

UNIVERSAL
LIBRARY

OU_162230

UNIVERSAL
LIBRARY

OSMANIA UNIVERSITY LIBRARY

Call No. 595.7 Accession No. 2070

Author C. S. G. W. C. S. G. W. J. W.

Title Wonders of insect-life

This book should be returned on or before the date
last marked below.

WONDERS OF INSECT LIFE

WONDERS OF INSECT LIFE.

*Details of the Habits and Structure
of Insects, Illustrated by the Camera
and the Microscope*

BY

J. H. CRABTREE, F.R.P.S.

Author of "Woodland Trees," etc.



LONDON

GEORGE ROUTLEDGE & SONS, LTD.
NEW YORK: E. P. DUTTON & CO. 

FOREWORD

THE study of insect-life is not merely fascinating in itself. It provides a host of examples and illustrations of such noble aims as "living for a purpose," "striving for the best," "helping one another," "bearing each other's burdens," and "sympathy in sorrow."

Besides, some of the most popular scientific inventions of the day have borrowed their sources from the simple, subtle, scrutinizing habits of insects. We have yet much to learn from the humblest of Nature's children.

This volume is not intended to cover all the ground of the Insect World. It selects representative members of the principal species, and endeavours to treat them, with more than ordinary detail, in popular language. The author hopes that it may create a deeper and more lasting interest in living creatures whose characteristics are not less curious than they are wonderful and entertaining.

J. H. C.

CONTENTS

PAGE

I. COLEOPTERA

THE STAG-BEETLE	-	-	-	-	I
THE LADY-BIRD	-	-	-	-	8
THE COCK-TAIL BEETLE	-	-	-	-	13
THE DOR-BEETLE	-	-	-	-	19
THE WATER-BEETLE	-	-	-	-	24
THE WATER-BOATMAN	-	-	-	-	31
THE WATER-SCORPION	-	-	-	-	37

II. ORTHOPTERA

THE GRASSHOPPER	-	-			42
THE CRICKET	-	-	-	-	47
THE EARWIG	-	-	-	-	54

III. HEMIPTERA

THE FROG-HOPPER	-	-	-	-	61
APHIDES	-	-	-	-	67

IV. DIPTERA

THE HOUSE-FLY	-	-	-	-	74
THE CRANE-FLY	-	-	-	-	85

	PAGE
THE GNAT - - - - -	92
THE GAD-FLY - - - - -	98
THE SHEEP-TICK - - - - -	105

V. NEUROPTERA

THE DRAGON-FLY - - - - -	109
THE LACE-WING - - - - -	116
THE MAY-FLY - - - - -	122

VI. HYMENOPTERA

THE WASP - - - - -	129
THE HUMBLE-BEE - - - - -	139
THE ANT - - - - -	146
GALL-FLIES - - - - -	154

VII. LEPIDOPTERA

THE SWALLOW-TAIL BUTTERFLY - - - - -	161
THE CABBAGE-WHITE BUTTERFLY - - - - -	167
THE EMPEROR-MOTH - - - - -	173
THE DEATH'S-HEAD MOTH - - - - -	178
THE TIGER-MOTH - - - - -	181
THE ERMINE-MOTH - - - - -	183

VIII. APTERA

FLEAS - - - - -	193
MAMMALIAN LICE - - - - -	201
BIRD-LICE - - - - -	206

Wonders of Insect Life

THE STAG-BEETLE

THE largest of our coleopterous, or sheath-winged, insects is the Stag-Beetle (*Lucanus cervus*), so-called from the jaws of the male bearing a resemblance to the horns of a stag. The beetle looks very formidable in its pointed head-gear, and is apt to strike terror in the mind of a stranger who has not heard its threatening hum or seen its warlike approach. Truth to tell, the Stag-Beetle is one of the most innocent, harmless, and highly-respected insects of which Britain can boast.

Curiously enough, the Stag-Beetle haunts only certain specialized localities. North of the Tweed it is seldom seen; here nature-lovers would be delighted to make its acquaintance. But the Stag-Beetle has no inclination for northern latitudes. I have sought it long and often in the woodland preserves of the Midlands, where giant oaks and elms abound; in Hagley Park, where

many of its near relations enjoy a comfortable home ; and in Charlecote Park, where rugged elms, stately lime-trees, and ancient oaks would provide a luxurious refuge. But no, the Stag-Beetle has no place there. And one must hie away to the counties south of the Thames Valley to make any close acquaintance with these interesting insects. I have noticed large colonies at Greenwich Park, in the neighbourhood of the Observatory ; and a fair number at Twickenham in the vicinity of " Pope's Garden." In the New Forest and the woodland tracks bordering on the Weald of Kent they are as plenteous as humming-bees. Every oak-tree, in the season of their greatest activity, can furnish a handful on a vigorous shake of its branches. The " brave old English oak " is the chosen habitat of the Stag-Beetle ; and here is spent a considerable portion of its career.

If we could dissociate the notion of its being fearsome and dangerous, the Stag-Beetle is really an attractive specimen. Curious he may be, but every detail of his anatomy is brimful of points of interest which belong to the general observer as much as to the skilled entomologist.

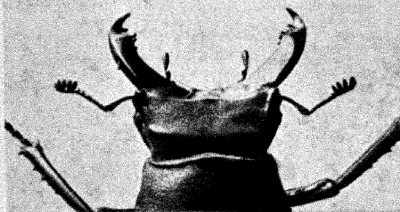
The insect has a flattened body, separated

as usual into head, thorax, and abdomen. Its head is the most remarkable factor of its structure. The antennæ are short, four-jointed, and club-shaped. They are extremely active members. Beyond these antennæ are the mandibles of the male, which, as a rule, are half as long as the rest of the body. In well-matured insects the length from mandibles to the tip of the tail is 2 to 3 inches. Hence, there is no mistaking the Stag-Beetle when we come in its track. But it does not sting. Nor does it bite, except when driven into difficulties and forced to act on the defensive. Then it will not hesitate to use its cudgels and fix both jaws in the tegument of its foe.

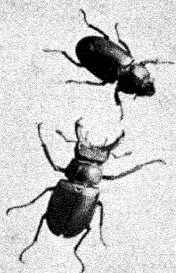
There are many Stag-Beetles which do not approximate to the size given above. They are diminutive, ill-developed insects, with no terrific-looking jaws; and one might easily imagine that they did not belong to the *Lucanus* family at all. This degenerate appearance, however, is believed to be entirely due to hard times endured while the insects were passing through the larval and pupal stages. They certainly do belong to the Stag-Beetle family, and have habits similar in all respects.

The mandibles of the female beetle are not, in any sense, abnormal. They are sharp and used for cutting incisions into boles of trees where the insect deposits her eggs. These are laid in small groups in the crevices of the oak, elm, lime, and willow—generally in the late autumn—and they hatch in the early spring. The larvæ are large, greyish, and fleshy, with heads hard and horny, and six limbs that hobble along very clumsily. Owing to the fact that the back of the grub is turned inwards, it is very difficult for it to walk on a level surface. Nature has ordained that it shall follow a sinuous course in the heart of the tree. For six years does this larva roam about in its early home, grinding, sawing, boring, and eating, until it becomes plump and powerful, attaining often enough to three inches in length.

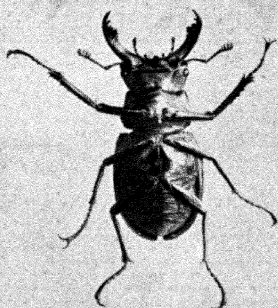
When the period of pupation approaches, it shrivels up into smaller dimensions and makes a cocoon of wooden chips and "sawdust." This blocks the boring completely, and is so located that, when the pupal stage is over, the mature insect is within easy reach of the exterior. Males and females have their first meal on the tree of their birth. Wherever any exudations or juices are to be



Head



Male & Female



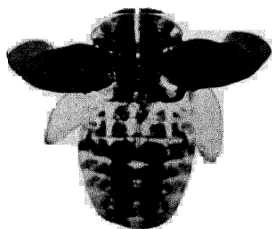
Limbs & Eyes



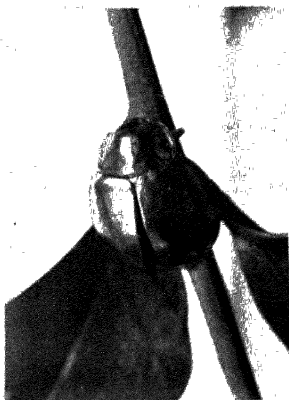
On an oak-tree



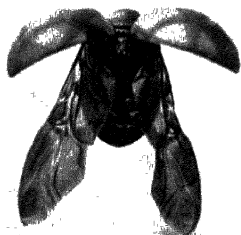
Larva



Pupa



Adult



On the wing

found issuing from the bark, there will the newly-born Stag-Beetles assemble and, with the hairy processes on the maxillæ and labium, they will lick up the juice until the bole is dry. When this frugal meal is over, they turn instinctively to the leaves of young trees where, as a rule, plenty of honey-dew can be found. This is more appetising than the meal of bark-food ; and it is delightful to watch these young insects drink in the sweet nectar from the leaf-surfaces. For leaf-buds the beetle has a special preference, as these are often bathed in mucilaginous coverings. Ripe fruits, too, do not come amiss ; and a fine male beetle will delve his mandibles deep into an apple to suck the juice from within.

The life of the insect in its mature stage is brief. A few days at most is sufficient to complete the cycle of its uneventful career. With the evening twilight the male beetles may be seen winging wildly abroad, while the females are resting quietly on the tree-trunks, hewing away with their jaws into the outer bark. The combats among the male beetles are furious and often fatal. The weaker insects soon go to the wall ; they are pinched and pierced by the antlers of the more powerful members of the colony. In this way the

ill-developed beetles are considerably thinned off. With the remnant, the battles waged are sometimes loud and long.

One comes to my mind which was fierce and deadly. Two beetles, fully-matured, presented a remarkably fine pair of "horns." Each flew high in the air and appeared perfectly at ease until they approached a small cluster of females settled on the bark of an antiquated oak. Then came the storm. As one was about to settle on the branch of the tree the other espied him, and darted at him immediately with full force. I thought he had seized him. But no, they were in the air again, the second in hot pursuit of the first. As they were well matched in size and speed I felt sure of "events" shortly. The first wheeled round and zig-zagged as if pretending to escape. His foe was thrown off for a moment. For a moment only, though, as the first rebounded and made straight for his pursuer, struck him, and clenched his mandibles. There the two were locked in mid-air, each flying, each pulling the other, neither letting go his hold until they fell exhausted to the ground and there lay still locked together. A slight tap of a walking-stick caused them to release each other and attack the

invading stick. They were easily shaken off and No. 1 took to its wings again, pursued as before by No. 2. The air-race was continued until they vanished from sight. Then they re-appeared near the oak-tree; and No. 2, evidently the stronger, having got his rival under the shades of the tree in a very exhausted condition, caused him to alight and completed his *quietus*. It was a valiant struggle for conquest.

THE LADY-BIRD

CERTAINLY one of the prettiest members of the largest family of British insects is that known to us from our earliest days as the Lady-bird. We sang its praises in song and story when children at school. Years of acquaintance with this little beauty has not diminished our tender regard for it. To-day it is a valuable member of the insect community. Silent, innocent, bright, and active, the Lady-bird performs more useful work every summer season than any other insect of the coleopterous (sheath-winged) family ; and is thoroughly deserving of every welcome we can accord it.

Throughout the European Continent and in America it is held in high regard ; the more so as its excellent qualities become more widely known. In France the happy titles of *Bête de la Vierge* (the Virgin's creature) and *Vache de Dieu* (God's cow) are bestowed upon it ; and parents curb their indulgent boys who, from so-called " sport," strive to hunt it

down. It is quite incredible that the Lady-bird should in some parts of the country be regarded as an obnoxious and destructive insect. Obnoxious—never ! It may be destructive ; but it destroys only the hosts of aphides which would spoil the foliage, flowers, and fruits of a whole season. Who then can complain of its destructiveness ? Nature preserves a beautiful equilibrium in regard to Lady-birds and aphides : it is found that where plant-lice, or green flies, abound, the Lady-birds add to their own numbers in about the same rates. It follows, therefore, that, in the great struggle for survival, the aphides never gain the ascendancy ; and our gardens and orchards make due progress in spite of their nefarious inroads.

The seven-spotted Lady-bird (*Coccinella septempunctata*) is the commonest member of the family. It abounds in woods and gardens during the summer months, and hibernates in winter under trees, in hedgerows and stone walls. During the colder months it ambles forth, rarely using its wings except when escaping from pursuit. This insect is generally of a brilliant scarlet colour, with black spots equally divided on the two elytra, the largest spot appearing in halves at the head

of each wing-cover. The colour, however, is by no means a certain or regular factor, and varies from scarlet to brown and dull yellow. The elytra are posed over the wings, thorax, and abdomen, concealing these entirely. The body of the insect is black, its six limbs are short, and its progress slow. The tarsi, or feet, have each three joints only, while beetles generally have four or five. The feet are well adapted for walking over rough or smooth surfaces. The insect can, with comfortable facility, walk on a vertical window-pane as easily as on the leaf or branch of a tree. Even more : it can walk on the under side of a horizontal piece of plate-glass without dropping or faltering in a single step.

Lady-birds do not enjoy an effulgence of light. They prefer shady corners and dark hiding-places whence they can emerge on the prowl at opportune moments. Then they stalk forth as true hunters, and are not long in discovering the haunts of the aphides and cocci. In the midst of an aphid colony the Lady-bird deposits about ten minute ovate eggs, greyish white in colour, and then takes its departure to another twig where a similar deposition occurs. The innocent aphides care not one whit for the interference, and actually

nestle the eggs in their midst as if to promote the hatching. Yet these eggs, when hatched, are to produce larvæ which, to the aphides, mean complete annihilation. After five or six days these eggs are pierced at their extremities, and the larvæ begin sucking the juices of the aphides with the appetite of perfect gluttons. Not until the whole colony is drained to the skins does the larval Lady-bird move to another position: when this removal transpires, the larva will seek protection from the eyes of birds by masking itself with the dried skins of its victims.

The larva imitates the colour of the twig—a brownish grey. It is covered with yellow-green spots, again to assist in evading capture, for it is a precious morsel to the tit and the sparrow. The skin of the larva is sprinkled over with tubercles. Its six legs and pointed claws enable it to grip the tender twigs; its movements are slow like those of the mature insect, but this is of little consequence, as the aphides are in no hurry to escape their captors. The larva can therefore take its own time over a meal.

When fed up, the larva spins a short thread of finest silk, and attaches itself to the underside of a leaf or a twig, swinging gently in

the breeze by its slender anchorage for ten days or thereabouts, to undergo the pupal change. At the close the pupal covering slits open, and the matured beetle emerges from its envelope. As yet its wings are feeble and inert ; they are folded under the elytra and these are but faintly tinted. The spots are there ; and as the colour becomes more pronounced the spots become more conspicuous by contrast.

Two other species are fairly common—the 2-spotted (*C. bipunctata* and the 22-spotted Lady-bird (*C. 22-punctata*). The former is similar in size and shape to the 7-spotted species. The latter is smaller, being about one-seventh of an inch in length, and revels in woodlands and hedgerows with elytra of dazzling yellow hue. The Lady-bird is seldom on the wing except during the warmest days of July and August. Then it is frequently seen in the air with elytra lifted, and its large gauzy wings performing rapid sweeps that defy capture. The busy beetle is then seeking a nesting-place ; and no time is lost in performing its last and supreme duty.

THE COCK-TAIL BEETLE OR DEVIL'S COACH-HORSE

NO !greater contrast could well be imagined than that between the Lady-bird and the Devil's Coach-horse, or Cock-tail Beetle. Here is darkness contrasted with light and brilliant colour, fleetness of foot with plodding ; ferocity with innocence ; resistance with gentleness.

The Cock-tail (*Ocypus olens*) is a member of the brachelytrous (short-wing-covered) species, and one of the commonest of British beetles. From our earliest days we have seen Cock-tails scurrying along by the side of the roadways just as twilight was creeping over the country-side. It is then that this insect emerges from its lair to sally forth in search of prey. In the day-time it keeps away from human ken, burrowing deeply in the hedge-side, and contenting itself with several hours of complete repose. If the day be wet or dull it will, after the crafty habits of its kind, steal towards the mouth of its burrow and

entrap any passing fly, centipede, millipede, or luckless worm. The Cock-tail utterly derides fear. It has no more regard for the powers of a thick walking-stick than for the gentle pat of a blade of grass. In its native haunts it is a veritable lord of creation.

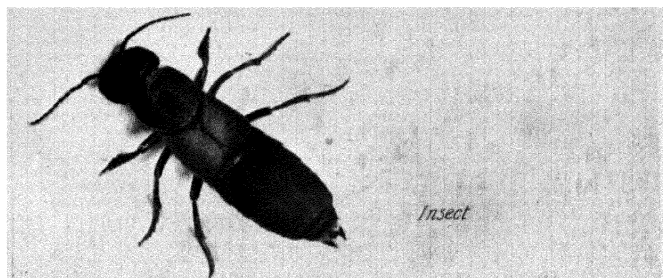
In colour it is almost as black as jet. Its head is hard, horny, and wider than the thorax; the eyes are fierce and threatening. Over the thorax are the short elytra partly covering the flanking wings which fold under the insect's body. The abdomen is divided into segments that allow a rising and falling motion when the insect is disturbed. At the tail are two whitish vesicles, which exude an inky concoction that sets at bay any foe of the Cock-tail. Just as at its hinder extremities the insect is naturally protected, so in the front of its head are ample weapons of defence in the shape of powerful mandibles and maxillæ. These jaws will attack insects four times the size of their owner, and make fierce lunges at a four-inch worm.

On the wing the insect is known for its wonderful stability and capacity for long flights. It flies with incredible speed over long distances without troubling to rest by the way. It can thus capture and devour

insects that would never venture near its burrow ; and it is no rare occurrence to see a hungry Cock-tail ruthlessly invade a swarm of gnats airing themselves under an evening sky. Then the Cock-tail appears to be happy, and takes full advantage of a cheap meal.

One evening, near the close of June, I encountered a mature specimen of this insect in a quiet country-lane. It was creeping forth slowly and stealthily from its burrow, and apparently making for a crane-fly at rest a few inches away on a small stone. I stood for a few moments watching the progress of the beetle. More slowly and more slowly it scrambled until, when within two inches, it seemed as though it would make a sudden bound at its prey. With a twig in my hand I barred its progress ; and the beetle, instead of pouncing on the innocent fly, snapped at my twig, seized it with its mandibles, and stuck to it like grim death. I lifted the twig from the ground and shook it in the air ; no matter, the beetle clung to its imaginary foe until a smart tap released its talons. The insect stood there with its tail defiantly raised and its open jaws ready for another attack. The crane-fly, evidently

alarmed at the disturbance, hastened to other quarters. But the Cock-tail knew nothing of retreat : it stood bravely facing the twig, with its extremities raised for a fight. When the twig was lifted out of sight it quietly crept away. I struck the twig again on the ground immediately in front of it. Up went the head and tail in an instant, and the war-like Cock-tail again seized the stick. I shook it off as before, and tried the bait of a pin. This was bright and shiny. The Cock-tail's dignity was wounded. In blank derision he seized the pin and was hurrying away with it to his den. But hold ! I wanted the pin for other purposes. He seemed disappointed at being unable to bear away his booty. Then I gave him the offer of a finger-tip. Ah ! what now ? Still he was not afraid, although the finger-tip was ten times the size of his head, and more. His tail was still aloft, the mandibles fully extended, but he moved not an ace. I pushed the finger nearer by sudden spurts : at every spurt he raised his head and tail defiantly, and at one swoop sent his curved jaws into my finger. Of course they passed into the region of nerves and feelings, and pierced both outer and inner skins. The grip was not painful, but



Insect



Emerging from its den

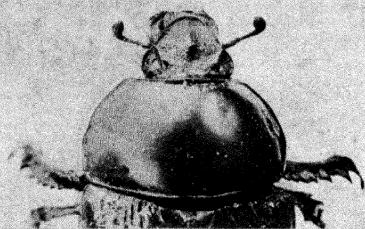


On the prowl

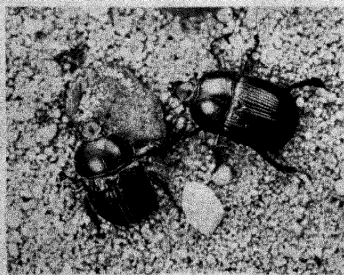


A characteristic attitude

PLATE III: THE COCK-TAIL BEETLE



Head



On the hunt



Mites clinging to limb-joints



Dor-Beetle mite (greatly magnified)

it was certainly fierce. We parted company the best of friends after an interesting quarter of an hour.

The eggs of the Cock-tail are abnormally large ; no other British insect approximates the beetle in this respect. Each egg is about one-tenth of an inch in length, and of a grey colour. The eggs are laid underground in small clusters, and hatch out in the spring. The larvæ are black scaly creatures with six limbs, but without any semblance of wings or elytra. They are terribly voracious, and practise through their lives a career of slaughter among other less-powerful insects. Their mandibles are pincer-like. Seizing their prey by the thin neck, they pierce its body and suck up all its juices, leaving nothing but the shrivelled skin.

With the approach of summer the larva sinks into the ground and enters the pupal stage. The pupal wings can be discerned in a few days wrapping the body like a dark brown shroud. The elytra appear short and stumpy. When a period of fifteen to twenty days has elapsed the pupal covering bursts ; the new beetle crawls from its hole, and continues its wanderings in search of insect prey.

The Cock-tail Beetle, although so apparently

ill-tempered and destructive, is not to be regarded as the enemy of mankind. It is, indeed, rather the reverse. Few beetles do more to rid the ground of a vast number of smaller insects which, if tolerated, would do enormous injury to our fields and meadows, orchards and gardens. In the late summer and early autumn, when the crops are at their best and a host of flies are on their errand of destruction, Cock-tails are most numerous. They thus check dangerous inroads on the farmer's property.

THE DOR-BEETLE

THE Dor-Beetle (*Geotrupes stercorarius*) belongs to that family of case-winged insects which burrow in the soil for the purpose of depositing their eggs. It is also known as the "Watchman," or as the "Shard Beetle," from the hard, horny nature of its elytra. It is probably one of the most familiar of British beetles. In the sunny days of July and August we cannot plunge far into the country without hearing the ominous hum of the Dor. Maybe it will be less polite than the majority of insects, and so far miss its way as to collide with us without apology. Such occurrences are by no means rare in the summer time, when the beetle is most indifferent in its course. On several occasions, on an evening's ramble, I have experienced the rude impact of Dor-Beetles. They do not suffer the slightest injury. After a temporary rest on the ground, they fly away as if nothing unusual had happened.

The Dor is not at all an ungainly insect. It is jet black in colour on its upper parts

and of a bright, shining violet underneath. The head is rather flat, triangular in shape, and bears a well-marked tubercle in the centre of the clypeus (forehead). The thorax is fairly smooth, showing little or no sign of grooving, but is dimpled, or "punctured" near the edges. The elytra are closely ribbed with parallel fissures and punctured slightly at the margins; they form a strong convex covering for the body of the insect, and are sometimes used to conceal the hind limbs as well.

The limbs of the Dor are hard, tough, and entirely fringed with hairs and bristles. These bristles, indeed, form a clue for distinguishing the male from the female insect. In colour, form, and size there is a remarkable similarity in the two sexes. The tibia of the front limb of the *male* has a prominent erect spine, and the hind limbs are deeply serrated on the inner fringe near the hip joints. In the *female* Dor these features are absent. The antennæ are short, and terminate in a club-shaped comb. Their vibratory activity is very acute during flight.

The Dor is abundant about stables and farmsteads in summer, its purpose here being, of course, the deposition of eggs in the

farm-refuse. In an average two-horse stable it is common enough for a score of Dors to establish themselves ; and, as their presence is seldom detected, owing to their silence, they have a comfortable habitat. The humming propensity is exercised in mid-air ; it vanishes in the stable or the shippon. Here the beetles crawl about in crevices and dark crannies for hours, before selecting a suitable nidus for the eggs.

Beyond the bounds of the farm-buildings the Dor will seek a safe spot in the fields, and burrow twelve to fifteen inches below the surface. Here two or three eggs are deposited. Probably one only will hatch. The eggs are covered over with loose earth, roots, and small stones, and the burrow is otherwise left open so that, on emerging, the larvæ may have easy passage to their food. These never travel far away from the burrow. They are ravenous feeders, but usually find quite sufficient nutriment to fit them for the whole of the larval career. The mother Dor is wise enough not to place all her eggs in one nest. The risk of burglary and plunder from earth-worms and subterranean insects is too great to be regarded with indifference ; and if the Dor deposited the whole hatching in one

burrow the extinction of these beetles would be considerably hastened. After the first laying, the beetle moves a few yards away to the next food-spot and delves another burrow, planting a few eggs as before. Thus in eight or ten different localities she will distribute her progeny ; so that even in the event of accident or predaceous attack some of the larvæ are almost sure to emerge and survive.

The larva is a slim, white grub with six stunted limbs and feet turned inward for climbing and creeping in the soil. The head is brownish black and slightly wider than the body. When fed up, the larva returns to the original burrow and remains mute for a while. The pupal transformation proceeds slowly. Hence the pupa often falls an easy prey to burrowing insects of other families. It cannot in the least defend itself ; and may frequently be found in the soil with a deep circular incision in its side. The fatal wound has been inflicted by an unseen foe.

The Dor, in its wanderings for a nesting-place, is not so partial to fields and meadows as is often surmised. Abutting on the sea-shore between Heysham and Morecambe, in North Lancashire, was a rough stone wall.

A Dor-Beetle of respectable dimensions came buzzing along. It evidently meant important business, and made straight for the short length of the wall. This was amply covered with lichen and moss, but was punctured here and there with dark recesses. The beetle wheeled round and round in narrowing circles, as if making for one crevice in particular. Sure enough, it dropped on a stone near this hole and immediately entered the dark cavern. After a watch of ten minutes we saw the beetle emerge ; and a cursory inspection revealed the fact that she had been egg-laying. It seemed curious that such a locality should have been selected at such short notice. The reason was not far to seek ; this wall was backed up with road sweepings.

Parasites are numerous on the Dor-Beetle. They ensconce themselves mainly at the joints of the limbs, under the elytra and at the base of the wings. These belong to the *Acarus* family, and do not incommode the beetle to any serious extent. They cling to it, crawl over it, feed on it, and accompany it on its aerial flights. The parasite is a tiny red mite which spends the whole of its career on the beetle.

THE WATER-BEETLE

IN the air, on the ground, or in water, the Water-Beetle (*Dyticus marginalis*) finds a suitable home. It lives in stagnant pools for a considerable part of its career, and there finds a fitting environment for its various stages of development. *Dyticus* is a warrior bold, and a remarkable insect in many respects.

