

TEN LITTLE HOUSEMATES

KARL VON FRISH

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Metrical measurements have not been converted in this translation. For *the* convenience of those who are not familiar with the metrical system, the following approximate equivalents are given:

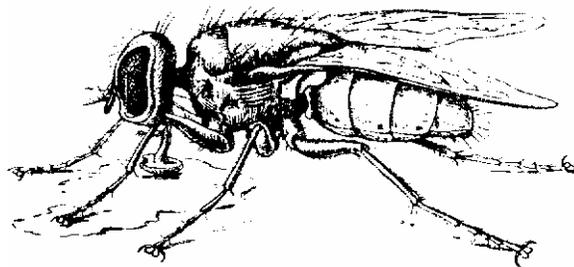
1 kilometre (km) = 1,000 meters = 5/8 mile

1 metre (m) = 100 centimetres = 3-1/3 feet

1 centimetre (cm) = 10 millimetres = 2/5 inch

1 millimetre (mm) = 1/25 inch

THE HOUSE-FLY



A WEARY man has settled down for a well-earned nap after his midday meal on a hot summer day. All around is peace and quiet and his thoughts are just drifting over the frontier of dreamland when a house-fly, after cruising several times round the room, feels that the only place where it could possibly relax is on the man's forehead. It neither bites nor stings, but it tickles. Too nimble to allow itself to be caught and too silly to learn from experience that the human face is not the best air-strip, such a fly can drive all but the most placid to distraction. No, there's no doubt about it —the house-fly is a troublesome creature!

If on the other hand, this happens after the first winter has fallen; the man will probably not be so cross. For at heart he is interested in all life. Outside, trees and plants

have not yet awakened from their long winter sleep. Most of the lively birds have disappeared. Not such stay-at-homes as we they are now enjoying life under sunny blue skies, while the butterflies and all the tiny creatures that populate the air in summer seem to have died. We almost welcome the sight and the sound of a fly in our room. It's not a "troublesome creature", we think, not even a nuisance. We are inclined to look at it as one of Nature's handiworks and to wonder if there is not something nice about it after all.

Everyone must admit that the fly is a trim little creature. And it does seem to set store by cleanliness; at least it doesn't scamp its toilet, for we often see it giving itself a brisk and thorough cleaning of head, wings and legs. Surely it deserves a good mark for cleanliness! On the other hand, some of its habits are bad enough to make it nothing short of dangerous. So we won't sing its praises before learning more about its nature. Order-loving as we are, we shall first try to put the fly in its proper place in the animal kingdom.

Where the fly belongs, and what distinguishes it from man

Naturalists are inquisitive. Not content with observing the outside of an animal, they always want to know what it looks like inside. For centuries they have been cutting up all kinds of animals and studying them from every angle. The knowledge they have gleaned fills volumes, but we shall leave those to the scientist and pick out only a few essentials from their store.

If we dissect a dead dog, a crow, or a lizard, a newt or a carp, we always find bones inside; they provide a firm support for the body and give it its shape. The spinal column is the axis of the skeleton, and from it the ribs branch off to form the thorax. It carries the head in front and the bones of the limbs are connected with it by means of the shoulder and hip girdles. In spite of their many specific differences, the bones of a dog, an eagle or a carp all have the same basic structure and can easily be inferred from each other. Other physical characteristics also are unmistakably related; order-loving zoologists have therefore found it useful to place all mammals (including man), birds, reptiles, amphibians and fishes in one category or phylum and to call them vertebrates, after their most striking characteristic.

To get dry facts over and done with, we may add that, on the same principle of grouping together creatures that are similar, six other phyla of animals have been established: firstly, the protozoa (unicellular organisms), to which the most primitive animal forms belong. Some of these are too small to be seen by the naked eye, so that that we can only appreciate their beauty when we look at them through a microscope; secondly, the hydrozoa with the coral polyps and the jelly-fish; then come the worms and the molluscs (including the snail, the shell-fish and the octopus) and other forms which are more familiar. The echinoderms, which include the sea-urchin and the starfish, are probably not unknown to most of us. The arthropods with all the crabs, the millipedes, the spiders and the insects form the largest and most varied phylum. And it is to this that the house-fly belongs.

Man has given the vertebrates the first place in this system, regarding himself as the lord and king of creation, but in actual fact it is not at all certain that the insects are not better developed. Today throughout the globe about 70,000 different species of vertebrates are known, but there are 750,000 different species of insects. Of all the kinds

of animals of which we have any knowledge, three-quarters are insects. In creating them Nature has given unrestricted play to her imagination and she has blessed them with unparalleled fecundity. For what are the masses of people that crowd our cities or even the uncountable shoals of herring compared with the insects swarming in one single wood? There, wood-ants build whole ranges of hills, each mound being a home for thousands of insects. Everything, from the tree-tops humming with industry to the moss-covered soil under foot, buzzes with the ceaseless activity of myriads of living creatures. The observant eye sees them and traces their every step, though most people are not alert enough to notice them.

Yet man loses no time about acting up and taking notice once insects poach on his preserves. Then the *lord* of creation brings out all his big guns, though he does not always win the battle. When the nun, or night-moth, and other butterflies multiply too much for his convenience, he attacks them from the air and sprays insecticides on infested forests. He sends whole armies out to halt the advance of the Colorado beetle, even destroying his own crops in order to stamp out pests. Though he spares neither money nor effort, he has not yet managed to rid the earth of troublesome insects: he must be content with keeping them within their proper bounds. And he does not always succeed in doing even that. In wide areas of Brazil, for instance, the best laid schemes of planters have been wrecked only because of the existence there of leaf-cutter or parasol ants. They strip trees and shrubs bare with their sharp jaws, especially those with young, tender leaves, and do the *job* thoroughly. They carry their booty to their nests where they prepare a compost of the foliage for growing fungi, their main diet. Man with all his cunning has not yet devised any means of compelling these ants to beat a retreat. Nor has he found any means of combating the lust for destruction displayed by the termites in the tropics, nor can he do anything about the swarms of gnats or mosquitoes that make it impossible for civilized man to live in the vast tundra's of Northern Asia in summer. The tiny insects have often hitherto proved to be the stronger opponents.

Whereas in those cases man is vanquished solely by force of numbers, the structure of the individual insect's body gives it an added advantage. In many respects it is equal or even superior to the human body; only that in their case Nature's method of solving problems of function differ from those she employs in vertebrates.

Insects have no vertebral column — indeed no bones at all. Instead, they have an outer skin which gives them a firm frame. In it they are encased as completely as the medieval knight was in his coat-of-mail. But the insect's armour is not made of steel, but of chitin, a superior material. It is hard, as you can feel if you touch a beetle, and yet so light that it scarcely hampers its wearer in flight.

Of the vertebrates, only the birds and the bats have mastered the secret of flying, and in acquiring this art many adaptations and radical modifications were necessary. To insects, on the other hand, flying came naturally, as it were. They beat their wings often at a tremendous speed. A house-fly can do this 190 times in a single second. We are lost in admiration of the dexterity of the violinist's fingers when he enchants us by playing trilled notes, but he actually touches the string only seven or eight times a second. It is also because the fly is so very quick that it can so easily evade every attempt to catch or swat it. Has it then greater presence of mind than we? Perhaps it has merely a different sense of time, so that for a fly a second of time, in which it can beat its wings unhurriedly

190 times, is ample for a cruise through the air or long enough to make a leisurely escape from imminent danger.

If an insect were able to make comparative studies, it could only smile with pity at our breathing apparatus. We take air into our lungs through our two nostrils; the oxygen in the air is necessary for life in every part of our bodies. Not a muscle, not a single gland-cell, not the tiniest corner of our brain could live and work without oxygen. That is why the heart must pump constantly and drive the blood through the arteries. It supplies all the parts of the body with oxygen from the lungs with the help of no fewer than 25 billion red blood corpuscles. An insect has many "nostrils". They are located all along both sides of its body. They lead into tubes which ramify into a fine network of tiny vessels filled with air. These pass through all the organs and provide them with a direct supply of the oxygen they require. Could anything be simpler? So the heart has little to do: it is a thin tube which contracts without any great hurry, since its whole work consists in keeping juices and nourishment circulating throughout the body. The fly has no arteries such as we have, and therefore no arteriosclerosis either and no disturbances of the circulatory system.

And the amazing miracle of the insect's eye! In the case of the fly, the eyes take up practically the whole head; in other insects they are considerably smaller; but they are always composed of a great number of single eyes. Like minute telescopes, these eyes are packed closely together and can look in every direction at the same time. They register tiny sections of the field of vision, which are composed to form the complete image just as stones fit into a mosaic. Compared with our eye, where the image is formed on the retina, it is a different, but not a worse, way of seeing the world.

As far as smell and taste are concerned, many insects are far better off than we are. Their fine sense of smell has nothing to do with their many "nostrils", for their organs of smell are quite independent of their breathing apparatus, being situated in the antenna. How acute the fly's sense of smell is may be seen from the swarms that gather in a trice on decaying animal or vegetable matter, or on any freshly deposited excrement. These happen to be tit-bits for the fly. Their sense of taste is remarkable not only for its keenness but still more for the location of its organs. Many insects taste not only with the mouth-parts but also with the tip of their feet. A house-fly running round our breakfast table notices at once if it is treading on a drop of marmalade - a most convenient arrangement for creatures who are accustomed to find their food on the ground.

We have discussed only a few of the fly's organs. There is no need to do more. I merely wanted to show that flies are different from us in many things, and in many ways nearer perfection. In one respect, however, we are far superior, namely, in the development of our brain. Here the fly is on a much lower level. The fly's actions are mostly prompted by inborn instinct and not by reason, or reflection. This is another distinctive mark of this phylum of animals. Our relations with vertebrates can to a certain extent be more than merely physical. Our dog looks into our eyes trustfully, and we can make friends with a bird whose company we have enjoyed for some time; even so primitive a vertebrate as a salamander learns to know us and will come expectantly to the hand that offers it food. No matter how long we spend with a house-fly, we never make friends with it.

How to recognize a fly

Not all flies look alike. You may not have noticed that they differ in form and colour, and that they may even have different faces. But everybody will have noticed that there are big flies and small ones. I hope nobody thinks that the small flies are young ones. Actually, things are much the same with flies as with butterflies, where the larva: that emerge from the eggs have nothing in common with the adult insects: in the case of butterflies the larvae are called caterpillars; in the case of flies, maggots. A maggot grows into a pupa, out of which after a longish rest the winged insect appears as big then as it will ever be. So the big, fat bluebottles often found in the company of house-flies are not old, well-nourished specimens, but members of another species, just as ducks and geese are different species of birds.

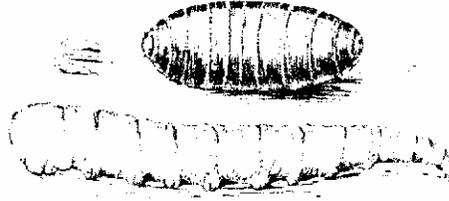
We have all heard of people who make a life-long hobby of collecting beetles or butterflies. There are also people who collect flies. Most of us might not be attracted by the idea of collecting house-flies and fat bluebottles all our life. Yet more than 40,000 different specks of flies have been described up to date. It can actually be a pleasure, indeed a passion, for lovers of Nature to stalk and observe flies, to collect and classify them. The variation in their habits and their shapes is astounding, though the observer will some-times be unable to see them without the aid of a magnifying glass. There are also giants among them, big hairy creatures, more like bumble-bees; others have black and yellow markings that remind us of wasps; others again — the gnats — have an elongated abdomen, long, narrow wings and still longer legs. If you catch one of this species by the legs, you will find yourself left with legs between your fingers while their owners escape. The same thing happens when a bird snaps at them: they quickly amputate the leg that has been trapped — better life with five legs than death in the dark inside of a bird. But there are more varieties of flies than I can describe. However much they differ in appearance, all flies have one feature in common: insects as a rule have four wings. Every child who has drawn a butterfly knows the shape of its broad fore and hind-wings. In bees and wasps the division between these is not so distinct, and you have to look carefully to see that they actually have four wings. When a may-bug settles, it tucks its fragile hind-wings under its heavy fore-wings — but four wings there are always. It is only the flies that make do with two wings, and that is why this order of insects is called “two-winged” (*Diptera*). So if you want to make no mistake about recognizing a fly, you need only be able to count up to two.

To be quite exact, flies really do possess four wings just like the other insects, but the hind pair have degenerated; they can no longer aid in flying and are called balancers or halteres, serving now only as the site of sense organs.

Life-history

Let us return to the house-fly. We know how it flies round and round lamps, we watch it climbing with the greatest of ease up the smooth surface of the window with the of little sticky pads at the end of its legs, and we often it enjoying a hearty meal at our breakfast table without so much as a by-your-leave. But where was it born? Where does the mother-fly retire to when she wants to lay her eggs? We have grown so fond of her that I am ashamed to reveal her secret: she prefers to make her “nest” on pig-manure! Where there is none, on horse-manure or an any manure-heap in the open. In bad or cold

weather, on manure in a warm stable or cowshed. And if that is not at hand, on any decaying matter that is equally unsavoury. Since it is not customary to keep manure or other decaying matter in rooms, we cannot observe the process of reproduction in-doors, except for the brief union between males and female that takes place in a whirl of flight.



Three eggs, larva (below) and pupa case. Magnified 5 times.

After about one day, or half a day if it is warm, the whitish maggots emerge from the eggs and fall on the decaying matter their mother has so kindly provided. They thrive on it and after about six days growth is complete. They have put on about 800 times their weight at birth. Just imagine a baby of 6-7 pounds at birth “swelling visibly” in less than a week into a monster weighing about 4,800 pounds! Here again, insects put man completely in the shade.

You cannot see the maggots growing. They stay under the surface of the dunghill — or wherever the mother has laid her eggs. If they are uncovered they wriggle out of sight very quickly — and wisely. For not only are they safe there from birds-early and late-but they need warmth and moisture, and would shrivel up in no time if they were ex-posed to the air.

When the maggot is fully grown, its outer skin hardens into a long, round, brown case, in which the pupa is hidden. It seems now as if life were extinct. But secret forces are at work under the hard case, transforming the flabby maggot into a winged insect. This process takes about a week, after which the fly bursts from the shell of the pupa to emerge into the light of day.

In their winged state, many insects live for only a few days or hours. Many at this final stage are not even equipped by nature with anything in the way of a mouth, and are un-able to eat. There is little sense in taking time to eat when life in any case is a matter of hours only, purposeless once the eggs are laid, a business in which little time is lost. The house-fly is *not* so short-lived. It begins to lay eggs about three days after abandoning the pupa case, and can still pro-duce progeny two months later. Of course it must be well fed; we can see for ourselves any day that the fly has no use for fasting. It sips now fruit juice, now sweet dregs left at the bottom of a teacup, or it alights on a lump of sugar, which it taps with its proboscis and moistens with saliva so that the sugar dissolved in it can be sucked up; at other times it enjoys tit-bits that we would not like and that certainly would not like us.

A house-fly can lay about 100 eggs in one batch, about 1,000 in the course of its life. If all the maggots hatched into flies and reproduced at the same rate, a single pair would produce 500,000 flies in the second generation, 250 million in the third, and in the fourth 125,000 million, i.e. more than six times the human population of the globe. If we remember how quickly one generation succeeds another, we can imagine that the descendants from one pair of flies would soon blacken the sky: we should be wading in

flies and be suffocated in flies. This does not happen because most of them die at the larval stage, partly as a prey to countless foes, partly as the result of bad weather and other misfortunes. Once we realize how enormously they could increase under favourable conditions, we can no longer be surprised at the swarms of flies in or near stables and pigsties with their perfect breeding places, or in southern countries with their ideal environment of warmth and dirt.

Where do house-flies spend the winter?

Autumn is a hard time for our house-flies. The colder days do not suit them at all. Still worse is a plague that works great havoc among them in late summer and autumn, when fed flies with twisted legs can often be seen on windows or walls, stuck fast to them by a filmy web of fungus threads. They are victims of “fly-mould”.

They have been attacked by a mould or fungus that starts growing inside their bodies, almost unnoticed at first. It swells till the victim shrivels up and dies. Then the fungus grows out of the “corpse” and scatters its spores, which will eventually destroy other flies.

Yet just as the worst of plagues has never swept airmen from the earth, not all flies are exterminated in autumn by this disease. The survivors have to see that their families get through the winter. Animals have different ways of getting over the cold winter. Many birds escape it by flying south, others put themselves on short rations and get through as best they can; the cross-bill alone is wise enough to make the seeds of conifers its main diet, so that it hatches its eggs when these are abundant, and can rear its young even in the iciest winter weather. For all kinds of deer winter is a weary time of fasting; the hamster feeds on what it has hoarded during the summer. In the insect world, the bees follow the same plan and get through the winter fairly well, if man does not take away too much of the honey they have harvested. Dormice, lizards and frogs preserve their lives by a long, deep winter-sleep: all the metabolic processes in their bodies slow down to a minimum, the fat they have stored in their bodies supplying all the food they need.



A victim of fly-mold

Very many insects live through the winter in sheltered places in the pupal stage, this being anyhow a time of rest. This was what the house-fly was thought to do. But though many species were seen to hatch from the great number of fly pupae collected in the open air during winter, the house-fly was not among them. House-flies seem to feel the cold very much and are evidently unable to survive the period of ice and snow in the open air, at least in countries with a severe climate. They live up to their name and are more attracted to living rooms and cowsheds in winter than in summer. Where there is manure, they can breed even in winter, though not so quickly as in the warm days of summer.

These little housemates of ours, then, belong to the few species of insects that do not dodge winter by hibernating.

In towns, during the winter, their chances of breeding are few. Even in the country they have a hard struggle against disease and bad weather. How is it then that they appear again in full force and so quickly soon after the arrival *of* spring? The reason probably is that they are not really stay-at-homes. If they feel the urge to travel, they fly considerable distances. So when the weather is favourable they are soon dispersed from their breeding centres. Two American naturalists took the trouble to mark a quarter of a million flies with paint. Traps had been set over a wide area at varying distances from the place where the swarm of coloured flies was released and a great many of them were caught. Thousands had flown about one kilometre from the starting point, and some were caught after having flown up to twenty times as far. Such light aeronauts have no difficulty in quickly spreading from a country area over a whole town, as has actually been proved.

How house-flies can be dangerous

We find house-flies a nuisance, particularly when they appear in swarms. But are they dangerous?

They leave tiny black specks wherever they settle for any time —signs that their digestion is in good order. But there are other traces, too; less obvious perhaps, but just as easy to detect: these are caused by the fly's habit of regurgitating tiny drops of food it has already swallowed. Their way of leaving droppings from both ends on whatever takes their fancy —sugar, bread, sausage, cake —is not exactly appetizing. Nausea is often the reaction of a sound instinct, as it is in this case. For the fly's dirty habits can be really dangerous to us.

We have seen that flies are not particular about what they eat. Their bill of fare includes cow droppings, human excrement (if available), the milk in our glass, or our sausage. Suppose, in the interest of clarifying our ideas, we forget the decrees of good manners and delicacy, and have a look at our own excrement through a strong microscope; if we look closely we shall see myriads of tiny living creatures in the now shapeless waste matter; these are the lowest form of vegetable life, fission fungi, also called bacteria *pr*, bacilli. They live their lives hidden in our intestines and thrive on our meals, all unseen. They multiply so profusely that billions are evacuated with every stool. They are so tiny that it would take about five thousand of them laid end to end to make a chain big enough to go round a fly's head. Slender as the fly's proboscis is, the bacilli are much thinner still, so that they are easily sucked up and later ejected on to our food in the way we have described. So, blissfully ignorant, we consume the bacteria flies have already absorbed from the excreta of others. And that is usually harmless, but not always.

As a rule, the bacteria regularly found in the human intestine do no damage, but they may include dangerous germs. Typhoid fever, for instance, is caused by a certain kind of bacillus which multiplies enormously in a sick person, masses of them often being found in his stools. They have such a power of resistance that they cannot be digested by a fly and emerge from its anus as lively as ever. The same applies to tubercle bacilli and similar scallywags.

So we see how the house-fly may spread a fatal infection. The danger is all the greater because the fly's legs and mouth can also come into direct contact with filth. Naturally it won't have much opportunity to do so where cleanliness is the rule and where modern sanitation takes care of what flies hanker after. But if we think of habits in the country, of poverty and war, we shall understand the verdict of the doctors, with considered the fly-plague the most important cause of the great losses by the American forces in the Spanish-American War of 1898. During that campaign typhoid fever killed about ten times as many soldiers as Spanish bullets did, and flies were the chief carrier.

All this is ancient history, and things have greatly improved in the meantime, but the danger still exists even today, though to a lesser degree.

How flies help doctors

Fault-finding will now be followed by praise. For flies can be useful, though, to be accurate, this is less true of our housefly than of its near relations — the fat bluebottle or the black-and-silver flesh-fly. They prefer to breed on decaying animals, bad meat, etc. The wriggling maggots the house-wife is horrified to find under game that has lain too long in the larder are generally the larvae of bluebottles or flesh-flies.

Many insects refuse to touch anything except the food their parents and ancestors have lived on for centuries. There are butterfly caterpillars, for instance, which thrive only on one distinctive fodder-plant and would rather starve to death than eat the leaves of other plants, however closely related in species they may be. Flies are not so particular. If there is no decaying meat at hand, they have no objection to overripe cheese, or a festering sore. As long ago as Napoleon's day, army doctors had noticed that a wound swarming with maggots often healed amazingly well and quickly. The reason seemed to be that the maggots eat inflamed, morbid flesh and so cleanse the wound. Furthermore, their droppings stimulate the surface of the wound and so help the tissues to grow and the wound to close.

As a result of these observations many doctors, Americans leading, have in recent times had the courage to deliberately put maggots in wounds that were not healing well, above all in the case of obstinate inflammation of the bone-marrow. These poor maggots, it is true, had to put up with all manner of baths and cleansing processes to which they were not accustomed by nature. But the ablutions they have to suffer evidently do them no harm, and they give the doctor a guarantee that he is not introducing any undesirable germs into the wound along with his strange little helpers. Carried out in this way, the method has yielded excellent results.

