodman (Fig. 80). There the hornet-like creature suns itself for an hour or more, looking decidedly dangerous even as it rests. When the sun is at its brightest the insect's feelers suddenly commence to quiver excitedly, and then, with a bee-like buzz, it takes to its wings, rising in the air and before departing flying about twice around our heads with all the characteristic movements of a dangerous stinging insect, causing us instinctively to duck, even though we may know the insect to be perfectly harmless.

Such an incident anyone may be fortunate enough to witness should they wander amongst willow and poplar-trees (but perhaps more often in the case of the former) during June and July, and, very naturally, a surprised eye-witness will desire to understand a little more of what has really taken place, and it is a curious story indeed.

The wasp-like insect is a quite harmless creature and is known to the entomologist as the Lunar Hornet-moth, so named from its remarkable superficial resemblance

77. The hole in the stump.
78. What came out of the hole.
79. A transformation scene: the brown skin burst open and a curious wasp-like insect quickly crawled on to the bark and developed its wings.
80. The black-and-yellow-banded insect looked decidedly dangerous as it rested.
81. The hornet-like creature was nevertheless a harmless moth, with transparent wings and a wasp-like body.
82. Eggs of the moth on the bark

to the dangerous stinging hornet. It does not really resemble a hornet, for if the two insects are examined together their difference is quite obvious; but the arrangement of black, yellow, and brown colouring, combined with the wasp-like form (for a hornet is only a large species of wasp), together with its similar habits of movement and flight, and the still more extraordinary transparent wings, give a distinct hornet impression (Fig. 81); and when that dangerous insect is under observation one does not stop to quibble over details.

This remarkable moth has, in the course of its evolution, become deceptively coloured to represent an imitation hornet or wasp, and the object of such mimicry is, of course, obvious enough, for the poisonous stings so characteristic of the wasp family render them immune from the attacks of many would-be foes.

The extent to which this mimicry has been carried is striking in many respects, for not only have the movements of these stinging insects been faithfully followed, but the moth is also able to

make a buzzing sound when it approaches very like that of a wasp or bee—a most unusual characteristic for a moth. Even their external anatomy is likewise largely reproduced. The antennæ, or feelers, are considerably more like those of a wasp than a moth (Fig. 80), while again the colours of the moth heighten the imposture; but the most extraordinary feature of all is the acquirement of transparent wings.

A moth in the ordinary way has its otherwise transparent wings clothed on both sides with innumerable minute opaque scales, all placed like the tiles on the roof of a house, and according to the manner in which these scales are arranged in groups and lines of various colours, so the markings and colouring of the wings are varied. Consequently, when handling the wings of a moth, we find our fingers covered with "dust," but which really consists of these microscopic scales rubbed from the insect's wings, and the more "dust" removed by the fingers the more transparent becomes the wings.

The wings of the Hornet-moth, however,

in acquiring a similarity to those of its protected model, have almost entirely lost their scales, only their margins now being so clothed, which gives them a dark edging, quite different from those of a wasp or hornet. In this connection it is an interesting fact that when the moth is enclosed in its chrysalis skin its wings are then clothed with scales, which disappear as it completes its development —a feature which shows that its transparent wings were derived from those of the ordinary type common to moths.

There are some fourteen species of these clear-wing moths found in the British Isles, but the whole family of them, excepting the species under consideration and one other nearly related insect, are much smaller than a wasp; they nevertheless all bear the characteristics of stinging insects, and probably derive protective advantages from their resemblance.

Now in the ordinary way a moth is of nocturnal habits, flying at dusk or in the darkness of the night; but our hornet-like moth flies during the day in the

sunlight. It is obvious that a mimetic resemblance to a wasp would serve no purpose to an insect of nocturnal habits, for the wasp spends the night in the nest. We see, therefore, that not only has the colour, external anatomy, and bodily movements of the moth become marvellously adapted to correspond with those of a wasp-like insect, but so relentlessly has it pursued the path of its model that it has even changed from a night-flying to a day-flying insect.

We should remember, too, that all these extraordinary changes have been effected quite unconsciously so far as the moth itself is concerned; it probably knows nothing of its remarkable similitude to a wasp. Such features are the outcome of variations, or "sports," which from time to time have approached wasp-like characteristics, and these individuals (being better protected than their fellows) have survived and conveyed to their offspring their peculiarities, the variations of the later generations again and again advancing in the same direction until we have the wonderful results here described.

We might very naturally suppose that a moth possessing such extraordinary protective characteristics would have become very successful in the struggle for existence, but this Hornet-moth is by no means abundant. Indeed, it probably represents an insect which has been much persecuted for very long periods of time by its natural foes, and only by means of these striking developments has it been saved from extermination. It is highly probable that in its perfect state (*i.e.*, in its moth stage) it is to-day particularly well protected, but there are stages in its history, before its wasp-like resemblance commences, when it has very dangerous foes to encounter; which brings us to that period before it emerged from the round hole in the willow stump.

When we examine the neatly drilled hole from which the moth appeared, it seems incredible that the insect itself could have cut that hole in the solid wood; nevertheless, such was the fact. When the female moth takes to her wings and flies in the sunlight, she soon finds a mate, and afterwards her business in life is to seek

for stumps of the goat-willow similar in size to that from which she herself emerged. Having selected a suitable branch, she deposits some of her eggs upon it (Fig. 82). The eggs are brown in colour, and are therefore not at all conspicuous when resting on the bark; occasionally, too, they are placed on the leaves of shoots near the ground.

In due course the little caterpillar emerges from the egg and crawls to suitable parts of the bark, and there commences to burrow into the wood, continuing until it reaches the central area of the branch, where it eats out a tunnel extending upwards for several inches, widening it as it grows.

Eventually it develops into a fairly large white, maggot-like grub, which not infrequently spends two years feeding within the branch; but it never forgets to pay due attention to the diameter of the entrance hole, for this has to be kept sufficiently large to allow of its emergence when it has completed its development. Also, it always takes careful precaution to lock and bolt the door against intruders

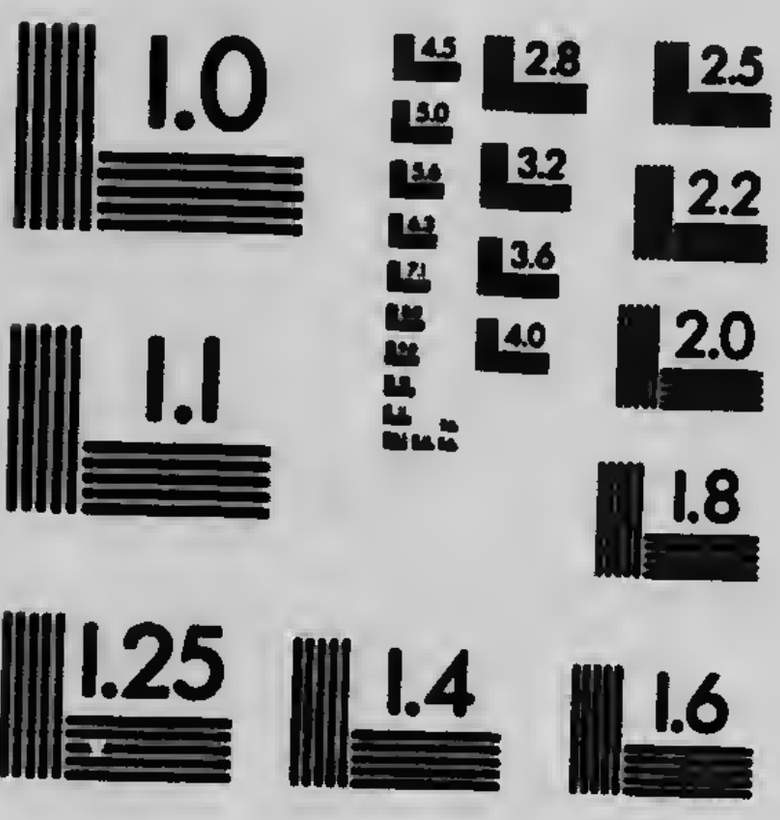
to its dwelling; for there are many dangerous foes outside that make it their business to enter any open holes that they may find. Sometimes these visitors are themselves in search of a meal, or it may be that they have young to feed; while still other uninvited guests make a practice of depositing their eggs in such situations, and then, when their offspring hatch out, they find a well-fed grub on which to prey.

To properly understand how the Hornet-moth larva guards its citadel against attacks of such kinds we require to carefully split down the branch in which it lives, and so get an internal view of the stump, as shown in Fig. 83.

The external hole is at the bottom of the left-hand division (Fig. 84), and it is seen to be barricaded on the inside by means of wood scrapings, which are held together by strong silken threads spun by the caterpillar and woven in amongst them. Should an enemy by persistent efforts effect an entrance through this obstruction, the caterpillar is still protected by a further barricade of the same materials, which at least does not encourage it.

MICROCOPY RESOLUTION TEST CHART

(ANSI and ISO TEST CHART No. 2)



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Thus protected, the larva tunnels its way along the heart of the branch with its head directed upwards. Then comes the time when it is full-fed, when a most curious instinct comes into play. The larva which has hitherto worked up the branch head forwards reverses its position and directs its head towards the place of egress. It then moults its skin and becomes a brown chrysalis, as shown in Fig. 84. The object of its change of position then immediately becomes obvious, for while the flexible body of the caterpillar could readily reverse its position in the tunnel, yet with the stubborn body of the chrysalis this would have been quite impossible.

The chrysalis lies by for some three or four weeks, during which time the moth matures, developing its transparent wings and wasp-like characteristics, until some morning when the sun has well-warmed the external area of the branch, the moth enclosed in the chrysalis skin is encouraged into active life.

Should the moth emerge into the cavity bored by the larva, its wings and soft body would get sadly damaged in effecting

3. An internal view of the stump. The Moth Caterpillar is seen on the left in the passage it has bored in the wood.

84. The caterpillar has now changed into a chrysalis, which, although legless, has to break through the barrier of wood-scrapings near to it and work its way down the boring to the hole and force its way through into the sunlight, as shown in 78.

85. An enlarged view of the empty chrysalis skin, showing that each segment is edged with spines which serve as "climbing-irons" to the pupa.

its escape; but such does not happen. The chrysalis steadily and persistently bores its way with its wedge-shaped head through the first barrier, and then slowly works its way down the boring until the closing defence at the entrance is reached, which it likewise penetrates, and so emerges through the open hole into the sunlight, as shown in Figs. 78 and 79.