Belonging to the coleopterous family, it bears two strong, leathery elytra covering two larger glassy wings. The head is bold and massive, with two compound eyes embracing a thousand facets, every one of which has its crystalline lens and optic nerve. The facets, as a rule, are hexagonal, but quite a large number, on microscopical examination, are found to be irregular in shape though six-sided. In fact, some approximate to the square, owing to two sides of the hexagon being almost obliterated. But the eye of the *Dyticus* is a wonderful instrument of vision : as is witnessed by the fact that it is employed by microscopists for the purpose of imprinting

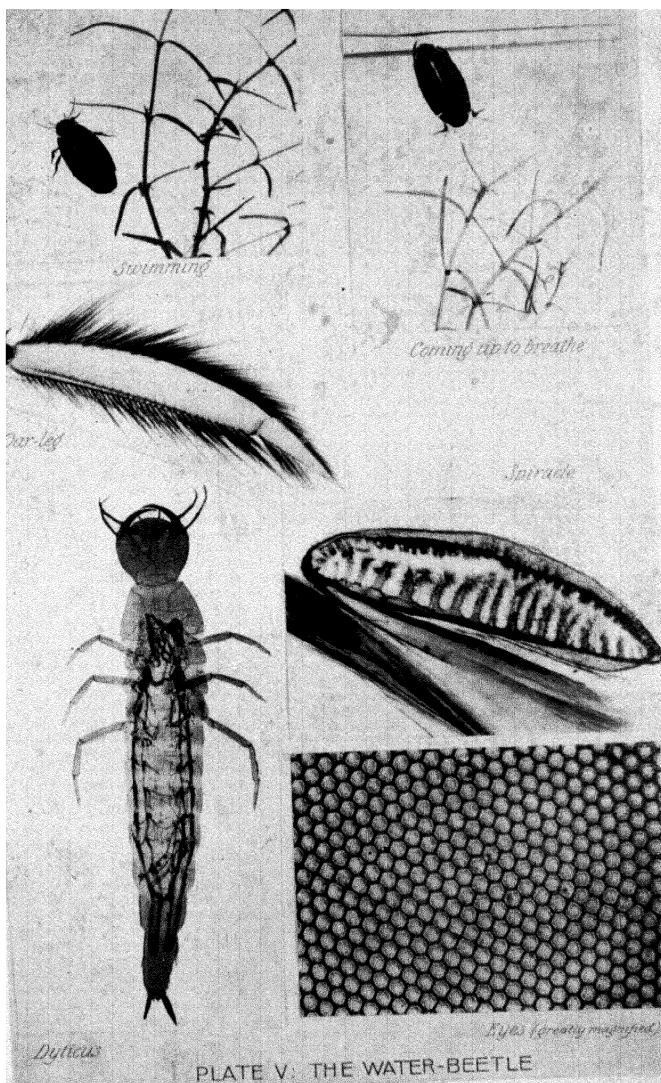
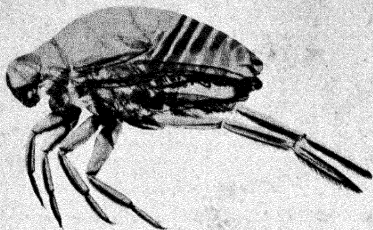
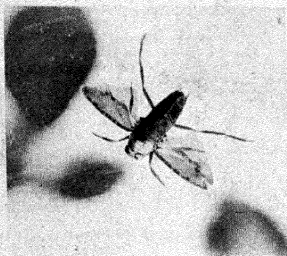


PLATE V: THE WATER-BEETLE



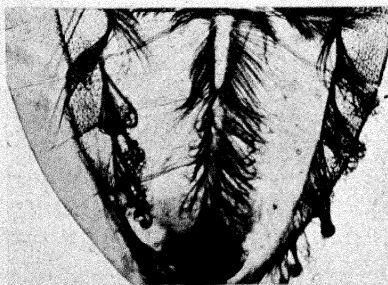
Larva



In flight



Swimming



Hairy fringe

a thousand images at once. It is well known that the eye of a Water-Beetle may be used like the lens of a camera ; and a postage stamp or any other well-lighted object may be photographed through it.

The beetle is provided with substantial antennæ of ten to fifteen joints and formidable mouth-organs, which account for its powers of destruction. The inhabitants of any fresh-water pond are considerably depleted when a Water-Beetle appears on the scene. The elytra are dull black in colour and margined with a yellowish border. Hence the specific name of the beetle, *marginalis*. They are smooth but punctured in several rows from base to tip longitudinally. There are no transversal punctures. Black, too, is the thorax ; and similarly bordered with a yellowish-brown band. By these features the insect cannot possibly be mistaken. If the beetle be held in the hand so as to examine the under side of the thorax, we notice a curious off-shoot, like a bifurcated tail, very flat and sharp. This appendage is evidently adapted to useful and protective purposes. The insect can scrape the weeds, trap its prey, protect its eggs, or wound its foe by means of this instrument. We shall not hold the

beetle long before feeling rather acutely a backward dig of this cutting edge. The insect does not rush forward when caught ; it creeps backward and employs this curious weapon with painful effect. In keeping with a general characteristic of the beetle family, the *Dyticus* exudes a fluid of evil odour which enables the insect to elude its would-be captors.

The limbs, however, are the most remarkable features of the Water-Beetle, especially in the *male* insect. None of the pairs are similar. The first from the third differs considerably. This is precisely what a naturalist would expect when considering their difference of purpose. The first pair is obviously intended for clinging or grasping ; and the upper three parts of the tarsus are much wider than the lower two parts. This section of the limb is flat and interspersed, nearly all over, with suckers ; one larger than any of the others, a second little smaller than the first, and a large number very small. The largest sucker is lodged exactly on the tarsal joint, and gives the beetle ample power to hold an object with great tenacity. The hind pair of limbs is fashioned for swimming. Flat, tapering, oar-like appendages, they can

execute marvellous evolutions in water ; but transfer, for a moment, the wily creature to *terra firma* or a plain table-top and there is a striking change in its behaviour. It hobbles, tumbles, wriggles about, as if making a clumsy somersault and then tries—all in vain—to gain a foot-hold. These oar-legs are fringed with brown bristles presenting a beautiful appearance as they float gaily over the water weeds.

The main distinction in the form of the *female* beetle is the absence of the swelled tarsal joint ; she has no suckers or anything equivalent to them. Her wing-covers, too, are grooved and punctured more closely than those of the male.

That the wings of the *Dyticus* are strong and powerful in flight may be judged from the fact of its rising from the water, by means of a weed stalk, and soaring high in the air over long distances in search of food or a fresh pool. Near a field path was a pond I had known for long as a favourite habitat of "water animals." While observing, with interest, the antics of its denizens, I noticed a goodly-sized Water-Beetle in the air, making for the pond. When immediately over it, the insect dropped suddenly into the water.

The wings were evidently not used in " planing down " ; but the beetle was quite comfortable and spent a lively time pursuing cyclops and water-fleas.

At the roots of the wings are minute winglets similar to those of the house-fly. Their rounded edges are closely fringed with hairs ; it is generally accepted that these winglets produce the humming sound of the beetle and have sensory nerves.

How the beetle, while living in water, obtains its necessary supply of fresh air is remarkable. For, being an insect, it must breathe. Furthermore, it cannot remain in the water more than fifteen to twenty seconds without " breathing." Hence it must shift for itself without much delay. The body of the beetle is much lighter than water, bulk for bulk, and the insect can keep down in the water only by using its limbs vigorously or by clinging to some submerged weed. When once it relaxes hold or ceases to paddle, it naturally rises to the surface. But its flat body is thicker and heavier in front than behind. Hence it rises with its hind parts uppermost. Lifting the extremity of its body just above the surface, it raises the elytra sufficiently to expel the effete air lodging

between them and the upper surface of its body, and takes in a supply of fresh air. This air-lock is effectively sealed between the elytra and the insect's body, and is in immediate connection with the spiracles and breathing-tubes which all open into this hidden cavity. When the bubble of air is exhausted the beetle rises again to renew the supply.

The larva of the *Dyticus*, like the parent, is extremely voracious. It is a yellowish-brown insect about two inches in length with six sharp claws and a mouthpiece of fearsome weapons. These it uses, without mercy, on all that comes in its way that is suitable for food. Its two mandibles are sharp, curved inwards, and hollow; so that the insect causes them to meet in the flesh of its prey and draw its life-blood. Like the parent, it must "breathe," and has two appendages to its tail provided for the purpose. These are tubular and are connected with the breathing-tubes throughout the larval body. When requiring fresh air, the larva rises to the surface of the water and draws air through its appendages.

The larval stage lasts about four weeks. At the end of this period the insect withdraws to the bank of the pool and burrows

into the soil, making a snug cavity, wherein a cocoon is woven of fine silk. In this the larva muffles itself up like a miniature mummy and remains for three weeks, if pupation occurs in early summer. If in late autumn, the pupa will hibernate for the whole winter and emerge a perfect Water-Beetle in the early spring.

If the Water-Beetle is required for the parlour aquarium, great care must be taken to allow it a tank of its own. Otherwise, it will soon clear the aquarium of any other occupants weaker than itself.

THE WATER-BOATMAN

THE generic name of the Water-Boatman (*Notonecta glauca*) means "back swimmer," and the specific term *glauca* has reference to the colour of the hairy processes on its body and limbs. The insect is a backswimmer to perfection. Its back is admirably suited for swimming or floating, being, in shape, like the keel of a boat—with this difference, that, whereas the keel is sharp in front and flat behind, the back of the Water-Boatman is flat in front and pointed behind.

Notonecta is an interesting performer in the water, and executes many evolutions which are entirely its own. It abounds in nearly every wayside pool or field pond; and may, at any season of the year, be requisitioned for the parlour aquarium. I have found several in small pools during the frosty days of January and February. In July and August they come with every draft of the net.

The insect has the advantage of a large head, which bespeaks intelligence of a sort. The thorax near the head is also more bulky

than the rest of the body ; the abdomen is flat and light in weight. The consequence is that when the insect rises in water, owing to its low specific gravity, it invariably rises with the head downwards.

When the Water-Boatman is closely examined, it will be obvious that its limbs were never intended for walking, running, or jumping. The fore-limbs are very short, and are folded generally under the thorax even when the insect is swimming. The only available use for them is to clutch suitable prey or food, or to hold on to water-weeds and stalks. They rather remind one of folded arms. The middle pair of limbs is much longer, strongly jointed, bent inward, and is employed constantly while the insect is resting or anchoring to stones or water-plants. This pair is used almost exclusively for anchorage. The third pair is different from either of its predecessors. Here the limbs are longer, and amply fringed with delicate hair-like filaments. These limbs perform the office of sculling, and resemble the ordinary oars of a boat both in form and in purpose. They are used entirely for the insect's movements in water. By them it dives or swims in all directions, for the purpose of obtaining food. Its

swimming operations are perfect ; the forward stroke finds the oar-limb fully extended and the fringe of hairs spread forth to press the water and produce motion. The backward stroke is facilitated by the hairs lying flat on the limb, whose tapering extremity glides through the water with little friction. The likeness to a boat and its oars is very striking when the insect is seen in water resting on a piece of weed.

If placed on a level surface out of the water, the Boatman shows itself to be in an unnatural element ; and when powerful enough will take to flight. The real wings are fairly large, and full of delicate nervures, but are concealed under the elytra. These are partly membranous and fit tightly to the sides of the thorax, enclosing the bubble of air which sustains the insect during its career in the water. For, like the Water-Beetle, this insect must have recourse to atmospheric air to keep its trachæal tubes supplied with oxygen. Under the elytra are the spiracles in two lines parallel to the hairy fringes which line the thorax. Continually absorbing fresh air from the small but ample reserve, the spiracles never clog with water, since they are completely shielded from water-contact.

When the insect rises to the surface, its oar-limbs are fully extended, and three points touch the uppermost film of water—the “paddles” of the oar-limbs and the tip of the tail. The oar-limbs form an adequate balance, while the elytra are slightly lifted, and a fresh supply of air is taken between them and the outer surface of the thorax. When this bubble is locked in, the oar-limbs beat the water with striking energy, and the insect rapidly descends on another hunting expedition. Owing to the small size of the Boatman in comparison with the air-reservoir within its elytra, the supply is sufficient to last from fifty to ninety seconds. If the supply is renewed in thirty seconds, the insect appears to possess more energy for swimming. A lengthy period of submersion need not be followed by a long spell at the surface. The air reservoir cannot be more than full; and the simple process of lifting the elytra ever so little is sufficient for a complete renewal. In bright sunshine the insect breathes “more freely,” and pays frequent visits to the surface.

The Water-Boatman is a paragon of cleanliness, and will never tolerate an atom of dirt on any part of its body. With its short forefeet it imitates the efforts of the common

house-fly to sweep from its head every particle of foreign matter. These two feet are always at liberty, and become very handy for cleansing operations. The second pair of limbs cannot be spared at all for this purpose. The moment the insect releases them from their anchorage, it rises rapidly to the surface. But the hind pair is frequently used for sweeping the elytra and rear parts of the body. Even in clear water the insect will not forget its toilet, and a piece of floating conferva is not allowed to impede any part of its economy.

To say that the insect is an inveterate warrior is but part of the story. It is not dangerous to insects more powerful than itself; but all other forms of pond-life are required to surrender to this relentless hunter. Cyclops, cypres, water-fleas, blood-worms, and pond snails fall under the ban of the Water-Boatman. Its eyes never slumber or sleep; and few passing entities escape immediate capture. Powerful mandibles are forced into the unfortunate victim, and every drop of juice is sucked from its vitals. Then the shrivelled skin is rejected and cast away.

The larva of *Notonecta* differs little from the parent except that it has no semblance of

wings or elytra. It is quite as ravenous as the perfect insect, and will attack other insects three times its own size. It lives to fight and eat. The pupa, too, is wonderfully similar to the full-grown insect. It bears the imprint of a pair of wings ; but these are lacking in development, and some time elapses after emergence from the pupal integument before the wings are capable of being used. The perfect insect is a veritable night-rake, and chooses the twilight for starting on its nocturnal expeditions. It will leap out of the water, suddenly open its wings, and fly with astounding vigour for so small an aviator. The dawn of morning finds it far away from its original home.

THE WATER-SCORPION

BE not alarmed when we speak of scorpions ; for the water insects of that ilk are among the most innocent, and are perfectly harmless to human kind. Indeed, there would be little reason for calling *Nepa cinerea* a “ Water-Scorpion ” at all, were it not for the prehensile forelegs which impart a resemblance, in miniature, to the dangerous arachnid of the South American forests.

Nepa is one of the three British Water-Scorpions, is the largest of the family, and, notwithstanding its name, is a very interesting insect for study and close observation. From its near neighbours the Water-Beetle and the Water-Boatman it differs widely. While the former beat the water by fits and starts, every few moments rising to the surface to breathe afresh, the Scorpion is slow, unmoved by excitement or disturbance, and simply rests on a submerged stone or the slimy bottom of the pool. Nothing seems to be of any concern to this insect, except during the

occasional intervals when it becomes hungry. For the merest mite must have food to replenish its energies. But for hours together the *Nepa* will remain in the water without the slightest effort to rise to the surface for a renewal of fresh air. Crawling among the water-weeds one would scarcely recognize this full-grown insect with six limbs. When it is stationary at the bottom of a pond, it looks like a small rusty leaf. Even when touched with a twig, it cares nothing for such trifles, and, like a crab, simply digs backward into the mud leaving nothing observable but its forelegs.

These limbs bend inwardly ; and are fitted for seizing unwary prey. When the Scorpion is feeling the pangs of hunger, it hides stealthily under a small pebble or behind the leaf of a water-plant, and merely watches with two piercing jet-black eyes for events. The moment a water-flea, a may-fly larva, or a young Water-Beetle comes along, the forelegs are fully extended and the victim is trapped in the pinching claws. There is no escape. There may be, and sometimes there is, a desperate struggle. The victim is often enough larger than the victor ; but the Scorpion sticks with grim tenacity until the larger insect

is exhausted and falls in the combat. Then the *Nepa* employs to considerable effect its short, strong mandibles until the victim's body is sucked clean of its juices.

When the meal is finished, the Scorpion folds the foot-joint into the trough of the tarsal joint, exactly as a knife-blade drops into the slot of the holder. There it will remain for a few hours until the Scorpion wakes from sleep. With a brownish-black body almost as flat as a piece of paper, the *Nepa* requires little nourishment to appease its appetite. It can live at peace with its neighbours during its own time; they will never disturb it. For, although so sluggish, it is too formidable a foe for them.

The Water-Scorpion has a straight tail, but this caudal appendage is not a steering appliance in any sense, and does not perform the function of a tail. It is, really, a tube divided into two troughs, connected in the centre by hairy filaments; and is used for breathing purposes. When the insect requires a fresh supply of air, it creeps steadily up the stem of a pond-weed and raises the extremity of this tube slightly above the surface of the water.

The appendage is in immediate connection

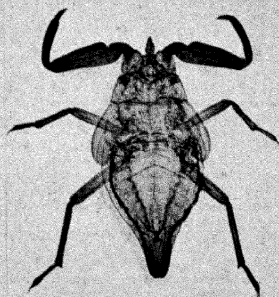
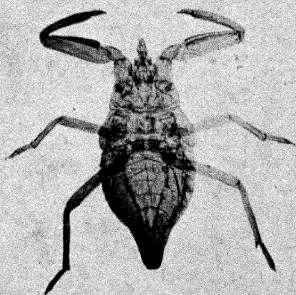
with the insect's trachæal tubes, which pass along the sides of its body and have no spiracles except those opening into the appendage. Insects, generally, are amply provided with spiracles in definite lines and at regular intervals along both sides of the thorax and abdomen. Not so with the *Nepa*. As its respiratory needs are so limited, it is confined to two minute spiracles for its necessary supplies of oxygen.

The larval Scorpion, which much resembles the parent in form and colour, cannot even boast a hollow appendage. It is provided with an apology for a tail ; but this is little more than a stump, and is closed against the admission of air. The larval body is not so flat as that of the mature insect, and has a swelling on either side of the thorax that marks the rudimentary wings.

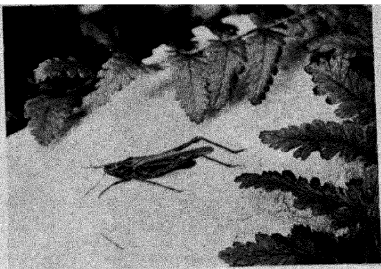
The mature insect has four wings. The two upper wings, or elytra, are horny except at the tips, where the tough material gradually merges to a membranous consistency. The real wings are concealed under the elytra ; it is seldom that they are used, and then only between sunset and sunrise when the insect is in search of a new home. They are of brownish tint, rather opaque, with a scarlet



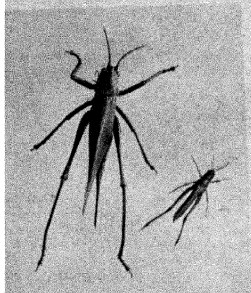
Insect



Larva (left) and Pupa (right) These differ only in degree



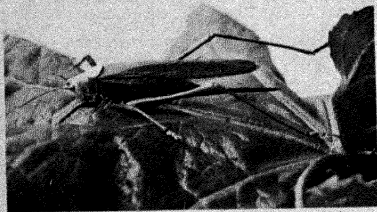
Common Grasshopper



Grasshoppers compared.



Wing (greatly magnified)



Great Green Grasshopper

spot near the base. When fully extended the wings add dignity and grace to an otherwise plain-looking insect.

Water-Scorpions lay eggs on the leaves and stems of pond-weeds. Occasionally the eggs may be seen on submerged stones or pieces of decayed wood. They are peculiar in shape. Each egg is fringed with seven hairy filaments arranged at equal intervals. When deposited, an egg rests in the hairy cup of its forerunner ; so that the whole hatch resembles a short string of greyish-white beads. Then the fringing hairs turn outwards, presenting short, sharp spikes to protect the fragile envelopes against possible attacks from the predaceous denizens of the pond.

THE GRASSHOPPER

THE Grasshopper is one of those insects which have the merit of being popular. It does no appreciable harm to anything or to anyone. It is the open-air representative of an important family, and charms our ears, ever and anon, during a sultry summer day, with its stridulating chirp.

The Common Grasshopper belongs to the locust family, which sounds rather uncomfortable ; but the British type is an innocent creature of modest dimensions and with no predisposition to spoil the pleasure even of a child. It chirps by rubbing the outer surface of its wing-covers over the inner surface of its stout limbs. We try to discover the locality of the call ; and by the time we are there the insect has hopped several yards away in the grass. As if bent on sheer trickery, it will lure its pursuer for a whole field's length ; and then successfully elude his grasp. Among the grasses, weeds, and stalks of many tints it is no easy matter to trace its peregrinations.

It is, after all, a winsome creature with an elongated body of a greenish-brown colour ; a prominent oval head with a pair of antennæ, short and club-like ; straight-veined wings and covers extending well beyond the extremity of the abdomen ; and two long, powerful, hind legs, whose jumping capacity is, comparatively, greater than that of the kangaroo. The part between the first and second joints of these limbs is developed to an extraordinary degree, and accounts fully for the athletic powers of the insect. The eyes, too, are compound, and very prominent. Between them are the ocelli, or simple eyes, arranged to form a triangle of observation.

Grasshoppers are vegetarians. Seldom do they touch animal food, unless driven by keen stress of hunger to depart from their normal good manners. Then they will not hesitate to attack each other with uncommon fury, and fight to a finish, the victor quietly consuming his adversary's limbs. This misfortune, however, only happens when several grasshoppers are confined in boxes or cages, and are thus prevented from pursuing their natural habits in the open fields.

With the stories of the terrible locust raids in America and on the Continent we are all

familiar. Happily, we are spared these trying experiences in Great Britain, as no such hordes traverse our green hills and vales. The common British Grasshopper is content to commit no further excesses than catching smaller insects that abound in the meadows ; it never makes itself obnoxious to the human kind.

The eggs of the insect are deposited in the soil, just below the surface, in small clusters. The mother will place one group satisfactorily to herself ; then fly off to another spot, and repeat the operation. This happens in the waning days of autumn, and five or six months will elapse before the hatching-time arrives. The chirping is entirely a faculty of the *male* insect and is, no doubt, employed as a call-note to his mate, whose silence is as complete as it can be.

The largest British member of this family is the Great Green Grasshopper (*Gryllus viridissimus*), which presents an imposing appearance in a bright emerald tint, almost the exact counterpart of the green blades of grass. It is the largest of our orthopterous insects, and is by no means so frequently met with as the Common Grasshopper. Still, in woodland dells and forest areas it is not of

rare occurrence among the trees. It has a decided preference for trees, and rarely keeps to the grass for any lengthy period, except when depositing eggs. The insect is about two inches in length, and, with outspread wings, measures three and a half to four inches from tip to tip. When on the wing, it is a brilliant-looking specimen. The antennæ are exceptionally long, tapering to a point and containing many joints. The wing-covers are roofed over the insect's body, which terminates in a long ovipositor.

As in the case of the Common Grasshopper, the *male* insect is the source of the significant "chirp"; his mate is powerless to utter any audible sound. But the chirp is produced by means differing from those of the common type. At the base of each elytron is a whitish disc covered with prominent nervures. When the elytra close over each other, these nervures come into contact, and the friction thus caused gives rise to the stridulating sound. There can be little doubt that the male insect employs his musical powers for the sole purpose of enchanting his spouse. When she arrives in response to his call, one of her first duties is to fawn on him by tapping his head and wing-covers with her antennæ. This

she can do to perfection, he bowing his head the while, with his antennæ quite prostrate.

Another species of British grasshopper is the *Meconemia varia*, a pretty little gem, fashioned in detail like the Great Green, but having a bright-yellow band on the thorax. This species is a lover of trees, and leaves the grassy lawn on its first flight. Henceforth it clings to the oak, the elm, and the sycamore. If young trees be shaken at the trunk, a handful of these tiny grasshoppers will relax their hold and fall to the ground. The curious feature of this insect is that it possesses no chirping appliance whatever, and is thus distinct from all other members of the family.

Grasshoppers have long been known for their medicinal qualities. From the mouth a brownish fluid of acid properties is exuded. This has, for ages, been applied to the hands as a "sure cure" for warts.

THE CRICKET

CURIOS and mysterious are the doings of the "Cricket on the Hearth." Time and custom have long honoured the humble cricket with the title of "harbinger of good." Men of all ages have welcomed it to their thresholds as the herald of peace, goodwill, and prosperity. Fortunate cricket! If all this confidence were well placed, we should expect many more hearth-stone singers, but, alas for the cricket! its friendly hosts are diminishing every year. Its haunts to-day are mainly in the stable or the barn, with an occasional visit to the farmer's cottage. Here the bairns are pretty sure to give the entertainer a hearty welcome.

Born amid the scraps of the rubbish-heap, the insect emerges from the egg—one of a great number—and crawls forth on its six legs to look out on the wide, wide world. It has no wings. Moults after moults occurs, every change of clothing improving the appearance of the insect and showing progress in development. At the last moults the wings

appear, two gauzy films under two horny elytra or cover-wings. Then the cricket is ready for flight, and to delight by its chirp the cottage-fireside of its host.

How this insect came to be held in such veneration is a matter of history, dating from remote periods when the lowliest creatures of the animal world formed part of the household of the Saxon labourer or villein. And the lapse of time has not entirely erased the superstitions which hung around the innocent Cricket. Needless to say, the insect has nothing whatever to do with luck or fortune, good or ill. It forms a humble member of the family of insects, coming and going as do other members, performing its little tasks, chirping and scavenging; then it retires to its chosen cavity to be seen or heard no more.

Poets have sung praises of its musical "thrills," and its beneficent omens. But it is far more interesting as an object of scientific study than as a companion of the wintry night. The Cricket is essentially nocturnal in its habits. In the day-time, when light streams hither and thither in every part of the habitation, the cricket is quietly sleeping in a crevice of the wall, or immediately under the floor-boards. It will not go far

away. Preferably, it will choose a spot near the fire-grate, for it enjoys a warm corner. But its preference for tropical heat makes the insect very thirsty ; and, if any damp clothing can be found, this is likely to suffer from Crickets perforating it to absorb the water it contains. They will jump or fly on wet clothing placed to dry beside the fire ; and, before detection is made, bite holes into the fabric. They are fond, too, of dark larders and kitchens where food is placed on high shelves without cover. A careful inspection will reveal the fact that they have been there helping themselves to anything sweet and appetising.

When twilight falls, and darkness covers the earth, the Cricket stalks forth beyond its favourite crannies. Still keeping near the warmer parts of the house, kitchen, stable, or other habitat, it makes itself evident by occasional jumps, flights, or thrilling chirps. Gilbert White tells us of Crickets crowding his home at Selborne. As he sat at the table writing his famous *History of Selborne*, the insects would suddenly swoop upon him, checking his quill and threatening his good temper. " At night," he says, " they became absolute pests, flying into the candle-light,

and even into the faces of persons sitting in the room." These must have been very audacious Crickets. Seldom, nowadays, do they become so objectionable, generally contenting themselves with a crawl on the hearth or under the fire-grate.

The piercing chirp of the Cricket is not in any way due to the exercise of mouth organs. It arises from grating one elytron over the other. The wing-cover bears certain veins or nervures, one of which is specially marked like a reed. This is termed the "bow," and grates over the tight drum between the nervures of the opposite elytron.