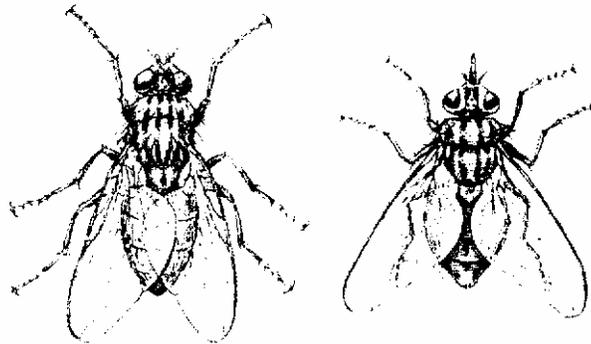
Biting Flies

Who has not discovered that there are house-flies which bite? These, however, are not bad-tempered members of the house-fly family but a different species, though very similar in size, shape and colour. The scientific name of the former is *musca domestica*, i.e. the house-fly, while zoologists have given the latter the imposing name of *stomoxys calcitrans*. *Stomoxys* means "sharp mouth" and that indicates the characteristic difference between the two species. Instead of the house-fly's suction proboscis with a harmless lobe at the end for dropping liquid, the stinging or gadfly may easily be recognized by its

protruding stylet. Another difference is that when they squat, their wings are farther apart. They are just as annoyingly persistent as the house-fly. We may flip them off our legs ten times and back they will come to bite us another ten times. Not that they delight in teasing us, but just because they want to feed on blood, as Nature has decreed.

It is a good thing for us that the gadfly is more attracted to cattle than to human beings. They sometimes distress cows so much that their supply of milk suffers. Gadflies also like to settle on horses and other domestic animals, and sometimes, quite harmlessly, on juicy fruits. In autumn their love of warmth drives them indoors and we become more aware of their presence. Hence the myth that houseflies begin to bite in autumn.

Their habits are similar to those of the house-fly, and they develop in the same way. Having saved the house-fly's honour by showing that the two species are not identical, we shall take leave of its bad-tempered counterpart.



House-fly (*left*). Gad-fly (*right*). The gad-fly's protruding stylet and the different posture of its wings make it easy to distinguish between the two species. (Magnified about 3 times.)

Protection from the house-fly pest

House-flies can become a pest in houses situated near cow-sheds, dunghills and similar places where flies like to breed.

We do not intend to discuss here ways and means of reducing their numbers by taking hygienic measures in cowsheds or by special methods of treating dunghills. We accept their existence and are only interested in knowing how to rid ourselves of flies in our homes.

Fly-glue is a good remedy. It consists of one part honey, three parts castor-oil and six parts resin, and can be made at home from the following recipe: Heat the resin and the castor-oil —carefully, as the mixture is inflammable — then add the honey, stirring all the time. Spread the glue on strips of paper or rods, and hang these preferably under lights or in other suitable places in the room.

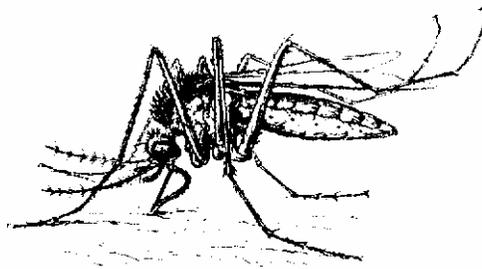
Instead of enticing flies to a sticky death, they can also be poisoned: Dilute milk or flat beer with the same quantity of water and then add formaldehyde (4 per cent, solution), which can be bought at any chemist's, in the proportion of five parts diluted milk or beer to one of formaldehyde. Sweeten the liquid with a little honey and pour it on shallow

plates containing little pieces of bread on which the flies can sit in comfort while they sip the fatal potion.

During the Second World War a new insecticide was discovered — DDT. These three letters are an abbreviation of the poisonous dichlor-diphenyl-trichlorethane, the full name having a meaning only for the professional chemist. During the war flies, lice and other vermin were not only a nuisance but also a grave danger as carriers of infection. DDT proved a simple way of destroying them with a thoroughness hitherto unknown. Paul Muller, a Swiss, who first produced the new insecticide, was awarded the Nobel Prize for his discovery in recognition of his services to hygiene. DDT is mostly used in powder form. It is a “contact poison” Insects need not eat it. If they only come in contact with it, they will die slowly but surely within a few hours or days. This insecticide does not harm human beings or domestic animals if it is used in reasonable quantities and according to the instructions. To keep down house-flies it should be dusted on window-sills and on the frames of window panes. Unfortunately, in countries where much DDT is used, families of flies have developed which are immune to this poison. Nature has a way of providing her creatures with a loop-hole of escape when wily man thinks he has caught them in his nets.

Here, as elsewhere, prevention is better than care. The best thing is not to let the flies into the house at all, and then there will be no need to devise means of combating them. Screens can be fixed before windows or doors, though of course they reduce the supply of light and air. And flies can be kept out if care is taken to shut the windows before the sun comes, for they enter the house only through windows on which the sun shines. The saying that a closed mouth catches no flies applies to our houses too. So if you must let the sun in, you will just have to put up with the flies.

GNATS



GNATS, the common mosquitoes of America, are “flies”, too. It is true that their tapering, slender body and their long, fine legs make them look different from the stout blue-bottles. But we must not let ourselves be ‘misled by mere looks. Gnats have only two wings and therefore they are flies. As with all members of this group, the hind-wings are represented by small balancers. When one is in the right mood, solitary specimens of the house-fly may not be un-pleasant. But gnats — sometimes called midges — can never be pleasant. They have a treacherous-and often silent mode of attack and we don’t feel them piercing our skin with their fine proboscis. The proboscis, for biting and sucking, lies in a sheath which is open in front and which bends back when the proboscis is in action; the lower end rests the while as a guide and support while the skin is being pierced.) but their bites itch all the more intensely.

Why gnat bites itch

Many people classify animals as either useful or harmful. Actually they are surprised that there is such a thing as a harmful animal: they simply cannot get rid of the idea that man walks the earth as the centre of creation and that everything else is there merely to serve him.

Anyone who looks round with open eyes will form a very different picture. He will notice that the humblest of living creatures are just as well equipped for the hard struggle for existence as the arrogant human race. We have already seen that the insect's breathing organs compare not unfavourably with our own; in gnats the organs of flight reach a high level of perfection, and every mechanic must admit that their proboscis is a masterpiece of ingenuity as regards both structure and mechanism. Why has Nature decreed that their bites should itch? Would it not be better for them if their contact with us were painless? We should not then have any occasion to swat them when we catch them biting us. There is plenty of evidence, however, to show that the irritation we feel is only the necessary consequence of an arrangement that is very convenient for the gnat.

The sight of a delicious dish makes our mouth water, which is only a short way of saying that the very sight of food stimulates our salivary glands to produce the secretion that helps us to swallow and digest it. The gnat, too, has salivary glands and its mouth waters when it settles to have a meal off us, though here the purpose is different: after it has pierced the skin, it deposits through the proboscis a tiny drop of liquid, which acts as a poison. It irritates the surrounding tissues and quickly produces a local inflammation. This is connected with an expansion of the blood vessels, which in turn leads to an increased flow of blood, as the redness round the puncture shows. We feel the effect of the poison as pain, and that may be fatal for the gnat. And yet this droplet, so inconvenient to us, is essential to the gnat, since it alone makes it possible for the hair-like proboscis to get at the food. In addition, the gnat's saliva has the extraordinary property of preventing the blood from congealing, so that the narrow passage of the proboscis cannot be blocked by any clot.

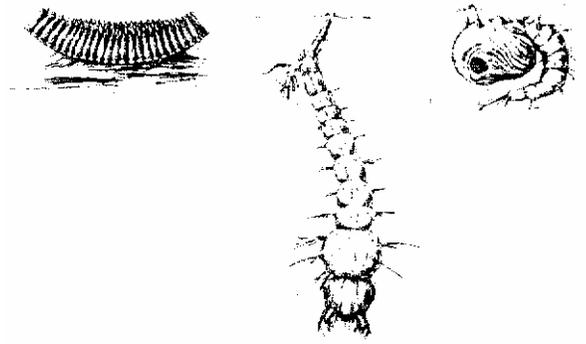
It is lucky for gnats that cattle are not so sensitive as we are. In spite of the irritation caused by their bites, they are often allowed to finish their meal in peace.

General remarks on blood-sucking

In a certain sense gnats are specialists as far as food is concerned. We never see them settling like house-flies on sugar or bread, on meat or unsavoury waste matter. They want to feed on blood, and it must be that of warm-blooded animals. Newts or lizards are not good enough for them, but they are not particular whether they get their nourishment from a human being, a cow, or a bird. Man is by no means their only victim. When considering their lust for blood we must make one important reservation: it is only the female gnats that suck blood. Nor are they a reprehensible exception in this respect, for there are other similar cases. Blood-sucking gad-flies, for instance, which often spoil the pleasure of bathing, and other big, fat horse-flies, sometimes a plague near cattle pastures, are always females. The males disport themselves on flowers and sip honey.

Is this because the females have a particularly malicious temper? Not really. There is good reason for this difference in the activities of the sexes. The female must bring her eggs to maturity. Compared with the reproductive cells in the male, the female's eggs are large and full of nourishment, later to be drawn on by the young life in her body. The skinny female gnats have no abundance of food in their bellies and so must first collect the material required to build up their germ-cells and to nourish their young. That is why they feast on blood. Blood is not a bad food. The stream of life flowing through our veins is laden with many good things, which are necessary for building up and developing cells. The male gnats, however, can collect the little food they need for their short span of life more simply in another way.

How a pest on land comes originally from water



The eggs of the gnat, or common mosquito, float all in a clump on the water like a toy boat. The larva (*centre*) and the pupa (*right*) live in the water, but breathe air on the surface through tubes. (Magnified 5 times)

Gnats constitute a pest only near accumulations of water, and the reason is not far to seek: they must have water if they are to reproduce. The females lay their eggs on the surface of water, many species lay also on damp ground, whence the eggs are washed into puddles by rain. When the larvas emerge, they dive down into the water and stay there during the entire period of development. Under favourable conditions this takes only about a week, but considerably longer if the weather is cool. In contrast to their mother, the larvae are harmless vegetarians and make do with some decaying vegetable matter; many species prefer animal food, and the myriads of tiny creatures living in the water provide a varied bill of fare.

One end of their bodies has access to the air, from which they have come, for their respiratory organs must be supplied with air under water, too. The larvae of our common gnat breathe in the air they require through a fine tube, by which they are usually suspended from the surface. From here they wriggle down below on occasional voyages of exploration.

The pupae of the gnat are not the barrel-shaped hard cases characteristic of house-flies. On the contrary they are lively little devils. While the larva is supplied with oxygen from the rear, the pupa has two short breathing-tubes perched like a devil's horn on its

head end. After two or three days in the pupal stage, the winged insect emerges. It floats about on the raft-like empty pupa case until its wings are dry and strong enough to carry it ashore.

The swarms of dancing midges or gnats which sometimes rise in the air like smoke consist exclusively of males. The females only dart in to snatch a mate and to elope with him for the brief nuptial flight.

Stagnant water, ponds and pools, even small puddles and water-butts are favourite breeding-places. Important as the water-barrel is for gardening, it is often a source of torment for those who frequent the garden. Only the cold of autumn checks the reproductive activity in many unheeded pools, which brings forth generation after generation of gnats to annoy us. When the weather gets colder, they seek protection indoors, above all in the cellars of houses, where thousands can be seen hibernating on ceilings and walls. So it is not till this season of the year, when mercifully they are not bloodthirsty, that they actually become our housemates.

The gnat or mosquito pest is worst in the tundra and watery plains of Siberia, Lapland and Northern Canada, where these insects make it practically impossible for man to settle, and in many countries of South America and Southern Asia: the notorious mosquitoes of these regions are very closely related to our gnats. It is easy to understand their abundance in the tropics, since they need water and love warmth. But it is not so clear why such swarms of them should be found in Arctic regions. In Lapland snow lies on the ground for eight months of the year. Why should these little pests be comfortable in a country where they will search in vain for cellars to protect them from the severe winter, where there is little rain during the short summer and where for miles and miles there are neither human beings nor cattle to supply their food requirements?

Much attention has been paid to this problem in recent years, particularly in Lapland. And the riddle has been solved. These species of gnats or mosquitoes do not survive the winter. It is only the eggs they have laid in the moist soil that survive. In spring these get into the numerous pools formed by melting snow. Although the soil consists of porous peat and is not washed by tropical rains, these pools remain for an astonishingly long time. The reason becomes apparent if a stick is pushed through the loose soil. It meets with resistance barely half a metre down. At that depth the ground is still frozen, which prevents the water from seeping away. But the pools on the surface of this ice-bound soil become amazingly warm, since in those latitudes they are exposed to the sun's rays day and night. Such shallow pools take weeks to dry up. Meanwhile the gnats can breed in abundance. Though there may be very few human beings and reindeer for them to attack when they swarm up into the air, there are millions of lemmings and voles, which serve their purpose equally well, probably the last thing that the traveller in Lapland would think of when he is racking his brain to find an explanation for the many gnats.

Mosquitoes as fever-carriers

Whoever travels by train south of Rome to Naples will pass through the Pontine Marshes. What a few years ago was a malaria-infested country, inhabited—as in Roman times—by a few needy shepherds, is now a prosperous province. Thanks to large-scale

draining installations the marshes have been dried and arable land has replaced poor pastures.

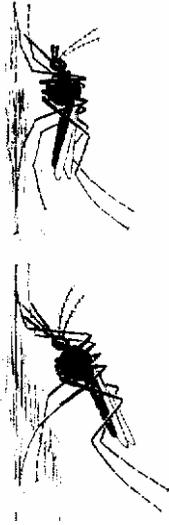
It was not actually the marshes that kept this region from being cultivated for long centuries. There would have been room for farms between the swamps. All who settled there, however, were unfailingly attacked by a severe fever, attributed formerly to bad air from the marshes. The real connexion is different and interesting enough to be considered more closely.

The disease in question is known as malaria or intermittent fever. It is not of course confined to the Pontine Marshes; even today, it occurs in other parts of Southern Europe, in Russia and Holland and occasionally in Central Europe, while it is one of the worst plagues in tropical areas in all continents. It is called intermittent fever because as a rule violent attacks alternate regularly with fever-free days. In many cases this fever is fatal, and in many others its ill effects are lasting. Scientists have discovered that malaria is caused by microscopically small unicellular animals of very simple structure, which live in the blood of the sick person. Simplicity of structure is not always connected with a simple way of life. The little parasites make very special demands on life and if everything does not happen in the way they are used to, they just perish. To begin with, they require as their habitat the red corpuscles in human blood. These are minute cells from the tremendous numbers of which the red colour of our blood is derived. They are quite invisible to the naked eye, but big enough for the still smaller parasites to grow and multiply in. Every time a parasite has eaten its way through a corpuscle, it attacks another, and since development, once started, is fairly regular in the warmth of the blood, all the parasites change quarters at practically the same time. This is when the fever becomes violent. It is the body's reaction to the poisons released from the decaying blood cells as soon as they are deserted by the parasites. When the latter have found new quarters in other red corpuscles, the patient enjoys fair health until the next change of quarters. They multiply so profusely that they can be detected in the tiniest drop of blood.

There are two sides to the life of such a parasite. The better the unbidden guest thrives, the more dangerous he is to his host, but if he kills his host, he deprives himself of his daily bread. From the parasite's point of view, therefore, it is expedient for some of them to emigrate to another human body in good time. For this passage they make use of a mosquito as a carrier. When a mosquito sucks blood from a sick person, it pumps up the parasites along with the blood. They settle down comfortably for some time in the wall of the mosquito's stomach and multiply at its expense. Then, guided by some invisible force, they slip into the mosquito's salivary glands. So when the mosquito later bites a healthy person, it injects the parasite with its saliva into his blood and he becomes ill. This is the only way of catching malaria and it can be spread by only one genus of gnat (*Anopheles*, the fever-gnat or malaria mosquito).

Nobody knows why none of the other species of this insect either in our temperate zone or in the tropics are good enough to carry the malaria parasite.

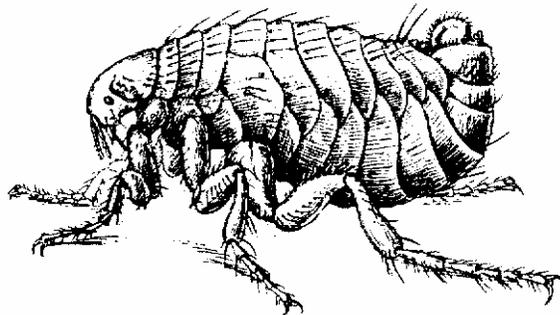
The Italian Government did a fine bit of work when it drained the Pontine Marshes and destroyed the breeding-places of the mosquitoes, thus restoring the country to health. But the scholars, who, in the seclusion of study and laboratory, revealed the chain of cause and effect that first made it possible to combat the disease, did a far finer job.



The different posture when it settles, distinguishes the malaria mosquito (below) most clearly from the gnat or common mosquito (above).

Efforts must be made to exterminate the mosquito; where there are no carriers, there will be no malaria. There are many ways of reaching or approaching this goal. In this case the Pontine Marshes drainage made it impossible for the mosquitoes to breed. Another method is to pour petroleum into the water; the film it forms on the surface blocks the insect's breathing-tubes and it is suffocated. Or natural enemies may be brought into play by putting fish into the pools, which immediately make short work of the mosquitoes young. In our own zone the greedy stickleback and small species of white fish have proved to be good scavengers, while the same service is rendered in warmer countries by certain little fish, which multiply so rapidly that in their native South American waters they are known as "million" fish. The money available and other local conditions will decide which method is best in individual cases. The house-fly may occasionally be a carrier of disease germs if it does not keep clear of filth on its wanderings. The mosquito, on the other hand, is a disease-carrier by profession, as it were, even if it has no idea of the damage it is causing. The links in the chain of contact are here far more rigidly forged, and the strongest of them is provided by the demands of the parasite itself; for better or worse it has chosen to adopt a complicated way of life.

THE FLEA



THE READER who has got thus far will now know a little about zoology. He will have an idea of what insects are; he will know that he can recognize flies by the fact that they have two wings and so he will be able to distinguish them from the four-winged representatives of this class in the animal kingdom. He will now be keen enough to put a flea —if he can get hold of one —under his magnifying glass and try to discover how many wings it has. He won't find any, for the flea has no wings. And so what? How are we to put it in its proper place?

Fleas are certainly insects. Else why should “insect-powder” be used to keep them down? Such deductions would naturally appeal less to the classifying zoologist than the fact that the flea has six legs and other anatomical features characteristic of a member of the insect class. But what kind of insect is it? Experts are not at all certain. As a rule the best clue is provided by the wings and their veining which varies considerably from group to group. Here the flea does not help us. As a matter of fact its very earliest ancestors did possess wings, as is proved by the tiny wing-buds on every flea in the pupa stage, which however recede as development progresses. It has learnt to jump so well that wings became superfluous. And now we have to guess where it comes from. Some think that it is descended from the beetle, others from the *Hemiptera*, the order which numbers the blood-sucking bed-bug among its members. The theory most widely held is that it is descended from the fly. The many peculiarities of its structure, however, have led scientists to honour it by giving it an “order” of its own, just as the beetles, the flies, etc.... each form a separate order of insects.

To sum up, then, the flea is probably a close cousin of the fly. But it is not a fly: it is a flea.

What a flea looks like and what it can do

For most people a flea is probably just a black speck, which jumps away when they try to catch it. It takes a very strong magnifying glass to bring out details. Whoever has a microscope and a flea at hand, should try to bring them together. A rough sketch of what he will see is shown in the illustration. If we want to understand what we see, we must bear in mind that the flea family does not regard man as the central figure in its world. The many fleas on dogs, cats, mice and other mammals, in the feathers of innumerable birds outnumber by far the few that settle on human beings.

That is why its body is so made that it can pass unhindered through thick fur, or feathers. It is flattened from side to side and so has no difficulty in passing through the densest hair-forest, its keel-shaped forehead forcing its way through the undergrowth like the bows of a boat cleaving the waves. The proboscis (marked P in the figure) slopes down and backwards, the antennae (A in the upper drawing) can lie back in grooves in the head. Its shape is not like that of other insects (compare the illustration); there is no thin neck separating the head from the thorax and no slender waist between the thorax and the abdomen. Nothing is allowed to break the streamlining of its body —no bulge or notch to get entangled when the flea creeps through hair or feathers. The strong bristles slope backwards and serve the insect as a support when it moves about, while the strong claws on its feet ensure a good foothold. The hind-most pair of legs are particularly sturdy. Those are the flea's jumping legs. A flea can jump more than 30 centimetres high and more than three times as far. Of course that is not much. But translated into human

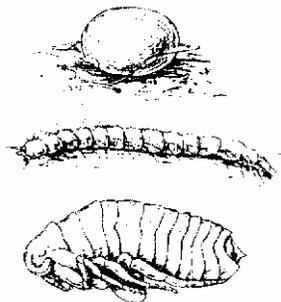
terms, an adult man wanting to compete with a flea would have to clear the high-jump bar at about, 100 metres and his long jump would have to measure about 300 metres. Such an athlete would have no difficulty in vaulting over Victoria Station in London. At one jump he could leap from Westminster Bridge to the top of Big Ben.

The flea's eyes are poorly developed and can certainly not tell a man from a tree trunk. Perhaps to them moving shapes appear as shadows. More important are the organs of smell, located on the antennae. Not much is known about the flea's sensory experiences. We shall return to this subject presently.

The life history of a flea

Mother fleas are indifferent mothers! While the house-fly at least takes the trouble to lay her eggs in manure and the gnat finds a puddle for the same purpose, so as to ensure the proper living conditions for their broods, a flea simply lets her eggs drop. Whether or not they land on a good place is left entirely to chance.