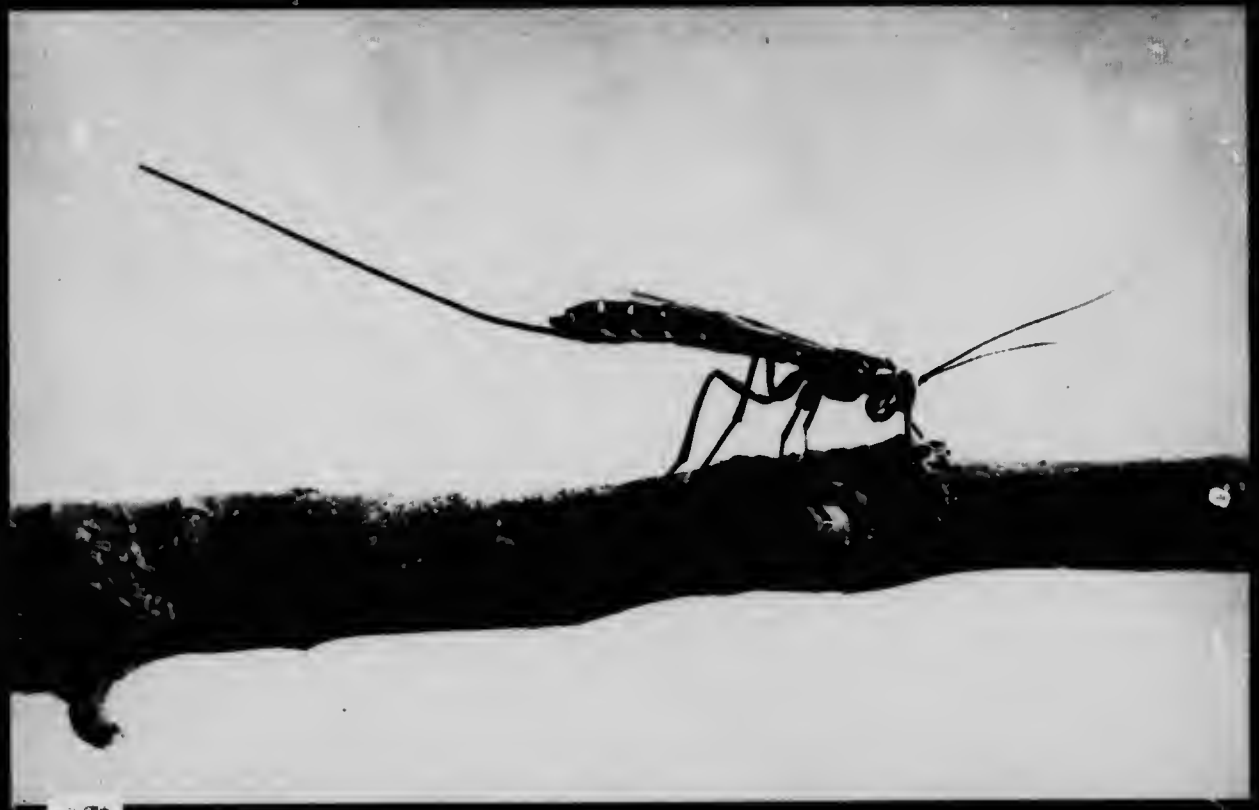
Since the chrysalis is not provided with legs or other limbs, it is somewhat astonishing how it can travel for several inches through the boring, especially as it has to force its way through barriers which resist the attacks of many of its natural foes. The movement, however, is explained if we examine the empty chrysalis skin which it leaves behind (Fig. 85), for each segment is provided with a row of strong spines which act as "climbing irons," gripping the sides of the boring as the pupa works its way downwards.

Such, then, are a few of the marvellous details revealed by consideration of a simple round hole in a willow stump. Unobservant people who wander in the

woodlands may perhaps learn from this brief history of a queer insect that there are more wonders in a wood than the obvious flowers and the birds; indeed, to those whose perceptive faculties are well-developed every hole in a tree, or even a leaf, unfolds a story of its own.

Even around the hole we have studied another curious insect life story commences, for each of the raised dots seen on the bark in Figs. 77, 78, and 79 was once a living insect, but one which lost its limbs and became sedentary as it sucked away at the juices of the tree. Meanwhile, as it increased in size, scales of wax oozed from its body and encased it, finally fixing it to the spot, and under which it perished—first, however, leaving its batch of eggs, from which its six-legged offspring will eventually appear and crawl from under the scales of their dead parent's body to roam the tree and then settle down as other scale-insects for a like fate.

Or let us suppose that we were able to spare the time to watch the various enemies that approached the entrance hole



to the caterpillar's boring during the two years or thereabouts in which it was feeding, what strange stories we could relate! I can only refer to one of such visitors here—that illustrated in Plate X.

There we have another wasp-like insect, with what looks like an enormous sting, with which it probes the hole, persevering until it has completely penetrated the caterpillar's barricades, and then departing. The caterpillar would remain quite unharmed, but not for long, for that long "sting" was really an ovipositor or tube for placing eggs into the boring, from which hungry grubs would hatch and prey upon the caterpillar. Surely, then, we cannot wonder at its double barricades.

The attacking insect is known as an Ichneumon fly, and is a species but seldom seen in the Channel Isles, although I found and photographed the insect here illustrated in this country. On the Continent it is a much more familiar insect, and there the Hornet-moth consequently has a greater need for its wood and silk defences, which may sometimes prevent such attacks. In this country the cater-

pillar still constructs its strong barriers against less formidable foes and the possible danger of a casual visitor such as the one illustrated.

CHAPTER X

THE LIFE-STORY OF THE PAINTED LADY BUTTERFLY

(*Pyrameis cardui*)

RARELY can a butterfly be said to be cosmopolitan, but the Painted Lady almost achieves that distinction, for it is found (and often abundantly) in almost every country in the world, excepting, perhaps, the Arctic regions and South America. Although the insect frequently occurs in large numbers, yet the irregularity of its appearance is striking. Sometimes, for several consecutive years, the butterfly collector diligently searches in vain for specimens; then some day unexpectedly, as he saunters along, he is overjoyed at the sight of one of these handsome insects on the wing. With net in hand he wildly pursues it, and the butterfly eventually alights in a

meadow near by, where thistle or clover-blooms abound. Imagine, though, the astonishment of the collector when, after carefully approaching the spot, he finds resting on nearly every flower a Painted Lady Butterfly—a multitude of them before his eyes. Such an incident has happened to many entomologists in nearly every corner of the earth. Where the insects come from so suddenly after, perhaps, years of absence, has long been a puzzle. However, the fact that these insects migrate is now well established; and this habit of migration, leading small or large groups to take advantage of suitable winds for the journey, probably accounts for the cosmopolitan distribution of the species, and at the same time for its numerical strength, for the race must naturally benefit by dispersal of its superfluous numbers to fields and pastures new.

Having now accounted for the sudden and extraordinary appearance of the butterfly, we may proceed to consider the details in the life-history of an individual.

It was in the early morning of the 8th

of June—the year need not concern us—when one of these butterflies suddenly put in an appearance on the English coast at Folkestone, and selected its pitch of land—for an attachment to a particular area, or stretch of land, about which they often career for several days together, is another curious characteristic of this species of butterfly. So our butterfly kept up the traditions of its race, and boldly manœuvred to and fro over its selected plot, occasionally resting and sunning itself on the tops of some tall thistles, where the charming chestnut browns and reds of its wings, contrasted with the black and white of their fore-parts, gave it a most fascinating appearance.

After it had worked off some of its superabundant energy, and had sampled the various kinds of nectar from most of the flowers that grew in its domains, this Painted Lady (for such she was in the strict sense of the word) proceeded to business. She made a kind of slow, circular tour amongst a clump of thistles and nettles which were growing together, fluttering from plant to plant, and moving

amongst their leaves as if engaged on a botanical investigation. A careful examination of a leaf on which the butterfly had been at work revealed some tiny pale green bodies dotted over its surface—so small that four or five could comfortably rest on the head of a pin. Nevertheless, they are wonderfully interesting little objects—the butterflies eggs, indeed; and in Fig. 86 some are shown as seen through the pocket lens of the writer.

Seeing that the butterfly herself feeds on the sweet nectar of the flowers, it is quite marvellous how she knows that her offspring will need green thistle and nettle leaves to feed upon; yet with unerring instinct she places her eggs amongst the leaves, and, apparently, she does not consider it important whether they are those of the thistles or the nettles.

Five days later (June 13th) the butterfly had disappeared. Indeed, it was highly probable that the spark of life within its frail structure had by that time succumbed to the large demands

made upon it, for it is seldom that the insect lives for many hours after depositing its numerous eggs. However, the safety of her species was ensured. The tiny and prettily-decorated eggs which she had placed so carefully and systematically amongst the leaves, were now bursting open, and from each broken shell emerged a little caterpillar—a baby Painted Lady!

These insect infants were greyish in colour, with rather large, shiny black heads, and covered with short bristles, and, of course, were very tiny when they first appeared. They soon proceeded to business and made inroads into the soft parts of the leaves, and, at the end of a fortnight, their bodies darkened in colour, and they became conspicuous about the food plants (Fig. 87). A week later still, they were exceedingly busy, and swarmed about the nettles (Fig. 88); and the following week (July 10th) the caterpillars were full grown (Fig. 89). They were then anything but handsome, their only decoration being some yellowish markings about

their bodies; but not the slightest indication was visible that they were presently to become lovely butterflies.

Eventually, one of the larvæ stopped feeding, and, after carefully selecting a suitable site beneath a leaf stalk, it slowly proceeded to spin a silken pad or cushion to it, finally attaching itself to this cushion by its tail claspers. In this way it suspended itself upside down, and there it hung a most dejected-looking object (Fig. 90). After it had been so hanging for a few hours, it commenced to squirm and wriggle its body, when its skin near the back of its head suddenly burst open. Then the caterpillar moulted its skin, for as the body wriggled the skin slowly shrunk up towards its tail-end, where it was attached to the silken cushion. Illustration Fig. 91 shows this process taking place, just at the half-way stage. At the end of four minutes the shrunken skin was free, but it could not yet fall away, for it still had to be freed at the point of attachment to the stem (Fig. 92). Presently, though, the developing

86. Eggs of the Painted Lady Butterfly—magnified.
87. The little Caterpillars on the nettle leaves.
88. The Caterpillars when three weeks old.
89. When four weeks old they were full-grown.
90. Preparing to become a Chrysalis.
91. Moulting its skin.
92. The skin cast at the end of four minutes.
93. The Chrysalis.

insect detached itself, let the skin drop to the ground, and then re-attached itself to the silken pad (Fig. 93). This seems a very extraordinary feat, for, apparently, the insect must loosen its hold while allowing its cast skin to fall. However, close examination shows that at the extremity of the body are numerous minute hooks by means of which the insect attaches itself to the silken pad. It, therefore, probably detaches some of the hooks while the others remain connected, and so the skin is gradually passed over the point of attachment and falls to the ground. We no longer then have a caterpillar to consider, but a pupa, or chrysalis—the next stage of the insect's development.