The insect chirps for no special reason of joy or fear. If, when one is heard on the hearth, we begin to play the piano or organ, the insect becomes silent. Similarly it ceases its chirping if a piece of wood or a metal tray be dropped near it. On the other hand, if all is calm and still within, but a fierce storm is raging outside, the chirping is strong and continuous. If the weather be calm, the insect chirps at intervals, if undisturbed; it will then crawl away to another place and be silent for a while.

The Cricket is a poor aviator. It has wings large enough to fly, but cannot proceed with

steady and certain flight, and is sure to knock its head against one obstacle or another. Its flight is so jerky, rising and falling most awkwardly, that the insect finds its safety best assured by crawling along the walls or on the ground. Its wings are evidently framed for short flights only, but sufficient to enable it to change its locality at short notice. And it is remarkable how Crickets will suddenly pounce on a cottage, remain there for two or three weeks, then depart as suddenly as they came.

Under the microscope the tongue presents a beautiful object for study. It has no sucking tubes such as the Blow-Fly has. It merely licks its foods as a dog and cat lick theirs, or swallows it whole, for it has no teeth to nibble at precious morsels it may discover in the larder. The mastication is done by means of a hard, horny gizzard, which the insect uses as a miniature grinding-machine.

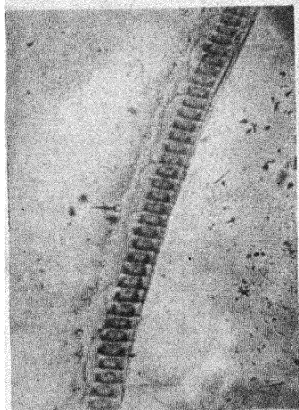
One feature of cricket-life must not be overlooked. These insects are terrible warriors ; and, if several are placed in confinement for a single night, the next morning presents a fearful story of "killed and wounded." Hence, on no account should crickets be confined, except singly. Even if

well supplied with food, they cannot agree as to each other's share ; and become threateningly quarrelsome before half an hour has passed. When in the thick of a struggle, they simply tear one another to pieces with the fury of a tiger. They do not become cannibals unless reduced by lack of food to the utmost extreme. When free to roam at their own will, they live at peace with each other ; and, save for their occasional depredations in the kitchen, and piercing music in the dead of night, Crickets are in no sense alarming.

The query has often been asked : " How does the female cricket hear the call of her swain ? " As a rule, hearing organs are connected with the head. But the cricket has no apparatus about its head corresponding to ears. And yet it is quite certain that the chirp of the male is heard by his mate even when he is entirely out of sight. On one occasion I noticed in an old farmer's cottage two male crickets emerge from a crevice near a coal fire. No females were visible and the two visitors were apparently amusing themselves on a bare hearth-flag among the crumbs spread by the farmer's own hand. These unselfish crickets set up a quick succession of chirps ; louder and louder the



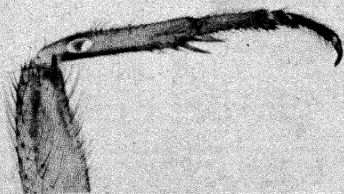
Male



Chirping file



Tongue

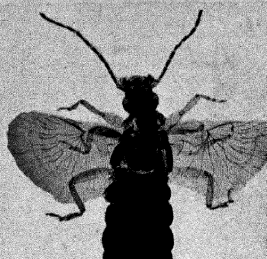


Foreleg, showing ear

PLATE IX: THE CRICKET



Male



Outspread wings



Head of male (greatly magnified)



Female

volume grew, until four females emerged from about the fireplace to participate in the meal. The males seemed satisfied, and the chirping ceased.

The sense of hearing is lodged in the shank of the fore-leg, which is pierced by an aperture, oval on one side and circular on the other. This aperture is covered at both ends by a tense disc of membrane resembling the tympanum or drum of an ear. The air-tube of the limb is expanded between these drums and is surrounded with delicate nerve centres. It is fairly obvious that the vibrations set up by the chirp are communicated to the drums, and the adjacent nerves respond accordingly.

THE EARWIG

HOW the Earwig (*Forficula auricularia*) can have fallen into such bad repute is mysterious, and unfortunate for the insect. It is held accountable for creeping into the ears of mortals while sleeping or dozing in the open air, and then piercing the brain, with tragic results. It is, indeed, curious that such a notion should have been launched ; but it is none the less true that the idea still lives. It is secretly cherished in outlying hamlets in our own country, and throughout the civilized world an opinion akin to this reigns in the minds of many people.

A moment's reflection will convince every intelligent person that, even if by chance an earwig did crawl into the folds of the ear and penetrate within the ear-tube, it would be completely barred by the strong tympanum or drum. This it could not damage in the smallest degree. So far from reaching the brain, an earwig would doubtless be trapped at the very threshold of its attack. The insect is not concerned about our ears ; and

would make no effort to trouble these valuable parts of the human economy.

It has also been unnecessarily blamed for the formidable appearance of the two appendages at its extremities. These are sharply hooked and, when meeting together, seem to pinch with a suggestion of pain which is not agreeable. Here, again, there is no cause for alarm. If the earwig pinched a little finger with all the inherent force at its command, the finger would hardly be conscious of the pinch. The forceps are certainly more formidable than vulnerable. No doubt these appliances are provided for the creature's self-defence rather than as offensive weapons ; and they never seem to be used unless the insect is seriously disturbed.

The gardener has, justifiably, a few words to say about the earwig which are far from complimentary. The insect has a passionate fondness for flowers, and for those parts—the corollæ—which constitute the real beauty of many flowers. And while the gardener sleeps peacefully in his chamber, and darkness covers the earth, the earwig makes havoc of his choicest blooms. Dahlias, peonies, and chrysanthemums especially come in for unwelcome attention, and many pretty

flowers are destroyed in a few hours. I do not forget the sharp work of a colony of earwigs on a bed of beans which had been tended with consummate care for several weeks. Above all things, there was no suspicion of earwigs. The plants grew luxuriantly ; stems and leaves were near perfection. Buds could be counted by the hundred—it was indeed a hopeful enterprise. A few more days elapsed, and the speckled floral envelopes began to unfold. “ Delightful ” was the only word applicable. The sight was unique.

Another morning dawned, and we were intently examining the flowers, as something had assuredly gone amiss. The corollæ had been nibbled dreadfully—scarcely a flower remained untouched. A strict search revealed the cause—a wholesale attack of earwigs. Many of these had fallen to the ground and decamped into the crevices of the soil, for earwigs are essentially creatures of darkness. Others remained to tell the sad story, and they were artfully concealed in the innermost cavities of the leguminous flowers. We imagined the host would return at night-fall, and so planted a goodly number of cane-sticks among the bean-stalks. On each stick was placed a small inverted flower-pot or

some similar "trap." It was enough. The ruse succeeded. Early the following morning we examined the traps, every one of which contained from two to six live earwigs. And they were most difficult to catch; some dropped to the ground immediately; others scrambled rapidly over the flower-pots onto the plants and onto our clothing. The capture was, however, a substantial one and considerably reduced the number of our invaders.

It is surprising that an insect half an inch in length, with no big weapons, can make such havoc. The damage is due to numbers.

The insect has a flat, round head, with compound eyes set flush with the forehead, and two antennæ of fifteen joints. It has no ocelli, or simple eyes. The limbs, six in number, are somewhat clumsy on a smooth surface but remarkably nimble when climbing a flower-stalk. Then the claws lay hold on the stalk and make rapid progress. The thorax partakes of the flat nature of the head, and is very small. It covers the basal portions of the elytra. These, too, are insignificant, but cover a pair of wings which, when fully expanded, would occupy a space eight times as large as that of the elytra. Such a

remarkable folding of wings has no compeer in the insect world.

The earwig flies only at night, so that observation of its flying secrets is difficult. It has, however, been established beyond doubt that both for opening and closing the wings the insect calls into service its forceps, bends them over its back, and manipulates the folds under its raised elytra. The body of the insect is large and bulky, dragging along the ground, however much the limbs may be raised to meet the difficulty. The male earwig has nine distinct segments besides the *curved* terminal clasp; while the female has only seven and a clasp of *straight* teeth.

The chief redeeming feature of the earwig is seen in its "affection" for its progeny. Eggs are deposited under stones or in minute crannies, and the mother is tenderly mindful of her charges from the first. If there be any apparent doubt as to their safety, she will move the eggs from place to place until perfect security is obtained. When the young are hatched, the mother becomes intensely excited, fearing lest some unseen foe should devour them. She will walk round about her little family, her antennæ vibrating furiously, and gather them under her limbs just as a hen

gathers her chicks before an approaching storm. At the first threat of danger she will draw the young larvæ close to her, and bravely risk even death rather than leave them to their fate.

Another pleasant feature of the earwig is its scrupulous regard for cleanliness. Like the house-fly and the domestic cat, it uses its limbs for clearing any dust from its back or wing-covers. It will also "wash" its face with becoming grace and dignity, and spends considerable time and effort in preening itself.

The larvæ are white in colour, with jaws and eyes reddish brown. They are tolerably active, and similar in form to their parents, excepting the wing-covers, which are entirely absent. The forceps in the young earwig are crude and powerless. Several moults occur before they gain much strength. Then the pupal stage is entered, wherein the nymph continues its activities as before, and displays evident markings of wing-covers which are developing. The earwig does not sleep in its pupal stage. Further moultings occur, and the fully-developed insect appears on the scene in a curious dress of white and light-brown. Weathering and sunshine bring

about its normal tint of dark brown, and the earwig begins its work of destruction on the nearest flowering-plant or fruit-tree.

The fact should not be overlooked that these insects are extremely fond of apples and pears. In the season they will bore into the fruit of the apple, and ensconce themselves snugly in a small opening during the day to escape detection. At night they will eat ravenously, but instead of keeping to the same drupe they make a raid on a large number with equally disastrous results.

THE FROG-HOPPER

WITH the dawn of summer days comes the white spotty deposits on the hedgerows known as "cuckoo spits." How these came to be associated, in any sense, with the cuckoo is lost in the oblivious past. Authorities differ as to the origin of this curious idea. The cuckoo does not spit, nor has it the least concern for these accumulations of bubbles which bespatter the blades of grass in the field and the woodland. Still, the notion has been handed down to us, and in our earliest days we were taught to regard these white specks as the discarded property of the bird which heralds the approach of sunny days.

Nor is the idea confined to the British Isles. In France the "bubble house" is attributed rather to the frog than to the cuckoo. Hence the man of Burgundy speaks of it as *Crachat de Grenouilles* (Spit of frogs); Holland, Belgium, and the Spanish Peninsula have an abundance of what the people term "frog spits." The fact is, however,

that neither the cuckoo nor the frog have any connection whatever with the bubble-spots. They are merely the deposits of the liquid food of the insect *Ptelus bifasciatus*, commonly known as the Frog-hopper.

In the late summer the female insect lays her eggs on the weeds and the grasses about the hedgerows. The eggs are exceedingly small, and may be found, as a rule, about the axils of the blades in small numbers—seldom more than three or four in one place. These minute specks remain *in situ* throughout the winter. Sometimes they fall from the grass-shoots into the ground, and are completely lost to sight. In May or June they hatch, and the young larvæ attach themselves to a growing-point on the grass-plant, where tissues are soft and juicy. Here the insect nibbles at the skin of the plant and sucks the sap from its internal vessels. The sap passes through the larval tissues, imparting life and growth to the little Frog-hopper, and is then deposited in the form of bubbles. As these condense into a watery fluid, they are replaced by others, so that the aggregate cluster remains about constant. There is no quality, in this effluent, of soapy consistency. Maybe there is a small quantity of oily matter which

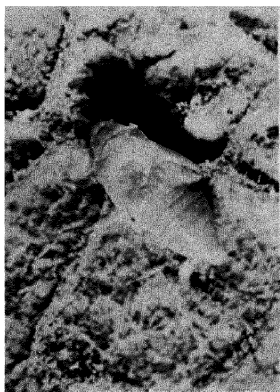
will assist the peculiar conformation. The chief purpose of the bubbles is to protect the helpless mites within from nefarious attacks by birds and insects. These latter are unable to see the larvæ within, and pass them by ; if, however, a Frog-hopper, or its larva, happens to be uncovered, it is nipped up in an instant, as the insect forms a soft, sweet morsel for the birds.

The larva of the Frog-hopper affords an interesting study. When the conglomeration of bubbles is gently cleared away, two or three specimens are discovered ; they make no attempt to hurry off. They cannot yet hop, skip, or jump. Each larva raises its snout in a defiant pose and looks upon the invader with two compound eyes, brownish in colour and very prominent. The number of individual eyelets has, probably, never been counted ; but judging from the appearance under a high-power microscopic objective it must be considerable. Certainly the larva has keen powers of vision, for when it is approached with a pencil-point it clears away intelligently before being touched.

The larval skin is, at first, a creamy white ; it then tones to a light green and remains so until the pupal stage is reached. Attached

to the thorax are the stumps of prospective wings. These are somewhat peculiar, and remind one of the appendages of a penguin. The mature insect has four wings of a highly-developed character. The larval stumps give little promise of such perfect wings. The upper stump, longer than the lower, is narrower in diameter and tapers gently to a blunt extremity. The lower stump is thick and abrupt with a sharp termination; it forms a prominent projection, while the upper serves rather the office of a covering. The body is composed of several segments that are free to move on each other within a limited range. In this larval state the insect has no delight in being uncovered, and will deposit bubbles with commendable speed to re-conceal itself.

Mature development makes material differences in the aspect of the Frog-hopper. The prominent snout of the larva that was used for sucking juices from plants develops into a wide aperture for dealing with solid forms of food. The compound eyes are more prominent, as if tacked on to each corner of the triangular head. Two ocelli—simple eyes—appear near the base of the head-line, and the thoracic cover assumes the form of a



Larval state



"Cuckoo-Spits"

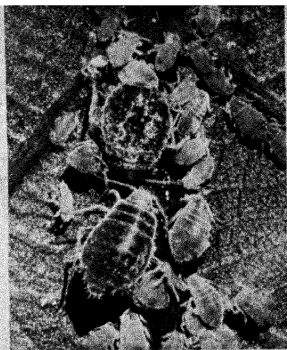


Wings developing

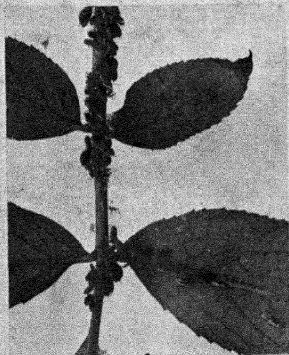


Insect

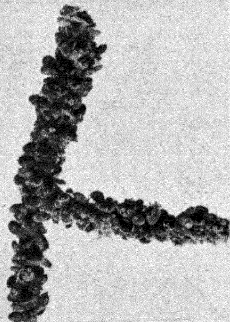
A happy family



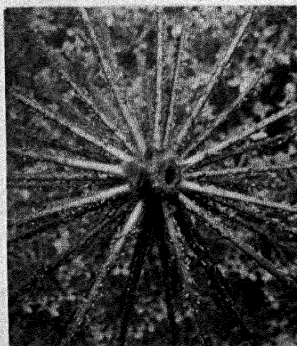
Aphides on elder



A numerous colony



Woolly Aphids



Aphides on wild angelica

shield with two eye-marks near its upper border.

Except at the points of their attachment the wings are now quite clear. The upper pair are possessed of greater strength, and are beautifully sprinkled with whitish specks, which are really minute projections like scales in appearance. On closer examination with a high-power lens they are found to form an array of tubercles issuing from the membranous covering of the wing. The upper wings strike one as being elytra, pure and simple, but the delicacy of their structure at once disposes of this idea.

The lower or inner wings are gems of detail. They are extremely thin and delicate, almost perfectly transparent, lined longitudinally with hairlike nervures, and fringed with a beautiful edging. When the Frog-hopper is at rest, these inner wings are protected by the upper pair.

The insect now becomes brownish-black, sometimes with two light-coloured bands on its thorax. Hence the specific term "*bifasciatus*." By this time it has found the power of its limbs as well as of its wings. The front pair and the second pair are used for walking and crawling at slow pace. The hind pair

forms the "hoppers"; these are longer, and are provided with sharp spines at the end of the tibia, allowing the insect a substantial buffer-effect when about to spring. The Frog-hopper's remarkable jumping powers are well known. At the mere approach of a finger-tip the insect leaps without the remotest notion of a goal. It generally falls between the leaves or grass-blades and is lost to view. This astonishing capacity for jumping is not much aided by the insect's wings; it results from the strong femoral muscles on the hind limbs.

APHIDES

THE secret history of the Aphis is coming to light ; and what was formerly a curious problem in the insect world is no longer shrouded in mystery.

No one can look upon a colony of Aphides in the summer-time, whether it be on an elder-tree or on a rose-bush, without wondering " whence came they." A single Aphis may be on the tree at 9 a.m., and a veritable swarm appear at 6 p.m., all sprung from the single Aphis. Herein, for a while, lay the mystery. Close observation has revealed the fact that the Aphides which first appear in the spring and early summer are viviparous. They are neither males nor females, but mere nurslings that are capable of reproducing their kind. They have no ovaries, and multiplication occurs by the process of gemmation or budding on the individual Aphis. In this remarkable manner each Aphis reproduces twelve to sixteen young Aphides in a single day, and then dies off, leaving nothing but a fragile tissue to record its fleeting existence. Every one

of its young is also possessed of similar powers. Each insect, immediately on its appearance, finds a succulent spot on the leaf or twig, and begins to extract the sap of the plant. It grows to maturity in a few hours and reproduces young.

It will be evident that by this viviparous method of multiplication a single *Aphis* may be the source of thousands in a few days. Thus, also, the vast hosts of *Aphides* that swarm over our gardens and orchards may be accounted for. The French naturalist Réaumur estimated that at the fifth generation an *Aphis* might become the great-grandparent of 5,904,900,000 young ones. No eggs are deposited by these early *Aphides*; the hatching would hardly keep pace with the countless hosts we discover.

Later, in the autumn, when millions of *Aphides* have died off and the family is threatened with entire extinction, true males and females appear, and eggs are deposited. Then the parents completely disappear from the stage of action, and the fertilized eggs remain dormant for the winter. In the spring they hatch and bring forth the viviparous *Aphides* which are the parents of the summer hosts. The fertility of the eggs has

been proved to extend to the ninth and eleventh generations.

The insects may have wings, or they may be wingless. As a rule, the early Aphides are all wingless, and even later the females seldom possess these adornments. The males appearing in the autumn are often winged ; but this provision is of little value, as the wings are very indifferently used. The fore-wing is much larger than the hind-wing. Both are extremely thin and fragile, but are beautifully marked with nervures.

The insect has six hair-like limbs, with which it can crawl along only very clumsily ; each limb terminates in a two-jointed tarsus and two sharp claws. The head bears two jointed antennæ generally thrown back over the insect's body. These, too, are of finest construction, and seem to be sparsely used for any purpose. With two black eyes, a flat forehead and strong mandibles, the insect forces its way to the growing-point of some young twig, and there spends the whole of its brief career.

Head and thorax are welded together, the latter supporting the insect's slender limbs. The body, or abdomen, of the Aphis is provided above with two processes exuding a

sweet fluid much sought for by members of the ant family. We may often see these projections with two crystal drops at their extremities. This fluid, known as "honey dew," falls on the leaves and branches, and is eagerly sucked up by wood-ants in particular.

The ants not only feed on the honey dew but tend the Aphides themselves with fondest care. Not satisfied with conducting the "aphis-cows" to their own larder, they will mount the plant-twigs and milk the Aphides in their own abodes with all the dexterity of a practised milker. A milking ant raises its two forelegs and gently squeezes the body of the Aphis. This pressure causes a large drop of fluid to exude from each process; the ant then absorbs the honey dew with evident zest.

Ants will decoy, by every possible allure-ment, these Aphides to their nests. Once there, they are interned with comfort to themselves and infinite benefit to the ants. Here they are fondled and caressed beyond measure; here they provide liquid food for the ants for the mere taking.

Were it not for its innate destructive-ness, we should have a greater liking for so

interesting a member of the insect world. But the onslaught of the insignificant *Aphis* is incredible. By sheer numbers it baffles all calculations. It attacks where and what it will, practically without let or hindrance. It invades the garden, the pasture, the orchard, and the conservatory. Its abode may be on the back of a single leaf at first ; in a few hours the whole plant is involved, its leaves are crumpled, curved, and stunted, to form new homes for the colonies, and natural growth becomes impossible.

Perhaps the most conclusive evidence of these disastrous effects is to be seen in the hop country, where the insect strikes terror into the hearts of the hop farmers. Neither rain nor drought affects the hop-harvest so much as the presence of the hop-aphis. The little yellow mite sometimes practically destroys the entire produce. While in some years the duty paid on produce has aggregated to £450,000 in value, it has fallen in other years to £25,000 ; and the main cause of this enormous depletion is attributed to the prevalence of Aphides. When once their hosts gain headway among the hop-plants, it is almost impossible to check their depredations.

The larvæ of Ladybirds and Lace-wing

Flies are their deadliest foes. And if the mature insects of these families can be induced to take up their abode among the infested plants, there is a smart clearance of Aphides in a brief period. The Ladybird deposits her eggs right in the midst of the Aphis colony. These hatch in a few days, and the larvæ greedily devour every Aphis within reach.

Another inveterate enemy of the Aphis is the small Aphis-Ichneumon Fly, which hovers over the Aphis colony, and eventually alights among them, depositing its eggs on the bodies of the Aphides. These scatter themselves abroad when pierced with the ovipositor of the fly. The egg develops rapidly, and so affects the body of the Aphis that it becomes inert and dies. The larval Ichneumon then forces away the terminal segments of the Aphis, and escapes.

The Woolly Aphis (*Eriosoma Aphis*) is very similar in form to the Aphis of the rose- and elder-trees, but, for self protection, it produces a tuft of cotton-wool wherein it conceals itself to perfection. It abounds in orchards in the early summer, hiding in the channels of the boles of apple-trees and pear-trees. When once it becomes established

among these trees, considerable washing or spraying is required before it can be ousted from its chosen quarters. Do not wonder again on seeing the apple-trees of an orchard profusely whitewashed. The Woolly Aphis is not wanted there.

THE HOUSE-FLY

NO insect is so familiar to us as that commonly known as "house-fly."

We have, however, not *one* house-fly but *five* which respond to the title. Three of these are smaller than the rest, and are more numerous in our homes during the warm days of summer. Their names are curious :

1. *Musca domestica* (the common variety) ;
2. *Homalomyia canicularis* (a smaller variety) ;
3. *Stomoxys calcitrans* (a stinging fly).

These are the insects which populate our windows on a hot sultry day. We occasionally have, besides, the company of two other species known as Blow-Flies or Blue-Bottles. Their names, too, are quite characteristic :

1. *Calliphora vomitoria* ;
2. *Calliphora erythrocephala*.

These are closely allied in detail, the head of the latter being, however, larger than that

of the former. Beyond these there are certainly casual visits of other "flyers" to the home-circles, but they are immigrants pure and simple, and of little consequence.

The Common House-Fly (*Musca domestica*) is not, really, the commonest variety. It is most familiar, from the fact that it is so persistent in visiting the table, and feeding on whatever sweets are there provided. It is an interesting and inconspicuous insect with two gauzy wings, a blue-black body covered with black bristles and a rimy substance mingled with the thicker hairs. This rime is seen more clearly surrounding the compound eyes that adorn the upper portions of the triangular face. The eyes are brownish-red; the space between them, on the tip of the forehead, is crowned with three bright ocelli, or single eyes.

The smaller variety (*Homalomyia*) differs little from its congener except in size and colour. It adopts a dark grey tint; its body is cone-shaped, and the wing nervures do not conform to those of the common type. The nervure nearest the tip of the wing in *Musca* bears a decidedly wavy aspect, while that of *Homalomyia* makes a fine sweeping curve. Its compound eyes are a brilliant

red, hemmed in by rings of rime as white as snow. It is, indeed, a pretty little insect, fond of the sunlit window-pane, where it may often be counted by the dozen. It is also the least troublesome of all house-flies, seldom feeding at the table, never stinging or biting its host, and generally clearing off at night-fall.

This character cannot be granted to the third species, *Stomoxys*, which is an insect more troublesome and persistent than is desirable. Yet it is much more common than is generally supposed. In a London dwelling-house during an exceptionally warm summer I had ample means of observing this fact. The kitchen swarmed with flies during the day, and their incessant buzz continued well beyond night-fall. Various means of capture were adopted, and over a hundred were brought low. Of these by far the greater portion belonged to this stinging variety.

The fly is well covered with grey rime, and when resting, the wings are spread at right angles to its body. Essentially a blood-sucker, its proboscis is quite distinct from that of *Musca*; and the insect has a marked preference for the meat-cupboard.

The Blue-Bottle is a smart specimen of a dipterous (two-winged) insect, and might be more freely admitted to our company but for its penchant for the larder. If possible, it will get there. And once there, the damage it inflicts is sometimes irreparable. Just imagine for a moment what havoc a couple of Blow-Flies would do with a fresh steak. Within one brief hour the meat for to-morrow's dinner would be scattered over with patches of "fly blows" each "blow" containing thirty to forty creamy-white eggs which would hatch within twenty-four hours. In this brief period the meat would be too lively to be appetising and sound ; in fact, it would be utterly spoilt. Hence, in the Blue-Bottle season it is advisable to place all meat, fresh or cooked, in a fly-proof cupboard.

Notwithstanding this bad feature of the Blue-Bottle, it is an insect not unworthy of respect. It is an excellent scavenger, ridding the air and many a forgotten nook and cranny of many impurities. Its blue sheen, significant "buzz," and capacity for rapid flight, are not to be despised. It is, we all know, larger than the flies before-mentioned. Its eyes are reddish-brown, well set on the face of brownish-yellow.

The details of fly structure are very similar in all the species named. By far the most important feature is the head and its appendages. A slender tube, as fine as a needle, joins the head to the thorax. So fragile, indeed, is this juncture, that the fly is in danger of decapitation from any sudden impact against a solid body. But through this tube pass all the delicate sensations of light and heat which guide the insect in its flight. The head is shaped like an inverted triangle, with the eyes at the base angles, and the mouth organs at the apex. And such eyes as those of the Blow-Fly are remarkable for their delicacy and for the number of their component parts. Each compound eye comprises about two thousand facets ; every facet is a convex lens with a nerve-line passing to a common base ; and as the facets appear in every direction it would be difficult to elude the vigilance of the Blow-Fly. It is only when he is driven to a corner of the window, against a transparent medium which he cannot understand, that his capture is complete. The facets are, as a rule, hexagonal in form ; but they present many irregularities, some appearing almost square. The eyes of *male* flies are larger than those of their

mates, and occasionally extend on the front of the face so as to meet together. All facets are tinged with a reddish-brown colour, from colouring matter lodged immediately under the transparent cornea.