As a rule fleas breed best in the floors of houses. The maggots, which are hatched from the eggs after about three days, are like white worms (see figure below) and can wriggle quickly in much the same way as caterpillars. They have a preference for dusty crevices and cracks in floors, or for carpets and rugs, and dusty corners in beds and other pieces of furniture. They are not interested in blood-letting. They feed on all kinds of waste, which they find in dust. After about a fortnight they spin a cocoon for themselves like, say, the silk-moth butterfly, and retire inside to pupate. After another week or two, the flea emerges fully fashioned. It may be a male or a female, the male being the slimmer and smaller of the two. Both are bloodthirsty and lie in wait to spring on a victim, usually from the ground. How can they recognize their prey in spite of their undeveloped eyes? Perhaps they notice a shadow, perhaps they feel the warmth of a near body, or the current of air caused by movement; the sense of smell also plays an important part; otherwise it would be difficult to understand why they favour many people, show less preference for others and avoid some completely, since there can be little difference in their shadows or body temperature.



The eggs of the flea are relatively large. The egg of a human flea shown here (*upper sketch*) and the human flea are on the same scale (magnified 20 times). (*Centre*) A flea larva, not yet fully developed. (*Below*) A flea pupa, taken out of its cocoon.

A good while ago I was in Naples with a friend on one of my visits to the Zoological Station there, where I have often worked. We had taken a room high up in the Vomero.

The marvellous view over the blue Gulf to the lovely contours of Capri that greeted us when we woke was in itself a promising start to every day. The nights were not: so good, for there were swarms of fleas. We soon hit on a way of getting a fair night's sleep. Before getting into bed we would parade up and down the room barefoot and in our night-shirts, to be immediately attacked by a hungry army. Then we would take our night-shirts off and remove the fleas. My "bag" every night amounted to four or five, whereas my friend always caught thirty or forty. They seemed to prefer him; he had evidently a better smell in the opinion of fleas. In spite of this, he suffered less than I did, for he was only annoyed by their creeping, while I got a big blister from every bite. So the skin of different individuals does not react to bites in the same way at all, and the same is true of bites of other insects.

The amount of saliva a flea injects into the wound it makes is incredibly small. It has been calculated at 0.0004 of a cubic millimetre. This means that it would take more than one and a half million fleas to produce enough poison to equal the quantity of liquid in an ordinary drop of water. We can imagine the virulence of the poison when we consider that one such drop would set all the people in Hamburg scratching. We should only have to see that each of Hamburg's one and a half million citizens got his proper ration. This we could not do, since unfortunately we lack an instrument as precise as the flea's sucking tube.

If this little pest is left to suck in peace, it takes its time. It can enjoy one and the same puncture for several hours. As a rule, of course, irritation makes the host interrupt the process and the flea has to continue its meal elsewhere. Though the flea can hold its own with the heartiest of diners when conditions are favourable, it can starve just as well when times are bad. In empty houses it can fast for months without being any the worse. In normal circumstances, and if nothing untoward happens to cut its life short, it reaches the age of one and a half years.

The flea's love-concert

The female flea must find a mate before eggs can be laid. This may not be quite easy, either on the floor of a house, on a human body or on a dog's skin. The sense of smell will certainly help, but not when the couple are far apart. Fleas evidently have another means of making their desires known. At the roots of the hind legs there are rows of little spikes; with certain leg movements these spikes twitch the fine ridges on the abdomen opposite them, in the same way as the harpist's fingers pluck the strings of his instrument. We are familiar with the very similarly constructed organs used for chirping by crickets, grasshoppers and other insects. Their notes are quite audible to our ears, whereas in the case of the flea the whole musical instrument is so minute and the notes it makes so faint and probably so highly pitched that it takes the ear of a flea to hear them. Scientists have not yet found out where the flea's ears are located, just as no one has ever heard its voice. For the biologist it is a stimulating and not at all incredible idea that ears capable of hearing it should be able to catch a many voiced chorus from the thick pelt of an Alsatian, similar to the concert of crickets and grasshoppers we hear in grass.

My driving test

At last the day had come when I was to have my driving test. Accompanied by my teacher I arrived in good time to pick up the police officer in charge of the ordeal. Armed with paper and pencil with which to note my mistakes, he settled down in the back seat — not exactly soothing for the candidate. Now we were ready to start. Nothing happened, and no wonders, since I had forgotten to use the ignition-key, which drew some comment from the rear. Then things went all right as I drove round several corners. All at once the officer asked: “Is it true, Professor that fleas are dying out?” I hadn’t expected such a question. But I knew more about fleas than about a car, and we talked at such length on the subject that there was no time for the officer to set me more difficult problems in the art of driving, which was really what he was there for.

It was a question that was arousing quite a lot of interest just then, filling columns in the daily press. It was suggested that a plague had destroyed the fleas. They had become so rare that a shop which supplied teaching material was said to pay ten Reichsmarks for one flea. The firm, it is true, denied this emphatically, asserting that it could produce any number of fleas at any time. When I asked for some for demonstrations a little later, they regretted they could not give me any.

There is no doubt that the flea plague has been greatly reduced in our part of the world in the last half century. Some of the reasons are obvious. Modern vacuum cleaners make short work of the dust in corners and cracks (so necessary to the flea), the habit of wiping floors with wet cloths, which supplied the brood with the moisture it required, is gradually dying out, while steam heating makes rooms still drier, which spells death for the larva. And the oils now popular for treating floors are poisonous for them. So growing cleanliness and hygiene in the home often destroy the larva’s chance of survival and the decline in the flea population is quickly noticed.

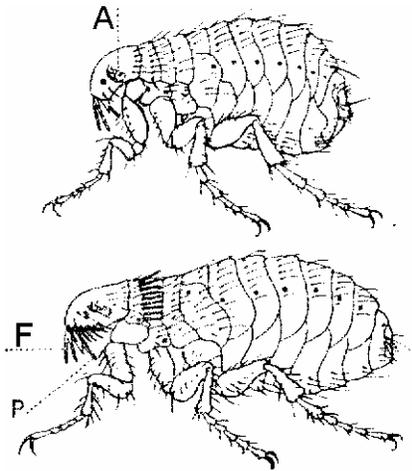
Whether these reasons are sufficient to account for the reduction in our population of fleas, or whether it has actually been decimated by some infectious disease, we cannot tell. At any rate such a disease cannot have spread very far, for travellers to the South or the East will not be slow to realize that the flea is certainly not dying out there.

About various species of fleas

Nobody is astonished that collecting butterflies can be a pleasure. But that a rich man with a penchant for scientific research should have concentrated entirely on collecting fleas from all parts of the world at considerable cost to his pocket is not so easy to understand. Yet his interest in collecting fleas proved most valuable, as we shall see very soon.

Just as there are many different kinds of butterflies or birds, there are also many kinds of fleas. Since they are so small, they can only be distinguished with the help of a microscope. As a result of extensive studies, in which the collection referred to above played an important part, about 1,000 different species of fleas are known today, of which 150 are to be found in Europe. That they differ in appearance will leave most people cold, though more interest will be shown in their varying tastes. What has been said up to now applies mainly to the human flea. Luckily for us, most species will have nothing to do with human blood, but live on certain birds and mammals. A flea from a swallow was starved for nine months and then put on a human being. It began at once to

suck, but stopped again immediately; when it was examined, it was clear that the Wood was so distaste-ful to the flea that it had not even got as far as its gullet. Birds are often very badly plagued by fleas, and their nests are breeding-places for the parasites.



(Above) A human flea. (Below) A dog flea. A —antenna, F = mouth-feeler, P = proboscis for piercing and sucking. (Both are magnified 20 times.)

The smallest mammal — the shrew — has the biggest flea. It is also found on moles, hence its name: “the big mole flea”. It is more than half a centimetre long. If we compare this with the length of a shrew’s body, the fleas that visit us would have to be as big as rats. Hedgehogs, too, are a happy hunting ground for fleas. Bats, rabbits, pigeons, hens and many other animals all have their own fleas.

Now it is not that a definite species of flea is invariably found on a definite species of mammal or bird. Many species like to vary their diet. The human flea, for instance, also likes dogs and has been found on badgers, foxes and hedgehogs. Vice versa, the dog flea also preys on human beings. A spot check proved to what extent this is true: of 2,000 fleas collected at random from all sorts of human beings, half were dog fleas. Not so often, but still not seldom do cat fleas, hen fleas and pigeon fleas desert their usual host, after which they are named, in order to suck human blood. That the rat flea does this may be fatal to us. Which brings me to the usefulness of a scientific collection of fleas.

The flea and the bubonic plague

If our interest in recognizing forms had not extended to this unpopular insect, if our delight in varying shapes had stopped short at this, the smallest order, our eye would never have been trained to distinguish between the many hundreds of flea species. Then perhaps the rat flea would have remained unknown and its disastrous role in spreading the bubonic plague would never have been discovered.

This disease, like typhoid fever, is caused by a particular kind of bacterium. They are far more malignant than the typhoid bacilli. If a man is attacked by the bubonic plague he has little chance of survival. In India it kills hundreds of thousands every year. It was already known that it could attack rodents as well as human beings, and that it was

rampant among rats. But the causal connexion between the rat plague and the human plague was not detected till later, and the rat flea was found to be the most dangerous carrier. When it sucks the blood of diseased rats, it absorbs plague bacilli at the same time. These live in the flea's intestine and multiply there, sometimes for months on end. The flea can eject lively plague bacilli both in its saliva and in its excrement, thus spreading the infection. As long as the infection is confined to rats, we are not interested, but heavy casualties among rats as a result of the plague mean famine for fleas, and they must look round for another source of nourishment. Then the risk arises of their settling in considerable numbers on human beings. So a violent epidemic of plague in rats often heralds a similar outbreak among the human' population.

The flea circus

Troupes of performing fleas used to be a familiar attraction at fairs and other festivities. Whether their antics are too tame for modern spectators, or whether the declining flea population has produced a shortage of trainees, or whatever the reason may be, such performances are seldom seen or heard of today. Actually such a show could not compete with the entertainment offered by other performing animals, say at Hagenbeck's or Sanger's circus. The real artiste in the flea circus is not the flea, but its trainer. He knows how to fix a harness of fine silver or copper wire so cleverly round the breast of his fleas that they cannot slip through. Then the flea is suspended from a chain, not of course the kind of chain that tethers the watch-dog, but one suited to the tiny captives, now fettered for life. Then comes the only thing the fleas must learn for their performance, namely, that jumping no longer his any pyrpoec. After spending some days or weeks in the vain attempt to jump, they resign themselves to walking.



At this stage it is again the dexterous trainer who makes them display their extraordinary strength. He arranges races between Lilliputian teams harnessed to a coach of thin sheet brass or to a paper carriage; or he fixes a tiny sword under a foreleg and delights his young audience by staging miniature duels. To heighten the fun, the participants may be clad in coats-of-mail; others, dressed as ballet dancers, dance in a ring. As a grand finale, the showman astonishes his audience (and perhaps makes their flesh creep a little) by turning up his sleeves and rewarding his performers by letting them refresh themselves on his blood. It seems a pity that the flea circus is dying out.



In a flea circus.

The Amber Flea

All the remarkable things we have learnt about fleas will not, I am afraid, raise them in the estimation of most people. Yet in one respect they have a right to look down on us. I am not thinking of their jumping feats, which outshine by far those of any human champions, nor of the efficacy of their poison, which might have called forth the envy of medieval potion-brewers, but of their age in the history of the earth. If fleas understood these things they would look down their noses at us as a contemptible rabble of parvenus.

Remains of animals and plants from bygone ages have often come down to us as fossils. No fossilized fleas have been found. It is of course quite credible that fleas should have got into muddy deposits and that when these solidified they should have left petrified impressions there. But who would attempt today to look for such a fossilized flea in the conglomeration of rocks?

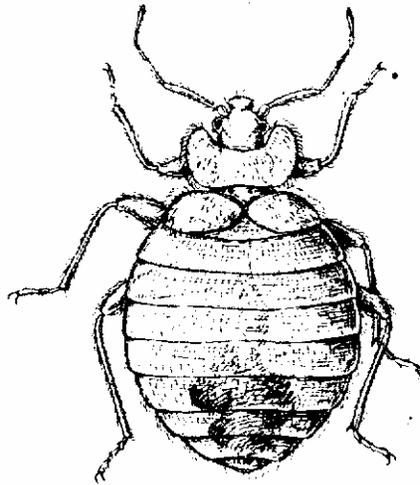
And yet some decades ago a flea was actually discovered which had lived in the Eocene Period of the Tertiary Age, that is, about 40 million years ago. At that time it had, by some mischance or other, had the bad luck to stick to a clammy drop of pine-tree resin. It was immured in an air-tight prison that hardened, and is thus better preserved than an Egyptian mummy.

Amber, the present form of this antediluvian discharge of resin, is much sought after in the market today. Where the movement of the waves washes it out of old deposits — as at the bottom of the Baltic — it is eagerly collected on the shore. Zoologists keep a sharp look-out for amber, since all kinds of insects came to a sticky end in the ideal fly-paper provided by the yellow drop of resin; they have been preserved so well in it that the student today can look at them through his magnifying-glass and count the bristles on their legs or study all the details of the veining on their wings. And so the Amber Flea got into the hands of a zoologist. He found that it belonged to a genus that has practically the same form today. For long it was a unique specimen, but a second example of exactly the

ame kind has recently turned up. Perhaps this genus annoyed shrews in the forest primeval just as it does today.

The beginnings of the human race can be traced back about one million years in the history of the earth. But 40 million years ago a mouse-flea was jumping about in the shape it has today. Is this not enough to inspire us with a little respect for the flea?

THE BED-BUG



IT IS NOT exactly pleasant for those who set store by cleanliness and look askance at vermin to discover a flea in their immediate surroundings; but to find bugs in the house is nothing short of a catastrophe.

Why do we not find those two parasites equally repulsive? Is it because bugs are bigger? Or because we see them running away while a flea escapes from our sight at one jump? Or because bug-bites are more painful? Because they lust for our blood as soon as they can breathe, whereas fleas begin life by crawling unseen in the dust? Or it is because bugs have a nasty smell, or because they are more difficult to get rid of?

Why bugs should make us squirm will always be their secret. But their unpleasant qualities should not prevent us from paying them some attention.

A plea for justice

To avoid any misunderstanding I should like to make it clear straight away that I have no desire to defend the bed-bug. I am only anxious that we should not condemn whole-sale all the 22,000 species of bugs that have been recognized up till now. Many of them use their mouth parts in order to feed fairly harmlessly on plant juices as their close cousins, the plant-lice and the cicadas, do. Big green, brown or red and black striped bugs living on trees are a common and striking sight on the tops of big blossoms and on leaves. They are not shy and have no desire to hide; their unpleasant smell is a good protection against greedy enemies. Nor do all bugs smell. Many species do not offend sensitive nostrils in the least. Thousands of little bugs, often attractive in colour, may be found among the many insects that swarm peacefully and happily in a summer meadow. The

biologist, interested as he is in all forms of life, would be sorry if they were not there. Many of them pursue other insects, lay them low by an injection of their poisonous saliva and then suck them dry. Very few venture to attack birds or mammals. It is a short step from highway robber to parasite and one that is easy to explain. The booty they select is too big to kill and consume, so the robber becomes a blood-sucking parasite. And it is these blood-suckers that are responsible for the bad name the entire bug family has in respectable society.

On the appearance and the habits of bed-bugs

Most of the bugs we have been talking about have wings and know very well how to use them. In bed-bugs the wings are mere remnants and of no use whatever. They have forgotten how to fly, and just because Nature is so very loath to drop old habits, we find that even today every new generation of bugs is equipped with rudimentary wings, though these do not grow with the bug but retain their stunted form as mere stumps (see adult bed-bug, magnified about 7 times).

They use their feet all the better. As they are interested in human beings only as a source of food, returning to their resting-places as soon as their appetite is satisfied, their regular route is from their retreats to bedsteads and back. They like to hide in cracks and corners of the bedstead, in the frames of pictures, in panelling or behind torn wall-paper. They attack sleepers, for they are fond of darkness and quiet. Since they generally take up their quarters near beds, no great strain is put on their marching powers. If hunger drives them, however, they can travel a considerable distance. Sometimes armies of them can be seen moving from an infested flat, which the occupants have left. They will run along the outside walls in search of new hosts. If they are hungry enough, they forget their antipathy to light, and a neighbour may even find them entering his flat by an open window in broad daylight.

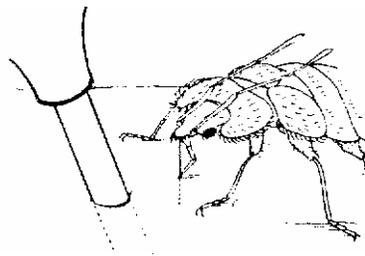
More often their invasion is unintentional, for bugs often get into houses with old furniture, picture-frames and other equipment or in clothing. And there are other opportunities for stowaways: their taste is by no means restricted to human beings, for they also attack cats and dogs, mice and rats, bats or rabbits. They also prey on starlings, sparrows and swallows, while hens and pigeons are often terribly plagued by these parasites. So co-op for poultry or rabbits, or deserted swallows' nests in the eaves often gain them entry into a house, though few will think of looking for the invaders in such places. Once indeed, bed-bugs were seen moving towards a house like tight-rope acrobats along telephone wires which were attached to an isolated dovecot,

If we look at the bed-bug's bill of fare we have just indicated, we see that their hosts always live in or near human habitations. Bugs seem to depend for food less *on* a particular kind of blood than on where their prey lives, a dependence which probably goes very far back. Since they have always been partial to warmth and dryness, they probably preyed even in prehistoric times on animals which had their resting-places in caves. Then prehistoric man arrived and improved the bugs' chances of life. From their standpoint, all the advances in our living arrangements, from the simple hut to the convenient flat of today, are merely the result of modernizing the cave, whose essential features — dryness and uniform warmth - have been retained and intensified. And bugs have remained faithful to the atmosphere to which they were accustomed.

Meals, social and family life

Bugs are fond of social life, though that takes different forms from human gregariousness. For us the dinner-table is a popular centre of sociability, whereas for the bug meals are strictly private affairs. When feeding, it does not concern itself about its fellows.

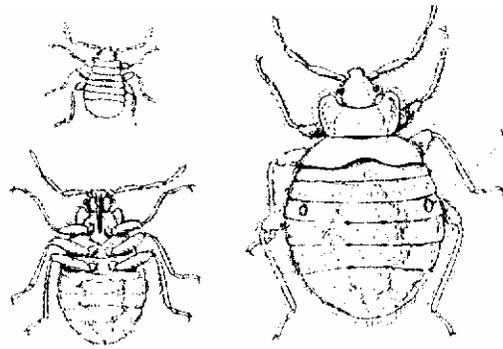
As with fleas, both sexes of the bug are blood-suckers. The male bug is as a rule more slender than the female and not so greedy. While the female can absorb at one meal a quantity of blood equal to twice the weight of her body, the male takes at best only as much as his own weight. The fact that the proboscis or beak is so very fine makes it all the more remarkable that this quite considerable amount of blood can be sucked up in about ten minutes. The proboscis looks bulky because of its outer sheath, which bends at an angle when feeding is in process and does not pierce the skin. The following comparison may serve to show how fine the pro-boscis proper is: when a doctor injects a local anaesthetic or any other medicine into a patient, he uses a syringe, an instrument with a very fine, sharp, hollow needle. Instrument-makers try to make these needles extremely fine so that the puncture may be as painless as possible. Yet, the puncture made by the very finest needle is still more than 500 times bigger than the wound a bed-bug makes when it bites.



A bed-bug's proboscis is more than 500 times finer than the finest needle in a doctor's syringe. In the figure the proboscis is seen piercing the skin vertically, while the bulky sheath is bent backwards at an angle and does not pierce the skin just as in the case of the gnat. At rest, the proboscis lies in its sheath and is bent back, as may be seen in the lower left drawing.

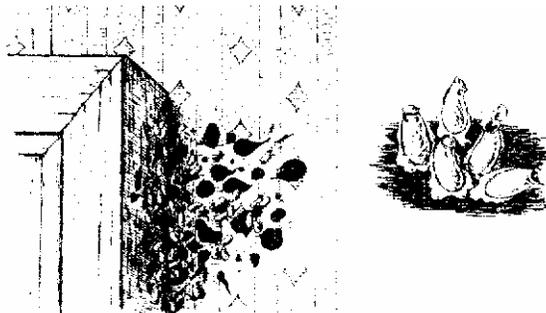
If bugs prefer solitary meals, they like plenty of company in their resting-places. Males and females, old and young, are often seen crowding together. All sizes and ages are re-presented, and young and old look alike except for the absence of the wing-buds on the former, and the very youngest are pale in colour unless their skin is reddened by a recent meal of blood, which shines through the skin for a time. Flies lay their eggs in manure, gnats drop them on water, fleas let them fall into dust, and none of them pay any more heed to their brood. Have bugs a better family life? Do they know anything about bring-ing up their young? No. There is not the slightest sign of any such thing. Their sociability consists merely in crowding together in suitable hiding-places, perhaps because they enjoy the smell of their kith and kin. The expert can spot the places where bugs assemble in an infested house by the yellowish, red-brown or black droppings that foul woodwork or walls. It is there that females like to lay their eggs. These are made fast

by a sticky substance produced along with the eggs, which hardens with exposure to the air.



The larva of the bed-bug at three different stages of development: newly hatched, after the second moult, after the fourth moult; it is mature after it has under-gone five moults. The figure of the second stage has been drawn from below in order to show the position of the proboscis when at rest. W—organs with cells containing bacteria. (Magnified about 7 times.)

Where houses are steam-heated, bugs breed in winter, too. About three weeks after the eggs are laid, the young insects hatch. They are fully grown after about eight weeks and can then live and multiply for months, even for over a year. There is one striking thing in this family chronicle which we have not mentioned so far: in the case of flies, gnats and fleas, the larva hatched from the egg is entirely different from the adult in shape and habits. When a larva is grown, it pupates and the fully formed insect emerges from the pupa. In this case, however, it is unmistakably a little bed-bug that creeps out of the egg. There is no pupal stage. The next section will explain this striking difference.



Excrement and eggs of the bed-bug, on the right a few eggs (magnified about 7 times). They are firmly fixed to a surface by a sticky substance.

The art of jumping out of one's skin

When the tiny bug slips out of the egg, it is not laid in a cradle. It has the power to use its limbs from the very beginning of its life, and soon goes off in search of food. If it finds none, it can starve for two months. No new-born human baby could survive such conditions. In the bug world, however, as in that of other blood-suckers, a period of forced fasting may occur only too easily, and Nature has taken care to equip these infants

with the necessary power of resistance. Of course, they cannot grow as long as they find no food; but one generous meal is enough to make them grow quite noticeably.