The chrysalis is at first of a greyish colour, but when it has been hanging for a few hours its angles become burnished, and it then presents metallic shades of various hues: green, crimson, gold, and silver, according to the position from which it is viewed.

On July 11th two larvæ became chrysalides at almost the same time, beneath

the cleaned central vein of a thistle leaf on which they had been feeding (Fig. 94), and there these pupæ hung motionless for twelve days (July 23rd). But not until the end of that time did it become obvious that some further development was taking place. The chrysalides then lost their metallic splendour and became greasy, and through the outer skin the coloured wings of the butterflies, now almost ready to appear, became visible.

So few persons have seen a butterfly emerge from its chrysalis into the world of sunlight, that here was an opportunity not to be missed. To seize the opportunity, however, was not so simple as it seemed. Although we know from external happenings that the butterfly is almost ready to appear, yet just when it will emerge we are quite unable to foretell. Therefore, we have to wait Nature's time. This waiting sometimes becomes tiresome, for the butterfly may appear at any moment during about twenty-four hours from the time the chrysalis changes its colour; occasionally the butterfly emerges almost at once, while others may wait the

whole of the twenty-four hours, or even longer; so that there is no criterion as to the exact time when the insect will appear. It is, therefore, essential that a careful and persistent watch should be kept upon the chrysalis, especially as the butterfly only occupies a few seconds in making its emergence and then very quickly extends its wings.

After six hours of waiting, one of the chrysalides under observation suddenly moved—just a slight jerk. Then the broad end gently bulged and burst open. Through the opening immediately appeared the head of the butterfly, quickly followed by the forelegs, by means of which the insect gripped the stem and so assisted in more comfortably extricating its latter parts (Fig. 95). A moment later it was on the stem, leaving behind it the broken and empty chrysalis skin (Fig. 96); and in this way the chrysalis changed to a butterfly.

How disappointing, though, is our butterfly. It has dumpy wings, looks like a cripple, and is altogether unlike the parent butterfly that so gaily flashed its colours

in the sunlight! Almost immediately that thought occurs to us our butterfly begins to grow in beauty before our eyes. Its dumpy wings lengthen out and begin to reveal their charming colours (Figs. 97 and 98); indeed, the whole process is a delightful transformation scene in miniature. Yet there is no doubt about its reality; there the butterfly hangs on the stem of the plant—a lovely insect that a few moments before was apparently a dry and lifeless object.

There, then, the butterfly hung, clinging by its legs, its wings dangling in space, for they were limp and wet and quite unfit for flight. At the end of an hour, though, things had changed. It was then obvious that the wings were no longer wet and flimsy, for they had dried rigid and bore quite a trim and neat appearance (Fig 99), and, what is more, they were also under muscular control. This latter fact soon became apparent. It was nearly mid-day, and the bright sunshine was particularly attractive to this creature of the sunlight whose birth we have witnessed. Indeed, its frail form was so

94. Two Chrysalides.
95. One of the Chrysalides suddenly bursts open.
96. A moment later the Butterfly was on the stem.
97. It begins to grow in beauty.
98. The wings lengthening out.
99. At the end of an hour it was ready for flight.
100. Away it travelled up the stem.
101. It opened wide its wings and revealed their lovely colours.

crammed with the joyousness of life that it could not afford to waste a moment of the golden time. Instantly the wings were under control, the butterfly became impatient. Its feelers quivered, its legs moved rapidly to and fro, and finally its wings began to flutter; and it was at that instant when the butterfly seemed to realize that it possessed a new and wonderful power. Restraint then was out of the question; away it travelled up the stem (Fig. 100) to the topmost point, and there it took its first outlook upon the new world of space it had to conquer. The erstwhile caterpillar that filled up every moment of its existence in searching for and devouring green leaves, allowing intervals for resting, was as dead and forgotten as if it had never been. Here was a creature whose food consisted of the sweet nectar of the flowers, and who would never eat a green leaf while it lived, for it lost its mandibles when it threw off its last caterpillar skin, and now it had only a long, coiled sucking proboscis which it unrolled to search the depths of the flowers. Its outlook on life

evidently gave it much satisfaction, for it suddenly opened wide its wings and revealed the lovely colours of their upper surface (Fig. 101). Where and how it got those marvellous organs with all their wondrous hues was quite a mystery. Evidently green leaves were the working basis for their production, yet that knowledge does nothing towards explaining the mystery.

The opening of the wings was but a preliminary movement. After the butterfly had sunned itself for a few minutes, it quietly pushed off from the stem into space. It did not at first fly very far, but after a short rest it again rose on its wings, and then that same bold flight that characterized the parent butterfly when it careered over its selected plot near the sea-coast was reproduced almost exactly.

Yes, our butterfly, at least, was safely launched, but what would happen afterwards? Probably several days would be occupied in the simple pleasures of butterfly life, such as frolics in the sunlight with its brothers and sisters that appear

about the same time, and imbibing all the sweet nectars from the various flowers. Or there may be love-making, for any day suitable winds may bring a few or a multitude of its species to its near neighbourhood, and amongst such visitors may, of course, come its mate. As we have seen, the development of the butterfly occupies only about six weeks, so that even in the short British summer there would be time for another generation to appear. Another possible happening is that some day when the brother and sister butterflies are sunning themselves, a strong wind may commence to blow, so strongly that with almost one consent the butterflies will rise and drift before it, and so be carried high and driven onwards and onwards, until at last the strongest fliers of the family that remain will find that the wind has ceased to blow, and that they have come nearer to the earth. So tired are they from their long, forced flight that they all alight. Of course, they may have dropped in some remote part of Europe or Africa, or elsewhere; but that does not matter in the slightest

so long as nettles or thistles, or similar food plants for their offspring, are to be found there together with warm sunshine —those are all the things they need.

Perhaps, too, the same strong wind will have brought to the same place others of their species, among whom they will find mates that have also stood the test of a journey; and in this way, by the natural law of heredity, a race of still better fliers will be forthcoming for the journeys of the future. In this manner, from small beginnings, the species may have developed an instinct to fly before a strong wind; and as the species have benefited by the habit (because it extends the area over which the insect is dispersed, and thus enlarges its opportunities in life) so it naturally follows that the habit has become inherent, and thus we find that the Painted Lady can now claim almost the whole world as its home.

CHAPTER XI

FLEAS (*Pulex*)

THE entomologist is able to produce evidence which tends to show that fleas were once two-winged flies, which, owing to the development of the parasitic habit, have so completely lost their functionless wings, that even the entomologist himself can now scarcely trace their rudiments. That explanation probably throws some light on the manner in which the various flea species became associated with special and widely-removed hosts, for coming of a family of winged flies they would have ample opportunity of seeking and selecting those animals best adapted to their requirements.

It follows, therefore, that there are fleas and fleas. The dog flea is not the same species as that which patronizes the

domestic cat; and the common flea which inflicts its surprise attacks upon mankind without the slightest respect of person, is still another distinct species; indeed, each kind more or less severely restricts its attentions to its respective host—although an occasional misadventure may prompt a species to make the best of a bad job.

Remarkable as it may seem, monkeys probably approach the nearest to freedom from external parasitic visitors. They are not infested by fleas; and pediculi, or lice, are but very rarely found upon them. That they often appear to be cleaning their fur (or perhaps more often that of their nearest neighbour) from these pests is true, but observation has shown that they remove only bits of scurf and similar secretions from the skin. Indeed, it is this very habit of picking particles from the coat of each other by means of their sensitive fingers and opposable thumb, that has prevented parasitic organisms from establishing themselves upon them as permanent and specialized species. Other animals, which have only been able to

scratch and rub themselves when attacked, have fallen ready hosts to numerous species.

With the parasitic habit degeneration necessarily commences. It does not follow, however, that the subsequent development of an organism which falls from the standard of its race, is without complexity. As a matter of fact, a glance at the anatomy of a flea (Figs. 102–4) very conclusively shows how intricate and complex its evolution has been while on its downward path.

With the loss of its wings a marvellous development of the legs has taken place (Fig. 105); indeed, fleas are the greatest jumpers known in nature—although the locusts run them closely in this respect. The human flea has developed the jumping habit to a greater perfection than some of the species which are found on the lower animals. If a man of about six feet in height was as expert in jumping as the human flea, he would cover a mile in four springs and would reach an altitude of nearly 200 feet each leap.

The hedgehog is an animal which is

very abundantly supplied with parasites, and amongst these it possesses its own particular flea (Fig. 104). And, with regard to this insect, I was somewhat surprised a short time ago to discover that, when placed on the ground, it rarely attempts to jump, although it is provided with powerful jumping legs.

A hedgehog I had in my garden had been in hibernation for the winter months and had reappeared, much to the delight of my small boy, who the previous summer had made a pet of it. When visitors came, he got it out from its hiding-place to show them. One day fleas were found to be swarming upon it, although none had been noticed previously. They were in such abundance that they fell from it whenever it was handled; and it was owing to that fact that I made the discovery of this flea's curious habit of rarely ever jumping when on the ground.

The boy had taken the hedgehog in the kitchen, and consequently a search had to be made. It had been exhibited on a wooden table, and also on a linoleum-covered floor, both of which places pro-

102. Female Flea of Rat.
103. Male Flea of Great Noctule Bat.
104. Male Flea of Hedgehog.
105. Part of one of the jumping legs of a Flea, showing muscles of the thigh.
106. Pygidium of a highly magnified. This object is seen on the end of the body of the Flea shown in 102.

vided a dozen or so fleas, although the search was not made until half an hour had elapsed; indeed, the fleas simply hopped round and about each other, remaining more or less on the same ground. The discovery of this curious characteristic led me to make some experiments, and I found that at the end of an hour even, these fleas remained on the ground where they lost their host.

The explanation of this peculiarity is, I think, associated with the habits of the flea's host. The hedgehog usually has a regular track to his hiding-place, and ground freshly dug will readily show its track even the next morning, for its feet quickly flatten down the soil where it runs. Consequently, when the hedgehog flea loses its host, its safest policy is to remain on the track until the hedgehog returns (for it runs over its track many times throughout the night), when, I have no doubt, it can jump quite well. That, I think, is the explanation of the hedgehog flea's peculiar habit. I may also add that I do not think the hedgehog flea will migrate to man.

Fleas, therefore, are not only highly evolved in structure for their work as parasites, but correspondingly so in their habits; for doubtless, each species possesses characteristics associated with its particular host. The flea of the fowl presents a similar example of a flea which does not leap; it, however, runs swiftly.