At the crown of the forehead are three shining hemispheres—the ocelli, or simple eyes, of the fly. These keep watch for possible foes from above. During flight the insect must be on the alert ; and these ocelli provide the means of detecting danger before there is any likelihood of an attack. In the centre of the face are the fly's antennæ, quite puny in comparison with the " feelers " of insects generally. Blunt, three-jointed, and club-shaped, they are flanked by a beautiful black plume. The antennæ appear to bear some relation to the sense of smell. Lord Avebury discovered, in the course of many and varied experiments with flies, that the antennæ were unduly excited by the presence of strongly-scented solutions such as musk or essence of lemon. And it is beyond question that the fly is readily attracted by the scent of tainted meat.

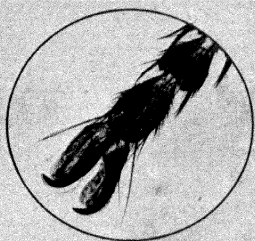
Extremely interesting is the structure of the fly's tongue or proboscis. This does not, as is often imagined, comprise one flat plate.

It is, in fact, composed of three distinct parts :

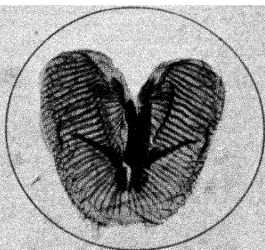
- (1) the basal holder, which is attached to the head ;
- (2) the central shaft, with a hard covering ;
- (3) the folded labellæ.

Of these, the labellæ are the most remarkable. In the living insect they are not spread flat as we generally see them depicted in illustrations. They are closed to form a spongy body acting as a sucker when applied to sugar or other foods on which the fly subsists. Each labella contains about thirty tubes lined with gristly rings. The tubes communicate with two marginal channels of larger diameter ; these again open into the mouth of the insect and are in touch with its salivary glands.

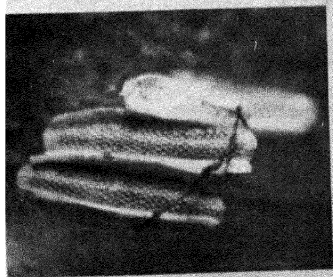
When the fly drops on a lump of sugar, a small droplet of saliva is poured on the solid piece. This liquefies a small quantity of the sugar, which is at once sucked up through the fine array of open tubes. If a fly be captured, and examined while held in the hand, it will be found to hold a minute crystal bead of saliva at the extremity of its proboscis. For dealing with material which



Claws & Pads



Tongue



Eggs



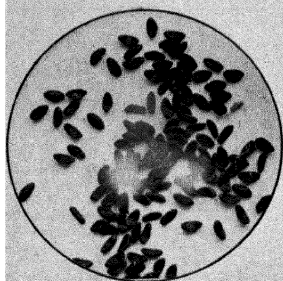
Winglet



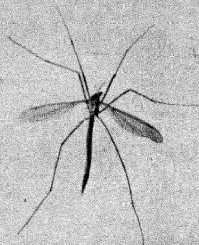
*Attacked with fungus (*Empusa muscae*)*



The Flies' cemetery



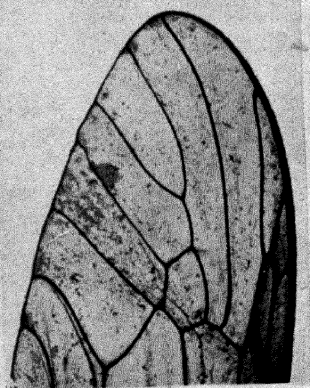
Eggs



Insect



Head



Wing

is not so easily melted the fly is provided with teeth, to the number of fifty at least, round the curved aperture of the mouth. These pulverize and thoroughly masticate delicate morsels, which do not enter the labellæ but pass directly into the mouth. The fly is thus provided with appliances for treating liquid or solid foods with perfect success.

The wings form objects of admiration when placed under the microscopic lens. The covering membrane is littered with hair-like filaments, invisible to the unaided vision ; and ramifying through it in definite channels are the tubular nervures which give strength to the wing and the power of flight. The front nervure, which strikes the air first and foremost, is the strongest of all and is bordered with a fringe of bristles. The fly is an aviator of the first order ; and, although its gauzy wings appear so fragile, they vibrate with a rapidity that is almost incredible. It is, of course, difficult to determine, with any degree of accuracy, the vibrating capacity of a fly's wings. Attempts have been made by comparison with certain musical notes ; and it has been estimated that the vibrations of the Blue-Bottle's wings amount to over three hundred per second.

“The buzzing” of the Blow-Fly has no connection with wing-motion. One held in my hand a little while ago was buzzing quite audibly without any movement of the wings. This peculiar sound comes from the spiracles, or breathing apertures. Just below the grating of the spiracle is a minute cavity enclosing sundry solid bodies. Little atoms are these ; but their rapid agitation is the source of the ominous “buzz.” As numerous spiracles are arranged in the sides of the insect’s body the combination of sound from all these will account for the volume which heralds the coming of the Blow-Fly.

At the angle of the fly’s wing are two other remarkable organs, the *alula* and the *halter*e, the former being immediately above the latter. The *alula*, or winglet, rather suggests an undeveloped wing ; but on closer inspection it is found to be quite distinct with a hard-bound contour and no nervures. Its outer scale is like a boat-rudder and is beautifully fringed. The inner scale is almost circular and abuts on the insect’s body. The *halter*e is shaped like a child’s battledore, and is evidently a strong nerve-centre. If this *halter*e, or “balancer,” be disturbed or mutilated the steering power of the fly is

practically destroyed. Its flight is irregular, and the insect immediately seeks rest on the ground. At the base of the haltere are certain minute papillæ, which are believed to convey some sense of hearing.

How the fly walks on a glass window or under a ceiling has puzzled many a young observer. But the operation is quite simple when the fly's wonderful appliances are known. The feet, or tarsi, have five joints, the terminal one with hooked claws and two soft pads with a black spine between. The pads are really fleshy sacs each covered with about twelve hundred hollow hairy filaments with open orifices. Within the five tarsi is a gland secreting a clear viscid fluid; the gland passes into each pad and forces the fluid through the hairy filaments. The orifices of these are, therefore, continually supplied with the fly's sticky fluid, and as there are 12 pads and over 12,000 sticking-points, the fly is amply equipped for holding on to any surface.

When a fly is attacked with the fungus *Empusa Muscæ* its progress is considerably hampered. The tendrils of the fungus delve into the body of the fly. It halts and rests too long; the viscid fluid in the pads becomes

hardened, and the insect is actually fixed to its own support for the rest of its life.

The fly's foot-prints may often be traced on the window-pane on a sunny day.

THE CRANE-FLY

THE Crane-Fly, known to everyone by its more common term "Daddy-Long-Legs," though one of our largest insects, is in itself perfectly harmless. It wheels its flight through the air without either "droning" or "buzzing." In fact, we should not be cognisant of its presence but for its curious darts to and fro with an occasional flap of its wings near our foreheads. It visits our houses, not from potent reasons of hunger or distress, but for warmth and shelter. It cannot endure cold or rain; at the approach of a shower Crane-Flies are exceptionally busy and obviously agitated. They make off, with all speed, to some sequestered cranny in the ground or under an old tree-trunk, to await the passing of the storm. Who shall say that the Crane-Fly is lacking in intelligence? It has many features of interest, and would, no doubt, be regarded with a degree of respect but for the terrible destructiveness of its larvæ.

This fly bears no stinging mechanism, and

cannot boast the biting mandibles of such a relative as the Wasp. Two innocent lancets are provided for its convenience in cutting up small items of vegetable matter. But, personally, we have nothing to fear from these. The fly would never attempt to force them upon us ; rather will it keep at a safe distance, abide in the window-corner to bask in the sun's rays, and nip up an occasional " midge."

It is blessed with remarkable powers of vision. A smooth black head is ennobled with two prominent hemispheres of eyelets, aggregating over two thousand, which look out upon the landscape in all directions, seeing friend and foe, which latter the insect knows well how to avoid.

The antennæ are delicate and beautiful. In a full-sized insect the joints number twelve to fourteen, each digit holding to its forerunner by a ball-and-socket arrangement. The base of each digit is provided with a ray of fine bristles. Two other processes branch forth from the mouth organs ; and it is quite possible that these may act the part of secondary " feelers " to assist the fly in determining suitable places for laying its eggs. Two strong, hard jaws are in use when the fly is at rest.

Nibbling at "straws," or whatever tasty morsel comes in its track, the insect has an appetite of no mean proportions, although in this respect it is entirely "out of court" in comparison with its own larvæ. These are simply ravenous.

To the thorax, or chest, is attached the fly's six limbs, thin, thread-like appendages as flimsy as blown glass and dislocated at a mere touch of the finger. But for these "long legs" it is clear that the fly would be able to cut through the air with greater velocity, and stand a better chance of escaping when pursued by an enemy. But Nature has bestowed these limbs for other purposes. If a Crane-Fly is caught by its limbs, it simply dislocates them and disappears as merrily as if nothing very serious had occurred. The method of doing this is revealed by the microscopic lens. It is there we discover the limbs to be merely hooked together; there are no tendons or binding ligaments such as we possess about our elbows or shoulders. Hence, if the insect finds itself held by its extremities, it suddenly hooks off its captured digits and speeds away. It is not at all likely that the same individual "grows" fresh limbs; this matters very

little. When the fly has reached this stage of maturity, it has but a brief span to live, and its broken limbs will be found ample for the process of egg-laying. After any considerable amount of mutilation it is pretty certain that the fly betakes itself to the nearest possible roost. In several instances I have noted this. One fly, in particular, was caught by two feet between a finger and thumb. It immediately detached itself and made for the nearest window-sill, there laid its eggs, and dug into an adjacent crevice in the wall. Although careful watch was kept on this crevice the fly did not appear again.

The wings resemble those of other dipterous insects except that they are provided with extra strong nervures, all combining to make a very firm juncture to the thorax. The front, or costal, edge of the wing is ribbed with a double nervure and protected by a heavy line of bristles. The "hop-skip-and-jump" method of flight adopted by the Crane-Fly is doubtless largely due to the interference of its legs, as the wings are remarkably well developed for long or sustained flights. At the junction of the wings the halteres are very prominent. In fact, the Crane-Fly exhibits these to advantage more than any other

dipterous insect. When the fly is on the wing these halteres, or "balancers," are in rapid motion, and possibly serve some sensory purpose such as was indicated in the case of the House-Fly. Unlike that insect, however, the alulæ of the *Tipula* are almost extinct. A mere speck at the inset of the haltere is the only indication of them.

The body of the Crane-Fly is soft and pulpy. The softest touch flattens it and destroys the insect. In the *male* insect the body ends in a blunt stump; in the *female* it terminates in a fine needle-like point, and includes the ovipositor from which the eggs—from two hundred to three hundred—are laid. The manner of this procedure is peculiar. The fly generally hastens to the fields, the meadows, or the marshes, and plants its hind feet deep into the grass. Then, setting its fore limbs right up in the air, it is able to preserve its body erect while the eggs, one by one, in quick succession, twelve in one place and twenty or more in another, are safely deposited. With an insect in captivity I have noticed the ovipositing occur at different hours of the day, and on different days. When the process is finished the insect seems to have nothing more to live for. It hovers about

aimlessly and retires—for ever. Curling up its long legs as if to shield itself at the fatal moment, it seeks some darkened corner and “sleeps.”

Brown, shiny, and ovate are these eggs of the Crane-Fly. In the dark snug nest they hatch in fourteen days, when a host of larvæ, known as Leather-Jackets from their hard tough teguments, are found simply swarming just under the surface of the soil. Such an army of voracious creatures it is hardly possible to conceive. They emerge during August and September and live throughout the winter, spring, and summer, gnawing away all the while at grass, herbs, and roots without intermission. Vast areas have thus been destroyed, root, stem, and blade, by these invisible Leather-Jackets tearing away incessantly during half the agricultural year. Frost does not kill them; it only sends them deeper into the soil to feed on good roots. In July or August they pupate, being fed up to the length of an inch or over, and then resemble a miniature black mummy of three segments covered with bristles. The pupa is, of course, quite alive, and shows its vitality by using these bristles to wriggle itself lower and lower into the earth to a place

of safety. On the covering the lines of the future wings and limbs of the insect are clearly marked. In sixteen days the pupal case splits near the head, and the perfect Crane-Fly emerges, to begin its first flight.

As the larvæ of this insect are so destructive, farmers and landowners are well advised in allowing free access to their fields and meadows, especially during the closing days of summer, to curlews, rooks, crows, starlings, peewits, and other insect-eating birds. These will, in a few weeks, capture and destroy more Leather-Jackets than a farmer's plough could account for in a whole season.

THE GNAT

AT Matlock Bath, the popular Derbyshire village in the vale of the Derwent, the day had been "wet and fine," but mainly wet. But between 7 and 8 p.m., when quietly roaming through the vale, a strange phenomenon appeared before us in the near distance. Dark, moving clouds arose about twenty feet above the ground. They were not rain-clouds. Neither was the curious appearance due to fog, to mist, or to dew. One cloud seemed to swoop down within a few yards of the ground. Now the secret was out. These clouds were huge swarms of Gnats, commonly termed Midges. Of course, there are Midges so-called which are not gnats at all and do not belong to the *Culex* family. These we shall refer to presently. Seldom, even on a sultry summer day, do the Gnats make such a brave show as that seen at Matlock Bath. Literally there must have been many thousands of them. And for two hours, at least, there appeared cloud after cloud in the calm atmosphere of that eventide.

Gnats have a preference for valleys, low-lying lands, and marshy tracts ; but have no desire for water except at nesting-time. They seldom fly to any great altitude—twenty to thirty feet being their highest ascent.

The Common Gnat (*Culex pipiens*) is a very interesting little insect. Unfortunately, its details are so minute as to be hidden from our unaided vision ; but under the microscope we discover a little wonder. The male Gnat is beautiful with his plumed antennæ and scaled wings. He is a most innocent creature ; he has no sting, and is incapable of inflicting injury. What he likes immensely is to dance in the twilight, or under the cool shadow of a large tree, and exhibit his plumes to the fair demoiselles of his family. The female Gnat is not so good-tempered. She has a piercing sting, which most people discover at one time or another during their summer rambles. This sting operates with a sucking tube, and is used entirely to draw blood from the insect's victim. Tube and lancet are both inserted into the wound, while the insect plants itself immediately over it with outstretched limbs. The sting, suctorial tube, and sharp mandibles form a veritable

armoury of weapons, which are used without mercy as occasion offers.

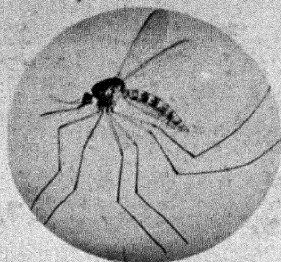
Although at ordinary periods the pond and stream afford no great attraction for the female Gnat, she seeks the water of some stagnant pool for nesting. Hovering around for a few minutes, she finds a strong blade of grass, a chip of bark, a small stick, a piece of paper, or any light floating material, and settles upon it. Taking a survey of the new situation, she cautiously walks to the edge of the chip, clinging firmly to it with her two fore-legs. If she relaxes her hold, the result may be disastrous : her wings will touch the water, and she may be unable to rise. The middle pair of limbs rests on the water ; the hind pair dips in, and is crossed as if forming the letter X. An egg is deposited in the upper angle of the X and held there until a second egg is dropped and cemented to it. Then another egg is placed against the first and second ; and so the tiny grey atoms are laid side by side with their pointed tips inclined towards each other. By this unique method an egg-boat is made, concave at the top and convex underneath. From three to four hundred eggs are fixed together with adhesive material to form this curious boat. From its

shape it cannot possibly topple over ; neither can it sink. It if were lifted out of the water and dropped from a considerable height, the boat would float the right way up. These egg-boats may often be seen on ponds, pools, or water-butts during the early summer months.

When the eggs have been sailing to and fro with the wind for about ten days, the lids at the base become detached and the larvæ drop into the water. By this time the mother Gnat has come to the close of her career. When the egg-boat set out on its first day's voyage, she bade adieu to the world ; she toppled into the water or flew to the bank, and there went to her last sleep. But the little divers are full of life. Hundreds of them are shooting about, darting to and fro, making merry in their watery home. They are ravenously hungry, and devour all the minute Water-Fleas that come in their way. Each larva is provided with a circular fringe, about its mouth, of grasping tentacles ever and anon wheeling victims into the tiny aperture. The larva feeds on solid food ; but the perfect insect will claim nothing less than the life-blood of its unwilling host.

Another feature of this larva is that it must

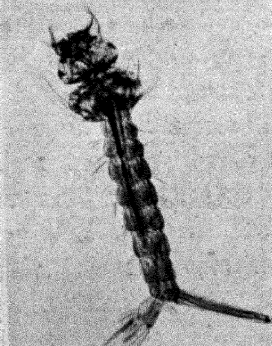
come to the surface to breathe—not with its mouth, but by means of a tube near its tail. Close to this breathing-tube is a delicate fan-like structure, which serves as an excellent rudder to steer the larva in any direction. When, on the approach of danger, the breathing aperture is closed, the larva sinks in the water by its own weight. The *pupal* skin removes the breathing-holes from the tail to the head, and closes the mouth entirely. So that, although the pupa comes occasionally to the surface to breathe, it can eat nothing : and yet it squirms and dives about in the water as if it were a perfect insect. When the pupal stage is drawing to a close, the little mite rises to the surface and swims on its back for an hour or so in the warm sunshine. There is a gentle rift in the covering, and a real Gnat's tail is forced through. For the next few minutes a sharp struggle ensues ; the new insect tries to wriggle out of its entanglements ; but it is weak, and the clothing is tight. Another pull, then another, and the bulky body is set free ; a new head appears, and new eyes look upon a new world. The wings lie still, limp and powerless ; the young gnat cannot use them yet. Just a little more sunshine, and they will stretch



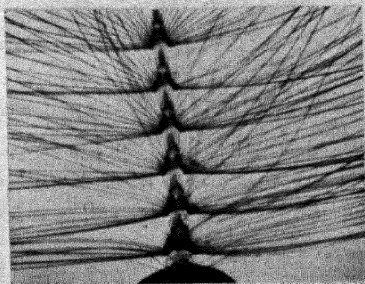
Insect



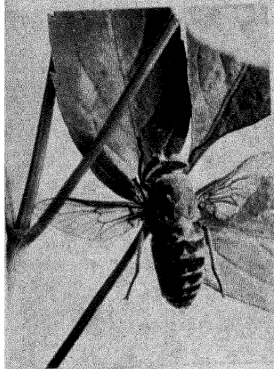
Pupa



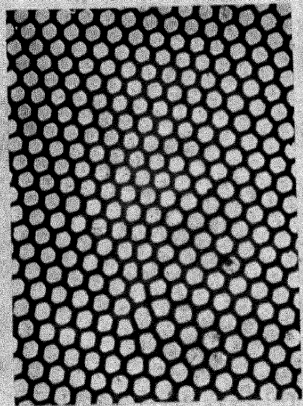
Larva



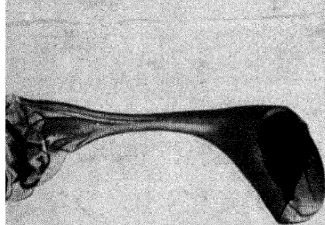
Central portion of antenna (greatly magnified)



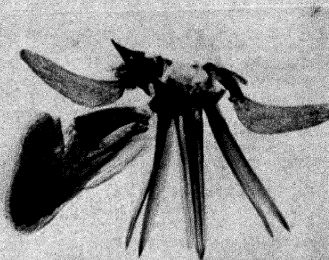
Insect



Eyes (greatly magnified)



Balancer



Mouth-organs

and become strong. Then off she goes on her first flight. Nothing remains behind but her useless pupal relics. She, with a host of others, has gone to swell the swarm which gather round us in the garden and on the lawn.

The Midge has a wonderful array of eyes. They seem to be fixed on every available part of the insect's head ; not merely at the upper extremities, as is the rule with insects. Moreover, the eyes of the Midge are not six-sided, and do not fit into each other like a honeycomb. Each eye is almost circular, and is distinct from every other. A fine piece of mosaic work fills the space between the eyes, each of which has the front cornea projecting from its setting, as if producing its own separate image. Doubtless, the Midge has acute powers of vision ; and it is not surprising that it is so smart in evading its pursuers.

THE GAD-FLY

A SMALL group of insects that deserve careful study are the Gad-Flies, sometimes called the Warble-Flies or Bot-Flies. These members of the great family of diptera (two-winged flies) are very imperfectly understood ; and every year adds to our knowledge of their characteristics.

Warble-Flies are terrible pests ; and for that reason they call for the earnest attention of all animal-lovers, if only to encompass the extinction of the flies at the earliest possible moment. It has been computed on good authority that in certain years damage has been done to cattle, horses, and sheep by these flies and their larvæ to the extent of £700,000—a prodigious amount when we consider the insignificance of each member of the genus.

The Horse Warble-Fly (*Gasterophilus equi*) is an insect well known to farmers, hunters, and team-owners. It is not a formidable-looking creature ; and in itself does very little damage. Its mouth organs are crude and rudimentary : it does not bite, nibble, or

sting ; in fact, it eats very sparingly from the time it issues from the pupal shell. In dimensions it rarely exceeds half-an-inch in length, the wings are glassy, brownish-black, and when closed extend beyond the extremity of the abdomen. The eyes are compound, strong and prominent. The body is covered with black, brown, and white hairs ; the limbs terminate in hooked claws which can hold tenaciously to the host on which the insect lives.

It is during the hottest days of summer, between the hours of 11 a.m. and 3 p.m., that this fly is most persistent in its attacks on the horse. It will not fly much in cloudy weather ; during rain it is completely hidden away in the darkest crevices of the barn or stable. It is essentially a sunshine insect. Even then it does not attack the horse with hard, vulnerable weapons. The simple, instinctive purpose of the fly is to deposit its eggs—not many—on the hairs of the horse about the shank, shoulder, or between the knee and the hoof. The fly is very ingenious in selecting a locality well suited to its purpose. And the eggs are laid one behind the other, each being provided with a clasping process that holds the egg firm to its support until the

animal, from a temporary feeling of discomfort, turns its tongue in that direction and sweeps off the cluster of eggs. It has been urged that, when depositing the eggs, the fly also injects some poisonous irritant in the root of the hair ; but evidence of this is not conclusive. Horses may often be seen " cleaning " their shin-bones ; and during this innocent process of cleansing, the eggs of the Bot-Fly are transferred to the underside of the horse's tongue, where warmth and moisture soon promote the hatching. The spiny-covered larvæ do not stay there : after the first moult they are smooth greyish-white Bots capable of crawling freely, and they find their way into the channel of the horse's food. Another moult occurs, and the Bots, each provided with two strong hooklets to its mouth, fix themselves to the animal's digestive apparatus and absorb the fluids which should nourish and strengthen the host. These larvæ are most injurious to the animal when they pierce its tissues, as they frequently do, and thread their sinuous way to the region of the spine. There they produce swollen spots which make the horse sore and irritable. The larvæ pierce the skin with their tails outward ; at these extremities are two spiracles

which are constantly inhaling fresh air. When about an inch in length the larva emerges bodily and drops to the ground. Just beneath the grass it passes to the pupal stage, using the hard larval skin as a protecting shell. A few weeks longer and the pupal case bursts open, and the fully developed Warble-Fly rushes forth to commence its life's errand.

Mature Gad-Flies are very similar in structure, although they select different animals for their hosts. But the larvæ of the various species are vastly different in their habits and methods of attack. The Gad-Fly of the cow (*Aestrus bovis*) deposits its eggs directly in the skin of the host ; as a rule, within an inch of the spinal column. It selects two to six spots for incisions ; and in each lays three or four eggs. When these hatch, the larva has its tail with two spiracles projecting from the nest, which may easily be detected by the swelling or "warble." This is very irritating to the cow, and, if not removed, the continual drain of the growing larvæ saps the very stamina of the animal.

Warbles vary in size from half-an-inch to two inches in breadth. There is no possibility of mistaking them even on a cursory examina-

tion. With animals kept in poor pastures they are most pronounced ; and are often the chief cause of prolonged weakness and ultimate death. Few cows, heifers, or calves can bear the attacks of these larvæ with equanimity. The Warbles continue active throughout the autumn, winter, and spring, unless forcibly removed and destroyed. For nine or ten months the cows are subjected to this enervating disturbance. When summer dawns, the larvæ creep from the nest and fall to the ground, where pupation ensues. The pupa is wrapped in the dried skin of the larva until, in a few weeks, it splits the containing shell and takes to the wing.

Cattle in the field make no secret of the approach of the Gad-Fly. The very moment its ominous " buzz " reaches the ears of the herd nervousness is displayed by every beast. The cows rear their tails in the air, mount their horns and ears aloft, and stampede over the turf as if for very life itself. And we wonder what all the commotion is about, and what is the cause of it. But the frightened cattle see and hear more. These winged terrors mean, to them, days, weeks, and months of suffering. The bark and the snap of the strange terrier are as nothing compared

with the attacks of these small insects. I have seen cattle rise suddenly from the ground while ruminating, run helter-skelter to the nearest pond, and stand together as near the centre as possible, for the purpose of avoiding a few Gad-Flies. These insects detest water, and stop at the bank.

Sheep, too, have Gad-Flies (*Cephalemyia ovis*), which torment their host in a peculiar manner. The female fly selects a hot, sunny day for operations, and leaves her place of concealment for the nearest flock. Her methods of attack are sly and deceptive, as sheep are quick to detect danger before it actually arrives. But the foxy little insect, after a preliminary buzz in the air, approaches her prey in abject silence, often creeping stealthily along the ground and hiding in the grass. The hapless sheep sees nothing, hears nothing, until the fly leaps into her nostrils and sticks there until about six eggs are deposited. The animal shakes her head, points her nose aloft for relief, scampers over the field—all to no purpose. The enemy will not relax its hold until the eggs are well secured. Then it flies away to some other victim. The eggs hatch in the passages of the nose; and the larvæ, instead of falling to the ground, force

their way upward into the frontal cavities of the sheep's head, inflicting great irritation and suffering. The larva is covered with short spines ; it is about half-an-inch in length, and bears two sharp hooks near its mouth for the purpose of clinging to the sides of the cavity while absorbing food.

When fully grown, the larvæ retrace their way by the breathing-passages and are expelled when the animal sneezes. Just below the ground they pupate for a week or two before the final stage of development. From the hatching of the egg to the evolution of the perfect fly occupies from nine to ten months.

THE SHEEP-TICK

IT certainly seems curious to speak of the Sheep-Tick (*Melophagus ovinus*) as a first cousin of the House-Fly. Yet, after mature consideration, entomologists have settled the vital point—the Sheep-Tick is a dipterous insect, *i.e.*, it has, or should have, two wings. It is placed in the same category as the *Hippoboscidae* or Horse-Flies. These do possess two wings, which are always in evidence. Whether the Horse-Fly be at rest or on the wing, these appendages are easily recognized. But the Sheep-Tick must be observed very closely, even with a microscope, to detect the slightest trace of either wing, winglet, or balancer. No marked examples can be found. Infinitesimal tufts are all that can be observed.