Like all arthropods, bugs have their growing pains. The outer case of chitin can only stretch to a certain limit. Like a too-tightly fitting jacket, it does not allow the body *to* ex-pand much. Here the bug makes use of a method of self-help which as a rule has been proved efficient by ail arthropods: it jumps out of its skin. It bursts its case of chitin and casts it. This is easier said than done, for in the process each of the insect's delicate legs must be drawn out undamaged. Moulting is always a critical moment and causes far more deaths than children's diseases do in our nurseries. If all goes well, the old skin, an exact impression of the body and its six legs, lies beside the moulted animal, which can ex-pand for a few hours until the new coat-of-mail hardens.

This process is repeated five times in the life of a bed-bug before it reaches its final size. At least one meal of blood must be taken between every two moults. Since there are also tiny wing-buds on the mature animal, the latter differs very little from its larva. This is not the case with the winged species of bugs, where the adult insect can be recognized at a glance by its fully developed wings, while the larva in the first stage have no wings at all, and later only buds. There is a good reason why the wings should not be fully developed till after the last moult, for even the greatest skill in the art of moulting could not prevent a full-size wing from being damaged on its way out of the chitin sheath.

The moulting procedure adopted by bugs is also followed by grass-hoppers, great numbers of whose tiny, and as yet unwinged, larvae can be found in the grass in spring, also by plant-lice and by many other insects. In their early stages the habits of such insects resemble those of the adults of their species the chief change at the last moult being the fully developed wings. Such transformation can take place without any interruption of the life cycle. But in the case of the fly, the flea, the butterfly or the beetle, whose larvae are quite different in appearance and habits from the mature insect, things are different. Here, the shape and the internal organs must undergo such a complete change that the life cycle has to stand still for some time. This is the reason for the "pupa". Outwardly it is a period of rest but, inside, the organs of the larva are disintegrating and it assumes its ultimate shape. In the last moult the insect splits the pupa case and spreads its wings.

The wording of the last sentence recalls the old idea that pressure from the growing body bursts the skin, i.e. that moulting is a mechanical process. Recent investigations, how-ever, have shown that the whole matter is not so simple, and hugs have supplied experimenters with excellent material.

It has long been known that vertebrates have certain glands which do not empty their products through ducts, as the salivary glands discharge saliva or the liver gall. The secretions of these ductless glands are emptied direct into the blood-stream which flows through the glands; so they pass with the blood throughout the body and as hormones have a great influence on the ordered course of vital processes. Our thyroid gland is such an example and is necessary for the regulation of growth. If the thyroid gland in a young person is removed, or if it is destroyed by illness, the development of his body and his mind suffers. There are many other "blood" or ductless glands, which must all work together in a complicated way if all the processes in a healthy body are to develop properly.

Until recently little was known about hormones in insects. That the moulting process is regulated by a definite hormone was first demonstrated by a simple experiment: The head of a bug (not a bed-bug, but a related species) was cut off. We should not survive such an operation, but it takes more than that to finish off a bug. It lives on without a head for many months and may even live longer than bugs with heads. But it does not moult again. Now there would be nothing surprising about a decapitated bug not being able to jump out of its skin. But if blood from a healthy bug is injected into it, moulting takes place quite normally, even in its headless state. Experimenters found that there is a tiny gland right beside the bug's brain and that the moulting process is caused by the product of this gland being emptied into the blood. The headless insect has lost this gland and so can only moult if it receives the necessary hormone from a healthy blood donor. The most astonishing thing is that the hormone controls not only the time of the moult but the changes in the body connected with it. If the blood of older bugs is injected into younger ones which have not yet moulted for the last time, the latter are mature whenever they moult next. On the other hand, if ductless glands from larvae are transferred to adult bugs, these start moulting again and assume the characteristics of youth.

We shall not dwell longer on these learned details. Perhaps enough has been said to show that the results of such experiments have a meaning for life in general that extends far beyond the world of bugs. No animal is so insignificant that it might not reward our attention with great discoveries.

How the bugs get their vegetables

A wise mother sees that her family gets sufficient vegetables and fruit. That is good for them. Now we also know why. Such a diet is rich in vitamins — substances which are essential to life, although their importance was not recognized for a long time because they are present in food only in small quantities and are needed by the body only in small doses. But if our diet contains too few vitamins, or none at all, our health will suffer severely.

What has all this to do with bugs? We must remember that all living creatures are equal in the eyes of the great law of life: men are not superior to mice, nor bugs to men.

If we examine a bug under a magnifying glass, we shall see on either side of its intestines a small organ whose use is not at first sight apparent. It is neither a heart nor a gland, nor has it anything to do with either the intestine or the muscles. A very strong microscope reveals that its cells are filled with many living bacteria. Earlier references to these, the most primitive forms of vegetable life, as causers of dangerous diseases have left unpleasant ideas about them behind. Bed-bugs unfortunately do not die from these bacteria, they do not even sicken because of them; on the contrary, they go into a decline if these bacteria are taken from them. The two organs we have just mentioned are there especially for the bacteria, their sole purpose being to provide them with a home and means of nourishment. Things have been so arranged that no bug is born without these bacteria; they are present in the mother-bug's body and find their way into the egg-cells, and later into the organs prepared for them during the growth of the bug's body.

Such an association with bacteria and other primitive vegetable forms is common in insects. It is known as symbiosis, by which term we understand a partnership of two

different organisms living together for their mutual benefit. It is easy to see the benefit for the bacteria. They are provided with a suitable retreat where they can thrive excellently. And as they can be so providentially transferred from one generation to the next, there is no fear of their dying in the hard struggle for existence as long as there are bugs. How the bugs benefit has long been a puzzle. Why should a bug provide unbidden guests with free board and lodging among its intestines and arrange for them to be handed on to the next generation if it got nothing out of it? *Observation* and experiment have now led to the view that the bacteria are essential for the bug's nutritional requirements, they supply it with the vitamins necessary for healthy growth, just as we secure vitamins by eating fruit and vegetables.

Bed-bugs in electing to live on blood have chosen a very unbalanced diet, poor in vitamins. If we compare them with other blood-sucking insects, we recognize a remarkable law: if only the adults are blood-suckers while the young insects live on other material containing vitamins, no bacteria and no organs for these will be found, but where blood is the sustenance even of the larvae, symbiosis is always present. If vitamins were lacking for a whole life-time, the result would be disastrous. The habitats of the bacilli are like beds of vegetables where these blood-suckers unwittingly cultivate miniature vegetables as sources of vitamins.

This view is based on careful experiments and is well-founded. Yet there are still sufficient unsolved riddles connected with symbiosis in insects to provide scientists with many sleepless nights.

How can we get rid of bugs?

Some people never worry about insect bites. Not that they are particularly heroic. They just happen to react differently. A person may not feel gnat-bites at all and yet be greatly irritated by bites from a bug. Others again do not respond to bug-bites. A well-known entomologist once caught bugs in one hour in a room in a Russian town, and thousands were, still running about. Four other people sleeping in the same room declared unanimously that they had not noticed any bugs, and they certainly had not scratched themselves.

But these are exceptions, and most people prefer to sleep in a room free from bugs.

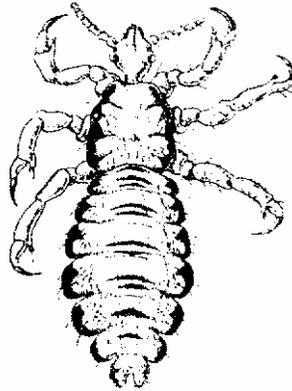
If a traveller is compelled to sleep in an infested room, he will find it a help to give the bed a good dressing of insect powder, then to move it as far as possible from its original place in the room, taking care not to set it against a wall. It will take the bugs some time to locate the bed again.

Other measures are called for when one's own flat has become infested. It is not easy to clear a room of bugs. It is no use leaving the flat for some time in the hope of starving them out. Adult bugs can fast for more than a year. If there are not many, it is possible by lying awake for an hour and switching on the light every ten minutes to catch them one by one. That, of course, would be an exasperating business if the room were badly infested. A thorough search in all cracks and corners will yield a good "bag". It does not help much either to give the walls a thorough coating of paint. In one of his stories Gottfried Keller, the Swiss writer, describes how the hero goes to bed in his old room and how flabbergasted and rather touched he is to watch a bug, re-invigorated by the warmth

of spring, moving like a tiny blue mountain on the old, familiar wall which had been freshly painted months previously. This has nothing to do with poetic licence, for similar observations are recorded in scientific books too.

Half measures are bound to be followed by a recurrence of the evil. The next section will show how vermin can be exterminated once and for all. Meantime, it would be best to have the infested room fumigated by an expert at the job.

LICE



AT THE beginning of this book it has been stated that the art of flying comes naturally to insects. I am now in the rather embarrassing position of having to confess that lice cannot fly, any more than fleas or bugs can. There is not a vestige of wing-buds on their bodies. Yet I stand by my statement. It is because the insects just mentioned are parasites that they are an exception to the general rule. They need not travel far to find either food or mates. That is why their means of locomotion are so simple. Lice are not closely related to the blood-sucking insects we have been discussing up till now, nor even to their namesakes, plant lice, which have much in common with bugs. Lice are in a class apart from other insects and have their own special order.

Various species of lice and their different preferences

To the human flea it is all one whether its host is a human being or a dog; it can be perfectly happy with either and is content on occasion with the Wood of a badger or a hedge-hog. We saw in the last chapter how varied the bug's bill of fare is; in comparison the louse is more particular about its diet. At the outset we should be clear that we cannot speak of "the" louse. Their order does not comprise as many species as that of the flea or the bug, but all the same we do know some sixty different species of lice. They live exclusively on mammals. The blood of birds, not to speak of lesser creatures, has no attraction for them. And in addition they follow strict rules with respect to mammals. One species lives on the stag, another on cattle, a third on mice, and there is a rabbit louse, a dog louse, a goat louse, a pig louse (though it will suck human blood too), even an elephant louse, which settles behind the ears of that huge animal and is an adept at piercing even its thick hide. We can almost say that every mammal has its own louse; and apparently every louse is convinced (if indeed it is possible to convince a louse) that its particular mammal is the only palatable one.

As a rule one mammal gets along with one species of louse. Man is an inglorious exception, for he can accommodate three species on his body: the head louse the body louse and the crab louse. They all drink the same blood, but not from the same tap. The head louse likes to live among the hair of the head, while the crab louse prefers the hairy parts farther down; the body louse may also be found in bur, but it is less of a local patriot than the others, and roams all over the body, a favourite haunt being the inner side of clothing, as its Latin name indicates (*vesti-menti*).

The tenacity of lice

A head louse has not the dash of a gnat, neither has it the temperament and jumping powers of the flea. Not that it feels these deficiencies as it crawls sedately in the hair, for it has a special compensating equipment: strong claws on its feet (see illustration) and powerful muscles which allow it to stick its claws in and hold fast to the hairs. It just re-fuses to be dislodged. Nor does it leave the human body in order to rest elsewhere or to lay eggs.

About two weeks later the young lice hatch out and leave the eggs (“nits”). Except for their size they are very like adult lice and have the same habits as these right from the start. That is why, like bugs, they can dispense with the pupal stage. After about three weeks they are fully grown and can breed without having to leave the forest of hairs on the head at all. Generations of lice can find accommodation on one and the same head. They are models of clinging tenacity, persistent hangers-on.

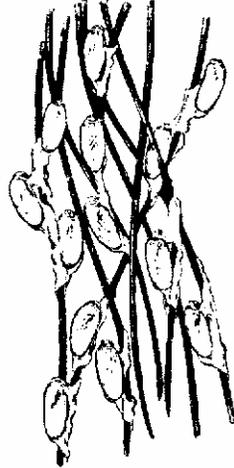


The claw at the foot end of the louse's foot is admirably adapted for hanging on.

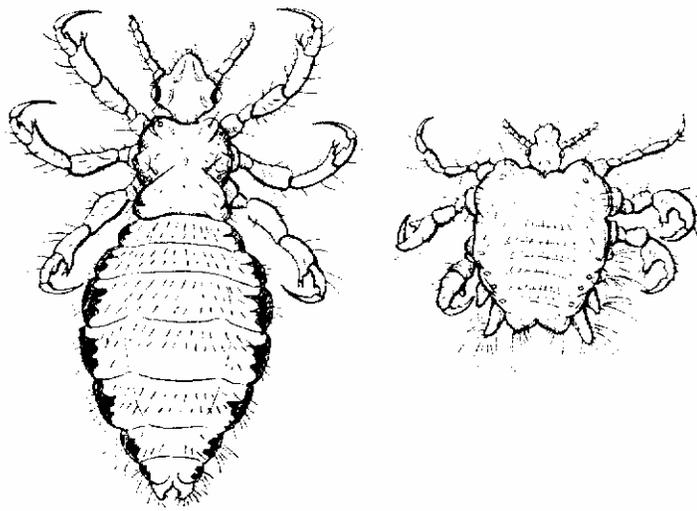
And their bodies are well equipped to maintain their attachment. Their firm claws enable them to hold their ground even against the will of a higher power. With its forefeet alone a louse can carry up to two thousand times the weight of its body for a whole minute. This is more than the strongest athlete could ever hope to do; it would mean holding up a weight of 150 tons in his hands! The substance cementing the eggs to the hairs gives its young the same security and prevents the eggs from being detached.

The sense reactions of the louse are also in conformity with its sedentary habits. They seem to feel most comfortable when the thermometer stands at 80-86 degrees. This was discovered by experimenting with what we call a “temperature organ”. Imagine a longish passage divided into sections into which lice are herded. It is heated at one end and cooled at the other, with intermediate temperatures in between, so that the temperature falls throughout its length. Just as the pipes of an organ are arranged according to their

length, the sections in the passage are graded according to their degree of warmth. The lice show a decided preference for the place with a temperature of 80 - 86 degrees, which is obviously what they like best. Since they hanker after these conditions on the human body, too, they keep hair, where the skin gives off warmth; they are safest there and also nearest their nourishment. And just because food is never far off, they do not over-indulge themselves as bugs and fleas do. They prefer to take many snacks at intervals of a few hours.



The head louse fastens its eggs (nits) to the hairs with cement that hardens.



(Left) A body louse. (Right) A crab louse. (Both, like the head louse on p. 65, are magnified 20 times.)

In appearance and habits body lice resemble head lice very closely. We noted that they are to be found more frequently on other parts of the body than the head. They usually cement their eggs more to the seams and rough surfaces of clothing rather than to hairs on the head and elsewhere. Crab lice differ in shape and are smaller. But they cling just as tenaciously to the thickets of hair where they have chosen to settle.

Annoying and dangerous vermin

Most blood-suckers carry their piercing mouth parts in a clearly visible sheath hanging down under their head. A louse's mouth looks quite harmless, showing neither sheath nor dagger, the latter being drawn far back into the head. It is extruded only at meal times. The food is sucked up in a few minutes. We know that lice are not hard drinkers; they treat themselves to small helpings of our blood at a time, but return for more all the oftener. Their bites are just as irritating as those of other vermin. Thanks to their nasty habit of clinging to us, they can multiply on our bodies to an extent which — apart from other considerations — can be detrimental to health. A well-known zoologist has reported that in 1915 he removed 3,800 living lice from the shirt of a Russian prisoner of war. In another case as many as 16,000 lice were collected from off a dirty tramp.

On lice-infected heads lice are particularly numerous round the ears and on the hairs of the neck. They can even be seen clinging to the eyebrows and the beard. The bites itch so much that it is difficult not to scratch, thus causing wounds, which become easily inflamed if dirt gets into them. The discharge from them mats the hair, a condition that is furthered by the nits and their sticky cement. Where the hair is worn long, the result is a tangled mass (a "Polish plait"), which it is as difficult to straighten out as the legendary Gordian knot. The only thing to do is to cut the whole thing off.

If it had only been a matter of avoiding "Polish plaits" and sores produced by bites, less effort and money would have been spent on the battle against lice during the First World War. There was, however, something more serious at stake. A few weeks after the outbreak of the war; the German army on the eastern front was badly infested with lice. At the same time typhus wrought terrible havoc among soldiers and in prisoners' camps. Such epidemics used to be regarded as necessary concomitants of war and no preventive measures were known. A short time before the war broke out; however, lice had been recognized as the sole transmitters of typhus fever. If there are no lice, there is no risk of infection for anyone who lives and sleeps in rooms where there are even dozens of typhus cases. Lice also carry other, less common, fevers and plagues (relapsing fever, trench fever, five-day fever, etc.). The best way to prevent such plagues from spreading is, therefore, to see that all lice are destroyed.

Gas warfare against lice and other parasites

To eradicate lice completely is easier said than done. Of course lice are not difficult to kill; with a little patience they can easily be found and caught. This is more difficult in the case of young lice since they are often too small to be seen; in the case of body lice with their habit of roaming all over the body, it is like looking for a needle in a haystack. Where several people are to be deloused, it is hopeless to try to catch every single louse. Infested bodies can be thoroughly cleansed with the help of chemicals. But how are clothes and underwear to be treated so as to kill every louse and destroy every egg? The application of the experience gained in gas warfare to anti-vermin measures was a great success. Poison gas is a most lethal weapon. It finds its ways into all pockets and into the hidden folds of clothing; it is safe to use it also for things which would not stand up to treatment by steam or dry heat. After various gases were tried out it was *decided* that prussic (hydrocyanic) acid was best. During the First World War, as soon as the danger was realized, many cleansing centres were established. Such places had an air-tight chamber in which clothing and other suspected articles were piled for treatment. If

fumigation was carried out efficiently not a single louse-egg had any chance of surviving. People were only too glad also to smoke bugs out of hidden crevices in living-rooms.

Today this method, one useful product of the War, has been perfected. Since prussic acid must be used with great caution because it is highly poisonous for man, it has largely been replaced by less dangerous gases and gaseous mixtures. The expert must decide how best to proceed in individual cases and according to the vermin concerned, conditions in infested rooms, etc. Fumigation as a method of destroying vermin is now used to an undreamt of extent. In flour mills, for instance, trouble is often caused by a small butterfly — the flour moth. Its tiny caterpillars live in flour; they not only feed on it and foul it with their droppings, but Ac threads they spin make it ropy. These lumps often choke machinery and hold up work. So big mills have their entire plant fumigated at regular intervals, perhaps once a year so that the pests never have a chance of surviving. Stocks of flour and other foodstuffs are not damaged, since the poison gas is so volatile that it disappears immediately if premises are aired for a short time. In cold storage plants, too, where rats and mice can be a great plague, the same method is often applied. Perhaps the greatest benefit derived from gas warfare was the extermination of rats on ships, a constant source of danger since they were feared as carriers of bubonic plague from overseas. The fumigation of big steamers is today a popular way of ridding them as radically and quickly of rats and other vermin as ever any Pied Piper could have done.

How one can get lice and how to get rid of them by methods other than those of gas warfare

If any reader imagines that lice have such good claws and are in all senses of the word so attached to their native quarters that they will stay where they are and certainly not emigrate, say, to his own head, he is mistaken. There are many reasons for such a change of quarters. Where the hair is thickly infested, lice like to take the air on ribbons, head-squares, or on the lining of hats. So all that is necessary is to put on one of those articles by mistake. Or one may lean without thinking against the upholstery of a rail-way carriage or a car and inherit lice from a less hygienic predecessor. In the same way direct contact with hair in crowds may be disastrous. So there is no disgrace about getting lice; but it *is* a disgrace if nothing is done about them until they have produced generations of progeny.

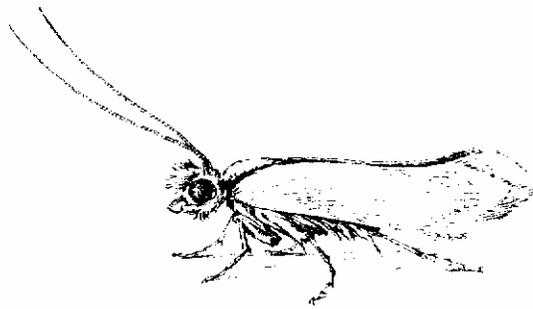
Now, nobody will launch a poison gas attack because of a few head lice. Indeed it would scarcely be advisable to do so as long as they are on our heads. So we must look for a simple and safe home remedy. And there are plenty: vinegar (Sabadella or wood-vinegar), or petroleum. Other more or less suitable preparations are on sale at every chemist's. Any of these is well rubbed into the hair and then the head is well wrapped in a towel, which must be left on for three hours, or better, overnight. After the towel is taken off, the hair is thoroughly washed, and the dead nits can be combed out with a small-tooth comb. If necessary, the whole treatment must be repeated.

Body lice, with their preference for settling in underwear and other clothing, have still more opportunities to change their quarters. Quite considerable numbers of young lice can be blown by the wind from dirty clothes to clean ones. If there are not too many and if body-linen is changed regularly, little harm will be done. Their stamina is so poor that they soon starve to death if separated from the human body. So they can scarcely thrive

where cleanliness prevails; they only come into their own in an environment of poverty and filth, or where unusual circumstances make hygienic living impossible, as is often the case in times of war.

Boiling infested underwear is of course a sure way of killing lice and their eggs. Another good method is to wash such articles in warm water in which 2 per cent creosote soap has been dissolved. Articles which will not stand this should be exposed to dry heat (about 140 degrees) for 30 to 60 minutes. A hot iron is also quite good. All those measures will work only if the body is thoroughly cleansed at the same time, solutions of carbolic or creosote soap being added as a precaution. All these remedies are rather troublesome and generally out-of-date now that DDT (see p. 26) provides us with a simple and effective means of control. Heads infested with lice are sprayed with DDT. Underwear infested with body lice can be impregnated with a liquid DDT pre-preparation. This not only cleans such clothing for the time being but acts as a safeguard for several weeks.

THE CLOTHES MOTH



HOWEVER long winter lasts, the great day does come when we are sure that it has gone for good and when all winter clothing can be stowed away till next year. Wise housewives then have a busy time laying things in moth-proof storage.