The body of these degenerate insects has, likewise, become marvellously adapted to their requirements. It is clothed in a suit of mail, perfect in fit and rhythmic in action. Its horny segments are provided with bristles all pointing backwards, and it is these bristles, combined with its smooth surface, which account for the flea's extraordinary power of slipping through closely-pressed fingers; for, if it can only wriggle forward, these bristly segments prevent it from slipping back again. Also, the body is laterally compressed, being so flat that it can bear enormous pressure on the soft body of its victim without ill effects. This compression of the body is common to many forms of animal parasites, but the fleas are remarkable for their lateral flattening, for the bodies of most

other forms of parasites are compressed from above and below.

On the terminal segment of a flea's body is seen the curious organ known as the "pygidium" (Fig. 106). This is a most extraordinary piece of mechanism when seen highly magnified, being provided with disc-like orifices from which arise long, sensitive bristles. It is very doubtful what sensory function this organ serves, but it has been shown, with some probability, that it represents the flea's auditory apparatus.

It now remains to consider the head of the flea, for in this part of its anatomy are contained the weapons with which it inflicts its so-called "bite," which is really a minute puncture opened by a pair of strong and flexible knives toothed along both their edges. These blades vary somewhat in form in the fleas of different animals (Figs. 107 and 108), and between them is a suctorial tongue, also coarsely toothed, by means of which the flea increases and absorbs the flow of blood from the wound made by the saw-like lancets.

The whole head is covered with a

polished helmet (Fig. 109), and bears an eye on each side. The eyes are not provided with many facets, like those of insects generally, but consist of a single round lens backed with a very black pigment. Behind the eyes are the minute antennæ, or feelers; while in front of the head there is a much larger pair of jointed mouth-feelers, which probably serve to direct the flea where to apply its lancets.

The flea, like other insects, deposits eggs, which are of a comparatively large size, and in the case of the human flea twelve is a maximum batch. The larvæ which hatch from the eggs are bristly, worm-like animals, and they will feed on almost any organic dust and dirt that happens to be near, such as that rubbed from clothes, fur, feathers, etc.; they will also thrive on powdered breadcrumbs and similar food materials. As a consequence, they are often reared between the boards of houses where floors are left unswept. After ten or twelve days' feeding they change into the pupa stage, and a week later emerge as perfect fleas. In cold weather their development takes longer.

107. Mouth-parts and toothed lancets of a Rabbit Flea.
108. Toothed lancets and mouth "feelers" of the Human Flea.
109. Head and fore-parts of the Human Flea.

It is a curious fact that the human flea proper, although common in Europe yet does not thrive in America, and is there very rare. A common species which infests both the cat and dog there, however, also becomes a pest in houses.

There are a hundred or more kinds of fleas known to infest mammals and birds, yet each species more or less severely restricts its attention to the animal of its own selection; thus the cat, dog, hedgehog, bat, squirrel, mole, fowl, pigeon, etc., each have their own specific flea.

CHAPTER XII

THE MAGPIE MOTH AND ITS PARASITES

AMONGST those insects that work mischief in the gardens and fruit-farms, the Magpie, Currant, or Gooseberry Moth (*Abraxas grossulariata*), as it is variously called, holds a very prominent place. The British Board of Agriculture have, indeed, found it necessary to issue a leaflet giving methods of prevention from, and remedies for, the attacks of this destructive insect.

The moth appears about midsummer, and it frequently flies during daylight. Its wings are white, bearing numerous deep brown or black spots and blotches together with some yellow markings; consequently, it is a very conspicuous insect. It derives its popular name, Magpie Moth, from the bold markings of its wings, while its other familiar names have reference to

the plants upon which it works so much havoc during its larval period.

Some of the eggs of the moth are shown in Fig. 110 magnified twenty diameters. They are somewhat oval in shape, and their shell structure bears a silvery appearance and is beautifully reticulated with a delicate pattern, which is revealed by means of a magnifying lens, as the illustration shows. Although the tiny eggs have so attractive an appearance under the lens, it is nevertheless from these little objects that the fruit-grower's trouble arises. When the female moth has once deposited her numerous eggs amongst the leaves of gooseberry or currant bushes, it becomes a difficult task indeed to protect the foliage of the bushes from being more or less completely stripped later on.

In ten or eleven days after the eggs are deposited, the little caterpillars emerge, and at this stage are so small that they escape notice. Their feeding at this period does but little harm, and towards the end of August, or early in September, they give up feeding and spin bits of leaves together on the ground beneath the bushes.

Later, falling leaves afford them further protection, and so they spend the winter months.

The fruit-grower has probably failed to observe the advent of his enemy, but it is in the following spring that he detects the mischief that is being done to his trees. Just when the branches are becoming clothed with new leafage, numerous dark-coloured caterpillars may be seen biting out the hearts of the buds (Fig. 111), and should these destructive larvæ be neglected at this stage, the branches will quickly be denuded of their leaves, and the fruit crop for that season ruined.

So ravenously do the caterpillars feed after their winter hibernation that often by the first week in May they are full-fed. Some full-grown larvæ are shown in Fig. 112. They are of a cream colour, striped along the sides of their bodies with orange-yellow, and bearing large black spots along the back; indeed, they are coloured very similarly to the moth which they eventually become.

Now these contrast and conspicuous colours play a very important part in the

economy of this insect. Both the moth and the caterpillar make no attempt at concealment, but expose themselves boldly before their enemies ; they rely entirely on their gay and conspicuous colouring to warn off their foes. While many insect species depend for protection upon a more or less perfect simulation of their surroundings, whereby they become inconspicuous, the Magpie Moth, throughout all its stages in its development, takes the contrary course, and flaunts its colours before the eyes of its enemies, thus making itself as conspicuous as possible.

Such showy colours are generally associated with nauseous and distasteful properties, and insectivorous animals are consequently warned from making an attack upon species so coloured. A frog or a toad seeing one of these caterpillars in motion, may snap it up greedily, but will quickly reject it again, and nothing will thereafter persuade that frog or toad to touch another similar larva. Probably that first attack was wholly the outcome of inexperience.

This caterpillar is also distasteful to

birds, spiders, and many other enemies, and being thus enabled to escape from the attacks of some of the most formidable foes that prey upon caterpillar species, it naturally thrives apace and often becomes a serious pest, owing to its destructive work while feeding.

It happens, however, that whenever an organism outstrips its natural foes, and becomes too dominant in the struggle for existence, new enemies arise to check its ravages and restore the lost balance of power. So it occurs that, although in some seasons we may find the leaves of currant, gooseberry, or plum-trees being destroyed by innumerable larvæ of the Magpie Moth, it does not follow that there will be numerous moths later in the season, and that the pest will thrive and become still more abundant the following season. Probably, by the time the moths should have developed, Nature will have taken measures to correct the defect in her working scheme that has allowed an organism too decided preponderance, and will have checked it so thoroughly that, during the season that follows, the pre-

dominant species may become quite scarce. We will now, then, observe how any excessive development of the Magpie Moth is suppressed.

Last autumn in the writer's garden some gooseberry bushes were badly attacked by the larvæ of the Magpie Moth, and the caterpillars fed boldly in the bright sunlight, in their characteristic manner. Now, one could not approach these bushes during sunlight without finding swarms of what were apparently common houseflies buzzing round and congregating about the branches and amongst the leaves. This fact led to an experiment.

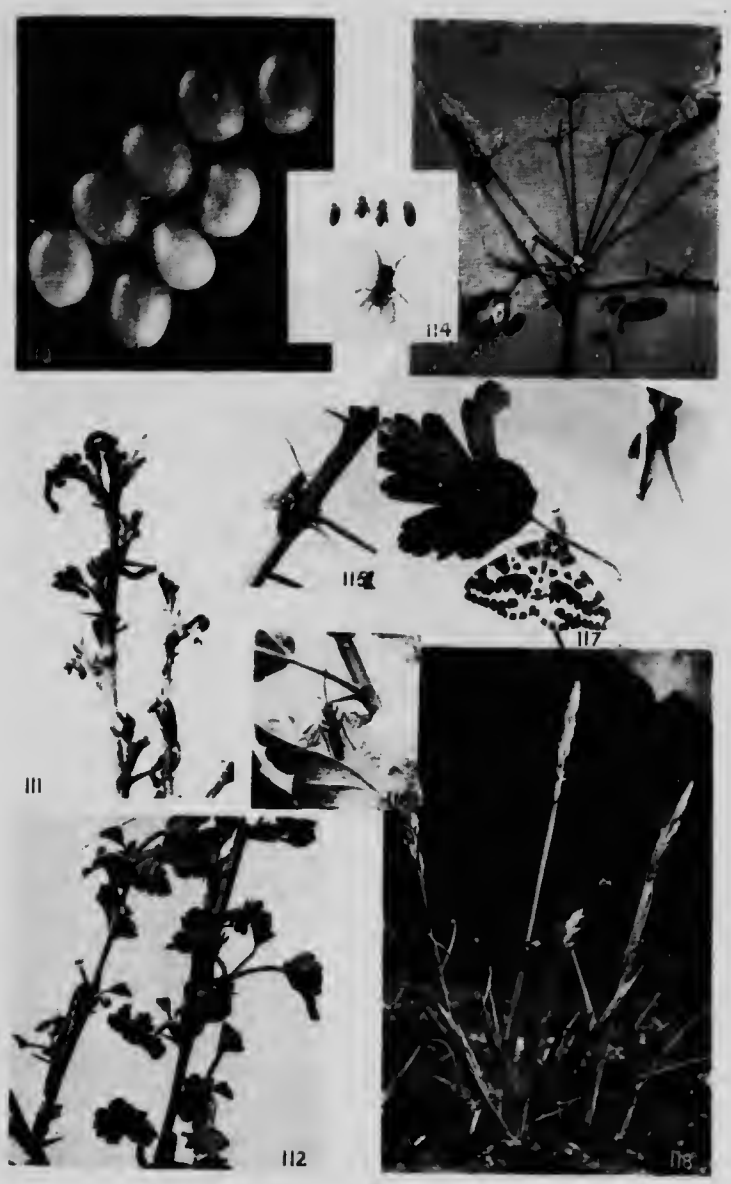
Some of the full-fed caterpillars were collected up and provided with some dried stems on which to form their cocoons. In the upper part of Fig. 113 two of the larvæ are shown in their delicate silken cocoons, in which, when they have moulted their skins, they change to the pupa or chrysalis stage; while below, on the right, another has completed its change into a chrysalis, its shrunken caterpillar skin being seen near it. In the lower part of the photograph, on the left, is seen another cocoon

in which appears the shrunken skin of a caterpillar and three comparatively small chrysalides of oval form.