Still the Sheep-Tick, or “Ked” as it is termed, is an interesting object, more especially as it enters so largely into the acquaintance of the average sheep-farmer and stock-keeper. It is also parasitic on the dog, but its specially-chosen host is the sheep. Here

it lives and thrives among the fibres of the fleece, where it may be numbered by the hundred. It is, indeed, surprising to what extent these insects do intrude themselves on the flocks that graze innocently in our fields and meadows.

Happily, the parasitic Tick appears to do little damage to its host, except in the case of lambs or young sheep. On these the Tick is tantalizing, and irritating to the skin. It lowers the animal's vitality and nerve, and makes it prone to ailments of a more serious nature. It is a suctorial parasite, having a piercing tube, which is ejected from the mouth between two flat plates. The plates are lodged against the skin of the sheep, and the dart is thrust into the flesh, whence a droplet of blood is drawn.

The head of the Tick is peculiar. The antennæ are short and enclosed in two cup-lets, one on either side of the head. The eyes are small and arranged in two clusters of ocelli. The mouth organs are so located that they may be concealed on the under-side. A fragile link connects the head with the prothorax, and so slender is this link that, when detaching the insect from its hold, we sometimes discover that it is headless. The head

has been left at the insertion of the woolly fibre.

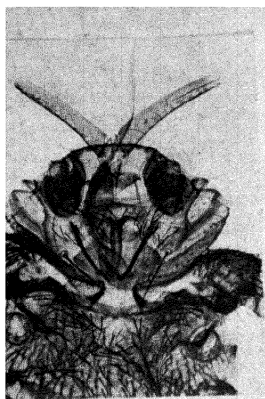
On each section of the thorax two limbs are attached, the first joint being thickened and flattened. The double claws are extremely powerful, and show how amply the insect is provided with climbing appliances. The abdomen is flat and pear-shaped. Like the rest of the insect, it is covered with short black filaments. The Sheep-Tick is, indeed, an agile creature, and is smart in evading its pursuers. Like the elusive crab on the sands of the sea-shore, the Tick can race backwards, forwards, or sideways, and hide itself deftly in the sheep's fibres. On the living animal it is difficult to catch, notwithstanding its frequency. When the sheep are treated to their annual "dip," and arseniuretted chemicals are added to the wash, the Ticks hasten from their fastnesses and are seen floating on the water in helpless confusion. Arsenic, in any form, is the fatal bane of the Tick.

Similarly, when a fleece is stripped from the carcase of a sheep, the Ticks, instinctively finding that the source of their food-supply is gone, emerge from the dark recesses and crawl over the surface of the fleece as if looking for a new home. If, perforce, they fall on

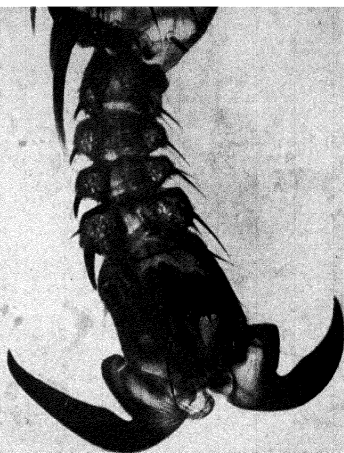
the floor of the tannery they hobble along awkwardly and may be picked up at will. Their angular claws are not made for smooth floors. Like the sloth of the South American forests, they cling to some support, seldom relaxing hold from birth to death.

On account of its smartness in evading capture the Tick is known in France by the name of "Spider-Fly"; and to the lithe spider it certainly owes some of its peculiar features. The horny nature of its integument and the manner in which the hairy covering lies flat gives the insect every facility for rapid movements among the fibres of the fleece.

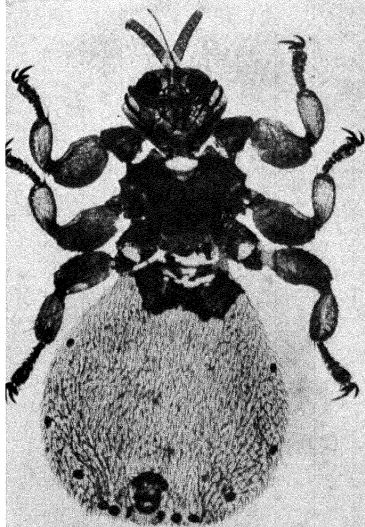
The female is larger than the male, and is more blood-thirsty in its ravages. Its body sometimes approaches the size of a pea. In tropical countries the growth is abnormal. Ticks are frequently discovered with bodies as large as gooseberries. The male Tick dies off early. The female deposits eggs at irregular intervals, one or two at a time, never in clusters. The egg-shell becomes hard before hatching, and in a few days evolves a creamy-white larva with a deformed head. Moultings bring the larva to a higher state of perfection; and after pupation, which is brief, a true dipteron is produced to continue the marauding propensities of its parents.



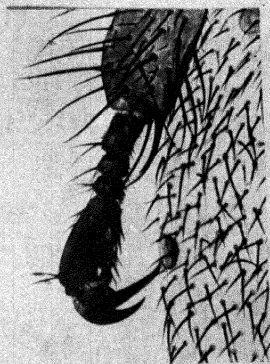
Head



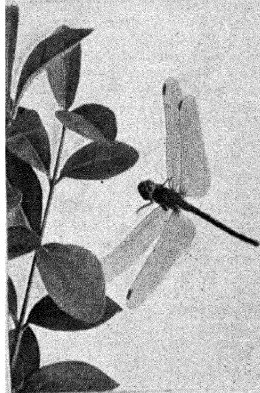
Foot (enlargedly magnified)



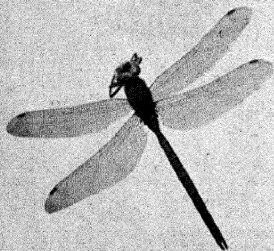
Insect



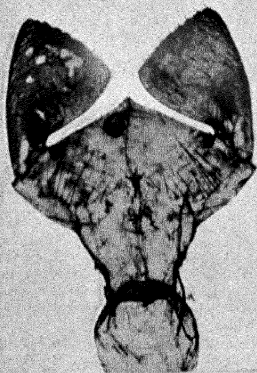
Foot end spiracle



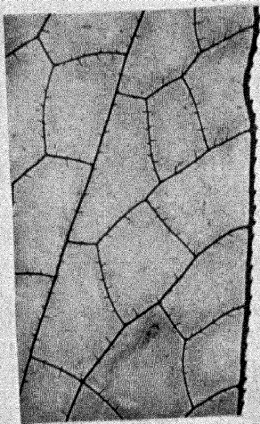
Cordulegaster annulatus



Aeschna cyanea



Mask of larva



Wing (greatly magnified)

THE DRAGON-FLY

THE commonest type of Dragon-Fly in Britain is the *Cordulegaster annulatus* a magnificent insect of ample proportions. This is the fly which is said to sting horses, cattle, and even sheep ; and is widely known in the North of England as the " Stingabout " or the " Horse-Stinger." As a matter of fact, it does *not* sting at all. It does not possess such an appliance as a sting ; hence, the antiquated notion of cattle-stinging may be completely disregarded. I have seen children run, as if for their lives, at the sight of a beautiful Dragon-Fly, for the simple reason that they have been taught to believe in its stinging propensities.

In the glowing charm of a summer sun there is nothing more healthfully exciting than the presence of a full-grown Dragon-Fly wheeling through the air at tremendous speed, eluding all the studied efforts of its pursuers, and soaring away beyond the reach of butterfly nets. We have not the remotest reason for

assigning to this insect a specious character. Rather should it be accorded a warm welcome, for it rids the air around ourselves of a host of pestering little insects that bite and annoy even though they do not inflict serious damage. Furthermore, the Dragon-Fly has no particular desire to disturb us ; it does not spoil our clothing, or visit the table, or invade the larder. If it be found flitting about our ears at all, it is sure to be on a bright warm day when the Gnats and other small fry are making themselves too evident.

Although the Dragon-Fly is a denizen of the air, it is born under water. Eggs, white or creamy, are deposited one by one while the insect is flying dreamily over the surface of some pond or stagnant pool. These sink to the bottom, and lodge for a brief period in the mud. Ten to fourteen days elapse, and the hungry larva emerges to begin its hunting activities. Few creatures of the pool are more ravenous than this larva. Its two glaring eyes are well set on the upper rim of its round head, and it is ever ready for an attack upon passing prey. The mouth organs are peculiar, but remarkably well adapted to their natural purpose. The lips completely hide what appears to be a mask, an insignificant

covering for its jaws. This "mask," however, can be unsheathed in an instant and thrust forth like a dart ; it can then be seen to be constructed of two powerful claws with which the larva seizes its unwary victim.

Although the young Dragon Fly has six limbs, it can do nothing much with them on the slimy base of the pool. It neither walks nor swims well. But for quick darts through the water it has few rivals. And these frequent "shoots" were, for a while, somewhat mysterious to observers. The insect has no springing muscles like the flea : its stumpy wings are mere fragments and of little use for swimming. How then does the insect shoot through the water ? Curiously enough, it is able to draw water so as to inflate the rear portion of its body, rendering this more than double its normal size. When preparing to shoot, this extra dose of water is rapidly forced out by powerful muscles, thus causing the insect to spring forward. More than this. Round about this water-vessel are the breathing tubes of the larva. No spiracles appear on the outer surface of its body. It "breathes" from within. The oxygen of the inflating water passes into the breathing tubes and gives the larva new life and energy. It watches

keenly for prey, hides all but its eyes in the mud and fills its rear vessel with water. Here comes a water-flea !—the larva shoots forth, and secures a meal. The mask is unsheathed and the minute flea is held in the grip of its talons. There is no possible escape for the victim ; it is drawn in by the claws to the insect's mandibles and devoured immediately.

Thus does this voracious larva feed and grow, revelling in its watery home amid hosts of lesser insects, until it is fed up and sinks as if lifeless. If we could peep into the shallow pool, nothing would appear to indicate where these atoms of life had fallen. They are there, however, moving with an occasional wriggle when disturbed.

When pupation is complete the insect wakes to a new life, and crawls to the nearest pond-weed. Its career in the water is drawing to a close. Slowly it drags itself by slender limbs up the weed-stalk to gain the open air ; and for the first time looks out on the world of green. But not for long. The creature is evidently ill at ease. The water evaporates from its tender skin ; its wings and limbs become dry. The skin is loosened and split at the back ; and out comes, very gradually, a new head, thorax, wings, and

body of a real Dragon-Fly. It is not full-grown yet. By no means. The limbs are frail and feeble ; the wings are inert and useless ; the eyes glare and glisten in the sunshine ; but the new creature is as yet only a poor weakling.

A few hours longer, with more strengthening rays of the sun, and the pale-looking fly gains colour and energy. Its wings extend ; its limbs grasp the weed-stalk ; its head and eyes beam with delight. One spring, and the real Dragon-Fly is away on its first flight.

The head of a fully-developed fly is a striking example of insect structure. The mandibles and biting apparatus generally are very strong. No wonder the fly will dare to attack in mid-air insects larger than itself. A large Cabbage-Butterfly darts across the path of a Dragon Fly in a garden near by. In a moment the fly rushes at its prey ; and as the latter is much the larger, for a minute or so there is a battle royal between the aviators. It seems as though success would come to the butterfly. It fights valiantly, being at the prime of its career ; but the fly seizes an upper wing at the base, lops it off clean and drops it on the garden-bed. The victory is now won ; the butterfly is quite

unable to regain its poise, and in less than two minutes the fly is wheeling round with the last remnant of its victim's thorax in its mouth.

The eyes of the Dragon-Fly are unique for depth of vision. The insect can discern its prey afar off, and darts for it in a direct line. Each compound eye is estimated to bear 10,000 facets, each having the usual hexagonal shape ; between the eyes are the three ocelli of simple spherical form with two short antennæ to " point the way."

In so powerful an insect it is curious to note how slimly the parts appear to be connected. The head is attached to the thorax by a mere thread ; the abdomen, in ten segments, is detached from the thorax with the slightest impact. The wings and limbs are much less liable to injury, being firmly riveted to the thorax and capable of great endurance. The Dragon-Fly is an occasional victim of the net ; and in the process of capture the insect sometimes loses its rear segments. This serious turn of events, although it may not appear to affect the activities of the insect for a time, must mean irreparable injury, the insect being devoid of any digestive apparatus. A merciful despatch should be

administered at the earliest moment after such an accident.

The wings of the Dragon-Fly amply account for its wonderful powers of flight. Each wing is broad, strong and well supplied with nervures, which add power and grace to the insect's movements in the air. Nervures extend in radial lines from the base of the wing to the edge ; and these are matted throughout with cross-nervures forming squares, oblongs, and triangles in every direction. A solid brown spot is added near the tip of the wing to give additional binding force to the whole mechanism, so that the insect is equipped for flights in any direction at the slightest impulse. It is a real master of the air.

THE LACE-WING

LIKE the Dragon-Fly the Lace-Wing (*Chrysopa vulgaris*) is the happy possessor of well-nervured wings. Hence its name. And certainly no member of the insect world has a better claim to delicacy and beauty than this insect. It lives in our homes and gardens during the warm days of July and August, emerging from its hiding-place just as the sun is sinking behind the western sky-line. It does not sport its gay clothing in the light of mid-day. Then it is sleeping, or crawling under the boughs, to seek a place of safety for depositing its eggs. At eventide it is sure to visit the kitchen and thus find its way to the window-sill, where its progress is blocked for a time.

The Lace-Wing preserves, during life, a lustrous green colour, with a greenish sheen on its wings, and eyes like burnished gold. When its career is closed, all these pretty colours vanish, so that it is impossible to preserve the Lace-Wing in its pristine beauty. Soon after the eggs are deposited, the female

fly retires to her secret refuge and is seen no more.

The eggs themselves are oval in shape, and do *not* conform to the usual plan of resting on the surface of a leaf. When an egg is deposited, the fly holds firmly to the under-side of a leaf and deposits the egg in space, attaching to it a thread of viscid material, which holds it about half-an-inch from the leaf-surface. When a sufficient length of thread has been exuded, the end is tacked on to the leaf and the fly repeats the process. In this curious way the mother-fly projects ten to fifteen eggs into space, where they will be safe from all intruders and be comfortably near the food-plant. It does happen occasionally that threads are grouped together, six or more ; but each thread bears its own precious burthen. At first, the eggs are greenish in colour ; but later they become creamy with two brown spots at their lower extremities ; these spots really indicate the eyes of the larva showing through the shell.

Lace-Wing larvæ are born hungry. The moment they leave the egg they begin to devour the shell. This is the first meal ; and it is soon dispatched. Then the tiny voluptuary turns to the next egg ; if within reach, it

pierces the shell forthwith, and takes to cannibalism as to a sweet morsel. This voracious tenderling stops not at its own kin, and kills all young ones not well hatched. With such a feast there seems to be no necessity for hurrying away to other pastures, and the grey mite remains master of the ruined shells until the pangs of hunger force it to launch away.

It is already in touch with the leaves of the rose-bush. A slight spurt and a short journey along the branches brings the grub to the growing point of a new twig. Ah! there is a crowded colony of green flies, the aphides for which the Lace-Wing larva is longing. In this region of plenty the young Lace-Wing becomes gluttonous. The feast is abundant; the work of destruction begins in earnest, and does not cease until the skin of every aphid is closely packed on the back of the invader. The mouth organs of the larva are peculiarly fitted for dealing with a host of aphides. The mandibles are carried inward; and instead of being solid, as in many insects, they are tubular. The larva plants these in both sides of the body of the aphid, and sucks from it every drop of juice it contains. The dry skins of aphides may often

be seen on the twigs of rose-bushes and hop-trails. If these are pierced, they show the remains of a Lace-Wing larva which has left them, after appropriating as many as possible to its own back, to evade capture by the birds. This curious way of cheating the birds out of their prey is not confined to the Lace-Wing larva ; but this sly grub certainly accomplishes the task in expert fashion, so much so that we should never imagine a living creature to be concealed under the mass of aphid skins.

When fed up, being literally satiated with the "milk" of plant-lice, the Lace-Wing larva sinks into well-earned repose. It has acted well the part of farmers' and gardeners' friend, and curls itself under a solitary leaf near the scenes of its exploits. The aphides have fallen at the rate of over 100 per hour to the rapacious attacks of a single larva. Imagine the enormous slaughter of these green flies by a single brood of Lace-Wing larvæ ! No wonder the wise gardener welcomes the Lace-Wing fly. Its tiny grub will account for more aphides in a few hours than he would destroy in a day.

A brief rest, and the larva becomes a chrysalis, smaller in size, and huddled together in

mummified form. But in the change a pretty little cocoon has been spun and woven, about the size of a pea, snowy-white and of beautiful, silken texture. There can be no doubt about the larva being an excellent spinner. It does not spin with delicate appliances arranged about the mouth ; hands or feet have nothing to do with this matter. The spinning apparatus is near the insect's tail, and is so remarkably acute that the thread spun is almost invisible. It is only when *scores* of threads are interwoven that we discover an entity in the shape of a cocoon with a living " mummy " within. The chamber is so small that the little creature must have been hard pressed when completing the last strands, for its head is actually doubled under its body.

It sleeps soundly. If the pupation occurs in summer or early autumn, its sleep will last but a few days—ten to fourteen at most ; if in late autumn, the insect will sleep through the winter and spring, and never uncurl its folds until the next summer dawns. Then the silken cocoon is split, a lid is formed, and the young fly peeps out on the light of a new day. The gauzy wings are weak, fragile, and crumpled. They hang loosely about the fly's body. The little mite crawls abroad to the

nearest sunlit spot and bathes itself in the cheering rays. New power and vitality come from this exposure ; the wings straighten ; the limbs strengthen ; and at one bound the insect flits away to its own secret bower. At this stage in the career of the fly its compound eyes attain their rich golden sheen. The term "Golden-Eye," as applied to this fly, is a happy one ; every facet is brilliant with the gleam of burnished metal.

It is urged against the Lace-Wing that it gives rise to evil odours, which spoil an otherwise excellent character. This, however, is merely a defensive provision to ward off the attacks of foes, of which the Lace-Wing has a small army. No evil comes to human kind from the innocent insect. Indeed, it is one which should always be accorded the warmest of welcomes.

THE MAY-FLY

SIX sweet hours of joy—and the perfect May-Fly has completed her existence. Is it worth living for? Let us see.

About six o'clock in the evening, just as the sun's orb is bending towards the sky-line, the insect begins its first aerial flight; and by the time the clock strikes twelve this ephemeral creature has either fallen into the water, or sought its last refuge on the grassy banks. Owing to the fact that its life, as a perfect imago, begins and ends in the course of a single day, the insect is termed *Ephemera vulgata*.

In May or early June it swarms over still waters or clear streams and rivers. It has a penchant for tempting danger; and will, therefore, play over those streams which are the chosen haunts of its direst enemies, the trout and the grayling. The fishes readily accept the challenge. The chance for them is a glorious one; and they will utterly ignore the quiet patience and sober anticipation

of a string of anglers, in favour of a wholesome feast of May-Flies.

The May-Fly is, indeed, a charming little being. It is about an inch in length, measuring half-an-inch from tip to tip of its wings, and boasts four of the prettiest specimens in the insect world. The peculiarity of these is at once observed in the fact that the front wings are three times the size of the hind wings. Indeed, the hind wings appear to serve little purpose in flight except affording ballast or support for the front pair. The front wings are powerful and efficient for the few fleeting hours of work they are intended to perform. From the tail portion of the insect depend three many-jointed filaments, apparently the glory and pride of the fly. Thorax and abdomen are brownish in tint; the head is black, and an occasional stripe of black may be detected running from the head to the tail.

It must not be imagined that the entire development of the insect is summed up in a few brief minutes. Two to three years are occupied in the whole of its evolution. The egg of the parent is usually dropped in the water direct; it may be deposited on the bank so near to the water's edge that the next

rain-storm will wash it away ; but by far the greatest number of eggs are oviposited as the fly is dancing near the surface of the water. These fall to the bed of the stream, where they are immured in silt and mud. Here the egg hatches, and the spruce little larva finds itself in the midst of good company with not a few formidable enemies. Fishes of various kinds frequent the likely abodes of May-Fly larvæ. Good food is here accessible with a minimum of effort. The larvæ do not appear in ones and twos, but by the score or hundred. Water-Beetles, too, enjoy their company in order that they may feed on them.

The May-Fly Larva is not a grub in the ordinary meaning of the term. It is, on the other hand, a well-developed insect, with a formidable head-piece, a curious thorax with a series of gill-plates on either side, six limbs, a semi-transparent body, and three short appendages, like tails, fringed plenteously with brown hairs. The gill-plates are very peculiar, and operate in supplying the insect with oxygen from the water on much the same plan as the gills of a fish. The plates are transparent, and afford a good opportunity for observing the pulsation of the blood in a living specimen. It is thought by some

naturalists that they assist the insect's locomotion ; but there is little evidence of this in the active life of the larva, which finds ample scope for six busy feet. The antennæ are much longer than in the perfect fly ; and there is good reason for this when we remember that the larva is pursued in the water far more than during its brief span in the air. The tail-like appendages, too, are shorter than in the imago —here again for a perfectly natural reason ; in the water the larva uses its fringed setæ as a rudder and nothing more ; the fly in the air probably uses her appendages to assist in depositing the eggs.

In house-making the larva has a fashion of its own. It burrows into the sand on the bank of the stream, in a direction indicated by the letter U, both ends of the track opening into the water. Thus, if pursued by some more powerful water-insect at one entrance, it may escape easily by the other. Careful observation of the dry bank on a hot summer day will reveal a host of these borings, left by the larvæ in favour of new ones constructed close to the water.

The pupa of the May-Fly differs but slightly from the perfect insect. On the back of the thorax we recognise the beginnings of " wings " in the form of four filmy plates which, as yet,

lie quite dormant. In fact, the insect at this stage, though not asleep, as is generally the rule with pupæ, spends the days, weeks, and months mostly in the confines of its minute chamber. The development of larva and pupa proceeds very slowly, and is seldom complete within two years.

In the fulness of time the pupa rises from its lowly bed to the surface of the stream. The sun is brightly shedding his rays on the gentle creature as it meets the air for the first time. Suddenly, its expanded skin slits from head to tail ; its wings now spread to the full light of day and it rests for a little while to sip new life and energy. Another minute and the insect leaps from the water, outspreads its filmy wings and flies to the nearest tree or shrub. It is not a perfect insect yet. It is merely resting again. There must be another moult before the final stage is attained. When this last tegument is cast off and left clinging to the tree-trunk, the May-Fly, perfect and beautiful, wings its way again to the stream to hover and dance in the waning light for a few brief hours.

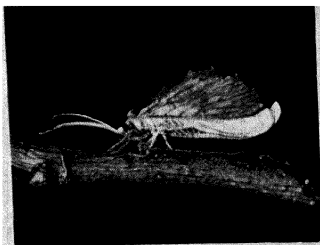
As a rule, the male flies complete their evolutions first, and are flitting abroad in swarms before the appearance of their mates.

When the latter launch forth later in the evening to join the host, the activities of the flies are wonderful to behold : darting, shooting, rising, falling, the May-Fly colony has now reached the zenith of its glory. Trout, salmon, and grayling jump here, there, and everywhere to snap the hapless victims that drop in or near the water. There is high glee in the water and out of it. The finny tribe have the supper of the season ; and retire not till that winged host has died away with the early morning hours.

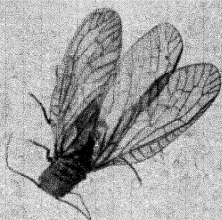
The perfect fly is a wonderful transformation. Its wings are unique in structure, and reflect in the sunlight the iridescent tints of the rainbow. The long antennæ of the larva are reduced to a mere stump, while the three " tails " are longer than the insect's whole body. The compound eyes are clear and penetrating ; the number of facets can only be estimated. They are so minute as to baffle calculation. Between the compound eyes are three ocelli, simple eyes, arranged in a straight line. Perhaps the most curious feature of the perfect May-Fly is that it has *no mouth* and cannot, therefore, eat anything. The formidable jaws of the larva are entirely absent in the fly ; all the mouth organs appear

to be welded together in a solid mass without aperture or muscles. Hence, from the moment the fly emerges from its last moult, it lives literally "on air." Not a particle of food, solid or liquid, can be taken in the ordinary way. Further, the fly has little or no need of food. The brief period of its existence is fully occupied in flitting over the water and depositing clusters of eggs. Its life-work is then complete.

England is spared the countless swarms of May-Flies which swoop down on the lowlands of Holland. In the marshy lands about the Zuyder Zee the larvæ abound. In the sultry weather of June or July the flies appear as darkening clouds over areas amounting to several acres. Seasons have been noted where the spent flies have littered the sands on the shore. A "storm" of May-Flies also visits the low-lying areas about the Seine and the Loire. The swarms approach like miniature flakes of snow, and cover enormous tracts, to the discomfiture of the farmers of the Llandes. Basle and the Swiss valleys have their "plague" of May-Flies in the hot days of September, when they lie scattered over the streets and roadways, and are gathered in heaps to fertilise the meadows and gardens.



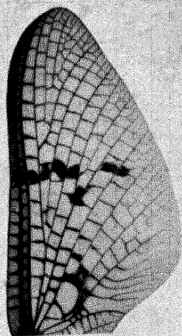
Lace-Wing



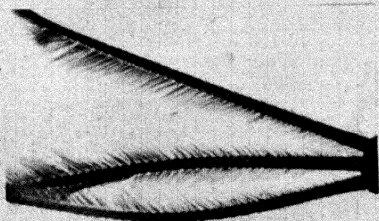
Chrysopa-Fly (near relative of Lace-Wing)



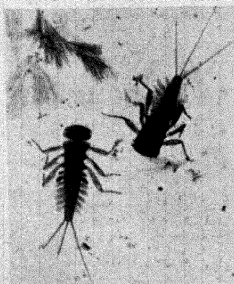
May-Fly



Wing of May-Fly



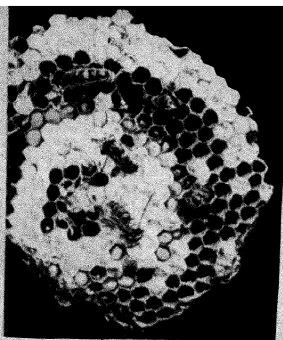
Tails of May-Fly larva



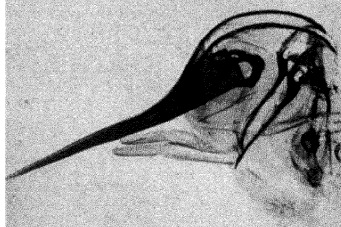
May-Fly larva



Nest: upper side



Nest: under side



Sting



Wings interlocked



Tongue & palpi



In flight

THE WASP

TO the lover of Nature in its varied forms and presentments it is not a little surprising that the world's first lessons in art and science come not from the growing intelligence of mankind but from the lowliest creatures of the universe. Long before the learned men in the Land of the Pharaohs were writing their profound impressions on papyrus leaves, the prototype of the insignificant wasp was hard at work teaching the world's first artizans how to make paper. Vegetable fibres, then as now, were collected by insects, pounded together, thoroughly mixed with sizing materials of their own making, and laid in thin plates to form their own homes.