Summer passes. Now and then a clothes moth flits through the room, a signal for much excited clapping of hands in a vain attempt to catch it. It may be brought low, or it just disappears, and the housewife wonders uneasily if her cellophane bags and sealed chests are really moth-proof. Autumn will show whether or not all her precautions - naphthalene balls and powder or newspaper wrappings-have been successful in preventing moths from eating out ugly holes in the family's woollen garments.

Although the fact is generally known, I should like to repeat that moths do not eat holes. Clothes moths are like butterflies. And butterflies have a fine, long tube, with which they suck nectar from flowers, but which would be of no use for gnawing a hole in a stocking. Moreover, clothes moths do not eat anything at all. They never break their fast during the months when they are in their winged state, and finally die of sheer weakness. This, however, does not exonerate them from blame in connection with moth holes, but it was away back in the caterpillar days of their youth that they were the culprits. Their progeny, if left to their own devices, will continue the work of destruction.

On butterflies in general and moths in particular

People often shake their heads sceptically when they hear someone asserting that clothes moths belong to the same order as butterflies. They connect the gay word butterfly with brightly coloured marvels that are inseparable from the joys of their childhood — the Brimstones, Cabbage Butterflies, Red Admirals, Purple Emperors and all the rest of them. And the stouter, drabber specimens, the Owlet Moth and their like, which come in from the darkness outside and hover persistently round our lights, are generally acknowledged to belong to the same order. We know that out of the eggs of these butterflies caterpillars are hatched which develop a hearty appetite and pupate when fully grown. After a period of rest the butterfly emerges from the pupa.

It is the large butterflies that attract the majority of collectors, who of course know that the same order includes the huge army of micro-lepidoptera to which moths belong. These resemble their bigger relations in all essentials and there are species of intermediate sizes between these two groups. Up till now some 100,000 different lepidoptera have been identified, 25,000 of them being micro-lepidoptera. There are several reasons why collectors are not as a rule interested in these smaller species. Many of them are so tiny that it is difficult to prepare and arrange them satisfactorily. Nor are they so easily classified as the big butterflies, not to mention that catching the latter is far more exciting and hence a greater delight. The connoisseurs who do not stop short at small butterflies are rewarded by their great variety of shape, their marvellous colouring and the intricate veining on their wings, though it takes a magnifying-glass to reveal all their beauty.

Strictly speaking, the layman knows more about them than he himself suspects. Which of us has not sometime or other bitten into a worm-eaten apple? The reddish “worm” is the caterpillar of a very pretty, small butterfly. Another species is responsible for the “worms” in plums. We often see a curious pattern of wavy lines on the leaves of roses or other plants. Those underground passages are made by the tiny caterpillars of a leaf-mining moth, which are so small that they can eat their way inside a leaf, without damaging the upper or the under surfaces. The larvae live in the open on leaves and blossoms, as caterpillars usually do. It is not uncommon to find on fruit trees and various shrubs bundles of leaves and twigs bound together in a web of white threads; such webs conceal the larvae of the small ermine moth, a small butterfly with narrow, shining fore-wings delicately marked with black spots. So anyone who knows where to look will find moths and their caterpillars at every step. Most of them escape notice because they are so small and do not encroach on everyday life. But when the ermine moth makes for our fruit trees, when the flour moth gets into our flour, when the caterpillars of the grain moth work havoc in granaries, or when the clothes moth brings the housewife to the verge of despair, man puts up a stiff fight, employing all the means of destruction his superior reason can devise, though often enough they cannot prevail against the inexhaustible fecundity of his small opponents.

Things digestible and indigestible

The clothes moth, then, is a small butterfly. Most of its nearest relations, called moths in the narrower sense by zoologists, live in the caterpillar or grub stage on leaves, seeds and fruit, on things, that is, which are obviously nourishing. It must seem at least rather strange to the expert in human foodstuffs that the clothes moth should choose to live on

fur and wool. We should neither enjoy nor thrive on such a diet. Not even if we were in the last throes of starvation would we bite into a bundle of hair. It would be of no use, either, since for us hairs are indigestible. What do we actually mean by “indigestible” and how can the caterpillars of moths exist on a diet of hairs? In order to answer those questions we must have a look at our insides and see what happens in the process of digestion.

The food we eat goes first into the stomach and then into the intestines. If it is to benefit the body it must pass through the wall of the intestine into the blood stream. That is possible only if it first dissolve in the watery content of the intestine. Many of our foodstuffs, sugar for instance, do so straight away; but when we eat bread or meat they must first be treated chemically and changed in order to be dissolved and then absorbed into the blood stream. This process is called digestion. It is brought about by “ferments” (enzymes), which are contained in the saliva, the gastric juices and in the secretions of the intestine, and which split food-stuffs up into simpler chemical compounds that are soluble in water. Different foodstuffs require different ferments. So whether we can digest a particular foodstuff will depend on whether our digestive juices contain certain ferments capable of breaking it down into its component parts.

Hairs originate in the skin. They are made of exactly the same substance as our fingernails or as the uppermost layer of all the skin over our body or as a bird’s feathers, a horse’s hoofs or an ox’s horns. The general name for this substance is horn. It is produced by the living cells of the skin undergoing a chemical change as a result of which they die off. It does not hurt to cut off nails or hairs, for they are dead, and therefore insensitive, parts of the body.

Like the living cells from which horn originates, it consists of protein substances. Protein is an excellent food. We only lack the enzyme or ferment that can tackle, break down and dissolve this particular form of it. That is why we cannot assimilate either horn or hair. Now, the caterpillar of the clothes moth is equipped with such an enzyme and can subsist on hairs and feathers just as well as we do on meat and other protein foods. The bodily make-up of very few animals includes an enzyme which enables them to assimilate horny substances. We regard this property as strange just because it is rare, whereas we take the strangest things for granted when we experience them every day! Familiarity does breed contempt.

An investigator who was interested in the habits of moths made the following neat experiment: a patch of cloth woven from green cotton and red wool was left to moths. After some time green stains appeared on the patch, as the moths ate out the red wool and refused to touch the cotton. Cotton is a vegetable product. The lignin it consists of is chemically absolutely different from horn, which is an animal substance. Other enzymes are necessary to digest it and these are lacking in the clothes moth. That is why they cannot live on cotton.

Anyone who is interested in the less familiar phenomena of digestion will find just as much material for rewarding study in moths as in men. The clothes moth is not unique in this respect. There is, for instance, the wax moth, dreaded by keepers of bees for its devastating propensity for destroying the precious honey-combs. Wax is appreciated as food by the caterpillars of the wax moth because they have an enzyme that can break it

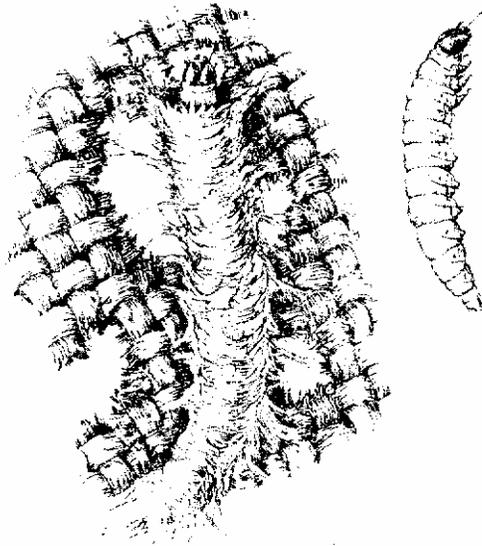
down. The larva of another species of moth lives on butter and also on the fat of dead animals or men.

Even when the skeleton of an antelope is bleached by the sun of the African desert and when all the digestible parts of its carcase seem to have been devoured by marauders of all sizes, then a moth appears whose larvae gnaw the horns away; hundreds of pupae that cover the decaying horns are a proof that they have got what they wanted. So we get back to horn and to those who relish it. Quite a number of moth species are known in Africa and Asia which live in the caterpillar stage on horse-hoofs, buffalo-horns and the like. Our clothes moths were of course compelled in Adam's day to search for their food in the open air. Today, too, in the outdoor world the skin and feathers of provide them with ample stores of food. Here moths perform almost a useful job as scavengers. For what should otherwise happen to all the decaying hair and feathers which disintegrate so slowly? Such inexhaustible quantities of waste matter enable them to maintain their numbers in spite of the most drastic measures employed to exterminate them indoors.

How moth holes are made

A mother moth does not take the trouble to fasten her eggs on to the hairs of wool or other material. She cannot manufacture cement as lice and bugs do. So moth eggs are easy to shake out of cloth. If they are left to develop in peace the tiny grubs hatch from the eggs after one or two weeks. If the cloth happens to be woollen and of the right quality, moths probably feel like cattle on rich pastures; and they set to work immediately.

There are different ways of doing everything. And so there are different ways of grazing. When the farmer drives his cows out to a fenced-off grass field and lets them roam at will over it, the grass becomes shorter. Tufts of herbage may be left standing, a sign that the cows do not find them to their taste; but no "moth holes" are eaten into the grass. The grubs of the moth do not graze uniformly over their wool pastures either. They tend to concentrate on one spot and — if they like the food — make such a hearty meal that in a thin material a hole can appear within twenty-four hours. The moths are stationary for a good reason: they are building a home which they are loath to leave.



Caterpillar of a moth in its case. (Right) Side-view of a caterpillar removed from its case. (Magnified about 4 times.)

Caterpillars have spinning glands. They can produce a liquid thread from their mouths which hardens quickly in the air. Thus, the mature “worm” of the silk-moth spins a cocoon in which it pupates. Many other butterfly caterpillars construct protective quarters for themselves in this way, for use during pupation. Small caterpillars can often be seen letting themselves down from a twig by a thread. This trick of spitting out a thread to be used like the climber’s rope when they want either to make a lengthy descent to avoid danger or merely to change their abode might well be the envy of mountaineers.

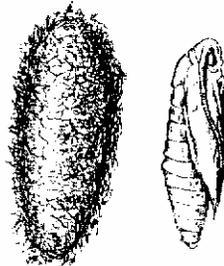
As soon as the moth grubs are hatched they weave themselves a tiny tube to live in. They camouflage their home perfectly by covering it with bits of hair they have cut off, for the hairs are naturally the same colour as the material from which they have been removed. The grub need only push its head out of the tube in order to bite off and devour all the hairs one by one. In the case of fur, the grub has no objection to polishing off the dry skin too. When nothing is left within reach of the top of the tube, the home is extended a little. This of course is not done unless it is absolutely necessary, which explains why the feeding-places are so sharply defined.

The quiver-shaped tube not only prevents the delicate body of the grub from being seen and hurt; it has another important purpose. In woollen material there are no springs and no dew. The grubs of moths get nothing to drink all their lives. They must extract from their food all the moisture they require. Now, hair as daily bread is exceedingly dry. It is astonishing enough that the juicy grubs should be able to satisfy their liquid requirements from it. They have to be economical with their supplies of moisture. If they were exposed to the air they would be in danger of shrivelling up. Just as bread is put in a tin to keep it from getting dry too quickly, so the caterpillars save themselves from giving off too much moisture by staying in the “tins” they have fabricated for themselves.

Home-loving though they are, moth caterpillars are, we must admit, not averse to roaming. When selecting a place for her eggs, the female moth is not very careful.

Whether it is just because she cannot find anything better, or whether she is just too careless or unable to distinguish, she sometimes lays eggs on material that is not suitable for the grubs. Impelled by hunger, they leave their quivers and go foraging for food. Nature has not equipped them well for walking.

The three pairs of short forelegs with their claws are just as little adapted for the purpose as the buds of the hind legs, particularly over the rough surface of cloth or fur. Here their ability to weave comes to their aid. When moving they never stops spinning, and fasten the thread to the cloth ahead of them, alternately right and left. So a silk ladder is formed of the many transverse threads and they can hang on to its rungs by their claws. This may be a cumbersome way of walking but they do advance and march gaily along at a speed of 40 centimetres an hour. When they eventually find better pastures, they settle down again.



When it has grown, the moth caterpillar spins a case for itself (left) and changes into a pupa in it (right). Magnified 4 times.

The duration of the caterpillar stage depends largely on the quality of the food available. If this is good, from the moth's point of view, development may be complete after two to three weeks. If it is poor, it may take a year. When they are ready to pupate they move to a place from which the winged insect, when it emerges later, will have little difficulty in reaching the open air — for example, from the interior of upholstery to near the surface. They certainly do not know why they do this. It is the instinct of self-preservation, one of the thousands with which Nature has endowed the humblest of her creatures. Having reached the surface the caterpillars weave a fresh quiver, in which they pupate. After two weeks at the earliest the winged moth appears. If the weather is cold the pupal stage lasts much longer.

The retiring female

Moths are generally seen flying in the warm season of the year. In centrally heated houses, however, they can breed all the year round. The number of eggs the female lays depends to a great extent on whether she was well or poorly nourished as a larva. On an average she lays about 100 eggs and takes about two to three weeks to do so. And this practically means the end of life as far as she is concerned. The male lives a few days longer.

What astonishes us is not that their life should be so short, but that it should be so long. For in their winged state they have only a vestigial mouth and intestines and are therefore incapable of eating or even of drinking throughout the weeks they live on the stores they have accumulated in their bodies as young caterpillars. And they draw to such

an extent on their stores that when they die their bodies have only a half or a quarter of their original weight. With all their strength exhausted, life comes to a standstill, like a car that stops dead when the last drop of petrol has been used.

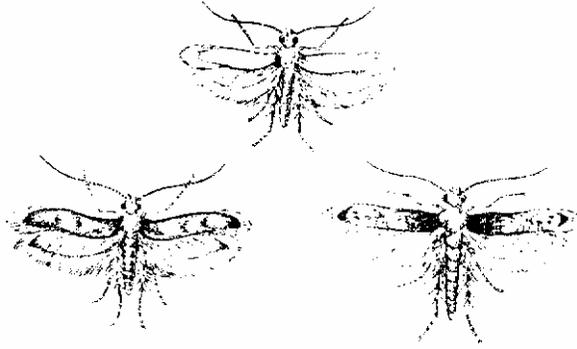
In many butterflies the sex can be distinguished at a glance. It is only the male of *the* Purple Emperor that is brilliantly coloured and the Female Brimstone Butterfly can be recognized immediately by its pale, whitish wings; the male Aurora Butterfly is marked with the beautiful orange-red spots. The male clothes moth is quite drab. Its narrow wings have the same dingy light-brown colour as those of the female. It must certainly have charms of its own to attract the female, but they must appeal not to sight but to another sense. It may be that it gives off a seductive scent that our nose cannot detect. Similar facts are known of other butterflies.

In one point, however, the male clothes moth is strikingly different from the female, and here I come to something that will lead to a disconcerting conclusion: the male often flies briskly about, whereas the female is averse to flying and generally hides in folds and crevices. It is little; wonder that she is a reluctant flyer, for her egg-laden body is about twice as heavy as the male's but with only the same wing-span. When female moths are disturbed they scurry off in search of a fresh hiding-place. So when a lively moth flies round the room there is no point in the whole family chasing it. It is only a male. There are plenty of male moths, actually about double the number of females. So the birth-rate will not be affected if a few more or less are killed. The female lies low; she does not often fly about voluntarily - a pity, since every female moth caught in good time means 100 eggs fewer.

Three kinds of moths

Before we launch a campaign against moths I must confess that I have omitted something: there is not one clothes moth only. There are three different species in our homes, which threaten our clothing, our carpets, upholstery and furs. The clothes moth proper is by far the commonest. A rare species is the case-bearing clothes moth, the "Fur" Moth although it confines its attention just as little to furs as the clothes moth does to clothes.

These two species can resemble each other so closely that most zoologists will find it difficult to distinguish them. The third species is the Tapestry Moth (right). I don't know where it gets its name from. At any rate its grubs also enjoy our woollen garments. The mature moths are easily distinguished from the other two species by the spotted wings, which are dark near the body. It won't be mistaken for a Clothes Moth by those who know anything about the latter. Those who do not know the difference and who indiscriminately every small butterfly they can catch in the house — to the sorrow of the butterfly-lover — may also catch a Tapestry Moth. It won't matter much, for it will very probably be a male.



Clothes Moth proper (*top*), “Fur” Moth (*left*) and the Tapestry Moth (*right*).
(Magnified about twice.)

Now that I have unburdened my zoological conscience we may disregard distinctions, since the same measures of moth control may be applied in dealing with all three species.

Moth control

In his fight against moths man has an ally which is not widely known: a small ichneumon-fly. It hunts out the young moth caterpillars, pierces their bodies and lays an egg in each. This egg hatches inside the caterpillar into a grub-like larva, which gradually eats up its host from within*! At first it spares the caterpillar’s vital organs so that they may continue to function for the benefit of its parasite. When the caterpillar has completed its growth, the larva of the ichneumon is almost the same size. Then the caterpillar’s last hour has come. The cocoon it manages to spin is at the same time a coffin for itself and a cradle for its parasite.

Many moths also fall victims to spiders and other enemies. But there are also many left and the housewife must take measures to protect her possessions against them.

The old custom of brushing and beating articles that may be attacked and airing them helps a lot. For the caterpillars shun warmth and light and will abandon their cases if disturbed even slightly. The brushing, however, should not be done indoors, otherwise the homeless caterpillars will find fresh pastures in other articles and the result will be more moth-holes than before. Moths can also be destroyed by carefully ironing the cloth they have attacked with a hot iron.

Another common protective method is to wrap clothing, etc. in newspaper. We have no proof that moths are averse to printer’s ink, so it does not matter whether the wrappings are of printed paper or not. If only they are thick and have no openings whatever, no moth will get in since it cannot eat its way through paper. Provided there were no eggs or caterpillars on the articles, paper wrappings will keep them safe. To this fact we owe the moth-bag, an excellent invention.

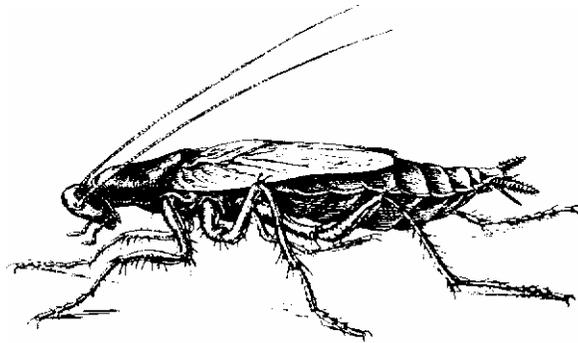
There are many chemical moth-balls and powders, made mainly of naphthalene, camphor and similar compounds. They are not only preventives but, if used in sufficient quantities, they destroy the moths themselves as well as their eggs and caterpillars. To be effective, they must be generously applied, and articles thus treated must be well wrapped in paper or something similar and stored in a box which should then be hermetically

sealed to prevent the chemicals from escaping. Some preparations must be re-newed every three or four weeks.

The chemical industry has discovered a more effective means of moth-protection, which has proved better than all these older methods: to treat materials in such a way that they can never be attacked by moth caterpillars. This is best done while the material is being manufactured. Impregnation with eulane is the best-known method and it has stood the test of time. Material thus treated is moth-proof. If eggs are laid on such cloth and young caterpillars begin to crawl about, they soon die. Most woollen and fur goods can be treated at any time by experts, for instance in a dry-cleaning enterprise. There are other similar preparations on the market which enable the housewife to do her moth-proofing at home: soaps for washable articles and salts for materials which cannot be safely laundered.

But until the contents of wardrobes and drawers are moth-proof, down to the last stocking, the war on the domestic front against moths will not be won.

THE COCKROACH



To THE zoologist cockroaches are insects which are closely related to grasshoppers and crickets. They are just as unpopular as clothes moths but differ in all other respects from them as much as a green grasshopper does from a butterfly.

A community that has come down in the world

The cockroaches of antiquity were very similar to those of today. Masses of them lived in the dense thickets of ferns and horsetail grass in the shade of the luxuriant vegetation which in due course formed deposits of coal. They are among the most primitive of living insects, whose ancestry goes far back in history to a time when there were no flies, bugs or butterflies. The amber flea with its 40 million years is a mere stripling compared with those cockroaches, many fossils of which have been found in deposits estimated to be 280-300 million years old. A span of even 300 years sees marked changes in the habits and customs of human society, whereas a period of 300 million years was not long enough to make any difference to the cockroach's preference for the twilight of the humid, dark forest. The giant ferns and tree-like horsetail grass have disappeared. But the greatest number of all known cockroaches still inhabits tropical

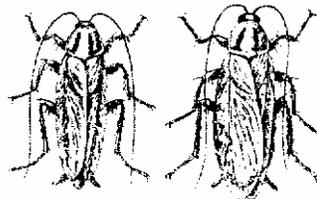
forests, an environment in which living conditions probably resemble those produced by the primeval flora most closely. In the temperate zones they are comparatively rare.

A few species have become housemates of man. They have learnt to invade houses, being fond of places that are dark and humid. It may be that such places stir in them memories of their ancient home in primeval forests. They thrive best in kitchens, bakeries, breweries, warm larders and hothouses. They shun the light and hide by day behind cupboards and chests, pictures and panelling, in cracks and crevices round sinks and heating pipes, waiting till it gets dark before they come out in search of food. They fall on everything that is palatable, though naturally the cockroach's taste is not necessarily ours. They have been known to eat not only potatoes and vegetables, bread and chocolate, sugar and honey, fat and all manner of garbage, fresh and decayed, but also paper, ink and shoe-polish, though the latter items could scarcely be of much benefit to them. When food is good and quarters comfortable they multiply tremendously. They then become a real domestic plague, not so much because of the stores they consume as because of their unsavoury habits. They crawl over everything, steal everything and foul everything with their droppings, and they give off a nasty smell. They have special glands which emit what may be a pleasant perfume to their organs of smell. If they are disturbed in their secret feasting, they scurry off to their hiding-places, making a rattling noise that can give timid people a bad fright.

Compared with their cousins who live in forests these parasites seem to us to be a somewhat degenerate, but nevertheless thriving, community. Transported by men with their household goods, they have invaded practically all countries. They can be brought into even the cleanest house by mere chance. They are not popular anywhere, as is seen in Germany from the names given to them in various localities. In many places in South Germany they are known as "Prussians", in the North as "Swabians", in West Germany they are called "Frenchmen", in the East "Russians". In Russia they are again "Prussians". Evidently one's closest neighbours have always been blamed for their appearance.