The chrysalis of this moth is banded black and yellow, and probably, like both the caterpillar and the moth, it derives protection from its bold colouring; indeed, the very frail character of the cocoon, in which the chrysalis is clearly exposed to view, points to that conclusion.

In favourable weather, at the end of three to four weeks, the moth is ready to appear, bursting its chrysalis skin and the silken threads of its cocoon, and appearing upon the branches to shake out the folds from its wings (Fig. 117). It does not follow, however, that such a successful issue always takes place; as the experiment previously referred to made clear.

It was obvious that something was amiss in the cocoon in which the three small pupæ appeared. In several other examples under observation the same thing occurred, and, after seventeen or eighteen days, from each of these little chrysalides there emerged what appeared to be a common house-fly. A closer glance at these insects



110. Eggs of the Magpie Moth—magnified.
111. Young Caterpillars of the Magpie Moth feeding on the new foliage of the gooseberry tree.
112. Full-grown Caterpillars amongst the leaves.
113. Magpie Moth larvæ changing to chrysalides, and, in the left corner, three pupæ of the Tachina Fly.
114. Two chrysalides of the Tachina Fly, with flies removed from them. Below is a Tachina Fly.
115. The Ichneumon Fly, which is parasitic upon the Caterpillars of the Magpie Moth.
116. Another view of the Ichneumon Fly.
117. The Magpie Moth just emerged from its chrysalis.
118. The Spider-hunting Wasp's victim.

revealed the fact that, although they resembled house-flies, yet they were really only near relatives of those familiar insects; a species, indeed, whose habits are very different.

These flies belong to the family *Tachinidæ*, and are commonly referred to as Tachina flies. There are numerous species, most of which in general appearance resemble house-flies (Fig. 114), or blow-flies. To man they are most beneficial, as, in the larva stage, they prey largely upon caterpillars which feed upon his crops.

Whenever a gooseberry, currant, sloe, or other bush, on which numerous caterpillars are seen to be feeding, is surrounded by a buzzing swarm of flies, some of which are continually alighting and moving amongst the leaves, it will be found that these are Tachina flies. Their function is to seek out plump-bodied caterpillars and, by means of a gummy substance, to fasten their eggs to the skins of the larvæ. From the egg there hatches a small maggot which penetrates the skin of the caterpillar, and feeds internally on that

insect until its development is complete. The caterpillar develops a ravenous appetite, but the nourishment that it absorbs all goes to benefit its internal boarders. Finally, when the caterpillar should change into a chrysalis, it usually has about sufficient strength left to construct its cocoon, which is the closing scene of its life. The parasites within then consume the vital parts of their host, and this final meal usually suffices to complete their development ; whereupon they break through the skin of the caterpillar that has reared them, and quickly change into pupæ within the silken cocoon, as shown in the lower example on the left in Fig. 113. In Fig. 114 two of these pupæ are shown side by side with the flies removed from them, and below a fully-developed fly.

Not infrequently amongst the bushes where Tachina flies are abundant the parasitic Ichneumon flies will also be found. These are hymenopterous insects, possessing, like wasps and bees, two pairs of wings, a feature which readily distinguishes them from the dipterous, or two-winged, Tachina flies. The Ichneumons

may be recognized by their active movements amongst the leaves, their long antennæ continually twitching and quivering with excitement while they seek for caterpillar victims on which to deposit their eggs; for although they belong to an entirely different group of insects to that of the Tachina flies, yet their method of attacking leaf-eating caterpillars for egg-depositing purposes, and the subsequent development of their larvæ, is very similar.

The Ichneumon flies, however, have probably attained a much higher evolution than the Tachina flies, for the latter will attack caterpillars of various species indiscriminately, and also the larvæ of beetles, humble-bees, wasps, and insects of other orders, and not infrequently they deposit more eggs on a larva than its substance will provide for their maggots; or they will even place their eggs on a caterpillar that is about to moult its skin, with the result that the young grubs perish when hatched from the eggs.

The more highly-evolved Ichneumon flies, however, rarely make such errors;

indeed, a particular genus or species of these parasites will sometimes prey upon only a certain family of insects, so that a caterpillar may have its special Ichneumon ; or, if it is an abundant species, it may have several Ichneumons which patronize it as their special host for the rearing of their young.

From some of the pupæ of the Magpie Moth under observation in the experiment previously referred to, the Ichneumon species illustrated in Figs. 115 and 116 emerged, one fly only from each moth pupa. The slender curved waist, attached to the lower part of the thorax, the long and pointed antennæ, and the fore-wings bearing a dark-coloured triangular spot, are all features which show well in Fig. 115, and which should be observed by all amateur entomologists desirous of distinguishing these insects.

When one has realized the significance of the persistent attacks of these parasites combined with those of the Tachina flies, it becomes plain that the larvæ of the Magpie Moth, although protected by their colours from many dangerous foes, have yet even

more formidable ones to contend with on which their warning colours exert no influence. So it happens that a mighty host of leaf-eating larvæ may quickly become converted into winged Ichneumon and Tachina flies instead of moths; then it may occur that Ichneumon or Tachina flies are in excess, and then their enemies in turn appear in abundance. Thus the balance of power in Nature ever needs and receives readjustment.

CHAPTER XIII

A SPIDER-HUNTING WASP AT WORK

THE pretty little wasp whose actions are here described was resting on a thistle-leaf while arranging her toilet. For fully ten minutes she had been so occupied, and now was smoothing out her fore-wings, which were smoky at their tips, excepting a conspicuous pale-coloured spot. She was barely half an inch in length, with a shining black head and thorax, and an abdomen two-thirds red and the remaining part black.

Unfortunately I am unable to show my readers any photographs of this insect, for, when these details were recorded, my camera was some miles away from the spot, and a visit a few days later only provided a victim of one of these wasps, which is shown in Fig. 118.

So far as I know, this particular wasp

has no common name, although it, or some nearly related insect, is, I think, known as the Path-Wasp. It, however, belongs to a family of solitary wasps known as the *Pompilidæ*, and is recognized by the entomologist as *Pompilus exaltatus*. These wasps reveal no social habits, such as those of the species described in Chapter V; each female wasp constructs her own nest entirely alone.

The day was very warm, and suddenly the sun blazed forth from behind a cloud, when instantly the little Wasp struck up a shrill, piping note and darted into the air. She performed a peculiar jerky flight for a moment or two and then returned to the thistle-leaf again, still singing her high-pitched note for all she was worth. She did not rest, but travelled rapidly along the leaf, down the stem to the ground, where it appeared to become very excited, although at first it was not obvious what her excitement was all about.

In and out amongst the fallen leaves near the ground she moved with each of her feelers curved at the tip and quivering and bristling with activity. She

seemed to delight in rapidly passing beneath any leaves which were conveniently placed, appearing on the opposite side, and then turning round with a kind of astonished air that was quite amusing, piping her note more merrily than ever when she turned and looked above the leaf beneath which she had passed. Into any little holes in the soil that appeared this lively insect promptly popped her head, withdrawing it almost as quickly; indeed, the whole of her movements seemed to indicate that she was in a most terrible hurry.

In the course of five or six minutes her search had covered several yards of ground, every leaf-fold and crevice in that area being closely examined. Then she met with a stone embedded against the root of a tree, and between the root and the stone she disappeared. I was expecting her to re-appear at the opening on the opposite side just as quickly as she had done from other similar crevices she had entered, but there was no sign of her. While wondering what she was doing beneath the stone, some object

appeared at the mouth of the hole by which the Wasp had entered—it was the black and red body of the Wasp herself slowly backing out.

Had I known nothing of the habits of this little Wasp, I might have suspected that she was being driven out of the hole by some indignant tenant thereof, but matters were not so; indeed, the Wasp was pulling out the rightful owner of this retreat—a Wolf Spider. The latter does not construct a snare, but hides under cover and then surprises and runs down its prey.

The Wolf Spider had itself on this occasion been surprised; for the plucky little Wasp had boldly entered its dwelling-place and there attacked it. The spider, finding an enemy within its home, would probably act as if it were dead, and then the Wasp, who is thoroughly acquainted with this manœuvre, would carefully examine it, and, being satisfied that it was not so dead as it appeared to be, would seize it and sting it in its nerve-cord, and so paralyse it, but not kill it outright.

When it was clear of the hole she

appeared to become very nervous, continually looking behind her as she walked backwards dragging the spider, which was as large as herself. The pace at which the victim was dragged over the rough ground and between the herbage was astonishing. Indeed, it was obvious that she suspected an enemy was near, for her attention seemed divided between her treasure and her surroundings, and I am inclined to think that her nervousness was due to the parasitic Ruby-tailed Cuckoo Fly which was abundant on flowers in the neighbourhood. These handsome insect cuckoos, while themselves feeding on flowers, are ever on the look-out for some hard-working solitary wasp or bee conveying its capture to its nest; following up the trail they then await a favourable opportunity to deposit an egg either in the nest or on the prey, afterwards flying gaily off to feast on more nectar and pollen from the flowers, their home cares thus being satisfactorily disposed of.

The diligent little Wasp, however, had a much greater labour to perform, and

her anxiety showed clearly that she was fully aware of what was required of her. After she had travelled with her spider about nine feet, piping excitedly the whole of the time, she suddenly left it and flew into the air, as if taking a bird's-eye view to see if she was clear of all danger. Apparently she was satisfied, for she suddenly swooped down upon her victim and hastily dragged it to one side amongst some grass blades, and then, seizing the base of one, slowly climbed up it, also dragging up her spider. At last she reached a node from which a blade forked, and in the angle she carefully placed her treasure, touching and pulling it here and there to test if it was safely balanced. Then with a parting glance she flew into the air and disappeared from view.

About fifteen minutes later she returned, but only to look at her prize, for she flew off again almost instantly. Twenty-five minutes later she again returned and rushed hurriedly to her spider, but did not touch it. Instead she arranged her toilet for some eight or ten minutes. Evidently she had been digging her nest

in the sand-bank somewhere near, and was now having a brush up.

Suddenly she set up her shrill piping and literally tumbled to the ground with her spider, and then she seemed possessed of extraordinary strength, for the spider was dragged at a reckless pace for more than twenty feet, and then laid down while she fluttered her wings and quivered her feelers — perhaps she was taking her bearings. Another sharp pull sideways for a few inches then followed, when she suddenly let go, turned, and plunged her head into a neat round hole at the foot of the bank,

A moment later the Wasp and spider disappeared into the hole, the last view of the latter being its vanishing legs. Two or three minutes later the head of the Wasp appeared, and perhaps at that moment she was depositing her egg on the spider's body. Slowly she emerged, and then quickly raked up the sand with legs and mandibles, and neatly filled up the hole—so neatly, indeed, that, neglecting to mark the spot at the moment, I found it quite impossible to find it afterwards—

and then hurried from the place (as if afraid of being seen there) to brush up her wings before taking flight.