It is, indeed, marvellous what an amount of hard work, perseverance, and thorough efficiency are wrapped up in the life-history of this much-despised insect. The wasp, after all, is not the ruthless warrior he is often represented to be ; and he is totally innocent of many faults laid to his charge. One point

has been fairly well established by most careful observation, not by one but by many naturalists, that the temper of the wasp is ruffled only in self-defence, or in defence of its home. And who will blame it for that ?

Whatever may be urged against the character of the wasp, it certainly is not ungainly or lacking in elements of beauty. Its yellow and black bands are at least imposing, and in no sense do these spell " danger," as is often imagined. The wasp lives not for itself alone, but for the community at large. It feeds on smaller insects which would swarm around our heads and become an unbearable annoyance. As the harbinger of summer it speaks of approaching days of buds and flowers, grass and grain, sunshine and pleasure. It has qualities which we naturally resent at times ; but, if weighed in the balance, these characteristics are excelled by its phases of energy and business-like attention to duty. In this regard let us note carefully that the wasp-drones are born late in the season and die off early. The industrious wasps appear first—early in spring—and live longest.

We will examine the wasp and its colony. In the first days of April we have seen occasional wasps with unsteady gait and half-

dead appearance stalking in nooks and crannies about the roots of woodland trees. They are not in companies or colonies then. There may be one, two, or three about the same recess. If more than one, they do not seem to be concerned about each other. If picked up in the hand, they do not show much energy—perhaps a slight movement of the limbs or the head: there is no attempt at flying. These sleepy individuals are, in fact, the remnants of the previous autumn; they are the grown-up daughters of last year's stock, and for a whole winter they have been dormant within the cavities of the soil or of some solitary tree-trunk, until the growing days of spring, with welcome warmth and light, have drawn them from their concealment to begin a new life. They are the Queens of the coming colony. Let them alone for a few days, and wonderful vitality comes to them from heat and sunlight. These Queens do not help each other, although they may have come from the same stock the year before.

Choosing her own way a Queen sallies forth to found a new home. A disused rabbit-warren or a cavity under a tree is a favourite spot. The aperture selected must not be

too restricted in size ; the Queen wasp looks ahead to the possibilities of her large family and prefers an amplitude of space. First of all she must build. No house or other structure is erected for her. And she must, for a time at least, carry on operations alone. Hers is a tedious business ; but with her indomitable energy, night and day, the work is done without intermission. A small part of a leaf or bark is nibbled away and mixed with glutinous size made by the Queen herself. This miniature scrap of paper is then tacked on to a strong rootlet, and forms the " foundation-stone " of the new home. But wasps do not build one " stone " upon another. Fixing the first scrap to the rootlet, the Queen is constantly adding more paper until a small round dome is completed. Close by, another dome is made, and against the incept of these a third is placed. Thus three domes are formed in the shape of an equilateral triangle with openings *downward*. These are the bases of three cells, in each of which an egg is deposited by the Queen wasp. Drop out? Not at all. The wasp which manufactures size for *papier maché* can make gluten to fix her eggs to the dome.

While the eggs are hatching, the mother is

a paragon of industry. Layer on layer is added to the dome, the wasp building downward ; and as the structure lengthens it is modified in shape from the circular to the hexagonal. This plan economizes space and provides for the safety of the young broods. There is no aperture left between the cells. A considerable saving of work is also secured. Instead of a whole circle, only four sides of a hexagon are required ; two sides are already finished. Row after row of these cells is completed and filled with eggs ; a tier is formed comprising one hundred and fifty to two hundred cells all on about the same level and pending from the same roof. When the first-laid eggs are hatching, the mother wasp is completing the tier. Then the larvæ must be fed. The Queen herself prepares the food, stores it in cells specially selected for the purpose, and spends every available moment in feeding her first progeny. What a remarkable example of energy is this Queen wasp—making paper, building a nest, depositing eggs, feeding her young, and keeping the enemy at bay.

When fed up, in about three weeks, the larvæ weave a whitish grey cocoon over the mouth of the cells, and are transformed to the

pupal state. Another week or ten days finds an ominous rift in the cocoon and a young wasp's head protrudes. A dozen more follow suit; and, as these are all *working* wasps or "neuters," they give immediate assistance to the Queen, especially in the matter of building. From this time forth progress with the nest is sure and rapid. New cells are made, and fresh tiers are fixed one under another, the roof of one tier being used by the working wasps to feed the larvæ in the tier immediately above. Five, six, or eight tiers are thus built by an increasing number of workers until the available space is comfortably full. The Queen wasp is much averse to over-crowding, and space must be left for the containing-wall of the nest to be strong and durable.

Hence, when the tiers are well-nigh finished, they are connected at their edges and adequately bound on all sides by a new structure resembling a hollow sphere, in which cells and wasps are all contained in absolute darkness, but safe from harm and free to pursue their daily task. One little aperture in the lower portion of this "ball" is provided for entrance and exit. Beyond this the house is entirely closed. Every atom of the building is com-

posed of *papier maché* made by the Queen bee and the neuters.

From this remarkable colony spring numberless wasps, few of which ever darken our threshold. The neuters have quite sufficient work at home. They seldom fly far away from the nest. Males and females do not appear until late in the summer or autumn. The female wasps make their *début* earlier than their brothers, and, after the laying of eggs is completed by the Queen wasp, they relieve her of her multifarious duties. The ruling spirit of the household simply sinks to quiescence, as if doting over her enormous brood. These female wasps do fly abroad, and occasionally make themselves too evident by their stings. Considerable quantities of food are also garnered by these late arrivers. In fact, very largely they are food-seekers and food-carriers.

The male wasps are the drones. They appear last of the great family, and are so inefficient and shiftless that they are dragged out of the nest almost immediately after they leave the cells. They do nothing within except hinder the progress of the workers. Wandering aimlessly about the mouth of the nest, they do not trouble our

homes to any appreciable extent. If they did, we should not be alarmed. They are quite harmless and stingless. It is only from stress of hunger that they migrate at all. In this they are quite selfish, for no food is taken by them to the nest. These males die off with the first frost. A few females survive the rigours of cold, rain, and snow. These become the Queens of the following year. The old Queen and head of the colony passes away in the midst of her progeny.

The structure of the insect itself is full of interest. The eyelets are practically countless ; they are estimated at from one thousand to twelve hundred. Each eyelet follows the hexagonal pattern so common in the compound eyes of insects. The external surface of each is convex. The insect's head is much like an inverted triangle with rounded angles. In the centre are the coronet and the clypeus. These together resemble a coat-of-arms with a crown above it. On either side of the coronet are the antennæ, short, vibrating " feelers " in constant motion. The clypeus or " face-plate " affords a ready means of identifying the different species of wasps. In the common wasp (*Vespa vulgaris*) the clypeus is marked with a black patch re-

sembling an anchor. The *Vespa germanica*, also a ground wasp, is more numerous than *vulgaris* and bears in its clypeus a vertical black line with a circular spot on either side. The tree wasp (*Vespa sylvestris*) has one central spot on its clypeal plate, sometimes no spot at all.

The wasp's mandibles are formidable and destructive, just the right tools for chopping bark and leaf, or gnawing away useless obstacles. Under these mandibles are the masticating apparatus, the maxillæ, palpi, and the labium (tongue). With the labium the wasp builds its nest, using the organ as a sort of trowel to flatten the layers of material. The wings are four in number, the front pair being folded along a medial line when the insect is resting or walking. During flight the front and hind wings are linked together. On the upper edge of the hind wing is a large number of hooklets (thirty to fifty) which engage a strong nervure on the lower edge of the front wing. Thus, in flight, the pairs strike the air with the impulse of two flat planes. The sting passes from the abdominal extremity, and includes a sharp lancet and a tube connected with a poison-gland. When the insect is attacked, the lancet is forced

into its adversary, the poison-gland contracts, and a speck is forced through the tube into the wound thus created, During the months of July and August the sting is the most pungent.

THE HUMBLE-BEE

VARIOUS names are applied to the Humble-Bee. Just to quote a few, we have "Humming Bee," "Bumble Bee," "Hummer-Bee," and "Sting-Bee." Very frequently this insect is confounded with the Hive-Bee, to which it bears little resemblance, belonging, indeed, to quite a different family. The Common Humble-Bee is *Bombus terrestris* (ground-hummer), while the Hive-Bee bears the technical name of *Apis mellifica* (honey-making bee); and, though both are hummers and honey-makers, there is considerable difference in their size, their appearance, their humming, and their honey-making capacity.

The Humble-Bee belongs to a smaller colony than the Hive-Bee. The former is content to share the community of a hundred and fifty to two hundred, the Hive-Bee is a constituent of a host numbering fifteen hundred to two thousand. The Humble-Bee knows nothing of hives or artificial habita-

tions. Neither honey nor other sweet attractions would tempt this insect to try luck at housing in pre-arranged buildings. It is essentially a creature of the soil, the mossy bank, the field and meadow, or the solitary hedgerow ; and here, after careful and patient search, may be found the home of the Humble-Bee. Somewhere within the mound is a well-proportioned cavity—eight to ten inches wide—dark as pitch, where *Bombus* resides for fourteen out of twenty-four hours every day. The path to this inner chamber is narrow and often devious. Seldom, indeed, is the passage wide enough to allow more than two insects to pass each other with comfort. The best way to discover this nesting-place is to watch the exit of the bees and trace the sinuous line of communication.

Inside the cavity are male, female, and neuter bees, the children of one or more Queens. A remarkable feature of this colony lies in the fact that the neuters parade themselves about the Queens at laying-time, and seize the eggs at the earliest moment, devouring them ceaselessly. The Queen is powerless. Until the neuters are fed up, this wholesale destruction continues, with the females holding aloof and waiting the result. When the

females grow in number and strength, and the neuters become inert through over-indulgence, a mild form of war is declared. The females assume the offensive ; and the rebellious neuters are reduced to proper control. Then they fall into line, and become the honest and industrious workers of the colony. The Queens are now at peace, and egg-laying proceeds with astonishing rapidity. Every member works in the Humble-Bee's nest. Males, females, and neuters have their duties to perform ; and when the colony settles down to serious house-keeping no more peaceful and enterprising family could be conceived.

The females generally present large and small varieties, both being actually engaged in cell-making and feeding the young larvæ. The cells are made of wax evolved by the bees themselves. Certain parts of the nest are devoted to large-sized cells for storage of honey and bee-bread. When the colony is well advanced these storage-cells become numerous and well stocked with material to last the whole of the season. Poverty is never a feature of the Humble-Bee colony. Neuters and females work splendidly together.

The neuter bees are also deputed to considerable work in obtaining supplies ; and

with the rising of the sun they sally forth to meet the opening flower at dawn, suck from the corolla whatever honey it may afford, and fill their little hip-baskets with bee-bread. Frequently, during the course of a single day, these bees make for home with bags filled to the brim. They do more. Hopping, skipping, and flying from flower to flower they act as fertilizers, bearing the staminate pollen of one plant to the stigma of another. The Humble-Bee is, indeed, a useful member of the insect world, and is deserving of the warmest welcome to our gardens and conservatories.

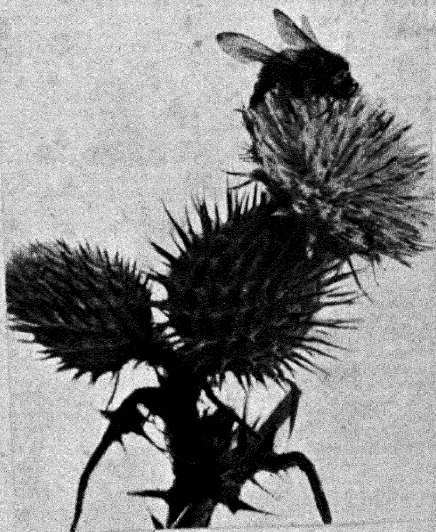
For leguminous plants such as the pea, bean, clover, and broom, the Humble-Bee has a distinct preference. It can easily delve into the floral tube in its endeavour to reach the honey-sac, and in the effort its antennæ rub freely against the anthers of the flower. They thus become well sprinkled with pollen grains. The bee is alive to the value of this honey and pollen ; it employs its forefeet vigorously to sweep the pollen from the antennæ and adjacent parts of the head, and mingles the grains with the honey-supply to serve as food for the young within the nest.

A careful examination of the cavity shows that the eggs are not deposited in hexagonal cells like those of the Hive-Bee. The only provision for the little youngster is the egg-shell itself, ovular in shape and made entirely of wax. The eggs lie promiscuously in one heap, or in several clusters near each other. When the hatching period arrives, in ten to twelve days, the larval bees nibble at the shell and crave to be fed by the females and neuters. They feed well for several days before pupation. A few days' quiet completes the transformation ; and the young bees emerge from the waxen shells to act their part in the community.

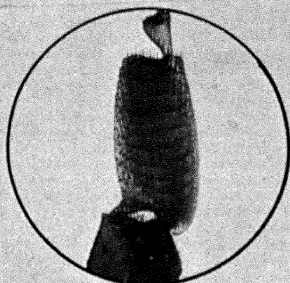
Of British Humble-Bees there are no less than eighteen distinct species, differing mainly in colour, or in size, or in both. The best known is the Common Humble-Bee already referred to ; other important species are the Carder-Bee, which weaves an elaborate structure for its nest ; the Wood Humble-Bee, which delves deep into the soil ; and the Stone Humble-Bee, which has a preference for loose stones, pebbles, and shingle. The honey stored by Humble-Bees is more concentrated than that of the Hive-Bee, has a reddish tint, and is too strong for the human palate.

The general structure of Humble-Bees shows slight variation in the different species. The body is ovular, and pointed somewhat at the extremity ; it is covered with black hairs and yellow rings. The thorax is almost circular, and is thickly strewn with bristles. The head is more or less triangular, and sometimes elongated in front where the mouth organs are in evidence. On either side are the compound eyes each with eight hundred facets, and on the crown of the head between these are the three single eyes (ocelli). The antennæ are jointed, and resemble elongated clubs. The antennæ of male bees have thirteen joints ; females have twelve joints only. The rings of the abdomen, too, are often noted to distinguish the sexes, males having seven rings and females six. The tongue of the Humble-Bee is elaborately fitted for the purpose of extracting honey from the flower. At its extremity is a delicately-constructed brush. The bee does not suck up the honey like the Butterfly or House-Fly ; it rakes out the juice and transfers it to the pollen basket.

The wings are beautiful gauzy appendages to the thorax, and bear a strong frontal nervure. The other nervures are well marked,



The Bee's breakfast-table



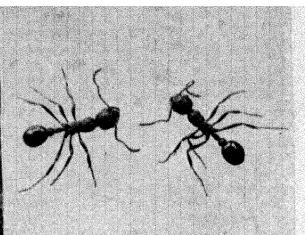
The Bee's bread-basket



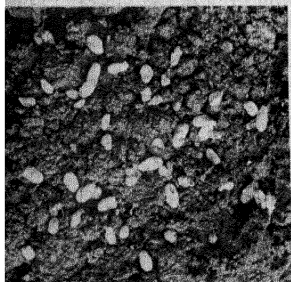
Sting



Nesting-place



Insects



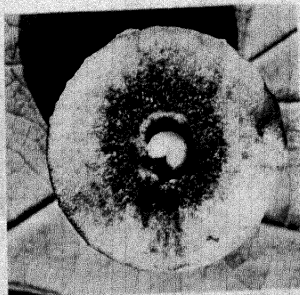
Cocoons



Larvae



Oak-leaf Galls



Oak-leaf Gall with larva of Gall-Fly

and seldom vary in design. The limbs are of more than ordinary import. Only female bees carry pollen and honey-baskets (called "corbiculæ"). The tibia of the hind limb bears an assemblage of black hairs which resemble a basket and contain the bee's daily gathering. Male bees have no such corbicula, and collect no honey or pollen. These, in fact, do little more than wander aimlessly about the locality of the nest.

With the first touch of frost the male bees die off; the neuters become sluggish and inert; and with the snowy days of December all that remain of the colony are a few female bees. These hibernate and come forth at the dawn of spring as the Queens of the new family.

THE ANT

ANTS are important members of the *social* insect-world. Wasps, Hive-Bees, and Humble-Bees share with them this honour. And it may be said with sincerity that the development of *instinct* in ants is much akin to *reason* in higher mammals. They appear to know precisely what they are doing, and how to do it. Let me quote an incident demonstrating the apparent intelligence of the ant.

From a respectable swarm hurrying about an ant-hill, an egg was captured from a fairly large specimen. The insect stuck to the precious burthen as if for life itself; but eventually relaxed its hold and bowed its head. The egg was slowly moved away from the "hill," followed by the insect, which made an occasional attempt to seize it, and was hidden under a small box pressed below the ground-surface. The insect continued to plod about the spot, scrambled on and around the box, but found no way of entry. Another daring attempt was made

to force the corner of the box. This, however, was strong enough to withstand a dozen ants. No matter ; the industrious little mite was not to be foiled. Digging vigorously under the side of the box, it found a way inside, drew forth the precious prize, and hurried back to the nest with the egg firmly clasped within its mandibles. Who shall say that some form of intelligence does not play an important part in the Ant's brief career ?

Ants do wonderful things. They build houses in their own style of architecture. They make bridges across waters broad and deep. They burrow under cottages and palaces. The ant-hill is a marvellous specimen of a dwelling ; every particle is contributed by the host of builders who select bits of earth, sand, flint, and clay as well as sticks, dead leaves, and bits of paper for building material. This is pounded and moistened, as man manufactures cement, and the whole is carefully constructed into walls, passages, courts, rooms, small chambers, and mazes. The channels are spacious enough to admit at least two ants passing one another, and the chambers are often large enough to hold a hundred. The eggs are deposited in special rooms or cavities where they can

be easily nurtured by the worker-ants. Small, oval specks of creamy white, these eggs accumulate up to hundreds in a single ant-hill and its subterranean chambers. Colonies of ants, numbering from five hundred to a thousand, are by no means uncommon. What then must be the number of eggs deposited by such colonies! ("Ants' eggs," generally so-called and often used to feed small fishes in the parlour aquarium, are not ants' eggs at all, but the cocoons: see below. Some of them are as large as Ants themselves and could not, therefore, be their eggs).

The egg is the Ant's precious charge. It lies snug and warm in the nest for about ten days, when the larva emerges to feed and be fed. Ants, like Bees, have a three-fold society consisting of males, females, and neuters. The two former have wings, for a time; when the females begin egg-laying their wings are dropped, or they are ruthlessly torn away by the powerful male ants. These males have strong mandibles which seize the membranous wings near their insets, and do not relax their hold until the wing is wrenched away. The males, themselves, retain their wings; no attack is made on them. But

their masterful career is soon cut short : they die off early in the season, and we are troubled by their flights for a few weeks only. The females do not concern themselves much about their offspring. Having deposited the eggs, they amble forth and dominate the more numerous neuters or workers, which take over all the nursing arrangements and perform the family-work admirably. As foster-mothers these neuters are unrivalled. The moment the eggs are deposited, the worker-ants are ready to pan them out from the promiscuous heap in which they are laid, to promote easy hatching.

When the little maggots begin to tap at the shell, the workers are there again to slit the tip of the shell, if necessary, and assist the larva in its effort to escape. The larva has neither legs nor feet. It merely wriggles about to get its food. Hence, the workers must attend to the feeding of the young brood as well as guide their first efforts at crawling. The worker is always wingless ; it has little need of these appendages ; all its requirements are in the soil or on the ground. Food for the young larvæ is not in the air ; the workers fully recognise this fact and may be seen on any summer day hurrying to and fro

near the nest carrying green stalks or juicy morsels to the young ones.

These neuter-ants are indeed marvels of tact and industry. During the day-time they keep the entrances and exits of the nest clear and open. Whether there be two or a dozen, all doorways are carefully cleaned out early in the morning. And as the twilight of eventide begins to gather, a number of workers may be seen, especially active, dragging sticks and bits of earth from every direction to close up the apertures. By dusk all doorways are closed and a sentinel is placed within to signal the approach of aliens. These do come. Sometimes they are formidable. A Wasp or a Bee, or an occasional Field-Mouse in search of Ants' eggs, will endeavour to invade the home of the Ant. But woe betide these belligerents if the Ant colony is a fairly large one! The females have stings; and by sheer force of numbers the unwary foe is driven from the threshold or stung so severely that he hobbles away as best he can.

The larva of the Ant is an excellent spinner. After two weeks' feeding, during which it never leaves the nest, it begins to spin a fine silken thread and interweaves this into an

egg-shaped cocoon. This cocoon is what is generally termed an "Ant's egg." Its texture, when examined under the medium-power lens of a microscope, is wonderful. Every thread is drawn round and round, one within another, until the "shell" is dense enough to completely hide the tiny creature within. Here it lies for a few days under the watchful eyes of the worker-ants, which gauge with perfect accuracy the period of pupation, and assist by their mandibles and claws the young Ant as it strives to clear itself from the silken envelope. The puny mites are tended and watched at every stage by the workers until well able to take care of themselves.

Ants, like the Lace-Wing and Lady-Bird, are notable for their attention to Aphides or Plant-Lice. They seek out the Green-Fly for the sweet nectar its body contains. Their concern goes further. Ants will ascend the stems of bushes and the trunks of trees, the oak especially, for the purpose of collecting eggs of Aphides and preserving them during the coming winter. These are placed in the cavities of the Ants' nest and tended with unstinted devotion during the cold months, so that they may hatch comfortably in spring

and bring forth an abundance of Aphides. But for what reason is this unique devotion? Herein lies the secret of this specious affection. The Ant milks her cow, the Aphis, at every available moment. It does not kill the "cow," as is the case with the Lace-Wing larva. It endeavours to keep the Aphides at one spot, on one twig or leaf, and, like a human milkmaid, passes from one to another, drawing an infinitesimal quantity of sweet juice from each. As the Aphides themselves imbibe fresh honey from the plants and flowers, new supplies are constantly available.

In bodily structure the Ant is well fitted for its life-work. A broad spheroidal head is provided with strong piercing eyes, and two antennæ of twelve or thirteen joints. The thorax, brown, thin and slim, supports its eight-jointed limbs, and a round, black body is attached to it by a slender junction, which enables the insect to wriggle about at a rapid rate in any direction.

The Wood-Ant (*Formica rufa*) is the largest of the British species, and is so called from its preference for woodland pastures. It is known also as the "Horse-Ant," not from any intimate connection with the quadruped but on account of its size as compared with other

members of the Ant family. " Hill-Ant " is another term applied to it, by reason of its habits of burrowing and raising the ground to form a miniature mound. This hillock does not by any means compare with the magnitude of operations below ground. It is merely an indication of the locality where a host of subterranean chambers and passages provide a home for, maybe, a thousand insects.

The generic name (*Formica*) is traceable to the pungent odour which arises when an ant-hill is disturbed. The smell of vinegar is very strong, and comes from the formic acid secreted by the ants to cleanse, protect, and sterilize their home.

GALL-FLIES

TO the species of Gall-Flies there appears to be no end. Already some sixty or more have been discovered on the "brave old English oak," and every year adds to their number. Further, the oak is but one of the many trees and bushes which harbour the larvæ and pupæ of gall-flies.

One of our commonest species is that which accounts for the curious formation known as "oak-marble." This insect—*Cynips Kollari*—is hymenopterous (membrane-winged) like the Dragon-Fly and the Ant, and bears a rotund body with a stumpy thorax and prominent head. The female fly invariably selects the growing-point or tender twig of an oak-branch for its onslaught; and, by means of an ovipositor, slits the soft tissues for the purpose of laying a single egg therein. The operation seems insignificant enough; and, although at the same moment the inoffensive fly secretes into this small cavity a droplet

of exciting fluid—probably with an acid-reaction,—the world would be no wiser for the operation were it not for the fact that a hard ball, as round as a marble, gradually forms on this very spot, with the little white egg at its core. The egg does not retain its original size or shape. When laid, it is rather long and flat. It grows to four or five times its first dimensions and becomes quite swollen, like a hen's egg in miniature. As it grows, so does its enclosure grow in thickness and density. Whether sap is arrested, and by chemical agency converted into solid matter, is not fully known. Possibly the normal growth of the plant at this point is deflected into the abnormal gall. At any rate, the gall is one compact mass of solid food-matter prepared by Nature for the little creature within, which, in the fulness of time, will emerge from its papery envelope a hungry larva.

When it does emerge, it begins to attack with unmeasured ravings the sides of its internal chamber. As the larva develops so does the chamber, until the whole sphere attains to the size of a boy's marble. Then the larva changes to a pupal stage, and lies in its den like a cast-up mummy. Head,

limbs, abdomen are wedged into the available space, leaving scarcely a hair's-breadth for movement in any direction. The little creature seems both unable and unwilling to move, and nibbles an occasional morsel from the wall immediately near its mandibles.

As it grows in age, it becomes more pliable, and the stiffness of its slender limbs wears away. It can turn in its den: darkness becomes tiresome, and the light of day would be welcome; but the mite is hemmed in on every side with hard, solid, woody matter, which is stout enough to defy the respectable blow of a small hammer. But it must come out. Its wings are well-nigh complete; its limbs are perfect; eyes and antennæ are ready for the sunshine; and the young *Cynips* bores a tube as "clean as a whistle" through the containing wall of its chamber. Where one gall only is concerned, this is a comparatively easy matter, and the Gall-fly is soon free. But where galls coalesce—and such is a common occurrence—how is the fly within to discover which direction to select for the nearest exit? In one direction it may have to bore only a quarter-of-an-inch; in the opposite direction it must bore three times that distance. This is sometimes too much for the

slender energies of the young *Cynips*; and it is discovered dead, through sheer exhaustion, in the thickened portion where the galls unite. One point is certain: the direction taken appears to be invariably as straight as Euclid's proverbial "line." It knows no curves or angles. *Cynips Kollari*, specifically named from its discoverer, is a busy member during the leaf-falling days of autumn, and may often be seen on oak-trees in the waning sunlight. Its antennæ are delicate and apparently very sensitive. In the males they have fifteen joints, in the females fourteen.

Oak-"apples" differ in size and shape from oak-"marbles," being much larger and more irregular. The surface is often crumpled. These are the offspring of another Gall-Fly (*Cynips quercus terminalis*), and contain many internal cells. The galls appear on the terminal twigs and on the rootlets of the tree. When gathered, quite an array of piercing holes may be detected, from each of which a young Gall-Fly has emerged on reaching maturity. It is not unusual to find from twenty-five to thirty larvæ in one of these apple-galls.

The flies are not devoured by birds, for the simple reason that they are able to secrete

a bitter fluid which is obnoxious to the bird's taste. Hence they have abundant opportunities for taking possession of the country-side in immense colonies.

Another Gall-Fly (*Cynips quercus folii*), closely allied to the foregoing, attacks the underside of the leaves of the oak, piercing the veins and stomata with its ovipositor. Herein is laid one egg only, and at every spot on the leaf so affected a pretty round gall begins to grow. At first it is a rich emerald, then bright yellow, and this gives way to a blushing red. The effect is the same ; within the gall a single larva is feeding on the juicy material by which it is enclosed. The gall is not hard and woody like that made by the *Cynips Kollari* ; and a fair amount of pressure between finger and thumb will reduce it to a flat condition. The gall is seldom more than a quarter-of-an-inch in diameter ; and a leaf will sometimes shelter half-a-dozen.