Appearance and habits

In addition to the common cockroach another species, the* German cockroach, is frequently met with in Germany. We cannot help thinking that even scientists have not been without the patriotic prejudices we have just indicated. For it was the famous Swedish naturalist, Carl von Linne, who gave the name of *phyllostoma germanica* to this species, although it is by no means confined to Germany but is found in all the countries of the civilized world and even in the most primitive and remote of human settlements.

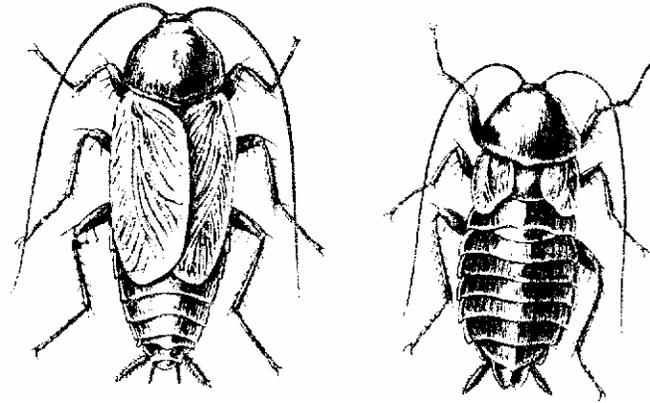


The German cockroach. (Left) A male; (right) A female (Twice their natural size.)

The mature cockroach is a little longer than 1 centimetre and is light brown in colour.

The oriental cockroach (*blatta orientelis*) is also called the black beetle. It grows to twice the size of the German cock-roach and is dark, almost black. The female of this species, even when fully grown, has only rudimentary wings, whereas the wings of the male are fully developed. American cockroaches are less common in our part of the world. They were first noticed in Europe in big ports, having obviously come over from America as stowaways. They are of course bigger than our common cockroaches. In the forests of South America there are species as long as a finger. Let us hope they will stay there!

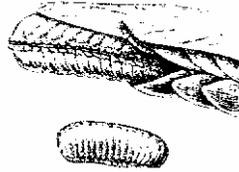
If looked at closely, cockroaches are neat little creatures. Their two long antennae, thread-like and mobile, stand them in good stead when they have to feel their way quickly through a dark room. The head has a different appearance from that of other insects; it has, one is tempted to say, the lofty brow of a philosopher! There is, however, probably not much behind it, for the brain is small. The flatness of its body enables the cockroach to penetrate into cracks, its favourite haunts.



The oriental cockroach. (Left) The male; (right) The female. (Twice their natural size.)

They seldom use their wings and only for short distances. On the other hand, they often bring themselves to make short jump, a habit in which their long-legged cousins, grasshoppers, have become champions. Cockroaches are best at running. They can sprint at a speed of 1 kilometre an hour, which of course does not mean that they can progress at this rate for an hour on end. They tire too quickly, and moreover, they do not need to have such staying powers. It only takes them a few seconds to reach their hiding-places, where they can recover from their exertions. Nature is not recklessly extravagant in dispensing her gifts and has only endowed those of her creatures with a capacity for endurance if it is essential for the preservation of their life. When the female lays her eggs she packs them in a hard, durable case. This is done automatically, not deliberately. As every egg leaves the ovary it is enveloped in matter secreted by glands, which hardens rapidly till a big, firm ball is formed, each egg lying neatly in its own compartment. The common or oriental cockroach deposits its egg ball or pouch after a few days, that is, it just lets it drop and troubles no more about it and its contents, the German cockroach is not so happy-go-lucky, it carries the pouch around, attached to its abdomen, for three or

four weeks, till the eggs are ready for hatching. Then the pouch drops, splits lengthwise, and the way into the wide world lies open to the young cockroaches.



Egg pouches of the common cockroach. (above). How the female carries the pouch under her abdomen. (Both sketches are magnified about 4 times)

Except that they have no wings, Ac larva: resemble their parents even in the first stage. They are at first so tiny that they can gain access to fresh territory through a hole 1 mm. wide and 0.5 mm. deep. So such a minute crack is big enough to enable these unwelcome visitors to enter a clean house.

Cockroaches moult six times before they reach maturity. Since we have come across this process already we need not describe it in detail. From the biological facts we are already acquainted with, we should not expect a cockroach to go through a pupal stage, and it would be useless to look for one. From the start the larvae have the same habits as the adults; but for the missing wings, their bodies have the same shape and no great transformation is necessary. After the last moult the wings grow quickly to their full size, and development is thus complete.

During the moults one of the long, delicate legs or some other part sometimes catches and is damaged by the sharp edges of the chitinous skin that has been cast. Trivial though such an accident may seem, it may have very serious consequences. For the greed of cockroaches knows no bounds. They have no objection to licking the blood of a near relative and once they have tasted it, they cannot stop until they have gobbled up their victim alive. Such cannibalistic habits may be of importance in maintaining the vigour of the species, since they ensure the elimination of weak and diseased members. Their practice of eating cases of quite sound eggs, which they often do, is inexcusable. Householders will naturally not protest. It is only a pity that such a habit has little influence on the fecundity of these creatures. They breed continuously in warm houses, even in winter.

The benefit of chewing

It is related of John D. Rockefeller that he wanted to live till he was a hundred and that, in order to achieve his aim; he used to spend a long time chewing his food very thoroughly. This may sound odd, but the idea behind it is absolutely sound. The digestive juices can act far better on well-masticated food than on solid lumps. It can then be assimilated more quickly and thoroughly. This is important for our general efficiency, since food is the source of all the energy we require for physical labour or mental activity?

It is natural for us to chew a piece of bread before we swallow it. A glance at the entire animal kingdom shows that the ability to chew is actually a rare gift. It is true that the pike's mouth is full of teeth, but they are sharp cones, pointing backwards, not adapted for biting up its prey, but only for preventing its escape. The frog gulps its flies down

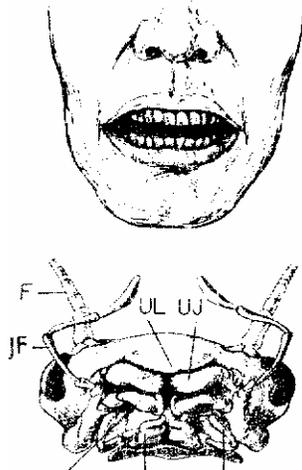
whole, and the giant snake similarly swallows a pig at one go. Of the vertebrates only the birds and the mammals grind down their food mechanically, the former by means of the grinding-stones in their gizzards, the latter with their teeth. It is no mere chance that the birds and the mammals should be warm blooded creatures with an active metabolism, energetic, and ahead of other vertebrates in mental ability too.

The same phenomenon can be observed among the lower animals. Such insects as do not live on liquid food are able to chew, and it is not an accident that they are superior to all the other lower animals in agility and general efficiency.

John D. Rockefeller might have envied the cockroach. It chews its food, not only with its mouth but, after it is swallowed, with its stomach too, this organ being equipped for chewing with sharp, hard, chitinous teeth and strong muscles. Ingenious though this invention is for completing the mechanical process of breaking down food, it is nothing compared with the imagination Nature has displayed in the structure of the cockroach's mouth-parts. They are marvellous enough to make it worth while spending a little time on them.

Mouths that bite, lick, suck and sting

When we bite, our lower jaw must meet our upper jaw, which is immovably fixed in the skull. The insect's biting processes are much more complicated. Perhaps to some extent this is a sign that insects are on a lower level of development than we, just as an old iron bridge, with its many supports and buttresses, may seem to be a clumsy and imperfect structure compared with a modern bridge. Yet the very variety of an insect's mouth-parts gives them evolutionary potentialities which vertebrates can never possess. We ourselves and all our kind move our jaws upwards when we bite. But there are different ways of doing the same thing. Insects bite from the right and the left. Cockroaches have very powerful jaws set with strong teeth of chitin. Chewing goes on in front of the mouth cavity. They have a flap of skin which covers the bite like an upper lip and prevents it from slipping out. Behind the first pair of jaws there is a second pair. The first pair relatively simple and strong in structure, are employed when brute force is needed, whereas the second can be used in so many ways that in comparison, our own jaws can only be described as a clumsy, unimaginative device. Sharp, finer teeth at the outer ends of this jaw serve to sever bits of food and push them towards the mouth; the folded part in the middle is covered with bristles and, along with another appendage, acts as a little brush which serves the purpose of cleaning feelers and legs when they are dusty; in addition, these parts have a jointed appendage (the maxillary or mandible palp), equipped with numerous sensory organs in the shape of hairs; they feel the bite while it is being "dressed" and check it for taste. After the second, extremely mobile, pair of jaws follows a thick lower lip, which prevents any of the food from falling out, and that, too, has appendages covered with sensory organs (labial palps).

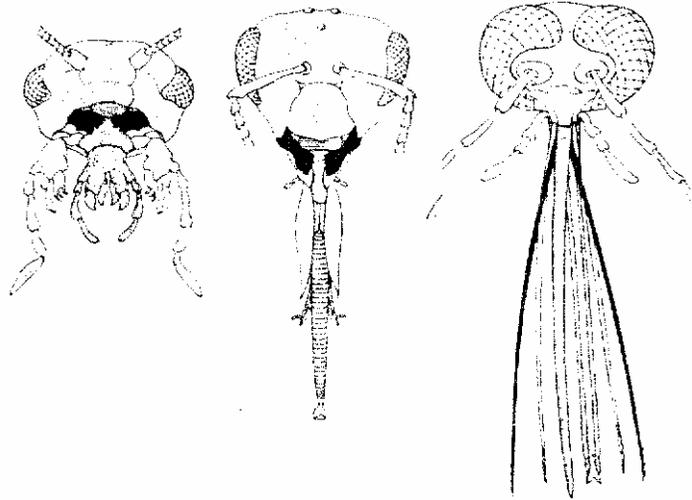


In man the lower jaw moves upwards to join the upper jaw, insects work their jaws from left to right. The lower drawing is a greatly magnified illustration of the mouthparts of the cockroach. UL- upper lip, UJ upper jaw, LJ – lower jaw, FJ – jaw feeler, LL- lower lip, LP – labial palp (lip feeler).

In spite of their complicated structure suet mouth-parts are regarded by experts as primitive and comparatively simple forms. All insects which have come down to us from the Carboniferous Age as fossils belong to species with such biting mouth-parts. In later periods of the earth's history new groups of insects appeared with specialized habits of eating. All who are interested in the evolution of the different forms will be struck with astonishment and admiration at the way mouth-parts are transformed into specialized instruments, very limited in use, but highly finished in form.

In wasps, for instance, the upper lip and the first pair of jaws have retained their original form and function, but the second pair of jaws and the lower lip have been lengthened and combined to form a movable little brush for collecting honey and other liquids. In bees these parts have been further lengthened and modified into a proper sucking tube. In gnats all the mouth-parts have been greatly lengthened and attenuated. The upper lip has been extended and its edges rolled in to form a thin sucking tube, and then come the two pairs of jaws, transformed into the finest piercing bristles dotted with tiny teeth, the "jaws" being movable up and down. The lower lip, which does not lie in a groove of the skin, serves as a guide.

The comparative study of forms, of whose richness our few examples can give but a faint idea, has led to the conviction that in spite of the differences in their appearance, all the mouth-parts of insects are derived from those of the most primitive of their ancestors and have been gradually adapted in the course of time to the foods of the different species. It is a small, but very illuminating example of the transformation all forms of life have undergone in the course of the development of species. Every naturalist probably has his own opinion as to what force were involved, but no one ever looked over the shoulder of the Creator when *he* was working on the creation of living creatures, and no man knows exactly how it has been done.



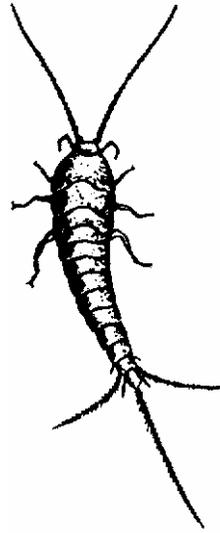
(Left) The biting mouth-parts of a cockroach. (Centre) The sucking mouth-parts of a bee. (Right) The piercing mouth-parts of a gnat (mosquito). Corresponding parts are shaded in the same tone. The adaptation to special functions is based on an extensive transformation of the primitive mouth-parts. Of the feeler located on the front of the head only the segments near the body are shown.

Cockroach Control

As soon as cockroaches have become a source of annoyance, steps should be taken to get rid of them. The measures, adopted will depend on whether they are merely a nuisance or a serious menace. In the home every effort will be made to exterminate such unsavoury propagators of filth. Cleanliness and the prompt removal of food remnants and kitchen garbage will help a lot. Cockroaches only settle where they find food and harbourage. If they have managed to do so, the simplest thing is to use DDT. A spray will prevent unnecessary expenditure. This will blow the powder uniformly and on to the insects' favourite runs and lurking-places, viz. round the skirting of the floor, behind pipes, radiators, boxes and similar dark retreats. As the egg-filled cocoons are very resistant, spraying must be repeated if no subsequent generations are to survive.

Cockroaches sometimes cause such damage that their eradication calls for costlier and more complicated measures. In libraries, for instance, they sometimes cut their way through valuable book-bindings, probably tempted by the glue, or they sometimes gnaw off the gold letters on the backs of leather-bound books in order to get through to the albuminous paste behind. In hospitals they are dangerous housemates, since they have been proved to carry the germs of disease both internally (in their intestines) and externally (on their legs). In such cases fumigation is recommended, a process we have already mentioned as being the most effective method of rendering a building vermin-free after one operation only.

SILVER-FISH



GENERALLY we do not notice these little insects, but if we lift up a flower-pot or shift a bag in the larder or open a drawer, we sometimes get a glimpse of a shining, silvery creature about one centimetre long darting hither and thither in terror, making desperately for the nearest cover. Its efforts to escape are sometimes cut short by a well-directed blow from the hand of a housewife, she being on principle suspicious of the intentions of every living creature she comes across in the house. So it is not often that we have the opportunity of studying this little creature at leisure. Before we have had a chance to have a good look at it, it has either disappeared in a crack or been overtaken by fate and reduced to a shapeless stain similar to that left by a clothes-moth in the same circumstances. Perhaps we shall deal more leniently with the next specimen we find.

Primitive insects

The silver-fish (magnified about 4 times in the illustration) belongs to the insect order, sharing its general characteristics — a segmented body, six legs, as well as other features which are revealed only by dissection. The two thread-like feelers on the head closely resemble those of the cockroach. The three filaments at the “tail”, stretching backwards as if to protect the body from behind, are distinguishing features of the silver-fish, and we wonder why Nature has not more frequently equipped small, defenceless creatures with such a practical device. The insect probably got its name from the shining scales covering its abdomen; they remain as fine silver dust in our fingers when we have crushed one of these little creatures. Such scales, formed from the chitin of the skin, are not uncommon in insects. We find them on many beetles. The brilliant colouring of a butterfly’s wing is produced by the delicate structure and colouring of tiny scales embedded in the surface — the reason why the lustre fades so quickly when the butterfly falls into the inexperienced hands of young people.

In the case of the silver-fish, only the abdomen is covered with scales, for it has no wings at all. None at all, be it noted. The caterpillar of the moth and the maggot of the fly have no wings, but they develop in the pupal stage and the fully grown insect makes use of them. Neither the flea nor the bug can fly, but it is certain that their ancestors could fly very well and that the wings have only receded in consequence of these insects’

parasitical way of life, a fact which is confirmed by the vestigial wings possessed by mature bugs today. There is not the slightest indication that the ancestors of the silver-fish ever were winged. The absence of wings, therefore, is considered to be an ancestral or primitive characteristic. Along with a group of cousins of various types, the silver-fish brings us, as it were, a message from the distant past.

While other insects were passing through all the preliminary stages before emerging as accomplished aeronauts, this little community simply stood aside and took no part in these developments. That was very long before the first human beings appeared on the earth. Other characteristics, too, point to the ancient lineage of these insects. That is why, insignificant though they seem, they have been singled out by the zoologist for special attention and why they are called “primitive insects”, although they, too, have changed in many ways since the birth of the insect family.

A harmless housemate

The scientific name of our silver-fish is *lepisma sacckarina* — the sugar guest — an official confirmation of its sweet tooth. And not without reason, seeing that sugar is one of its favourite foods. It is not fastidious, however, and is also content with all kinds of animal and vegetable waste. The quantities it consumes are so trifling that it causes no damage to speak of, provided exceptionally favourable circumstances do not allow it to multiply too much. As it requires a certain amount of moisture, it does not thrive in dry rooms. The love of moisture is here, as in many other cases, associated with an antipathy to light. That explains why we do not notice these little housemates during the daytime unless they are accidentally exposed. They lay their eggs in cracks and abandon them to their fate. From the very beginning the young resemble their parents in appearance and have the same habits. The housewife need have no sleepless nights on their account: they take about a year to reach maturity and so do not multiply at the same rate as other pests. On the whole they are entirely harmless housemates.

If the silver-fish are left undisturbed for a longish time in favourable circumstances, say in damp rooms which are little used and not thoroughly cleaned, they sometimes multiply to an extent that demands the employment of drastic measures of control. As they are also fond of dried paste or glue they may be a nuisance if present in sufficient numbers, since they will attack starched linen or curtain and damage book-bindings. They have even been known to gnaw through woollen material and leather.

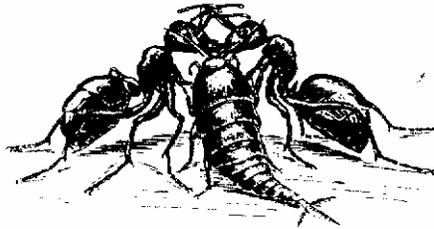
It is not difficult to get rid of them if the rooms are well cleaned and aired. Spraying their haunts with a good pyrethrum insecticide or with DDT is also recommended.

A glance at the relatives of the silver-fish

Only a few species of this primitive insect become our housemates. Most of them live in the open air, little known and hardly noticed.

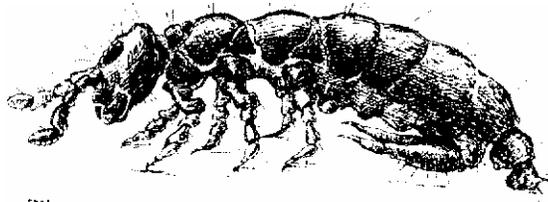
There is, for instance, one insect so like the silver-fish that the casual observer might well mistake it for one. Its habits, however, are entirely different from those of its cousin, who loves darkness and the four walls of a house, for it can be seen lying on a bare rock by anyone out for a walk in the hills.

Another relative lives as a housemate of ants. This “ant silver-fish” has shown considerable perspicuity and has hit on the right place for getting through life without worry-ing about its daily bread. For such an ant household is never short of stores. There are hundreds of thousands of inmates and they must all be fed. The innumerable insects that have been dragged inside provide an abundance of fresh meat, and there are sweets in plenty — honey and other delicacies. There are, in fact, quite a number of “guests” who make a habit of sharing the ants’ stores. They have *not* been invited, of course, but the ants just have to put up with them. Some of these gate-crashers are so small that they pass unnoticed. Others are literally so thick-skinned that the sharp jaws of the rightful owners of the house can make no impression on them. Others curry favour with their hosts and are given the run of the larder in return for the delicious scent and flavour of their secretions. They even go so far as to help themselves to the ants’ eggs. The silver-fish guest is neither small compared to the ants, nor is it armoured, nor does it possess anything that could appeal to their senses. If an ant has had the luck to find honey and, in accordance with the habits of the species, has regurgitated it to share it with its fellows, the parasite creeps up from below and steals the sweet drop right out of the mouth of the expectant member of the family. The thief then wisely beats a hurried retreat.



The ant silver-fish lives as a housemate of the ants and snatches the food from their mouths. (Magnified about 3.5 times.)

Another group of these primitive insects is not so good at running but all the better at jumping. For this it has a kind of spring fixed near the end of its toil and tucked under its abdomen when not in use the spring can work downwards and backwards when required. With the help of this device the insect then takes a jump of which a flea might be proud. The goal is immaterial. The insect jumps at random; it is bound to land somewhere; it covers ground and in spite of the clumsiness of its legs it is thus able to reach a place of safety if danger threatens.



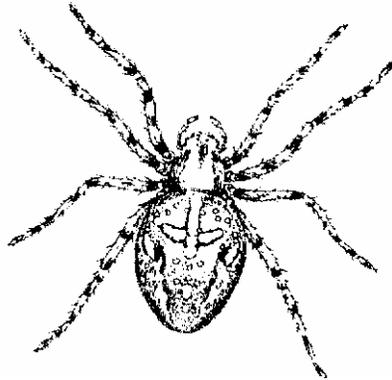
....
The water springtail. (Magnified about 45 times.)

These springtails are minute insects, much smaller than the silver-fish. That is why they are usually unnoticed, although they are to be found everywhere. They live in moist earth and are frequent visitors not only in our gardens but also in damp cellars and in flower-pots in rooms. Here innumerable members of a white species are often found,

whose jumping organs have atrophied, so that, like many other inhabitants of this earth, they can only make progress by crawling. A black species, often found on the banks of stagnant water, can multiply to such an extent that the ground looks as if it had been strewn with gunpowder. It is only when such a black speck is put under the microscope that we see its comical shape and its “spring tail” tucked under its body, which enables it to jump long distances. Another species inhabits snow-fields in the vicinity of glaciers. Observant mountaineers are often astonished to find this “glacier flea” and wonder what it lives on. They forget that such a tiny speck of life needs only the minimum of provender and can make do with grains of pollen and other organic dust that is swept even on to remote glaciers in more than adequate quantities.

Thus these little inhabitants of the earth can be found in the most remote and obscure spots, availing themselves of whatever slender means of subsistence even these may provide. We shall not begrudge them the one they may have chanced upon in the soil of our own flower-pots.

SPIDERS



WOMEN detest spiders, whereas men for the most part regard them with indifference. They deserve neither our hostility nor our indifference. They do us no harm. On the contrary, they rid us of many troublesome and dangerous insects; and they are among the most interesting of all the animals that make their homes in our more immediate surroundings. It is true that a house with cobwebs in every corner looks neglected, and we can't blame the housewife if she feels obliged to sweep them away. But must every web in front of a window, on the verandah or in the summer-house be destroyed, and its maker killed?