So the Spider-hunting Wasp labours for her offspring which she will never see. Nevertheless, it is provided with an ample store of living food material to supply its wants when it hatches from the egg; and, if no Cuckoo Fly, or similar parasite, has surreptitiously placed its egg on the spider, or within the nest, there will some day next season emerge from that hole a red and black active little wasp like the one whose labours have here been recorded.

CHAPTER XIV

THE DOR-BEETLE'S MITE

(*Gamasus coleoptratorum*)

WHEN, in his hurried flight, the clumsy Dor-beetle (Fig. 119) has collided with the branch of a tree, or even a leaf (for he is an unsteady fellow and easily loses his balance), he is not infrequently found on his back on a hard road or path, kicking his very hardest with his six legs, and yet quite unable to get his feet upon the ground. The metallic blues and purples of his underside show to perfection as he struggles, and it is at such a moment that we are tempted to pick up the insect. How often, though, have we immediately dropped it again on account of the crowd of little, pale yellow "parasites" that are almost invariably found clinging to its body and legs?

From a small-sized beetle I removed

forty-three of these Mites—a photo-micrograph of one of which is shown in Fig. 120—but that is a comparatively small number, for sometimes they literally swarm over the beetle. It is remarkable, however, that the beetle never seems the least bit inconvenienced on their account; there is, I think, a plausible explanation of that curious fact.

In the first place I would like to call attention to the clean state in which the beetle's polished armour is always found. Considering the noisome substances which it manipulates, and into which it completely burrows, it is rather surprising that it should not carry with it some trace of its labours; but, strange to say, it does not even retain the odour of its surroundings. The latter is the more astonishing when we take into consideration the fact that the ill-savoured burying beetles make their presence known in no unmistakable manner; but with burying beetles the Dor-beetle's Mite apparently has no connection.

Since the beetle's body and legs are clothed in a horny armour, we naturally

wonder on what the mites subsist; for it seems impossible for such tiny creatures to penetrate so hard a surface as that of their host; also, they never appear to be sucking the beetle's blood. More often they are seen to be quietly travelling over its anatomy, or, when still, clinging to one of its hairs by means of one or both of their mouth pincers—as shown in the photo-micrograph, Fig. 121.

We have, therefore, on the one hand, a beetle which, apparently, is not the least incommoded by what, normally considered, would be an embarrassing number of "parasites" preying upon it, and on the other, a host of "parasites" which seem to possess no desire to prey upon their host.

Probably the explanation is that the mites are the beetle's allies, and not its parasites. It may be that the beetle owes its spick-and-span and odourless toilet to the regular services of these little attendants. Many similar instances are known of apparent parasites which, on investigation, have proved to be useful allies, even in relation to such removed animals as fishes and birds.

119. The Dor-Beetle.

120. The Dor-Beetle's Mite, which serves as the beetle's toilet-attendant—magnified.

121. One of the mouth-pincers of the Beetle's Mite grasping a hair of the beetle, by means of which it can hold on.

In cases of this kind the services are usually mutual, and it is possible that the little beetle-mite requires in its economy a diet similar to that of the beetle, together with an occasional aerial conveyance to new grounds for mating purposes. In consequence, it has probably acquired the habit of engaging the Dor-beetle as its motor omnibus, reciprocating the service rendered by diligently cleaning down the machinery of its locomotion, the product of which labour may serve it as food.

A feature which tends to point to that conclusion is the fact that these mites are frequently found away from the beetles, hiding under stones, and in damp places; especially is this the case during the winter months.

With the advent of the cold weather, most, if not all, of the old beetles perish, and apparently the beetle-mites then leave the dead bodies of the beetles and wait until the next generation of their allies appears in the winged state. It is obvious that they are able to live for months together without any assistance from the

beetles, and just what advantages they derive from the association is difficult to understand; unless, as I have previously suggested, they have some relationship to the functions of mating.

I am inclined to think that the mites are reared on the ground, and that when a family has reached maturity, the individuals betake themselves to those quarters where the beetles will be sure to visit, and so they find a host. In this way they probably get carried to new grounds far from home, where they will meet with mates from other stock.

In this connection it is interesting to observe that the legs and feet of the mites are adapted for locomotion on moist land, being provided with claws and suckers, and that they have no eyes. It would be a distinct advantage, therefore, when an individual had travelled a long distance to suitable ground to find a mate, and yet had been unsuccessful, to get quickly conveyed to another similar situation; indeed, it may be that the beetle itself is the profitable hunting ground for finding their mates. In any case it is certain that

the mite obtains some advantages from its association with the beetle, and as these, on the whole, do not appear to be of a parasitic character, perhaps the suggestions offered here will tend to further investigation regarding the habits of these curious little organisms.

The mites themselves are queer little animals, and are not insects strictly speaking, but may be regarded as degenerate spiders. In their early stages they have only six legs, but when their development is complete, another pair appears. Their projecting mouth pincers can be either partially or wholly withdrawn into their bodies.

CHAPTER XV

THE LIFE-STORY OF THE PURPLE EMPEROR BUTTERFLY

(*Apatura iris*)

WHICH is the most beautiful of British butterflies? is a question that is frequently asked of the collector. The reply, of course, must largely depend upon the taste of the individual entomologist; for, although we have in the British Isles only some sixty or seventy species of these insects, yet amongst them there is exhibited a considerable variety both in form and in the brilliancy and arrangement of their colours. However, if the "palm" has to be awarded any one particular insect, perhaps the male Purple Emperor should be that one; for his rich shining purple certainly more nearly approaches the resplendent hues of some of the large and gorgeous butterflies

of tropical America than does the colouring of any other British insect of his class. Only in certain lights, though, does the Emperor exhibit his royal colour: when not viewed from the correct angle his iridescent lustre remains invisible, that area of the wing appearing of a sombre brownish-black.

The female insect is usually larger than her mate, and resembles him in general colour arrangement, the bands and spots of white, with touches of brighter orange brown, which enliven the velvety brown ground colour of the wings, being very similar to those of the male, but with one striking difference. No matter from what point of view they are seen, their brown surface never reveals the glorious purple sheen which characterizes the male insect, and from which the butterfly derives its popular name.

While in Central Europe this butterfly is often abundant, yet, in England, it is now restricted to a few counties, chiefly in the South, although Lincolnshire and Northamptonshire can claim a fair share of its patronage, and, likewise, Monmouth-

shire, in Wales. It occasionally appears in fair abundance in such places as the New Forest, and in woods in Sussex and Kent, but it is rarely found except in old, undisturbed woods of large extent, and as these become restricted in area so the insect becomes more and more scarce. Under such circumstances it is, perhaps, not surprising that this handsome butterfly, though well known by repute, has actually been seen in the living state by comparatively few people. Even in those districts where the insect still inhabits, it is but seldom observed, unless one knows where to look for it.

The male Emperor is not content with the ordinary see-saw flight of the normal butterfly species, but may be seen swiftly sailing above the tops of tall oak-trees, where he gets a clear space for the exercise of his flashing and resplendent wings, and an open field for battle should any neighbouring monarch happen to approach his preserves—a sure prelude to a determined fight. Generally, too, the Emperor selects the topmost twig where nothing obscures his outlook; and, after one of

his long, rapid flights, back he comes again to that identical twig—his royal throne, it may be. The female insect is much less rarely seen on the wing.

This is not the only curious habit of this beautiful insect: the kind of food it affects is another. We are told that the older naturalists captured this butterfly by means of nets fixed to handles of some thirty feet in length; but it requires, I fear, a better imagination than I possess to understand how these unwieldy weapons could be effectual to curb the rapid flight and lofty ambitions of the Emperor butterfly. When, however, the feeding habits of this insect became known, quite different methods were adopted to effect its capture. Now, in place of the preposterously long and unwieldy net, a dead rat, rabbit, stoat, weasel, cat, or almost any kind of putrefying flesh is judiciously placed here and there near the butterfly's haunts, and left for a day or two; for, incongruous as it may seem, this is the kind of delicacy that most tempts the imperial palate of this lovely insect. As soon as the bait has been discovered,

the capture of the quarry is easy, for the butterfly becomes so absorbed in its feast that it forgets to keep guard; indeed, so allured is it by this repast, that you can sometimes approach and touch the insect, without disturbing it. The female insect, however, is not attracted by this bait: her time is largely occupied amongst the sallows, on the leaves of which she deposits her eggs.

July is the month in which the butterfly appears, being early or late according to favourable or unfavourable weather. Where it comes from we need not, for a moment, consider. Then, after mating, eggs are deposited, the mother insect selecting the leaves of the willow, and sometimes the poplar or the aspen, as suitable sites on which her offspring may be given a good start in life. The larvæ will also feed on the foliage of the apple-tree.

In from ten to twelve days the egg hatches out its caterpillar, which is, at first, of a dark brown colour. After the first moulting of its skin it becomes green, like the leaf on which it feeds, and is then

provided with a pair of curious horns at its head. The method of feeding practised by the young larva is quaint. It commences its meal at the tip of the leaf, slowly consuming the leaf down each side of the central vein or midrib. When the meal is finished it ascends the bare midrib until it reaches the apex, and here it comes to rest. When its appetite returns, it again descends to the feeding area (or dining-room) below. In this curious habit this butterfly larva is not alone, for the young caterpillar of the White Admiral butterfly, which feeds on honeysuckle leaves, acts in exactly the same manner.

The larva continues thus to feed, rest, and grow until the "fall of leaf" approaches, at which time it has not attained half the size it will eventually reach. About the middle of October the young caterpillar, with that marvellous instinct so often displayed amongst Nature's unreasoning creatures, slowly and methodically descends to the base of the leaf on which it is feeding, and weaves a silken web around that portion of the leaf stalk where the detach-

ment is about to take place. Then, by means of other silken threads, it pulls the edges of the leaf about it, and in this leafy hammock it rests contented. When the time comes for the leaf to separate from the branch, although the separation actually takes place, yet the leaf does not immediately fall, for the silken web holds it, together with the caterpillar, firmly to the branch, and, if all goes well, there it remains throughout the winter months. Even if unfavourable weather should eventually detach the leafy hammock, and it drops to the ground, it will probably continue to lie undisturbed amongst other fallen leaves, and the only difference to the young caterpillar is that, in the following spring, it is compelled to crawl about until it finds the trunk of a tree which will lead it to its proper leaf food.