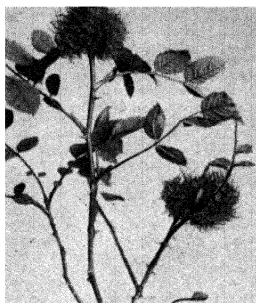
The *Cynips longipennis* also attacks the underside of an oak-leaf. At every point where an egg is laid a flat " spangle " gall is formed. This is smooth on the inner side, and is attached to the leaf by a short, slender stem. The outer side of the disc is

covered with minute filaments. The Gall-Fly within emerges during the month of March.

The Gall-Fly of the rose-bush has its own peculiarities. *Cynips rosæ* is its specific name, and its behaviour is somewhat eccentric. Its attention is bestowed generally on the wild rose-bush, where it seeks the most delicate growing points, and cuts them in different directions with its ovipositor. In every slot is deposited a minute white speck, a complete egg, and then the insect flies away on its last journey. Its life-work is finished, and it seeks repose and death in a cranny of the nearest hedgerow. The eggs grow very little in development; but the whole series of cavities containing them generates hard walls of woody material, and from the outer surface of these walls an abundance of mossy fibrils shoot forth with gaudy colours of red, green, orange, and yellow. Each fibril also develops off-shoots not unlike spines. This curious growth is known as the rose "bedeguar," or, more popularly, "Robin's Pin-cushion," and contains from twelve to twenty larvæ. The perfect *Cynips* emerges by boring the hard wall of its cell. As the larvæ remain in the gall during the whole winter,

the mossy envelope will do much to temper the rigours of frost and snow.

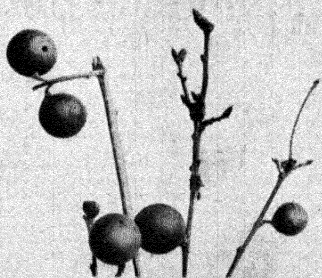
The Willow Gall-Fly is really a dipterous (two-winged) Gnat, *Cecidomyia saliciperda*, which pierces new twigs, branches, or leaves of various willows, lays an egg in each incision, and closes it with its own mucilage. The insect is very small ; as a rule, not more than one-eighth of an inch long, with head and thorax black, and wings covered with white hairs. The eggs are round, and orange-yellow in colour. The larva is linear, with rounded extremities and a well-marked " anchor " process, or breast-bone. The pupa is yellow, and remains in the gall throughout the autumn and winter, until April or May. The leaf-gall is generally reniform (kidney-shaped), and contains one insect only.



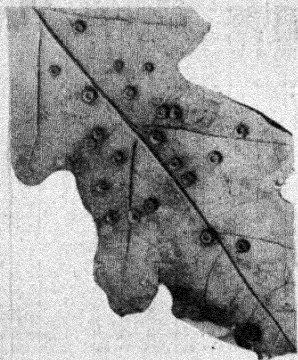
Rose bear-galls



Interior of beech-gall



Larvae bore into oak-galls



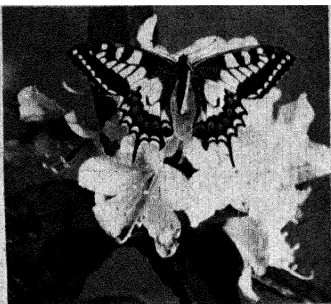
Spangle Galls



Willow-galls

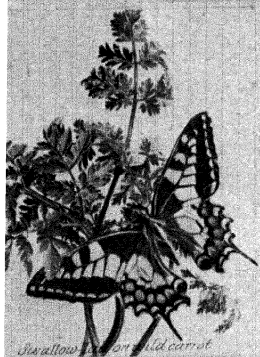


Apple-Gall with larvae

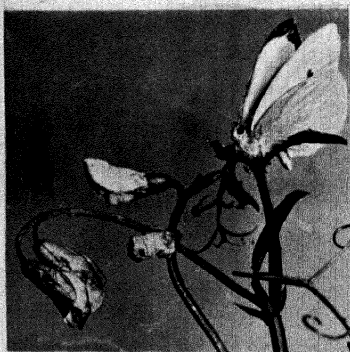


Larva of Swallow-tail

The Swallow-tail



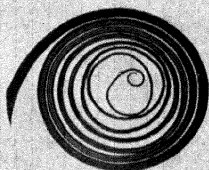
Swallow-tail on wild carrot



Large White on the pea stalks



Chrysalis of Large White



Tongue of Large White

THE SWALLOW-TAIL BUTTERFLY

THIS largest British butterfly is endowed with singular charm both of form and of colour. The Swallow-Tail (*Papilio Machaon*) is, unfortunately, fast becoming a *rara avis* in Great Britain, and is now to be found only among the Broads and Fen-lands of Norfolk and of Lincolnshire. In former days it was common in Kent, and in the orchard counties of the Midlands.

Its beauty and grace are unquestioned. It is a choice representative, the only one in Britain, of the Papiliones family ; and is so universally admired that Fen-land reed-gatherers prize the pupæ as much as the reeds, and gather them with scrupulous care. Their monetary value is rising year by year.

The specific term "*Machaon*" seems to have been applied to this butterfly as symbolic of virtue or valour. The historic Machaon was an eminent soldier and surgeon in the ancient Greek army when it attacked the city of Troy. With view to making an

entry into the walled city, the Grecians constructed an enormous figure of wood, resembling a horse, placed this on wheels, and drove it near the Trojan walls. Inside the wooden horse were Machaon and as many soldiers as the "animal" could contain. When the Grecian army retired, the Trojans, ignorant of the self-interned warriors, seized the horse, made an enormous gap in the walls, and dragged it into the city. Then did the Trojans give themselves over to uncontrollable revelry and feasting. Machaon and his men kept silent until the Grecians re-appeared before the city to find a huge gap unprotected. Here they entered with little opposition; and at a pre-arranged signal Machaon and his men leaped from their prison among the feasting Trojans. The struggle that ensued was short and sharp. Machaon was the hero of that great day, and Troy fell into the hands of the Greeks.

Such is the story of Machaon, whose name entomologists have given to the Swallow-Tail, though its only feature of virtue and valour appears to be its beautiful wings and wonderful powers of flight. Its wings are remarkably strong, both fore and hind. Their groundwork of black is relieved by

sundry mosaics of artistic form and style. The fore-wings are deckled with large yellow crescents down the centre, and a smaller series of curves near the border. The frontal nervure is well adapted for prolonged periods of flight. The hind wings have also a pretty series of yellow crescents near the border ; and the anal angle is extended like a narrow flat tail, which gives to the butterfly its popular name. The dark portions of the hind wings are tinged with blue ; and on the inner edge is a scarlet spot, almost circular, which gives the insect a decidedly attractive glow. The female is larger than the male and is " painted " in more prominent colours.

Like other members of this great family, its antennæ are clubbed ; the eyes are compound ; and there are two ocelli in addition to these. The wing-scales are mostly of the battledore type, and in number are well-nigh incalculable.

After flitting about for several days, the Swallow-Tail seeks its favourite food-plant—the wild carrot or the fennel ; and proceeds to ovipositing. The eggs are not very numerous ; and, being sheltered in the marsh and fen, are not easy to discover. The egg is almost spherical, of a yellowish tint

when first laid, afterwards turning to green, and then to purple. At this stage the period of emergence of the caterpillar is attained in a few hours.

At first the caterpillar is a black warty creature interspersed with grey hairs, having near the middle of its body a white band. The first and second moultings make little difference to its aspect. With each moulting it has grown considerably ; and at the third moult it becomes a beautiful green with an orange-speckled band on each ring. There is also a continuous black band between the rings. The larva, as is the case with butterfly larvæ generally, has three pairs of true feet pending from its thorax, four pairs of hooked feet to its abdomen, and one pair of pro-legs at its anal extremity. The head is noble-looking and dignified ; it is marked with black bands between the clustered ocelli, and is accompanied in the next segment by a peculiar horn-like adornment of a scarlet colour and shaped much like the letter V with the prongs curved. This horn (osmaterium) can be protruded or retracted at will. If the insect is disturbed, the horn is suddenly thrown out and emits a vapour having the smell of decayed fruit. Normally the larva

hides the osmaterium in the folds of the segment.

Eggs are deposited in May for the first brood, and in September for the second. The May broods hatch in twelve days, and extend the larval stage over six weeks. Hence, butterflies appear from them during or before August, and these produce the second brood. The eggs of this brood produce caterpillars which pupate in October and hibernate till the following spring. The larvæ attach themselves to the reeds of marshy plants, for the purpose of pupating, in the same fashion as Cabbage-Butterflies ; a belt of silk is slung round the chest, and the tail is fixed by a strong band of fibres. When the reeds in Fen-land are cut down in the early days of November, large numbers of chrysalids are collected and sold at considerable prices.

Occasional colonies are found in Kent, Hampshire, and Sussex in the South, and in Worcestershire ; but these are possibly immigrants from the Fens which have been imported as chrysalids and set free. In these localities they have not, for many years, been prevalent. And yet there does not seem to be any serious obstruction to the development of these charming butterflies in other parts

of the country. Given fairly extensive tracts of marshy ground where the food-plants grow, and reasonable peace from the worries and depredations of collectors of chrysalids, the Swallow-Tail Butterfly should be widely distributed through England and Wales ; and, since it does little or no damage to our own food-plants, it would not merely be tolerated but warmly welcomed.

THE CABBAGE-WHITE BUTTERFLY

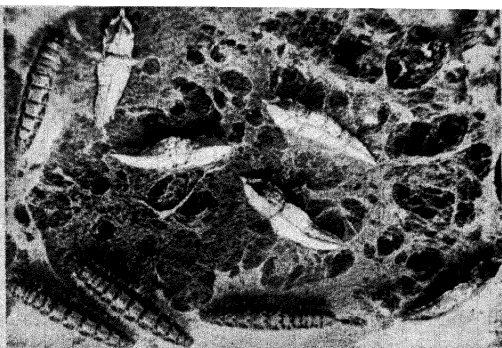
WHEN the butterfly season arrives, one of the earliest specimens observed in the garden is the Large-White or "Cabbage"-Butterfly (*Pieris brassicæ*). This insect is sometimes more plentiful than desirable; at any rate, gardeners think so. For, although it has a keen appetite for the nectar of flowers, its chief delight is to raid the kitchen-garden where the cabbages, broccoli, and carrots grow. When the Large-White is prevalent, the gardener is anxious about the success of his crops; and watches wisely for the deposition of eggs on his plants. These are rigorously dealt with; and he thus saves from ruthless destruction a considerable portion of his stock.

The Large-White is, after all, a favourite beauty of the country-side, and never fails to add verve and sparkle to an otherwise drab carpet of green. In the early days of May it springs from strange sources, having passed its pupal stage under the eaves of an ancient farmhouse, or within the crevices of a

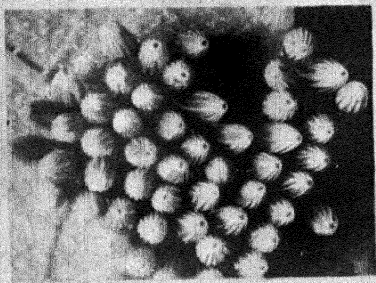
shady wall, or in the window of a stable. Here it has slept since the drowsy days of September, when all its kith and kin retire for the winter.

The wings of the Large-White are not quite as indicated by its name. They are slightly tinged with yellow on both surfaces, but particularly so on the underside. Both the males and females have the wing-tips edged with a profusion of black scales. The male has also a black line on the edge of its hind wings. The female Large-White, like the female Swallow-Tail, seems to afford a strange variation of the rule that the male is the more gaudily dressed : she is actually more profuse in "beauty spots" than her mate. She has two dark patches on the fore-wings, and a dash of black on the lower margin. The nervures of the insect's wings are frequently tinged with green, which produces a charming effect during flight ; and, in spite of its incursions on kitchen-garden produce, the butterfly is welcomed for its purity of colour.

The wing-scales are exceedingly pretty. White and black overlap each other with wonderful effect. The margins are bordered with hairs and club-shaped scales. The large area of wing-surface compared with the size



Pupae in webbing



Eggs



Larvae



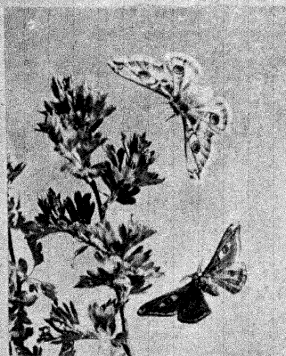
Larva of Emperor-Moth



Emperor-Moth



Death's-Head Moth



Emperor-Moths, male & female



Pupa of Death's-Head

PLATE XXVI: THE EMPEROR
and THE DEATH'S-HEAD MOTHS

of the butterfly's body fully accounts for the remarkable agility of its aviation powers. Even with a close net and a dexterous hand the Large-White is not easily captured.

Large-Whites begin their mating early. On the second day of their active life they gather together in small groups, sharing each other's company with obvious delight. They flit about with wonderful agility and grace for two or three days, and then seek a comfortable refuge for tired wings and for the propagation of their species. Contrary to the general impression, the Large-White does not always lay its eggs on a cabbage-leaf. I have found them frequently on the underside of nasturtium-leaves ; and turnips, carrots, broccoli, and mustard-plants are visited by them for the purpose of ovipositing.

A notable feature of this egg-laying is the number one occasionally discovers in a single brood. Seldom, indeed, do we find single examples. It is not uncommon to find from sixty to eighty in one cluster of eggs ; and occasionally I have met with over one hundred in a batch. From observations carefully noted, Large-Whites have been known to deposit eighty eggs in twenty minutes. The eggs are yellowish-white and elongated, some-

what resembling skittles. The shells are beautifully decorated with indentations from apex to base, and with parallel lines between the ridges. They are deposited close to each other, often in regular lines. These waxen envelopes, however pretty they may appear, are entirely devoured when the caterpillar within is ready to emerge. In seven or eight days the larval butterfly is fully developed, and is ravenously hungry. It nibbles first into the side of the shell, and forces an aperture through which it can push its head. From that crucial moment it feeds on the egg-shell until every atom has disappeared. Then, and not till then, the larva turns upon the food-plant found by its parent. Once let loose on this plant, the latter is devoured. The ceaseless nibbling of the mandibles of the grub works terrible onslaught, the fleshy parts of big cabbage-leaves being stripped in a few hours. In the afternoon a bed of plants may look bright and promising ; the following morning may find these as emaciated as skeletons.

Very naturally, the caterpillars grow rapidly and, as they are gregarious in their habits we discover from six to twenty closely huddled together on the under-side of a lea

where they are resting after a full meal. The caterpillar is somewhat gaudy in its green covering tinged with grey and interspersed with yellow lines ; this is dotted with small tubercles and whitish hairs. Moulting occurs four or five times during the larval career. Then the grub becomes inert—apparently dead. It dwindles in bulk ; it becomes soft and pliable without reviving. The chrysalid stage is dawning.

Pupation may occur in almost any situation. The larva is not very partial as to locality, if it can but shuffle off its larval coil. This must go ; the grub proceeds to spin a number of fine threads and welds these together at the tail-end of its body. To these threads the extremity of the chrysalis is attached. Then another bundle of threads is spun around the fore part of its body after the fashion of a chest-belt. Both belt and tail-thread are firmly fixed to the surrounding material, whether it be a tin vessel, a piece of glass, or a rain-trough.

By a system of rolling and twisting manœuvres the skin of the grub is slit along the back, and the insect thus clears itself of its integument. What remains is a mummified chrysalis beautifully marked with head and

wing lines, of yellowish-white tint and with rows of black spots. It is held *in situ* by the silken belt, and moves only when disturbed. If the pupa is fixed in the early summer, it will develop into the mature butterfly and emerge about September. If it is a creature of the late autumn, it will remain in the pupal state until the April or May following.

The prevalence of Large-Whites appears to have some relationship to the humidity of spring. If the earlier months of the year be comparatively dry, the pupæ are hastened in development and large numbers of butterflies are seen on the wing in May. Our own stock is often largely increased by foreign immigrants. Under favourable conditions, enormous flocks cross the Straits of Dover and mingle with our home types.

THE EMPEROR-MOTH

ALTHOUGH moths and butterflies belong to the same family of Lepidopterous insects, there are marked distinctions between the two genera, which are often imperfectly understood. Does the average schoolboy, for example, know whether a moth or a butterfly has its wings erect when resting? Many doubtless will say "both"; and some will say "neither." Although the distinction is not absolute and applicable to all of their kind, butterflies generally have wings erect in repose and moths have their wings either horizontally outspread or suspended aslant by their sides. Further, in the case of butterflies, the wings have no appliance to keep them connected during flight; while moths, when flying, have the wings on each side firmly joined by a stout bristle which springs from the front margin of the hind wing and passes through a ring on the back edge of the front wing. Thus the two wings on either side can be used as one, in exactly

the same manner as a wasp employs the hooklets in its pairs of wings. Again, a very popular distinction is seen in the fact that butterflies, as a rule, have the antennæ more or less club-shaped. They may and do vary in length, but the terminus is generally a club. Moths, at any rate such as are indigenous to Britain, never have club-shaped antennæ. These vary in form very considerably, and very frequently adopt a feathery style.

The Emperor-Moth (*Saturnia carpini*) is no exception to this rule. It is a beautiful specimen of the Noctuidæ family, so-called from their nightly peregrinations, and is one of the largest of British moths. The female is the smaller, and its colouring is less striking than that of the male. When the wings of this moth are fully outspread we have a picture of insect-life that is not to be despised. The prevailing colour is pearly-grey, mingled with bits of brown, yellow, and white. The margins of the wings are richly crescented with yellow; these are followed by brown streaks and a thin white relief-line, which considerably enhances the pictorial aspect of the moth. But the most striking feature of these wings is the "eye-spot." There are four—one on each wing. These are distinctive features

of the Emperor-Moth, and admit of no mistaken identification.

The "eye-spot" is black in the centre, with just a sheen of blue on its surface; this is surrounded by a ring of warm buff and another ring of black, bordered with a lighter buff colour. Occasionally in the male we may discover pleasing shades of violet and crimson. The tips of the wings often contain a warm dash of red or scarlet to relieve the general wash of brown. The Emperor is certainly stylish in colour, and seems to revel in its brilliancy.

The thorax and segments of the abdomen are sheltered with a thick covering of hairs, also brown or brownish-white; and the compound eyes look intently from each side of the head. The antennæ are doubly feathered. The filaments extend on both sides of a central shaft, converging at the base and at the tip.

Where the heather and furze bloom we may look for the Emperor-Moth in May or June. The male is extremely active on the wing, rising, falling, and planing with remarkable dexterity. His powerful wings are utilized to the full in captivating his mate, who is very nonchalant and irresponsible to his courtly behaviour. She remains almost

dormant on the food-plant. In fact, it is not a difficult problem to capture the female moth without using a net. The practice of enticing male moths by means of a captured female was formerly very common.

Eggs are deposited on the heather, sloe, or willow, in June and July ; and these hatch in four or five weeks if weather conditions are favourable. Warm sunlight assists, and cold or rain retards, the hatching materially.

The caterpillar, like its parent, is a handsome insect, and, when full-grown, is quite three inches long. Its colour is green ; but each segment bears a pinkish-red tubercle surrounded by a black ring. From each tubercle a cluster of hairs is produced, giving the larva a smart hirsute appearance. The larvæ assemble in groups till they are three months old ; they then separate to enter the pupal stage.

In October the larva spins a brown silken cocoon, in shape resembling a balloon with broad and narrow extremities both open, so that the perfect moth can escape without destroying its envelope. The cocoon is rather a unique structure, and speaks eloquently of the instinctive faculty of this little creature. At each extremity a special ring of bristles

is constructed turning outwards, and closing the aperture against any burglarious intruder of the insect world. The moment an attempt is made to intrude on the peace of the chrysalis the enemy is met by these pointed bars, and must inevitably retire. But the mature moth can creep through without the least injury, and thus gain its freedom with the coming of spring.

THE DEATH'S-HEAD MOTH

ABSOLUTELY innocent of the curious charges of terrorism and evil-omen often laid against the Death's-Head Moth, it remains a lively specimen of one of our largest insects. It is the most imposing of British moths, and, notwithstanding its presentment of a skull and cross-bones, few will deny that it has points of absorbing interest.

The Death's-Head Moth (*Acherontia atropos*) is a night-flier, seldom appearing in the bright sunshine ; and, under the cover of twilight, it searches out the potato-fields with view to establishing a home for its future progeny.

The insect is a very hairy creature, every part of its body being amply protected, even to the tips of its wings. Its head is imposing, with prominent compound eyes, peering from either side, and a couple of antennæ provided with sharp hooks at the extremities. Then the upper surface of the thorax bears the imprint—all in hair—of the death's head, for which the insect has become notorious. A gentle rub of the hand will temporarily

disperse this strange figure. It is a mere mixture of brown and white in certain lines. The abdomen is bulky and heavily clad. It is yellow in colour, with a black stripe down the centre, and dark lines marking the edges of the segments. Here, again, the hairs are numberless and have the appearance and feel of soft velvet.

Few insects have more charming wings than the Death's-Head Moth. The front wings are brown, generally, with dashes of warmer colour and sinuous markings of blackish tint. On each fore-wing is a significant white spot. The hind wings are even more striking in bright yellow lined with two broad black bands. The colour-plan is certainly attractive. Underneath, the wings are yellowish-brown, with a gentle shade of marking in grey.

At nightfall the moth may be sought, and with patience sometimes found among the leaves of potato-plants or amid the sprays of jessamine, snowberry, or deadly nightshade. On these food-plants it deposits eggs, which hatch in ten or twelve days.

The larvæ are as wonderful as the parent moths. Each grub attains to five or six inches in length, and is a robust example of the caterpillar tribe. It may be yellow, or green,

or light grey, though green is the prevailing tint. Its surface is dotted over with black specks, and each side is marked with seven purple stripes edged with white and meeting in the centre of the back like the letter V. These livid stripes assist materially in the detection of the insect just as the sun is waning. Near the tail a curious horny appendix is observed. This turns inward and then outward, ending in a sharp point. Its surface is rough and warty. The horn at the tail is an acquisition unknown among caterpillars generally. Why country folks should stigmatize the caterpillar as a "locust" is not quite clear. No illuminated comparison will reveal the slightest similarity between the two insects.

The larva loves potato-leaves especially, and will feed on them if possible until it falls to the ground to prepare for the pupal stage. This is done in October. It makes a cavity in the soil, about nine inches below the surface, and lines it with a viscid resin. The change reduces the big caterpillar to an insignificant little brown mummy-case, on which is lined all the main features of the mature moth. In this dark chamber the chrysalis remains until the dawn of spring.

A strange peculiarity in the moth and its

caterpillar is their capacity for emitting musical sounds. If the moth has a foot gently pressed it squeaks audibly, like a young mouse that has strayed away from the nest and is calling for its mother. The sound is not prolonged, and does not strike one as being an expression of delight. The moth certainly does not "sing" for the sake of attracting attention, either of its mate or its prey. The sounds are emitted only when the insect is attacked, or when danger is suspected. Then it shrivels up its wings and its crop of hair, much after the fashion of a brooding hen when its chicks are in danger. It is evidently excited; it shivers, bows its head, and suddenly whistles. The caterpillar emits a somewhat similar sound when disturbed, but the note is very sharp and shrill.

Whence these sounds proceed has not yet been made clear. Various theories have been shattered owing to the fact that both the moth and the larva are involved. The source is not likely to be the wings, the antennæ, the limbs, or the tail, as these are not common to both. It may be a combination of these in either insect. No doubt the sound is emitted as a means of defence, or to frighten the insect's foes.

Although the Death's-Head Moth does no great damage to crops or vegetables, it cannot be termed the well-beloved of the bee-keeper. It has a naughty habit of invading his hives, and extracting appreciable quantities of honey. It also spoils the hive-combs, thus inflicting damage not easily repaired. The bees themselves hold aloof when this monster enters. Hence he has it all his own way until the bee-keeper discovers his whereabouts. For these predaceous habits the moth is often termed the "Bee-Tiger," an appellation he thoroughly merits.

One enemy at least is too much for the caterpillar. An Ichneumon-Fly (*Trogus atropos*) tracks the larva at every turn, and looks upon it not merely as "good sport" but as a necessary and comfortable nidus for its eggs. Just as the strength of the caterpillar is waning and it is approaching the pupal change, the Ichneumon-Fly alights on its back, bores a hole through its integument, and deposits an egg in its body. From that moment the larva's career is sealed. The egg hatches, the grub feeds on the tissues of the caterpillar, and naught remains but a grey, shrivelled skin with a horny head-piece.

THE TIGER-MOTH

WHEN the summer-time is at its best, and sunlight is at a maximum, there is at least one insect that appreciates these meteorological conditions. The Tiger-Moth (*Chelonia caja*) is rather a late scholar in the field of insect activities ; but it makes up for the delay in the plenitude of its numbers.

We cannot amble forth very far by the hedgerows where the Great Nettle grows without meeting the larva of the Tiger-Moth. Brownish-black caterpillars such as these are not easily concealed from the eye of the observer of Nature's secrets. Hence, though they often rest in perfect stillness on the nettle-leaves or the broad blades of grass, they are easily distinguished from their green environment. Besides, they are such curious-looking creatures that the average school-boy would scarcely treat them as coming within the range of caterpillars.

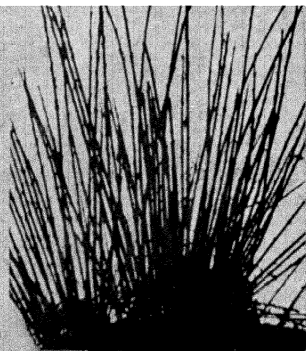
Watch them closely, and we soon discern

that they are caterpillars, nevertheless, although so very different in appearance from the common type. But they crawl in the orthodox fashion, and very smartly too, when disturbed. They are also endowed with six feet to the thorax, eight pro-legs to the abdomen, and two pro-legs at the extremity of the body, precisely in accord with the rule of limbs on caterpillars. Their appetites are ravenous, and little is left of the plant selected for breakfast, dinner, and supper. By nightfall it will present a sorry spectacle, if it survives at all.