Some say they are cruel creatures. How dreadful it must be for a fly to be swallowed alive! I don't know whether it is more painful to the in a spider's web or inside a swallow or in the treacherous toils of the fly-mould. It is doubtful whether insects feel pain at all as we do. When a cockroach has hurt its leg during a moult, it is fond of licking its own blood; sometimes it does not stop at the blood, for it has been seen having a mouthful of its own flesh —a self-devouring cannibal! If you take a pair of sharp scissors and cut a bee in two, taking care not to disturb it while it is taking a drop of sugary water, it will go on eating. Its pleasure — if it feels any — is even considerably prolonged, it cannot drink its fill, for what it sucks trickles out again at the rear, and hence it can feast on the sweetness for a long time before it finally sinks dead of exhaustion. The story of

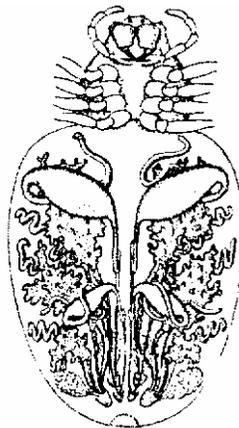
Munchhausen's horse, which was anything but dead although a portcullis had cut off its hind-quarters, might not be fiction in the insect kingdom, but sober fact. Observations like the above do not support the view that insects have an acute sense of pain. To be sorry for a bird in the claws of a cat is understandable and justified, but only a sentimentalist will be sorry for a fly caught in a spider's web. So let us tolerate spiders, at least as far as domestic orderliness will allow. Let us watch them for a little.

Of spiders in general

Spiders do not belong to the insect order; spiders and insects are two related, but quite distinct, classes of animals. Along with millipedes and crustaceans, spiders belong to the group of invertebrates known as Arthropoda, which is divided into four classes. Of these, only the insects are the happy possessors of wings. Since, however, there are also wingless insects, such as the flea, the louse and the silver-fish, with which we are already acquainted, the absence of wings is not an infallible distinguishing feature. The number of legs, on the other hand, does show whether we are dealing with an insect or a spider: insects have six legs, whereas spiders have eight.

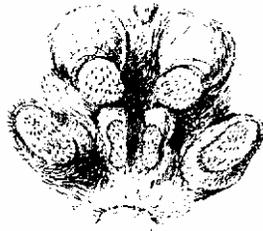
There is naturally no need to count wings in order to tell a garden spider from a dung-beetle, but there are spiders of all kinds and shapes, some 20,000 different species having been described. That is few in comparison with the hundred of thousands of different insect species which have been classified by naturalists. Nevertheless, there are too many spiders for us to be familiar with them all, and that is why the expert also counts legs before pronouncing his verdict.

This is true in particular of the mites, often very tiny creatures, which are classified with spiders in the wider sense. More like the usual idea of a spider is the daddy-long-legs, whose body rests on eight horribly long, spindly, jointed legs. When they come strutting over the table or the floor, they must often enough pay for their alarming appearance with their lives, though they are actually quite harmless creatures, which live on dead insects and decaying vegetable matter.



Garden or cross spider seen from below, on the under side of the head, the sharp fangs (jaws). On the thorax, the buds of the legs. Only the big silk-producing glands are shown in the sketch of the abdomen. They vary in structure and produce several kinds of silk, the quality varying according to the purpose for which it is used .

The true spider has big silk-producing glands at the end of the abdomen. They exude a silk which hardens in the air and which we know from their webs. Many insects too have silk glands; they spit the thread from their mouths as anyone knows who has ever watched a caterpillar making its cocoon. In the case of the spider, the glands have ducts leading to teats, known as spinnerets, situated near the end of the abdomen. They use their thread for various purposes: not all of them make webs from it. The little jumping-spiders are free-lance predators, not bound to webs. They can often be seen in grass, on roof-beams, and on walls, now lurking in wait for prey, now hurrying a few steps forwards using their eight small, but well-developed eyes to spot a fly, on which they pounce with a bold and well-directed jump. The jumping spider kills its victim with its poison fangs and eats it up without more ado. A loosely woven nest gives it shelter at night; it is in this that later on it lays its eggs and keeps watch over them. The big wolf spider also roams at large in search of prey. Many of them can be seen running over the stones at the edge of our lakes and rivers. They weave a cocoon for their eggs and carry it about with them, defending it when necessary. As soon as the young spiders leave their silken cradle under their mother's belly they crawl up to her back. They ride along on her thus enjoying her protection for some time.



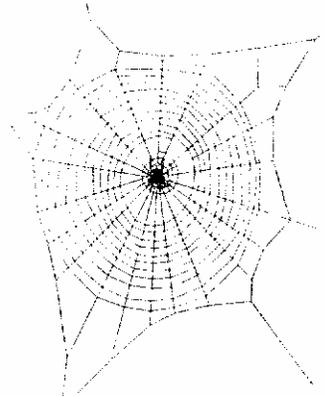
The 'silk factory' on a garden spider's abdomen. The six spinnerets are transformed vestigial legs. The silk glands terminate in the many pores on the spinnerets. Magnified 20 times. Teats slightly stretched apart.

Crab spiders take it easy. Arms outstretched, they take up their position on flowers, and wait motionless for their prey. If an insect comes flying along to feed on the nectar, it is caught in a trice; instead of having the nectar in its mouth, it gets the spider's deadly injection in the back of its neck. Such spiders even attack bees and butterflies, opponents far bigger than themselves. Many use their thread to weave a silk roof to serve as a shelter in bad weather, strengthening it and filling in the gaps by working leaves into it. Faithful as adult crab spiders are to their quarters, they are equally fond of roaming in their early youth. Even then they do not exert themselves very much; they seem to be indolent by nature. If a clear autumn day gives promise of an undisturbed journey the young spider finds a high place either on a paling or on the top of a blade of grass. It hoists its hind end as high into the air as possible, and shoots out its silk. Suddenly all eight legs let go of their foothold and grasp the floating thread; the gentlest breeze wafts the little parachutist over considerable distances.

As there are many young spiders in late summer and as many other kinds use the same inexpensive means of transport, these drifting spiders' webs are a common sight in autumn. They are always associated with what we call an "Indian" summer. The most remarkable use the spider makes of its silk thread, however, is displayed in her crafty trap. Two different species of spider that make absolutely different webs often live with us as our housemates —the garden or cross spider and the house spider.

The spider in her web

A garden spider uses its web both as a parlour and as a trap. Woven entirely of silk it is, according to our standards, a very elegant parlour. The spider, on the other hand, who manufactures this material herself, does not regard it as either elegant or costly. Anyone who has ever noticed the great number of pores where the silk glands terminate at the end of a spider's abdomen will realize that she need never fear a shortage of silk, which is a blessing since it is essential to her life.



A garden spider in her web. The spider sits in her lookout. From this lookout dry threads radiate like spokes of a wheel towards the outer framework. Between centre and circumference, but separated from these by intervening spaces, lie the sticky spirals of the trap. (Reduced in size.)

The web must be sticky if it is to catch flies. Yet the spider does not want to stick fast herself when she sits in her parlour or hurries over the strands, any more than we should appreciate having fly-papers strewn all over our floor. The dual purpose of the web is achieved by the use of two different threads: the centre, the spider's home, where she generally spends the day, is a network of dry threads. From this look-out rays of thread, also dry, are flung out as spokes to the outer rim. The web proper, between centre and circumference, is woven of sticky threads of silk produced by special glands (The sticky silk is produced by the three pairs of silk-producing glands which are coloured grey in the figure. The threads of the dry framework of the web come from the two pairs of big, bottle-shaped glands, the front pair of which extends to the spider's thorax. Secretions from special small glands near the spinnerets strengthen the places where the supporting and cross threads are attached to twigs and other objects. Three pairs of spiral, tubular glands, whose ends can be seen in the figure at the side of the big glands, produce the strong thread for the egg-cocoon.) the ends of which are made fast to the spokes. When the spider runs over the web, she uses the dry spokes and carefully avoids touching the sticky threads with her legs. In doing so, she is aided by two devices: at the ends of her feet there is an ingenious arrangement of hooks, toothed claws and bristles to help her hold on to the thin threads; then, if you look carefully you will see that the web is not vertical but somewhat slanting: the spider sits on the underside and moves along upside down, which makes it easier for her to avoid coming into contact with the sticky threads.



The end of a garden spider's foot, with hooks and toothed claws and bristles.
Magnified about 100 times.

Sometimes the garden spider does not sit in wait at the hub of the web but at the rim, where she often weaves a kind of shelter of leaves. But there, too, she literally maintains contact with her web, as she doesn't want to miss the moment when any prey enters the web. So when she has taken up quarters at the rim, she always keeps a forefoot lightly poised on one of the spokes, sometimes also on a specially constructed "telephone" thread. As long as it does not vibrate she can sleep in peace.

The catch

It may sound strange to say that a garden spider relies on her sense of touch to inform her when a fly right in front of her eight eyes is entering her web. Yet it is true. Her organs of sight are poorer than those of the jumping spider. She can probably distinguish where light comes from and she also uses her eyes to get about in her own familiar little domain; but however hungry she may be she is not aware of a fly dangling in front of her if it does not touch the web. Her *eyes* are incapable of recognizing it.

We humans speak of what a thing looks like. For us, sight is the most important, the guiding sense. It is only the blind who are able to make a subtler use of our inborn sense of touch; those poor people who are born blind and deaf, like the celebrated Helen Keller, learn to develop their sense of touch to an extraordinary degree of keenness. Web-weaving spiders have used their sense of touch from time immemorial. If they could speak, they would talk perhaps of how an insect vibrates, rather than of what it looks like.

It requires not a little imagination to understand the, make-up of a creature which learns by its sense of touch almost everything of importance to it. It is the vibration of the threads that betrays the presence of prey in the web. The strain on the web, which is indicated by the tension of the spokes, shows whether the catch is plump or scraggy. The exact spot where it is hanging is also conveyed by the sense of touch. If the prey does not move, the spider plucks every thread in turn till she detects the right one. She finds her way to it immediately, for she is a genius in following up clues.

When a fly has got caught in a web, the first thing the spider does is to rush out and secure her prey. Even though the sticky threads make escape difficult, the attempts of some of the stronger insects are sometimes successful — provided the spider doesn't overtake them. If she does, she immediately envelops her victim in a shower of fresh threads, with the help of her deft legs-rolling it round and round so rapidly that it is enmeshed in no time and is soon absolutely helpless and defenceless. During these operations she bites it a few times with her sharp upper jaws, which are connected with poison glands. The poison in them is so lethal that a fly dies of its effects in a few minutes. The threads of the web are then bitten through and the parcel of food is ready for

transport to the look-out, where it is immediately hung up by a short thread. Then the efficient spider has her jaws and legs free to deal with any fresh fly that might get into the web. If this does not happen, the spider settles down to enjoy her meal.

Now the spider's conduct is somewhat odd. It is as if we, instead of taking the top off a boiled egg and eating it with a spoon, were first only to bite it and, after spitting a little gastric juice into it, wait for the contents of the egg to dissolve and liquefy before we sucked it up. This is exactly what the spider does with the fly: she bites it, spits gastric juice into it and sucks up the dissolved contents together with the digestive juices. This process of spitting and sucking is repeated for some time and the persevering spider manages to imbibe all the dissolved muscles and intestines of the fly in a few hours. Only indigestible remnants of chitin are left and they are ultimately thrown out of the web.

If the spider has had a good day and has caught more flies than she can eat at the moment, the trussed game is hung up in the web as in a well-stocked larder. She scarcely ever grants an insect a reprieve and allows it to escape because her immediate needs are satisfied. On the other hand, if an enormous bluebottle or any other boisterous insect gets caught, the spider's anxiety for the safety of her web may prove stronger than her lust for prey, and with a few, quick tugs she tears the entangling threads and lets the booty fall. The web will then be only slightly damaged, not completely destroyed.

Fooling a spider

About 400 BC there lived an artist in Greece called Zeuxis. The story goes that he was such a master of his brush that birds came flying to peck at the grapes he had painted. A spider would never have been fooled by any Zeuxis, However life-like his painted flies might be, they would mean nothing to her. But touch her web with a tuning-fork that has been set in motion and the vibrations of which approximate to those of a fly's wings, and out she rushes to bite it. If the tuning-fork is quickly withdrawn before she reaches it and a pellet of paper put at the spot where it touched the web, the spider falls on it. The deception does not go so far, however, that she is induced to eat the paper. After a brief investigation she tears the threads it is hanging by and the indigestible "prey" is flung out. How does she spot her mistake?

It is not the light weight of the supposed prey that deceived her, *for* if a tiny ball of clay is wrapped in the pellet; the spider reacts in the same way. And it makes no difference if the pellet is moistened with water. On the other hand, if the pellet is soaked in a kind of meat extract prepared from steeping a squashed fly in water, the spider bites it as if it were a fly, poisons it, trusses it up with silk and carries it off to her nest, where she will spend hours trying to suck her strange booty dry. Such conduct may appear "stupid". But who can blame anyone for being stupid if his senses tell him he is acting rightly? This nice little experiment only shows us that not only the sense of touch hit also the sense of taste plays an important part in the spider's life and that she trusts it implicitly.

Another experiment, as simple as it is illuminating, has shown that the garden spider can lay claim to a modest measure of mental activity, at least to some kind of memory. Suppose a spider is sitting in her lair at the edge of her web. A fly gets entangled, is caught, bitten, trussed and carried to the look-out and hung up there. During the short

interval when the spider is getting ready for a good meal, a mischievous onlooker carefully cuts the threads by which the booty is suspended and the fly falls unnoticed to the ground. A dull-witted creature would simply accept the fact that the booty has disappeared. Not so the spider. She immediately begins to search her web patiently and thoroughly. One after the other she plucks and pulls at the spokes radiating from her nest. As they all sound alike, she runs to her shelter at the edge, half a metre away. Could she have hung the prey there and then have forgotten about it? When the search proves fruitless, back she runs to the look-out and plucks at the spokes again, and even runs to the spot near the edge of the web where the fly was caught. It is only after an inspection there, and further plucking yields no results that she calms down. She settles to wait for a fresh victim, herself a victim of the naturalist's curiosity, cheated of the good cheer which should have been hers by right, since she had obeyed all the laws of the instinctive art of dealing with her prey.

How a spider's web is made

The spider's masterpiece is her web. If she had learnt how to make it at a school for weaving or from her parents, we should have to take off our hats to her. In reality she is born with a perfect mastery of her art and it is to Nature that we must pay homage for having produced a creature so perfectly endowed with such accomplishments.

Let us take as an example the web of the garden spider, since it is fairly easy to watch its construction. We must of course be up betimes, for she starts work early. As a rule she makes a new web in the early hours of every day or every other day, the old one having been spoiled by dust, insects or leaves entangled in it, or by other wear and tear. It is only the outer framework that lasts longer. Let us assume, however, that a completely new web is to be fashioned. How does the spider manage to fix the first thread where she wants it?

The conical spinnerets that we have already heard about and which send out silk threads from the tiniest of taps, are in fact vestiges of rudimentary legs and capable of movement. Suppose a garden spider on a tree trunk is about to start on a new web. She lifts her abdomen high into the air shoots out some silk, stretching the spinnerets away from each other so that the silk forms a sail made of little tufts of thread, light enough to be borne away by the gentlest breeze. Thereupon the spider shifts her spinnerets to make them incline towards each other so that the silk threads that now emerge are combined into a single strand. This thread, sail in front, may float through the air for a distance of perhaps one or two metres. If this is all that happens, the spider hauls it back and eats it, and then tries her luck with another. If this one happens to come in contact with something solid such as a twig, it sticks to it. Then the spider makes her end secure, thus constructing her first bridge, which she immediately proceeds to cross, doing so in a very odd fashion: she bites the thread through, but keeps hold of the two ends with her fore and hind legs, her body hanging like a bridge between them: she runs forward, shooting out fresh silk all the time behind her and winding up the thread ahead of her on her forelegs. As she pays out more thread behind than she winds up in front, the thread is lengthened, so that the bridge sags. When she is midway she sticks the ends together and lets herself down to the ground. On landing she steps a little to one side (in Fig. II towards the spectator or away from him) and then fastens the thread to the ground. Thus

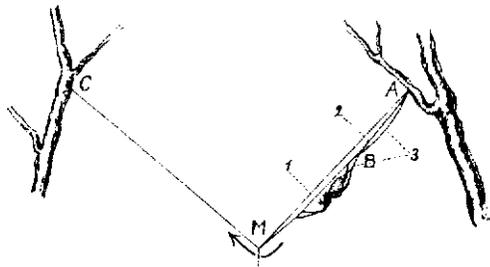
the first three spokes are finished and the few steps to one side have ensured the slanting position of the web, which, as we noted before is all important for the spider's movements later, when the web is finished.



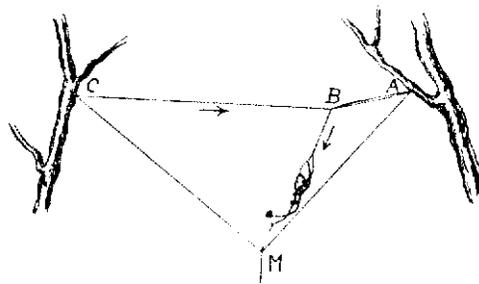
I: The bridge. So as to have a clear picture, the figure of the spider in this and the following illustrations has been enlarged. Figures I-XI show how the web is made.



II: The elongated thread of the bridge is fastened to the ground.

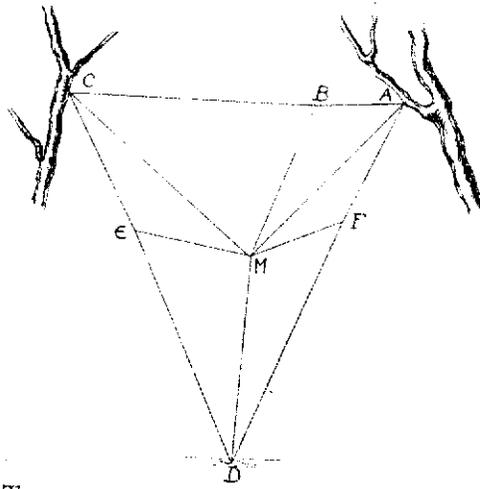


III: Preparing to stretch the first thread of the frame-work.

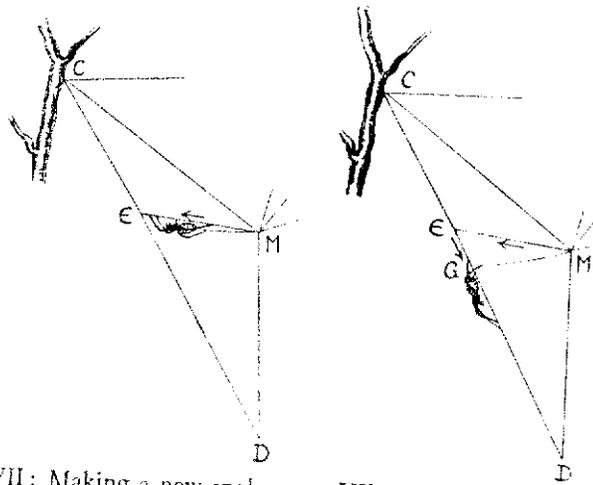


IV: The first thread of the framework (A-C) being tautened.

V: The outside thread is slackened; the temporary spoke B-M replaced by the final one.



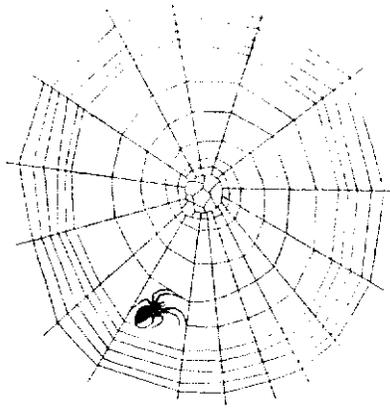
VI: Two more frame threads have been made along with two more spokes.



VII: Making a new spoke.

VII: Making a new spoke.

VIII: The new spoke being fastened to the frame.



IX: The spider pays out the sticky spiral for trapping her prey, working from circumference to centre. What is left of the temporary spiral can be seen between the spider and the centre of the web. The framework has been omitted from this illustration.

The next step is the construction of the first part of the framework. Now we must watch very carefully if we want to see how this is done. The spider has again climbed up to M, the centre of the future web (Fig. III). From M she runs to A and as she pays out a thread all the time, this spoke is now double. Back she runs along the double thread, still paying out, so that there are now three strands. After reaching a certain point—about at B—she suddenly does something, surprising but we immediately see why: at B she fastens the new (third) thread to the second one: running on past M to C, she reduces her output of silk, which tightens the new thread (Fig. IV) and thus pulls the second thread away from the first; thread number 3 is then fastened at C. In this way she makes a new spoke (B-M) and at the same time a part of the frame, though it is not quite satisfactory as it is over-taut and out of the perpendicular. To rectify this, the spider runs back to B and extends the thread of the spoke B-M, employing the same clever technique that we observed in the first stage of the construction: she bites the thread through, bridges the two ends with her body and runs on to B, paying out more thread behind than she winds up in front (Fig. V). In this way she replaces the original spoke by a longer one, the outside thread (A-B-C), which, slack at first, is shortened and the dip at B is straightened out. This procedure is repeated: more outside threads are made, always in conjunction with a new spoke, e.g. outside thread C-D with spoke E-M, frame thread A-D with spoke F-M (Fig. VI). Now we can recognize the foundation of the web, though many more spokes have still to be added. To do this, the spider, starting from the centre, runs along one of the spokes, say M-E, to the circumference. She keeps the new thread clear of the one already there, by guiding it with a hind leg and letting it roll over the claws of the foot as over a spool. When she has reached E, she fastens the new thread to the frame a little below E (at G in Fig. VIII).

In the present case the new spoke will be too slack, since G is nearer M than E is. But the spider hasn't finished yet! The spoke M-G is bitten through and replaced in the usual way, the spider's body forming a living suspension bridge between the two ends while she runs to M paying out the permanent spoke behind and rolling up its predecessor before her. As the spokes appear, one after the other, they are fastened securely together at the centre by cross-threads and the future observation post begins to take shape.