When the leaves appear in the following spring, the caterpillar no longer mincingly eats tiny portions from the tip of the leaf downwards, but ravenously devours any portion of the leaf substance, presenting during the process a most quaint appearance — as the illustration,

122. Full-grown Caterpillars of the Purple Emperor Butterfly.
123. The curious Caterpillar as it appears when feeding.
124. The Chrysalis viewed from the front, when it is inconspicuous.
125. A profile view of the Chrysalis.
126. The newly-emerged Butterfly clinging to its broken chrysalis skin.
127. When its wings had dried and become rigid.

Fig. 123, shows. In general aspect the larva looks like a large slug (Fig. 122), although its head horns are strong and hard, and not retractile like those of slugs; and what with the bright green colour of its body and its blue and white shaded horns, it becomes, for a slug, a most gorgeous specimen. Probably it gains some measure of protection against its enemies by this resemblance to a slug; for any caterpillar-feeding animal would hardly recognize it as a caterpillar, while slug-feeding animals, on account of its bright colours, would, perhaps, be too suspicious to attack it.

About the middle of June the caterpillar is full-fed, and prepares for its chrysalis stage. It first weaves a flat silken web to the surface of a leaf, to which it then attaches itself by its tail claspers; and, while thus suspended, it moults its last caterpillar skin, which shrinks back to its tail-end, where it is attached. The chrysalis is then exposed to view; and in the illustration (Fig. 124), it, together with the shrunken caterpillar skin, and the hard head horns, are shown.

The colouring of the chrysalis is very similar to that of the caterpillar, and both colour and markings harmonize so perfectly with the leaf to which the pupa is attached that, although the chrysalis is of a fair size, yet it is not at all conspicuous. When viewed from the front, its markings so accurately simulate those of the veins of the leaf, that the chrysalis presents a flat effect, and apparently becomes part of the leaf structure, as the unshaded side of Fig. 124 clearly illustrates. In Fig. 125 a chrysalis is shown in side view, and there it will be seen that the object really possesses considerable relief, although, as we have seen, its shadings tend to give it a flat appearance. Probably the chrysalis is by this means hidden from the eyes of its enemies.

In from sixteen to twenty days, according to the weather, the mature butterfly appears. In the illustration (Fig. 126) the newly-emerged butterfly is seen clinging to its broken chrysalis shell; while at the base of the latter is its last shrunken caterpillar skin and head horns. There it hangs with its limp and wet wings

128. The Purple Emperor Butterfly with wings trim and ready for flight.
129. Just before expanding its wings.
130. The upper surface of the Wings exposed to view.
131. A view of the under-side.

fully exposed to the atmosphere, until they become dry and rigid, when the insect can bring them under muscular control. In Fig. 127 this drying process is seen taking place; and in Fig. 128 the butterfly is shown trim and ready to commence its winged life above.

What a marvellous change it was from the sluggish caterpillar, whose only delight in life was to devour the green leaves of the sallow, to the light and delicate insect with fragile wings of lovely hues, and yet of sufficient strength to convey it high above the tops of the tall trees on whose leaves it was erstwhile condemned to crawl! Now, too, its vegetarian appetite has disappeared, for, as we have already seen, its food now consists of—— But look! the beautiful insect has opened wide its wings and revealed to us their wealth of colour; rich velvety browns broadly slashed with white, which with every changing movement become flushed with a gorgeous sheen of royal purple. It is impossible to associate this handsome child of the sun with the disgusting carrion on which it feeds—so

incongruous is the connection. Away it flies, but only for a short distance, for its powers of flight have yet to be developed. So we are enabled to make three final pictures of it (Figs. 129, 130 and 131) before it leaves us to soar above, higher and higher, full of the glory of life, to court its mate, and to do battle with its rival.

CHAPTER XVI

SOME DETAILS OF SPIDER LIFE

ONLY a very cursory glance into the details of spider life is needed to discover how very perfectly equipped are these animals for their special function of fly-snaring. The same cursory glance may also lead to a further discovery, viz., that the female spider, for sheer cruelty, stands almost unequalled amongst living things. In fact, we might go further and say that she is one of the fiercest and most savage beasts in creation.

I know that there are many good folk who will be quite ready to join me in declaiming against Mrs. Spider, or even Mr. Spider, for that matter. Indeed, you have only to mention the name of "Spider" to some people to make them shudder and exclaim, "Nasty, horrid insects!" It is not a little remarkable,

however, that, although they possess so great an aversion for spiders, yet they rarely can give the slightest reason for their dislike. Some good housewife, it is true, may complain that they make cobwebs; but, in view of the fact that these snares entrap many troublesome household insects, that is a trait which might almost be looked upon as a prime virtue rather than a sin. In a general way, indeed, it may be said that man possesses an instinctive antipathy for spiders, an antipathy which has arisen probably from the fact that some spider species are dangerous to his race, although the species found in this country are harmless enough.

Still they are "nasty, horrid insects!" I fancy some of my more sensitive readers will still maintain. But spiders are not insects, I must protest—a point which I need not have referred to here, but for that "learned" and tedious person the hypercritic, who will doubtless discover that this chapter, and also Chapter XIV, have, strictly speaking, no right in a book on Insects. Since, however, the

general reader probably expects to learn something regarding spiders from a book on Insects, I have dared to include the subject in this closing chapter. The chief distinctions between these little animals are that insects have their bodies divided into three parts, and possess three pairs of legs. Spiders, however, have their bodies divided into two parts, popularly speaking, head and abdomen, and they have eight legs, and therefore belong to quite a different class of animals; a class that includes certain spider-like creatures, such as scorpions, mites, ticks, and other allied forms, and one that revels in the scientific name of the *Arachnida*. The word "insect," therefore, is completely disposed of. Regarding the "nasty" and "horrid" epithets, I fear I cannot say so much against them, for Mrs. Spider certainly does some very nasty and horrid things.

It is no compliment to either Miss or Mrs. Spider when I inform you that, when they are wooed by the amorous Mr. Spider, the success of his advances largely depends on the state of their appetites.

In this way. Let us observe Miss Spider when she has just returned from one of her frenzied and bloodthirsty attacks upon a house-fly that has carelessly buzzed into her net. When Mr. Spider approaches, she is peacefully resting in the midst of her web, indifferent as to whether she is seen or not (for when she is hungry she is rarely found resting in her snare, but hidden away beneath a leaf near by, in prompt telegraphic communication, nevertheless, with her seat of warfare). At such a moment the advances of the male spider may be favourably received. On the other hand, suppose the expected house-fly has not appeared, or has steered clear of the trap laid for it, and Miss Spider's hunger has not been appeased. Mr. Spider's attentions would be received with equal welcome, perhaps even more encouraged by the cruel and relentless lady, but her intentions towards him would now be very different. Reprehensible as it may seem, Miss Spider would probably allow her lover to advance nervously along her snare, and then, like the fierce and ravenous monster that she

is, would suddenly rush upon him and devour him alive. This cannibalistic trait in her character seems all the more reprehensible when we consider the fact that in size and strength she is very superior to Mr. Spider. Even her successful suitor undertakes very grave risks should he displease her; indeed, he is sometimes seen to fling himself suddenly from the snare, and remain suspended on his silken ladder; and when he does this you may know that he has had a little tiff with Mrs. Spider, and, if he had not escaped, there would have been a tragedy in the family, in which Mr. Spider would very certainly have been the victim.

Mrs. Spider's love of slaughter and her savage disposition are supplemented in every way by her natural equipment. In Fig. 132 we see her beautifully constructed snare artfully suspended amongst the branches where flies would be least likely to see it. Away somewhere amongst the leaves she is lurking, waiting for an unwary victim. This marvellously-constructed device for ensnaring her prey

is the more astonishing when we consider its details.

If you notice Mrs. Spider when she is moving about her web, you will observe that she generally travels along the straight and radiating spokes, avoiding as far as possible the spiral or tangential threads; these latter are arranged with diabolical ingenuity for the capture of her victims. In Fig. 133 I have shown a portion of one of these threads as viewed through a microscope. It only needs a glance at the photograph to realize that it is not the simple thread that at first it seems to be. Studded at almost regular intervals along its length are large, and small, viscid, bead-like globules. Yes, Mrs. Spider's snare is not only a net in which to catch unwary flies, but a veritable bird-lime trap, which hopelessly entangles them as they struggle to effect their escape.

The whole snare, indeed, is a very marvellously evolved device. First, how nearly invisible it is for so large a structure! Then consider its wonderful geometrical arrangement, with every facility for the swift movement of the

132. The Spider's beautifully-constructed Snare.

133. A portion of the Spiral Thread—magnified to reveal its viscid globules.

spider in any direction, and for cutting free any part should a wasp or large fly become too troublesome. There are its simple and its compound threads, varying according to the function they have to fulfil, some of which, as we have seen, being studded with viscid beads. The rays and beams, along which the spider moves, are, however, not so studded, neither are the parts near the centre where it rests. Truly a remarkable structure, when we consider that it was evolved without the aid of any reasoning powers in the possession of the little animal that produced it.

To understand how these geometrical snares have been evolved to their present perfection, we have to consider the snares of some of the lowest types of these animals—for these orb-weavers stand highest amongst their race. Some simple types do not make a snare at all, but stalk and run down their prey, hiding until the opportunity occurs. Others, a little more advanced, construct a small tube in the ground in which to hide, lining its interior with silk, and, to keep

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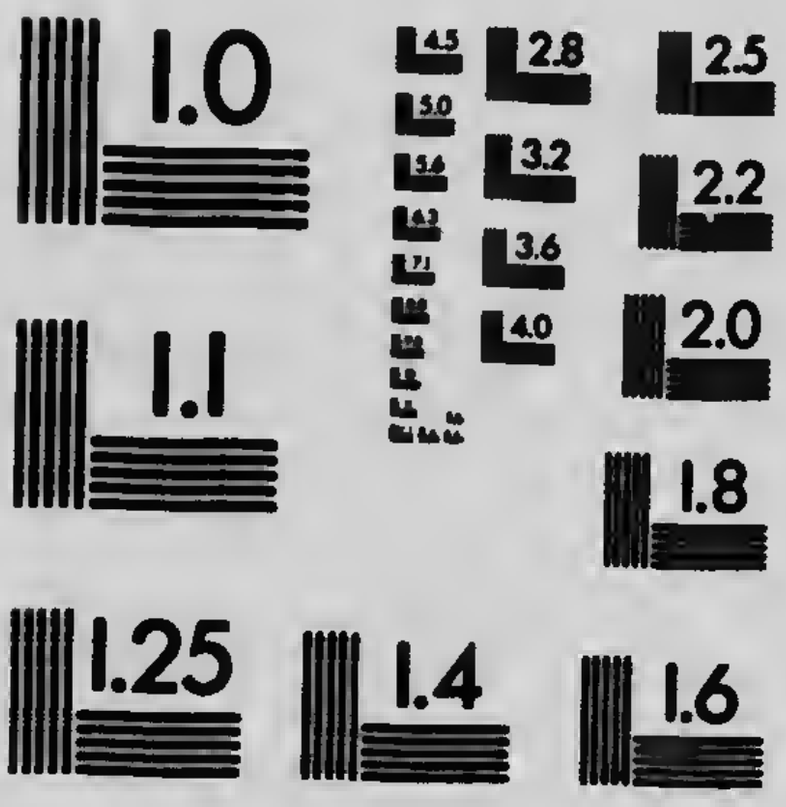

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out enemies, closing its entrance also with a silken web. From this it will be seen that the first use of silk-spinning was for the building of the home, to cover the cocoon and eggs, and to protect the mother and young. Probably, though, the closing of the entrance to the tube with silk has led to the beautiful and geometrical snares so familiar in gardens and fields all over the world to-day. The enemies of the spider and inquisitive insects would doubtless get entangled in this entrance web, and then the spider would have its chance, and thus would discover a new method of capturing its prey. In due course, guided by the success achieved by this new method, it would construct more and more complex webs outside its retreat, extending them to the leaves and stems of plants and similar objects; and thus by a gradual perfection of the primitive form in the course of the ages may have evolved the marvellous geometrical structures, with all their complicated details, which are so common to-day in gardens, fields, and woods.