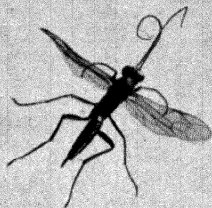
The larva is covered with a remarkable bush of hairs, or, more accurately, bristles, which impart to it an uncanny aspect. Compared with the size of the caterpillar, these hairs are long and scrubby, affording splendid protection to the insect against its formidable foes ; for no less than seven different Ichneumon-Flies keep an eye upon it, and attack it when it is least able to withstand an onslaught. So long as these hairy bristles can be stretched forth like the spines of a hedgehog, or the quills of a porcupine, no Ichneumon dares to pounce on the caterpillar, however aggravated its craving may be. This "woolly bear," as it is termed, would use



Two Woolly Bears on Great Nettle



Hairs of Woolly Bear



Ichneumon-Fly



Just emerged

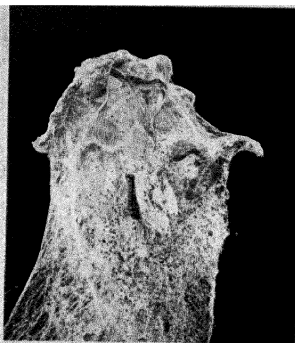


Web of Woolly Bear with pupa & cast-off skin



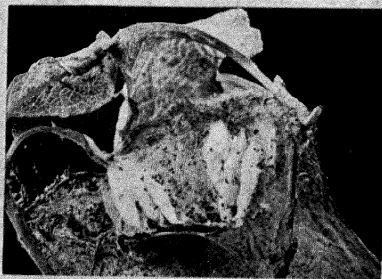
Tiger-Moth

Webbed home of larvae (one visible in front)



Ermine moths on bird-cherry

Cocoons



its spines to the uttermost, and the invader would have a sorry time. Each bristle, when viewed under the microscopic lens, is not a straight object like a pin or needle, but a jointed, horny substance interspersed with short spines, which, doubtless, are intended as effective weapons of defence. If the "woolly bear" is pursued to a corner, it will instantly curl itself in a ring and perhaps seek to deceive itself by simulating sleep. So long as there is the slightest suspicion of danger remaining near, this "sembling" will continue. When peace and quiet return, the caterpillar will slowly unfold itself and make for a safe place of refuge with all possible speed. In a few seconds it will be out of sight, and probably beyond recovery. It is, indeed, a wary creature. With its black head, brown-black hairs, and dark aspect generally, it is an object of considerable interest to countryside ramblers, who often collect a dozen or so to populate the insect cabinet at home.

After three or four moultings, the caterpillar spins yard upon yard of finest silk, and weaves an elaborate cocoon with a warm inner chamber. If we examine closely the delicate structure of this cocoon, the remark-

able traits of instinct wrapped up in the "woolly bear" will be at once apparent. So fine, indeed, are the strands of silk, and so fragile is the construction of this refuge, that the pupa within is quite discernible. In this silky home the dark pupa remains to hibernate. During the winter months it shows no activity, except that, when subjected to surface pressure, it will move its tail smartly from side to side.

In the spring-time, not very early, the mature moth creeps through the inverted aperture and basks in the sunshine of the outside world. It is a beautiful specimen. The fore-wings are a rich cream colour marked with black patches and streaked from base to tip with light-brown shades. The hind wings display a brilliant scarlet with black spots intermingled. The upper part of the thorax is brownish black, and amply sheltered beneath a thick covering of down. The abdomen is also a fine scarlet with black bars. Why the moth is termed a "tiger" is open to discussion; it has neither the tiger's stripes nor that animal's rapacity.

During the day-time the moth is generally at rest, or merely playing among the wild plants of the hedgerow. It may often be

discovered, when escaping from pursuit, running between the leaves for concealment. It is in the twilight that the moth finds its chief delight, sweeping through the air with an agility that is truly marvellous. To sit in a bower in the garden and watch a couple of Tiger-Moths at play among the flowers, just as the sun is dipping beyond the western horizon, is one of the peculiar pleasures of a summer eventide. It remains a happy memory.

THE ERMINE-MOTH

THE Little-Ermine (*Hyponomeuta padella*) is a favourite beauty of the country-side, and is, perhaps, more numerous in its season than any other moth then flourishing. The aggregate of its ravages in the later larval stage is surprising. Its appetite is then insatiate. And yet one cannot help admiring the quiet simple charm of the mature insect as it flits or jumps abroad in the twilight.

The Ermine is justly entitled to its name. Its white is that of untrodden snow, and bears some resemblance to the colour of the furry denizens of the North American plains. During daylight the moth is sluggish and torpid in its habits, seldom moving more than a few yards from its morning resting-place. Its spotted wings lie deflexed about its body, unfolding only at the impulse of some intruder. Occasionally it will simulate death, and refuse to move one single inch, in spite of the fact that it may be urged along.

The eyes of this insect are compound, and

prominent on each side of the head. The long antennæ form a characteristic feature, and are numerously jointed. The wings are covered with scales of various forms: the "spots" are generally arranged in definite lines, and consist of jet-black scales. The margins of the wings bear longer scales, many being club-shaped at their extremities.

Early in the month of July the Little-Ermynes are abroad seeking a suitable locality for depositing their tiny green eggs. These are generally laid in clusters of from twenty to thirty, near the junctions of the twigs. In a month or five weeks the eggs release their inmates, and the tree assumes a lively aspect. The small larvæ are particularly active, but owing to their infinitesimal character they devour comparatively little of the selected food-plant. This varies very considerably. The choice of the Ermine is not a fastidious one; it may be the apple, hawthorn, or bird-cherry.

From their birth the caterpillars begin the operation of spinning, and the tree is usually sprinkled with profuse webbing, the delicate work of the larvæ in making provision for their winter quarters. At the approach of frosty nights the webs are fairly complete,

and the caterpillars are snugly housed therein for the next five or six months. From the time of their retirement they seldom peep forth again until the spring-time.

When the fresh leaf-shoots appear, the dormant larvæ gather strength, wake from their winter sleep, and come forth to feed on the new leaves. The lapse of a long winter makes them ravenously hungry ; and branch after branch falls to their ruthless attack. The web, which is used by all, is considerably increased during the summer, and makes the tree assume a ragged aspect. Successive moultings have brought the caterpillar to half-an-inch in length. Its bright yellow body is spotted with black on each side of every segment ; and it bears a jet-black head of ample proportions.

The pupæ are formed in the webbing in a peculiar fashion, reminding one of a series of small whistling-pipes. Each larva as it settles in the thin webbing, which is, of course, common property, begins to operate strenuously on its own account, and weaves its own cocoon in the shape of a pontoon, each end tapering off and every cocoon being firmly attached to its nearest neighbour's. Thus the cocoons are built in lines of from six to a

dozen ; and these lines may be from four to six deep. All are arranged vertically, so that, if we imagine a cluster of white spools tied together in twenties, we shall have an enlarged semblance of a group of these cocoons. They are beautifully concealed in the peak-like cavities of the common webbing.

A few days more elapse—about the beginning of August—and the Ermine-Moths burst through the bases of these cocoons, and crawl about the food-plant for a little while. The Ermine is a typical insect for teaching lessons of patience. It seems to say, “There need be no hurry” ; and its whole life-history breathes the same maxim. In the day-time the moth is simply resting, or stepping leisurely from leaf to leaf, for, being smart and natty in appearance itself, it seems to have a peculiar delight in basking in the sunshine on leaves that are as green as emerald. I have noticed that Ermines placed on drab-looking branches have been quite dissatisfied with their position, have immediately gathered up their spotted white tresses, and transferred themselves to lovelier quarters. It is during the evening and early morning that the Ermine sallies forth for exercise. Then on its fragile wings it flits to and fro in a stilting

manner for short distances only. The moth seldom removes a hundred yards from its birthplace ; it is essentially a home creature.

When the egg-laying is completed, the final departure of the moth is at hand. It crawls or jumps to the base of the tree-trunk. Here are many quiet havens of rest where it will find sweet repose for the few days that remain of its existence. We see it no more ; for, before many weeks have passed, another set of insects appears in the soil about the tree-roots, and these account for the disappearance of the beautiful Little-Ermine.

FLEAS

NO work on popular entomology can be said to be complete without touching on the familiar and much-debated family of "Fleas." From at least Swift's day their ubiquity has been realized :

Great fleas have little fleas upon their backs to bite 'em ;
And little fleas have lesser fleas, and so *ad infinitum*.

And certain it is that Fleas play an even greater part in the economy of living things than is yet generally imagined.

Fleas are apterous (wingless) insects, parasitic on mammals. They are blood-suckers of an inveterate type. But, notwithstanding the unwelcome reception universally accorded to them, it is hard to believe that they live and move and have their being among the animals of the great universe without some useful object. It is felt that even fleas must have a positive place in Nature ; and *what* and *where* the sphere of these highly-developed insects may be has occupied the minds of authorities for half-a-century. That Fleas have a negative place in Nature we know : if

animals will not keep themselves clean, the flea steps in and finds an agreeable nidus in the uncleanness of its host.

That Fleas have many points of more than average interest none can possibly doubt. Not many years ago, the City of London boasted a unique exhibition of Fleas capable of performing various remarkable feats and disclosing some strange features of instinct. The show attracted large numbers of people from the metropolis and from the provinces—all interested in the powers and possibilities of the humble Flea.

The insects are of the *Pulex* family, and include members which associate themselves with man, with animals, and with birds. Each Flea has its own peculiarities. The *cat* Flea is not the *dog* Flea. The Flea of the mole is not the parasite of the bat. The distinction is so vital that seldom does the Flea of one animal trespass on the preserves of another. A Cat Flea, for example, will not live and thrive on a dog. The hairs of the latter are too hard and coarse; the cat Flea is more delicate, and seeks food among the silky down of the cat.

The Flea which occasionally disturbs humanity is *Pulex irritans*; doubtless more

frequently encountered than understood. In fact, our natural custom, when we discover a Flea, is to place it between two thumb-nails and end it. This well-established habit has prevented the Flea from being subject to the same circumspection as is given to other types of insect life.

The Common Flea is seldom more than one-sixteenth of an inch in length ; so that it can be examined in detail only under the lens of a microscope. Its round head is punctured with two glaring eyes, and has several powerful appendages, which amply account for its predaceous habits. The eyes are simple, consisting of one round ball sunk into a cavity on each side of the head. But we are chiefly concerned with a suctorial tube which the insect thrusts into the flesh of its host and therewith draws an infinitesimal drop of blood. This tube is flanked by two mandibles with finely-serrated edges, so that about six hundred teeth are presented to the foe. Close by are the two maxillæ, pointed triangular bodies ; maxillary palpi, or feelers ; and sharp-pointed labial palpi. Hence the Flea has quite an array of weapons fitted for his forays.

The body is *compressed*, that is, it is flattened

from side to side like a plaice ; not *depressed* like a skate. Behind the head are three thoracic segments, from which the six limbs subtend ; beyond these are the numerous segments of the abdomen—all composed of a brown chitinous material, which so amply preserves the insect from numerous foes. The limbs are obviously unfitted for walking. The first pair is short and crumpled, reminding one of a deformed cripple ; the second pair is half as long again as the first ; and the third pair is about twice as long as the first. With such eccentricity of proportion, it is impossible for the flea to take its “walks” abroad. It simply crawls upon its host. This disparity of limbs, however, performs another service. The Flea jumps. And the most cursory inspection will show *why*.

Each limb, traced from its inception, contains the coxa, a short thick digit ; a trochanter, a small wedge separating the coxa from the femur below ; then the tibia ; the five-jointed tarsus ; and the foot. The first two pairs of limbs present no remarkable features ; in the femur of the third limb is a strong muscle, which is the source of the Flea’s well-known spring. A Flea is quite

capable of jumping to an altitude of one foot, or about sixty times its own height. It lays its hind tarsi flat on the surface of its support, and, touching the surface with its fore claws, makes a bound much in the same way as the kangaroo makes its leap.

Fleas generally lay their eggs on matting or in rubbish heaps, and *not* upon their human hosts. The eggs are whitish, oval, glutinous objects about one-fortieth of an inch long. They are found in clusters sticking closely together, and may be very numerous. In an experiment tried with a favourite cat the following results were recorded :

Monday night	..	..	62 eggs
Tuesday night	..	..	78 „
Wednesday night	..	..	67 „
Thursday night	..	..	<u>77</u> „
Total for four nights			<u>284</u> eggs

This is not a bad record for the Fleas on a favourite cat which had the “run of the house” ; and rather indicates what a degree of prolificacy Fleas maintain.

The human species generally lays about ten to fifteen eggs ; and these hatch in seven to ten days. The larva is a long many-jointed item, creamy white, and devours solid

food only. It has strong, biting jaws. In ten days it weaves a small cocoon, and passes into the pupal stage—a mummified casing of light-brown rings. Two weeks later, and the mature Flea jumps forth on its career of blood-sucking. Thus the Flea passes through all the metamorphoses of a true insect.

The male Fleas are much smaller than their mates. Owing to this fact, they are sometimes mistaken for other varieties. They are also less numerous, and not by any means so voracious. The females are not only ruthless in attacking their hosts, but very pugnacious toward each other. They occasionally assemble in small colonies as, for instance, in a cat's or a dog's ear, but not for long. There is a dispute in the family, and dissolution follows. They are also extremely partial to living matter. Animal Fleas, like the mites of the beetle, cease parasitic feeding on the death of the host. Fleas are, indeed, parasitic only during a small portion of their career ; that is just about the prime of their lives, until the eggs are deposited.

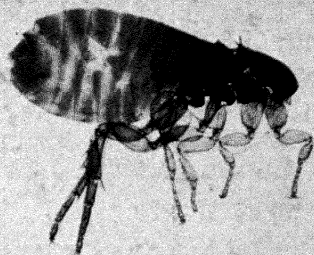
The Fleas of different animals are distinguished mainly by their antennæ, their fringes, and the length of their tarsal joints. The Cat's Flea (*Pulex felis*) is pale brown—

lighter in tint than the human type. The head is hairless, shining, smooth, and spotted with dark-brown dots. The fifth joint of the anterior tarsi, and the first of the posterior are longest. The Dog's Flea (*Pulex canis*) is pale-brown, with the head smooth, and serrated at the back. At the lower part of the head is a comb-like fringe. The tibiae of the hind legs are much expanded. The Flea of the Fowl (*Pulex gallinae*) is dark-brown, with shining, smooth, long head. Behind this is a comby fringe. The first joint of the tarsi is the longest. In the Flea of the Marten (*Pulex martis*) the back and lower margins of the head, as well as the thoracic segments, are distinctly fringed.

The Flea of the Squirrel (*Pulex sciuri*) has the head naked and smooth; and the thoracic segments are fringed above with spiny processes. The Flea of the hedgehog (*Pulex erinacei*) has the head naked, and a spiny fringe on the middle segment of the thorax. The Mole's Flea (*Pulex talpae*) is very peculiar in appearance. The head is shaped much like a miniature saucer, with the under rim as its forehead. Both the head and all the segments are heavily fringed on the upper margins; the last segment is

provided with a tail of bristles. The Bat's Flea has a hairy, prominent forehead, club-shaped antennæ, each divided into plates, and little or no fringe on its segments.

Fleas are not destroyed by mere application of cold water ; hence it is useless to send a dog to swim in a pond with view to ridding it of its Fleas. The insects will live totally immersed for twenty-four hours at least. It is only when water is raised to 120 degrees that it is effective.



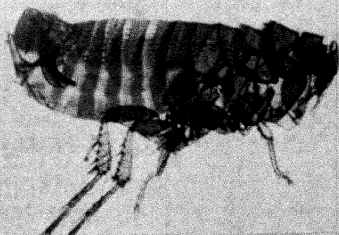
Flea of dog



Human Flea (male)

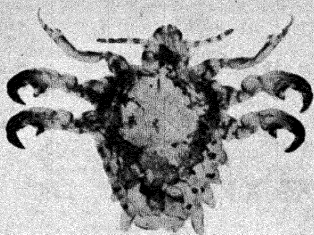


Human Flea (female)

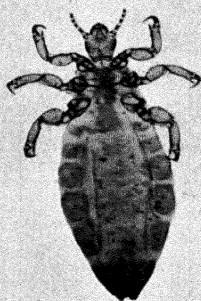


Flea of mole

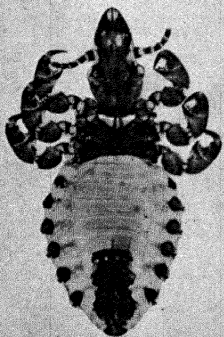
Crab-Louse



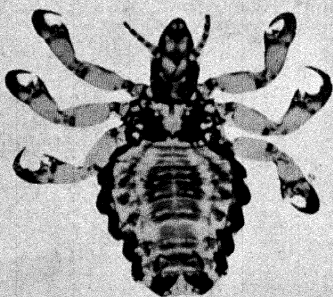
Body-Louse



Head-Louse



Horse-Louse



Pig-Louse

MAMMALIAN LICE

THE sphere of insect knowledge embracing the Anoplura, or Lice, has been much neglected in recent literature. Yet there is surely no reason for shirking a careful inquiry into the life-histories of an interesting class of insects which, though small individually, are among the most numerous and prolific.

Lice are parasitic, but not poisonous. They teach one and all the important lesson that cleanliness is essential to the well-being of man, of beast, and of bird, never troubling that which is clean, except as occasional and negligible trespassers, but ever reminding us that, if cleanliness is not respected, they will act as punitive factors or uncomfortable reminders.

Zoologically they are of unusual interest. The order Anoplura includes several known types such as the Head-Louse, Body-Louse, Crab-Louse, the group of Haemotopini (which are parasitic on animals), and various Mallophaga (bird-lice).

The most widely-known insect of this class is the Head-Louse (*Pediculus capitis*), which almost invariably infests the human *caput* (head). It is a slow but wily creature with six feet, each ending in a double claw peculiarly adapted for clinging to hairs and climbing for food. These feet, as in the case of insects generally, subtend from the small thorax, which bears two division-lines, separating the three thoracic parts, and a medial black mark. The abdomen shows no divisions or segments, but is margined with twelve heavy brown patches, six on either side, each containing a spiracle connected to the tracheal tube within. The head is bold but stumpy; the eyes are simple and prominent; the antennæ are five-jointed; and the mouth bears a short tubular process by which the insect draws a "drop of blood" from its host.

The Louse does not bite: it has no apparatus for the purpose. It simply thrusts the tube or haustellum into the flesh of the host, just up to the region of the blood-vessels, and exercises a suction effort with certain muscles located in the mouth. When not in actual use, the tube is withdrawn into the mouth; so that it is quite unusual to detect the haustellum in a living insect.

It lays an immense number of eggs among the hairs. Each egg is urn-shaped, has a flat lid, and is fixed to the hair with a mucilaginous substance made by the insect itself.

These insects are usually dark-brown in Britain ; in West Africa they are black ; in Japan and China they are bright-yellow ; among the Hottentots of Central Africa they bear an orange tint.

The Body-Louse (*Pediculus vestimenti*) is very similar to the last-mentioned insect, but its head is longer. The segments are scarcely noticeable. As its name implies, it fixes on to the clothing of its host for a home, operating from the textured fabric with its suctorial spear. It seems curious to remember that in the "good old days" of the Tudors this insect formed a welcome addition to the household ; and was suffered to ravish men, women, and children without let or hindrance.

The Crab-Louse (*Phthirius inguinalis*) differs considerably from the foregoing. It is indeed a strange living entity, and not a little puzzling even from the naturalist's point of view. The head bears a close resemblance to that of its congeners the *Pediculi*. The first pair of limbs is provided for walking ; the claws are quite different from those on the

middle and hind pairs, which are used for climbing. Hence the Phthirius can either walk or climb about its host. There is no visible demarcation between the head, thorax, and abdomen. The head is merely tacked on to the thorax, and this merges into the abdomen, which gradually diminishes in width. The abdomen is margined by hairy tubercles, each containing a breathing aperture connected with the trachea running alongside in the insect's body. The insect is about one-tenth of an inch long, and multiplies at a surprising rate under suitable conditions.

Lice do not undergo any metamorphosis. The form they assume at birth is continued through life. They moult several times; and each moult promotes the development and maturity of the insect.

The numerous family of Lice that is parasitic on certain animals is classed under the common term *Haemotopinus*, which embraces several species peculiar to the animals on which they live, each, however, differing slightly from the others. Thus the dog, the cat, the horse, the cow, the rabbit, the hare, the pig, the squirrel, the rat, etc., has each its peculiar *Haemotopinus*.

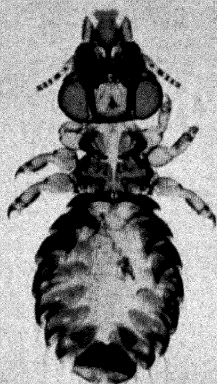
The general type of *Haemotopinus* is striking in its characteristics. It is a dusky-looking insect with an elongated head and five-jointed antennæ. The thorax is distinctly separated from the abdomen, the latter being composed of from eight to ten segments. The thorax is much narrower than the abdomen, and maintains the six limbs, which are doubly-clawed for climbing purposes. The abdomen is margined with black, horny warts, one on either side of each segment, with a white rim round the central spiracle. The limbs are thick, horny, and powerful. In some species the femur is striped with black lines.

The male *Haemotopinus* is smaller than the female, and the segments of its body are more distinct. The suctorial tube is confined within a hairy proboscis when not in use. The insects vary in size from one-twentieth to one-eighth of an inch in length. When they swarm on an animal, they do considerable damage in a brief period, and sometimes seriously undermine the host's vitality.

BIRD-LICE

THE Bird-Lice, or *Mallophaga*, have no suctorial tube with which to prey upon their hosts. Their weapons of attack comprise two powerful, horny mandibles, which chew and gnaw at the skin and the downy feathers. They are not blood-suckers, but devourers of the young feather-shoots with their juices. In doing this work of destruction they often inflict serious injury on the host. They undergo no metamorphosis, but continue in form much as they were when hatched from the egg.

These insects are quite distinct from the mammalian Lice *Haemotopini*, and are seldom, if ever, found on man or animals. Not only do they confine their activities to birds, but they are partial to certain birds and even to specific parts of the same bird. The damage occasioned to fowls, in particular, is alarming; and poultry-keepers are becoming fully alive to the necessity of holding the insects in check. The attacks on young chicks are responsible for a considerable depletion of stock every



Parasite of Fowl (Decophorus)



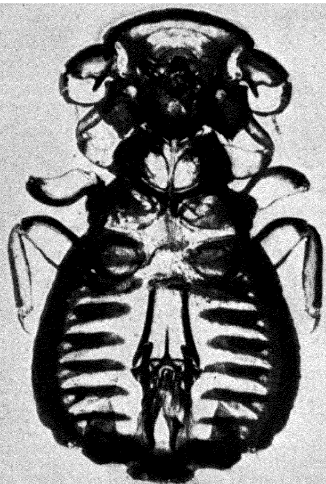
Parasite of Fowl (menopon)



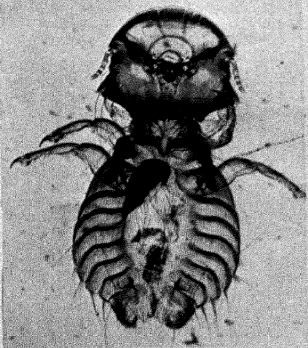
Parasite of Duck



Parasite of Bantam (Gonicolus)



Parasite of Peacock (Goniodes dissimilis)



Parasite of Sea-Gull



Parasite of Pigeon (Liposorus)

year : young birds are believed to be suffering from cold or from wet, but the chief cause of their undoing is often the injurious Mallophagan parasite.

Eight different species of Bird-Lice are known on British birds. These prey upon fowls, ducks, geese, swans, pheasants, turkeys, and pigeons ; swallows and martins appear to be specially prone to the attacks of these parasites.

Goniodes dissimilis is brownish-grey in colour, with certain markings that distinguish it clearly from other Mallophaga. The head is broader than it is long, and bears two massive jaws, which chop the slender feathers. The thorax is divided into irregular segments, each bearing a pair of limbs fitted for either walking or climbing. In front of the mouth is an array of black bristles. The antennæ are short, the first joint being most fully developed. The eyes at first appear to be compound ; but on closer examination they are found to be a cluster of simple ocelli near the extreme side of the head. Sundry dark-brown markings on the abdomen indicate the segments, which may be either eight or ten. At the base of each patch is a white spot with the aperture of a breathing-spiracle.

The anal segment is bifurcated. The insect is about one-twelfth of an inch long, and fixes its habitat under the wings and about the rump of its host.

Goniocotes hologaster is smaller than the last-mentioned, and much more prevalent. The head is shield-like in shape, and of a yellow colour. The number of its bristles renders it easy of identification : it invariably has two straight bristles thrust forth from the side of the head. The body-segments are clearly defined ; each has a broad, brown border, and a dash of brown near the medial line. The antennæ are longer than usual and are five-jointed. The insect measures about one-twenty-fifth of an inch in length, and for close examination requires the aid of a microscopic lens.

Goniocotes gigas is a larger specimen of the same family, but is comparatively rare. Its body is finely segmented, and bears significant brown patches on a yellow ground. Geese, turkeys, swans, and owls are its hosts.

Lipeurus variabilis has quite a distinct form. It is a small insect, only about one-fifteenth of an inch long. It is yellow, and bears a few dark-brown bands and spots on its thorax and abdomen. The thorax has

also a larger central disc. The elongated shape of the body is characteristic. In front, the head is circular, with a delicate fringe of brown filaments. The limbs are clawed for walking or clinging to the feathers. Every segment of the abdomen is flanged by two or three bristles; the anal segment is bifurcated. This insect is widely distributed among birds; and wherever it fixes its abode it is extremely prolific. In fowls, especially, it finds an eminently suitable nidus, as the temperature among the downy feathers is about 104 degrees Fahrenheit. The insect has a preference for wing-feathers.

Lipeurus heterographus is very similar in shape and habit to the last-named, but its head is more oval. It is also smaller, being only about one-twentieth of an inch long. Each abdominal segment bears a tubercle with six filaments. This Mallophagan is somewhat rare.

Menopon pallidum is about one-twelfth of an inch in length, is dark-yellow, and has a series of markings on the flanks of each abdominal segment. On each of these patches are two white dots indicating the breathing-apertures or spiracles. Every segment bears

from ten to fifteen filaments. The claws on the limbs are well marked and strong. The head is triangular, with acute corners at the base ; the body is hard, leathery, and smooth.

The insect is much in evidence when birds are being handled for any purpose. Then they leave the feathers, and jump on the hand freely. They are very abundant on domestic birds of all types, and have been found in large colonies on wild birds.

Philopterus docophorus presents rather a formidable aspect, although only one-sixteenth of an inch in length. It is chestnut-coloured, has a shining integument, and is covered with grey hairs. The head is triangular, with bold features at the mouth used for crushing and chewing. The eyes are compound, large, and glaring. Antennæ are five-jointed, and supported at their insets by sheaths. On either side of the mouth is a movable organ (or *trabecula*) which assists the insect in its maxillary operations. The head and thorax are joined by a narrow neck ; and from each segment of the thorax springs a two-jointed limb with a single claw. The body is segmented in from ten to twelve parts, and flanked by hairy plates, which enclose the

spiracles. This insect is common on all perching birds.

These Mallophaga do not undergo the usual transformation from larva to pupa and imago. The females lay minute eggs on the feather barbs ; these eggs are ovate with flat tops covered with lids. The marking of the egg is quite unique. It presents a series of regular hexagons. Delicate silken fibres are spun by the insect to fix the egg to its support. Obviously, these silken threads must be extremely fine ; about a dozen suffice to hold the egg in proper equilibrium. In about seven days the egg hatches, and evolves a pale-white Louse similar in form to the mature insect. This moults from ten to twelve times before attaining full size.

The Mallophaga are more tenacious of life than is often imagined. They have been kept alive for nine months, under favourable conditions. Considering the enormous rate at which they multiply, it cannot be gainsaid that they play an important rôle in the insect world.

THE END