The most important thing is still lacking: the sticky thread which is to trap the insects. In order to fix it, the spider must first make a temporary spiral, or scaffolding of dry thread. She runs from spoke to spoke, stretches her *abdomen* towards the circumference and, running round four or five times, fastens her silk thread to the spokes wherever it crosses them. When she reaches the circumference she turns and now works in reverse, running towards the centre, making a much closer spiral of sticky thread between the widely spaced rounds of dry silk (Fig. IX). She uses the scaffolding of the first spiral both in order to get from one spoke to the next and as a guide for the sticky thread, much as a gardener keeps his rows of plants straight by first stretching a guiding thread across, thus keeping the main lines of his plan intact while he is filling in the details. As the sticky spiral grows, the temporary one, having served its purpose, is bitten out, rolled up and thrown away. At last the web is finished. Time, too, or our patience would have run out! Naturalists are blessed with the gift of patience. They have watched spiders weaving their webs over and over again. All we have said is merely an introduction, for we have only described one particular way in which a garden spider might have made its web; it is astonishing how little the inborn skill of these animals is bound to a rigid system, how greatly their actions differ in detail according to local conditions and according to the weaver's character. If we were to start describing different webs of the various species of spiders, we should never stop.

My secret hope is that even this one example may induce many traditional enemies of the spider to watch one weaving her web if he ever gets an opportunity. The reader might then become an observer, the enemy even the friend of these amazing creatures, since hatred usually vanishes with increasing knowledge and understanding.

A spider strums his serenade

In spring and early summer male garden spiders are not interested in females. They spin their own webs and lead independent lives until they have attained their maximum size, which is not saying much, because even then they are smaller than the buxom females. Indeed, the males of many species are mere dwarfs compared to their partners. In the spider world we certainly cannot refer to the females as the weaker sex.

On fine days in late summer, the male leaves his web and goes roaming in search of a mate.

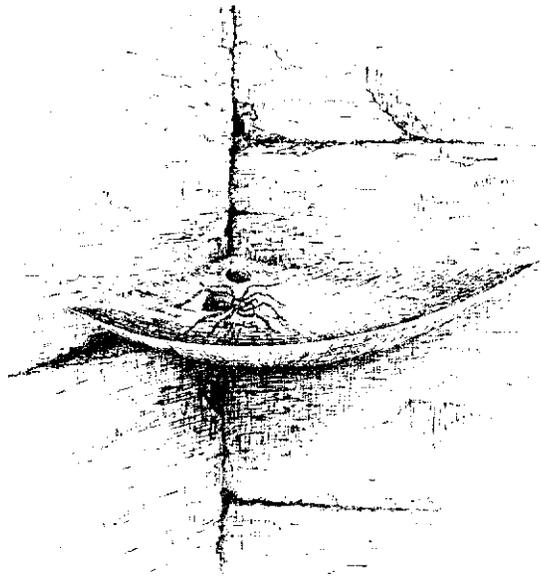
On such occasions every creature puts his best foot forward and makes the most of all his natural talents to impress the opposite sex. The peacock displays the glory of his tail; the blackbird pours forth its melody, while many butterflies emit an odour from special scent-producing glands which goes to the females' heads. What are male spiders to do? Their prospective partners cannot hear, their eyesight is poor, and they have little by way of a nose. So when the male spider goes courting, he concentrates on touch, the all-important sense in a spider's life. If he comes across a female's web in the course of his roaming, he attaches a strong thread to its edge from some suitable point in the neighbourhood and then plucks at it. The female in her parlour notices that the "telephone is ringing"; there must be an urgency in such vibrations, a special note of passionate desire communicated to the female's superfine sense of touch, for provided she is in the right mood, she immediately hurries to the thread and goes forth to meet her partner on the "bridge of love".

It is a dangerous job being a male spider. Should his visit be inopportune, it may end in his being seized and devoured right away by the bigger and stronger female. The same thing may happen even if the female submits to his advances though the end may be drawn out until she has had time to satisfy her sexual desires and her appetite for food. It is not uncommon for the garden spider to thus murder her mate once he has performed his function, and with other species it is the general rule. The male of some species is sufficiently diplomatic to offer the lady of his choice a trussed-up fly to dine on when he is approaching her, thus saving himself from being devoured.

Round about September the female garden spider lays her eggs, and deposits them in the soft, yellow cushion she has spun, which she keeps in a sheltered spot. Her life comes to an end with the first frosty night. In the following spring the young spiders hatch out of the eggs, exactly like their parents, only smaller. For *some* days nourishment is provided by the considerable supplies of yolk in their abdomens. Soon, however, they adopt the habits of the family and spend the summer catching and devouring prey. With autumn, the time comes for the males of this generation to sally forth to strum their serenades outside the webs of the females.

House spiders

The garden spider prefers to live out of doors, though she is not shy about entering our houses and often enough spins her web before our eyes. Where house spiders occur, and are tolerated they are our housemates in the true sense of the word. Their traps are to be found in the corners of our living-rooms, in cellars, attics and summer-houses. Though these mat-shaped cobwebs, which sag slightly in the middle, have not the artistic finish of the orb webs of garden spiders, they serve their purpose fairly well. When a fly or midge is caught in a web, with its legs entangled in the mesh, it is promptly seized by the watching spider.



The web of a house spider

She lies in wait in a tube woven in such a way that it is sheltered and leads into the bottom of the snare. The spider generally passes her time in this tube, emerging to catch game and disappearing into the tube with her prey in order to have a meal in peace and safety. In contrast to most other spiders, who live only for one year, the house spider may live from two to five to seven years, unless of course her days are cut short by the housewife's broom. For the cobwebs at the corners of walls and ceilings are traps not only for flies but also for dust and dirt. They are not regarded as ornaments, and, moreover, there is another reason for their removal: spiders in living-rooms and bedrooms are often dreaded as poisonous. Are they really dangerous?

Are spiders poisonous?

Spiders certainly are poisonous. The duct of a poison gland perforates the sharp point of the spider's upper jaw, its secretion, which is injected into the wounds made by the spider's bite, causing the death of the trapped insects. But can spiders harm us with their poison? On the whole, no. The jaws of a garden spider or of a house spider are not strong enough to pierce our thick skin; nor are they constructed for this purpose. If they really do succeed in doing this where the skin is thin, the results are no worse than those following the bite of a midge. We need not worry: none of these spiders will hurt us seriously with their poison! So, there is no point in our pursuing them as if they were dangerous animals.

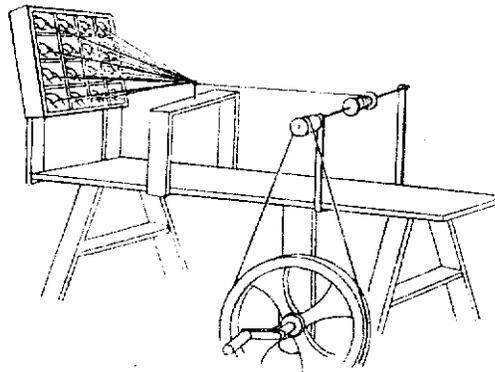
Some other members of the spider family do not have such a blameless record. The bite of a water-spider found in our part of the world can smart unpleasantly. The Italian tarantula, a member of the wolf spider species, can also bite quite effectively, though the consequences are not grave. Medieval reports of people "bitten" by a tarantula and being driven to go on dancing till they collapse from exhaustion are, like many such rumours, just fairy tales. There is, however, a wolf spider in Brazil whose poison may cause a severe affection of the skin over a considerable area round the bite.

Really dangerous is another kind of spider, several species of which are found scattered over various parts of the world: in Italy and Southern France there is the "malmignatte", a spider that hunts grasshoppers, in Asia a near relative - the Black Wolf, and in tropical America the notorious Black Widow. The bites of such spiders are not *only* extremely painful, but may cause fever, amnesia and other disturbances and they may prove lethal. Of course none of these spiders deliberately attack men as prey. But it can happen only too easily that some person or other, who may be reaping or who may perhaps just chance to pick up some leaves may inadvertently crush one of these spiders which, feeling itself threatened, will then bite in self-defence.

In England Black Widows have repeatedly been kept in zoos, with the appropriate precautions. How greatly they are to be dreaded is shown by the fact that in critical times they functioned as a kind of political barometer. When there was a possibility of war and a bomb liberating them from captivity, these valuable creatures, the whole collection of them, acquired from such distant lands, were all destroyed. The risk of their running wild had to be prevented at all costs.

Spider's silk

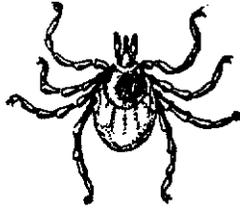
More than 200 years ago a pair of gloves and a pair of stockings made of spider's silk were submitted to the French Academy of Science, but much earlier than this, spider's silk had been used for sewing in many parts of China. Although occasionally the services of our garden spider as a silk manufacturer have been required, the big, web-weaving spiders of tropical parts are far more profitable for this purpose. In Madagascar and in the tropical parts of East Africa there is a "silk spinner" whose web measures almost two metres across, and the legs of the mature female of this species are a good twelve centimetres round. In spite of its size, it supplies a thread 0.007 mm thick, the finest natural silk that can be used in technical production. It is so fine that a length of it sufficient to go round the equator would not weigh as much as two kilograms. Other glands of the same spider produce a somewhat coarser thread which is also used by manufacturers. Spider's silk is as strong as the real silk produced by the silk-worm and is even more elastic. Material woven of spiders silk is extremely beautiful and durable.



Spiders as suppliers of silk for man

It would certainly have ousted real silk from the markets of the world if its production were not so costly. It is easy to breed silk-worms in great numbers, since they are content with a daily ration of leaves. Who would like to catch the flies necessary to keep a spider farm going? To save this time-consuming labour, either the egg cocoons are collected out of doors, or, alternately, adult females are caught and the thread drawn out of their bodies. Progressive factories have installed a simple, ingenious device for this purpose. About two dozen spiders are installed in a frame, one beside the other, by laying the slender waist of each over a little board and keeping it in position by means of a wooden slide. There the defenceless creatures hang in rows while the thread, which sticks to the fingers, is "milked" from their spinnerets. All the strands are combined *to form* a single thread and this is fastened to a spool which slowly revolves until the supply of silk is exhausted. In this way about 300 metres of silk can be obtained at one operation. If the spiders are let out into the garden at intervals, the "milking" can be successfully repeated after a short time. The yield of one female from a series of "milkings" is a thread of about two kilometres long, quite a respectable output. The process, however, is much too complicated to make large-scale production worthwhile. Dresses of spider's silk will continue to be one of woman's unfulfilled dreams.

TICKS

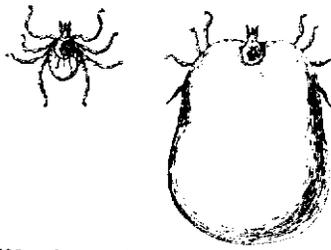


TOWN-DWELLERS who like taking strolls in the country and dreaming away pleasant hours on the edge of a forest are familiar with the wood-tick, an unwelcome guest, a “stayer”. In Europe it is the commonest and most wide-spread species of tick.

We know it in two very different forms, according to whether its belly is empty or full. If we notice a little brown disk crawling sedately on its eight legs over our skin, that is a hungry customer looking for board and a lodging to occupy for some time. *After* a few hours, if we leave it in peace, it will have bored its “beak” somewhere into our skin. It will stay there, sucking continuously till, after a few days, its shape will have changed beyond recognition: the blood it has imbibed will have swollen it into a bag the size of a pea.

Spiders that do not spin

Ticks have to dispense with all the luxuries which the better equipped true spiders can afford, thanks to their silk. They have no thread for trapping game, no silk cushion for their eggs, the males cannot court mates by “phone”, their young cannot shoot forth kites to waft them through the air, for none of them have silk-producing glands. Nevertheless, they are included in the same class as the spinning spiders since they have very much in common with them, including the number of legs.



Wood-tick before a meal (*left*) and after (*right*).

(Both figures magnified about 2.5 times.)

The mites and ticks, the Acarina, are, therefore, an order of the Arachnida. This includes many species with differing habits: the itch mite burrows in the skin of humans and other warm-blooded animals, the cheese-mite, as its name suggests, fancies other food, the flour-mite can work havoc in stored goods if it is allowed to multiply. Other species live as parasites of grasshoppers, butterflies and other insects, on whose bodies they appear as tiny, bright, red beads. Another species invades the breathing tubes of bees and can infest and destroy whole hives. Many other species might be added to this list; the observant will notice them in spite of their minute size, and often enough they will

force themselves on the attention of the unobservant too, on account of the damage they cause. The great majority, however, pursue their hidden ways on land and in water without coming into contact with man.

The tick is the largest member of the tiny Acarina. Its un-segmented body has a movable head projecting from a kind of ruff; the biting and sucking parts stick out threateningly in front. The females are distinguished from the males by the many folds of their skin. Not that these are worn merely for show! They are strictly utilitarian, these folds of skin. The female sex is greedier and it is only the females who can take in so much blood that their bodies swell up into bags the size of peas. In two days their body weight can become more than two hundred times greater than before. A human being would burst long before it had reached this stage. It is the folds in the female tick's skin that allow for expansion and thus make it possible for it to gorge itself without ill-effects.

Involuntary housemates

As there is good reason for the female's bloodthirstiness, we cannot blame her. Anyone who has to hatch out a few thousand eggs can do with a good meal.

As soon as the female has had its fill, it pulls its sucking mouth-parts out of the skin and drops to the ground. If this happens indoors, the consequences are anything but pleasant—for the tick. We may not be pleased when a slight irritation tells us we have got a tick, but the tick would be still less pleased if it knew what was coming. Nature did not intend them to be our housemates. It is unfortunate for them if they accidentally settle on our skin or—as more frequently happens—on a dog's skin, and thus get into a human habitation. They will continue to thrive as long as they stay on the skin and continue to suck, but once they fall off they will shrivel up very soon, instead of preparing for the next generation as every true mother does, consciously or unconsciously.

Ticks are not fastidious: in addition to humans and dogs, they will attack foxes, squirrels, hedgehogs and other mammals. In natural conditions, indeed, they settle far oftener on such wild animals as the latter than on a dog or human being, which is a blessing for the tick family, for in such cases the females, when they are engorged with blood, drop off from their involuntary hosts into the grass or moss in the forest, where they will find a suitable environment for the rest of their lives and where the future of their progeny is secure.

The tick's cycle of life

About a fortnight after she has dropped to the ground, the female starts laying her eggs, which she herself transfers to her head and back. After she has occupied herself thus for a few weeks, she begins to gradually shrivel up and, finally, hidden under some thousand eggs, she dies.

On hatching, the ticks have at first only six legs, which is surprising since they belong to the same order as the spiders. Actually, the last pair grows later, probably a matter of indifference to the lizards or snakes whose blood is the first to be sucked. After sucking for a few days the tick drops off and moults. Now eight-legged and already somewhat bigger, they attach themselves to another lizard or snake. After a further moult they

usually choose a mammal for their third and last meal. This sounds quite simple, but if we were tiny ticks, stationed somewhere in the grass or on the ground of the forest and had to wait for a lizard or, if we were older, for a fox or some other animal to pass our way before we could have a meal, I think we might have difficulty in conjuring up courage to cope with life.

How the infant tick manages to find a lizard, I just don't know. Probably nil it does is to wait until one crawls over it and then seize the opportunity. Many will wait in vain and starve to death. Owing to the combination of two circumstances ticks will not become extinct.

In the first place, they can fast for some time. Even the youngest of them can certainly wait a year for their first meal. One doubting naturalist cut his ticks' heads off to make sure they should not get a meal on the quiet. They lived in their headless state for four full years and even then they did not die a natural death. Actually, things do not happen like this. Of course there is not much chance of a lizard crawling today or tomorrow over a tiny speck in the grass. But one may come in the course of months, and if not this year, then perhaps next. And should some place prove so unfavourable that all waiting is in vain, the losses—if we forget the fate of the individual — are made good by the great number of progeny. It is, as we know, a natural law that animals with unfavourable prospects of survival are particularly fertile. One or other out of a thousand infant ticks will eventually come *into* contact with a lizard after it has waited and fasted long enough.

Older specimens, who may feed on us as well as on other mammals, are more adventurous. They creep up tufts of grass and wait at the top of a blade for a suitable host to appear. Often they seem to occupy higher positions so that they can let themselves fall at the right moment. I have a vivid recollection of a rest I once took under the low shingle roof of an attractive memorial on the Wolfgang see near Salzburg. When we set out again, we found we were covered with ticks. What betrayed our presence to them?

Animals with no sense of taste

Ticks have no eyes, so they cannot have seen us. The careful observer will detect for himself the sense they employ: he will notice that they sniff the air while they are perched high up waiting for a host.

Ticks, it is true, do not sniff in the way we do, for their organs of smell are located in little hollows near the “toes” of the first pair of legs. That explains why they sit with their forelegs raised, waving them slowly about in the air as soon as they are stimulated by a smell.

Another thing that helps them to find a host is their marked sense of warmth. If you put a few ticks on a piece of paper and hold a warm object several centimetres away from them, they will make a bee-line for it and follow the source of the warmth in whatever direction you choose to move it. After they have been enticed to some object with a good smell, perhaps to a piece of fresh fur, they immediately begin to wave their forelegs, which are lifted up like feelers while they are on the move, then halt and see to their moorings.

In their natural surroundings, too, they are apparently guided from their haunts to their prospective hosts both by the warmth emanating from the bodies of animals and men and

by smell. In order to observe better how they feed, an attempt was once made to induce ticks to suck blood from a bottle covered by a membrane which was stretched over the top. When the blood was heated to the right temperature, they were attracted to it but did not suck. Probably their sense of smell told them something was wrong. When the ends of their legs, where the olfactory hollows are situated, were cut off they did go for the blood. As soon as there was no counter-signal from the “nose”, the seductive warmth proved irresistible and they bored through the membrane and filled their stomachs with blood. Nor did it matter whether the bottle actually contained blood, for an enquiring person substituted soup, acetic acid and salt water: it made no difference to the ticks. They seem to have no taste. From time immemorial warmth and smell appear to have sufficed to guide them to the sources of food necessary for their survival. Creation’s scheme did not provide for the tricks of scientists.

Bird ticks

Not only mammals but also birds are often plagued by ticks. The wood-tick we have been discussing is sometimes found during its youth on various tends as well as on lizards and snakes. Many other species live mainly or entirely on birds.

One of these is the pigeon tick, which may occasionally be a housemate and a pest indoors. It belongs to a species of ticks which behave like bugs in that they attack their prey by night, returning to their retreat after a short meal of blood, Masses of them can be found in neglected dove-cots. Great numbers have been found under flaking stones of the Votivkiche in Vienna and of St. Mark’s in Venice or in other favourite haunts of pigeons. If they settle near houses they may become a great pest to human beings. An old house in Mainz was so badly infested that it was officially condemned and shut up. After nine months people thought the animals must have starved to death in the empty house. A new tenant, ignorant of the tick’s record for fasting, had to pay for his ignorance with a long and serious illness, the prolonged fast having made these pests particularly vicious.



A pigeon tick, ventral surface magnified 5 times.

In warm countries, particularly in the Levant, a bird tick which is parasitic on hens, ducks, pigeons and geese, and which works great havoc as the carrier of poultry diseases, is very common. Unfortunately these creatures are no re-specters of persons and, given the chance, they will attack human beings as well as birds. They are known in Germany as “Persian bugs”, a misnomer from the zoologist’s point of view, for they are, and always will be, ticks. Yet the name shows that in that area they are pests worthy of being ranked with hues. So let us be content with our own wood-ticks.

Protection *from* ticks

To come back to the wood-tick, the species we have to contend with most frequently. It is relatively harmless, though this does not mean that we like to have them suck our blood.

Sometimes they can be noticed before they settle, since they often crawl about on us for hours before they find a soft spot on the skin. In that case all that is necessary is to kill them. This, however, is not so simple as with a gnat or mosquito. They cannot be swatted or crushed by force, for their bodies are incredibly hard and tough. Experts say it is better to set fire to them with a match,

Things are more difficult when they have already burrowed into the skin. They should not be simply pulled out, for the mouth parts are so securely anchored that they are left in the skin when the body is removed and they then cause inflammation.

If the tick is not yet very swollen, it can be covered with a bit of fresh sticking plaster, the gum of which is still moist. Next morning the tick will come away with the plaster when it is removed. It relinquishes its hold perhaps because it is irritated by the chemicals in the gum and per-haps, too, being trapped under the plaster, it can get no air.

A method often recommended for extracting a tick is to bandage the bite with cotton wool soaked in paraffin. After some time the tick either withdraws its mouth-part voluntarily, or it can easily be pulled out. It must, however, have a thorough and lengthy soaking in the disagreeable liquid.

Victims who find such measures complicated and who prefer to wait will have gathered from the account given above that the troublesome tick will fall off in a few days of its own accord; once it has gorged itself, it has achieved its object.

CONCLUSION

SATISFACTION is a rare feeling. People are always more concerned about what has been left out than what has been included. This applies to small as to large-scale enterprises, and it troubles me not a Hole. For many of our housemates have found no room in this book, very probably those on which information would be particularly welcome.

Someone has snails in his cellar and wants to know how to get rid of them. Someone else finds centipedes and wonders whether they are blood-sucking insects or whether they are neither blood-suckers nor insects at all. Another is plagued by the notorious death-watch beetle, a fourth by the cheese-mite, while a fifth would be interested to have light shed on the mental life of the ants which have invaded his larder. Many will complain that rats and mice have not been discussed and, finally, there are those who ask about dogs and cats, or about goldfish and canaries. The list of such wishes is endless. So perhaps I may be allowed to say a word to justify my selection.

This book is not meant to be either an encyclopaedia or a textbook. All I wanted to do was to give some information concerning small housemates whose names are quite familiar although little else is generally known about them. I also wanted to show that there is something wonderful about even the most detested and most despised of creatures.

There's nought so humble, nought so small,
But has a lesson for us all,
The self-same magic everywhere,
For eyes that see, and hearts that care,
Riddles abundant, near and far
From lowly flea to distant star.

END