On the other hand though, some of these primitive tube-living spiders have evolved on quite different lines—viz., by perfecting their tube arrangement instead of their nets. Of course, such examples remain free hunters in the open.

In Southern Europe and other places trap-door spiders are familiar, and these animals represent the corresponding highest types of the tube-living species. In illustration Fig. 134 is shown at natural size the entrance to one of these dwellings. The door, it will be seen, is thick and beautifully bevelled at its edges, and close-fitting like a cork. When it closes, its outside surface is exactly like the surrounding soil (see photograph), and so the entrance to the spider's retreat becomes completely hidden from view. Some of these trap-door spiders attain a large size, and will occasionally attack young birds which they find in nests when moving about amongst the branches of the trees. One of these is shown at natural size in Plate XI.

The door is at first constructed of a layer of silk, which is spread across the

mouth of the tube. Bits of soil, moss, and other layers of silk are then introduced, until the required thickness is obtained, with, at the same time, a perfect resemblance to its surroundings. The hinge is also made of silk, and the tube is thoroughly lined with the same material. Within the tube during daylight the spider remains concealed, but at nightfall it pushes open its door from within and sallies forth to hunt its prey, leaving open the door to its dwelling, as shown in the photograph Fig. 134, all in readiness for a hasty retreat. In the latter case the spider bolts into her tunnel and pulls shut the door, which readily closes by its own weight, and then she clings to the silken threads of the under side, and also holds to the sides of her dwelling-tube; in this way she usually succeeds in defending her stronghold from dangerous intruders. Such then are the two lines of evolution pursued by the spider groups from the primitive types that dwelt in silk-lined cavities in the soil.

Now we may glance at Fig. 135, where are shown the spinnerets, or organs by

134. The Home of the Trap-door Spider.

135. A magnified view of the Spinnerets, which the Spider can use like fingers when manipulating the web.

136. Some of Silk-emitting tubes of one of the Spinnerets—considerably magnified.

137. Foot of the Spider, showing the comb-like claws, cutting-hook, and sensitive bristles.

means of which Mrs. Spider produces the silk she finds so useful. Within her body are powerful glands which secrete this web-producing material, and then it is squeezed through minute tubes of various shapes, large numbers of which terminate each of the spinnerets at the end of the abdomen. In Fig. 136 some of these numerous tubes are shown considerably magnified to reveal their structure. The spinnerets can be used like fingers by the spider, touching and joining up a broken thread of the web here and there, varying its construction with more or less simple or compound threads as may be desired.

It is plain that the anatomy of the spider is complex and highly organized as here we see. This becomes even more apparent when we consider those organs by means of which she carries out her cruel practices. Look at illustration Fig. 137, and see the array of combed claws and sensitive bristles contained in the foot of Mrs. Spider. The hapless fly that gets entangled in the intricate and viscid snare has, in addition, to meet

the attack of eight weapons of this description. How perfectly adapted, too, are these organs for adjusting, cutting, and holding the snare structure!

But the troubles of the spider's victim by no means end here. It is struggling to escape from the unexpected net which in some mysterious manner has suddenly enveloped it, when a creature of terrible aspect hastily rushes out upon it. Eight bead-like eyes glare wildly upon the terrified fly (Fig. 138), a large hairy and bristly finger-like palpi on each side of this appalling face waves and flourishes with angry menace in the air, apparently quivering with malignant glee. Then one of those combed and clawed feet is stretched towards the hapless prisoner (let us hope that it has by this time been frightened into insensibility), and the threads that hold the fly are suddenly tightened up as the monster pulls them together. Then the spinnerets eject a shower of silken strands over the fly, and it is spun round and round on the threads that hold it, until at last it is securely enveloped—still alive—in silken

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138. The Face of a Spider, showing its eight eyes, poison fangs, and a pair of hairy feelers.

139. The mouth-parts of a Spider, arranged to show the crushing teeth and poison fangs, and the jointed and hairy feelers.

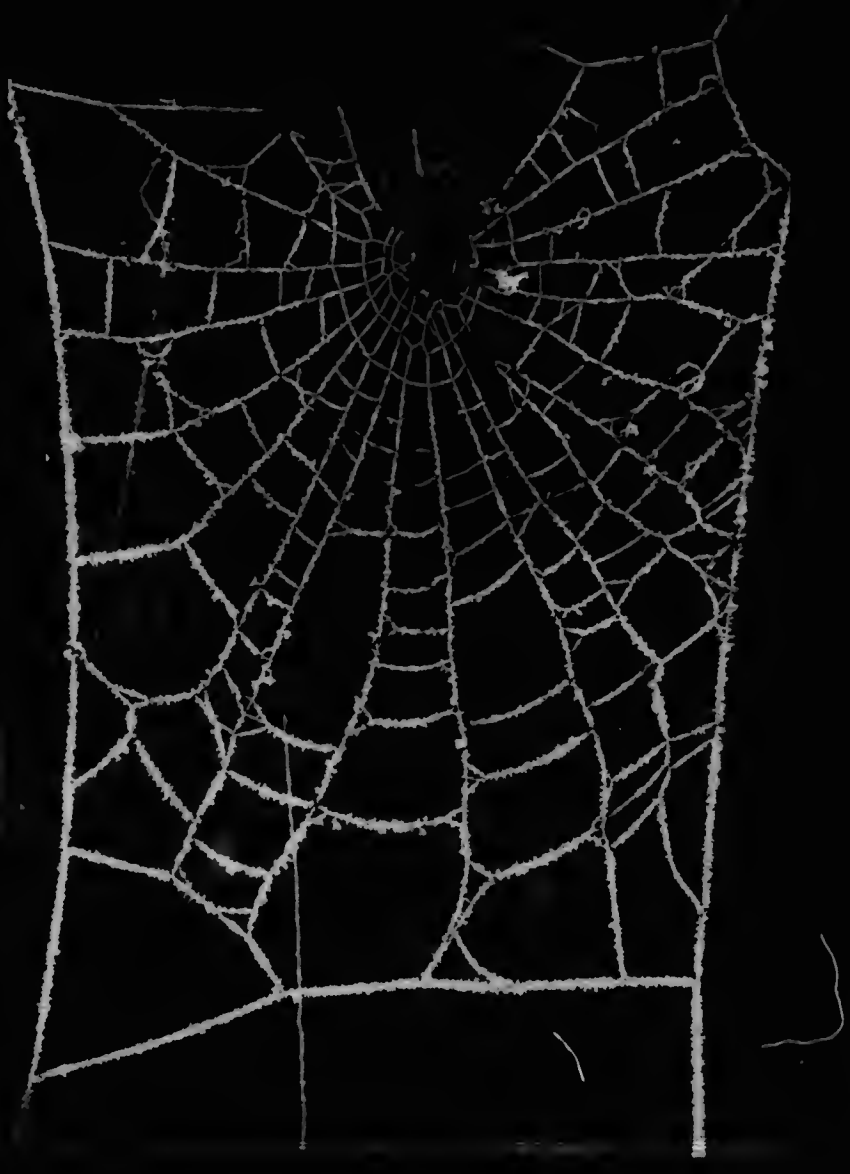
bonds. And so the fly is left in Mrs. Spider's larder, in durance vile, until she needs a meal.

It may happen, though, that Mrs. Spider is immediately hungry, in which case she pursues the same tactics, but they terminate more abruptly. Between those hairy and bristly palpi that were brandished so savagely about the hapless fly are two other terrible organs—two poison fangs, as deadly, so far as the fly is concerned, as those of the cobra. If Mrs. Spider is hungry, she attacks the silk-enveloped fly with these claw-like poison fangs, which are connected with a poison gland in her head. These fangs are also movable, and form most efficient grasping organs, each fang closing inwards in clasp-knife fashion. With these the spider holds its victim firmly in contact with its toothed crushing jaws while it extracts its juices. In Fig. 139 is shown a magnified view of these mouth organs of the spider.

Surely, then, considering the fearful equipment of Mrs. Spider and the savage and relentless manner in which she attacks her prey, her lovers, and even the husband

of her choice, we may say that she is one of the fiercest savages in the whole realm of nature. She certainly seems to show a little mercy when she poisons her victim before devouring it, but I am very regretfully inclined to think that she uses her poison as little as possible. It is obvious that she requires living prey, otherwise she would not store her victims alive. I fear that the use of her poison is largely reserved for unruly and troublesome wasps, bees, and similar "vermin" that occasionally become entangled in her snare. A little poison then probably assists in bringing her victim into gentle subjection.

I would like in conclusion to have said one good word at least to retrieve the character of Mrs. Spider, but facts are stubborn things to deal with. Even on the score of her economy, where I might plead for her, her unamiable traits make it impossible. Truly she consumes every particle of broken web and redigests it, and even her cast skin she eats up as if afraid lest it should be lost; but even her economy ends in disgrace, for does she not also eat up her superfluous lovers



in the same way—lest, perhaps, they might be wasted?

Mrs. Spider persists in her butchery until winter has commenced, and then becomes more or less dormant; but winter usually spells her doom, especially when she becomes old and feeble. A sudden and unexpected frost sometimes overtakes the exhausted spider that has toiled to spread a net for the last fly of the season, and then we may often find that Nemesis has at last overtaken the too greedy and ferocious lady spider (Plate XII).

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