Miscellaneous Publications, No. 37.

MINISTRY OF AGRICULTURE AND FISHERIES.

BENEFICIAL INSECTS.

LONDON:
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BENEFICIAL INSECTS.

INTRODUCTORY.

In their relation to cultivated crops, insects may conveniently be divided into three groups, viz. :—

Pests—those which are harmful, causing by their depredations serious loss to the cultivator and a diminution of the country's food supply;

Neutral or negligible—those which do not directly influence crop production;

Beneficial—those which by predaceous or parasitic habits diminish and keep in check the numbers of the Pests.

There is some overlapping between these three groups, but it is generally possible to assign an insect to one or the other.

In considering *beneficial* insects from the cultivator's point of view, it is only possible to deal with certain large groups, various members of which attack and destroy the worst insect pests to agriculture and horticulture. Of these groups, five are outstanding as amongst the very best friends possessed by the farmer, gardener and fruit-grower : they are Ladybirds, Lacewing Flies, Hover Flies, Ichneumon Flies, and Tachinid Flies. Only too frequently these insects are mistaken for foes and destroyed. It is hoped that the brief descriptions of them and short outlines of their life-histories herein given may help towards their wider recognition.

In connection with all of them one point must first be emphasised :—Beneficial insects seldom, if ever, exterminate a pest, or extermination of themselves would be likely to follow. The most they do is so to check the pests (which would otherwise breed in colossal numbers) that the damage suffered by crops is reduced to an almost negligible amount. Their work of destruction goes on unobtrusively, and only fails when some influence favours the pest or acts adversely on the parasite, allowing the former to survive in such overwhelming numbers that an effective control no longer obtains. The cultivator himself must then resort to artificial measures of pest destruction, but in doing so he must remember that he is often killing both friend and foe alike. He must, therefore, having once begun, be prepared to continue his spraying or other measures, and himself carry out the work previously left to Nature.

LADYBIRDS.

Ladybirds are beetles which do untold good by feeding in the adult and grub (larval) stages upon Aphides (Greenfly or "Blight"). Some kinds also feed on Scale Insects, Suckers, or other pests.

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The adult Ladybird is well known and is usually respected by everybody; but in the grub stage, being so very different in appearance and somewhat repulsive to look at, it is by no means so often recognised and frequently falls a prey to the uninformed zeal of the gardener, who complains of Greenfly while he busily destroys perhaps its greatest enemy—the Ladybird grub. The appetite of these grubs is enormous and they appear to feed almost continuously, 30 to 40 Aphides being devoured with scarcely a pause.

Description and Life History.—*The Eggs* (Plate I., Fig. 2) of the Ladybird are conical in shape and yellow in colour, going brown when about to hatch. They are placed by the adult insect in small groups upon the stem or underside of the leaves of a plant infested by Aphides.

The Grub (Plate I., Fig. 3) is a flattish, black, ugly creature with a big head and six legs on the fore part of the body. In some species it is marked with yellowish or reddish and white markings. After hatching from the egg, it soon begins to hunt, and on arriving at the first group of Aphides eats its way steadily through them. It is very active, an indefatigable hunter, and, on having killed out the prey on a particular plant or branch, will pass rapidly to the next. It grows quickly, changes its skin several times, and on becoming full-fed turns to a pupa on the plant or anything adjoining.

The Pupa (Plate I., Fig. 4) is a somewhat dried-up looking object when first formed, light yellow, but afterwards darker in colour. The shrivelled skin of the grub, out of which the pupa has emerged, remains wrapped round the "tail." After a few days, varying with the season, this pupa splits and the adult Ladybird crawls forth, being at first soft and pale, but hardening in a few hours and attaining the characteristic coloration.

The Perfect Insect (Plate I., Fig. 1).—The little round, red beetles with black spots, known as Ladybirds, are familiar to everyone. There are, however, many kinds, some red or yellow with black spots, others black with red spots. In certain kinds even the separate individuals vary in colour from black to red according to which colour predominates. Nearly all, however, have the characteristic shape and appearance, so that, apart from colour, they may easily be recognised as undoubted Ladybirds.

On emergence from the pupa, Ladybirds soon begin to feed upon Aphides. The females, after pairing, lay eggs and the life-cycle begins again. There are several broods throughout the summer, the last one hybernating, spending the winter asleep under bark of trees or in some cranny, when at times considerable numbers collect together in one place. With the warmth of spring they emerge from their hiding places and the first eggs of the season are laid.

3. Lady Bird Larva.

X.6.

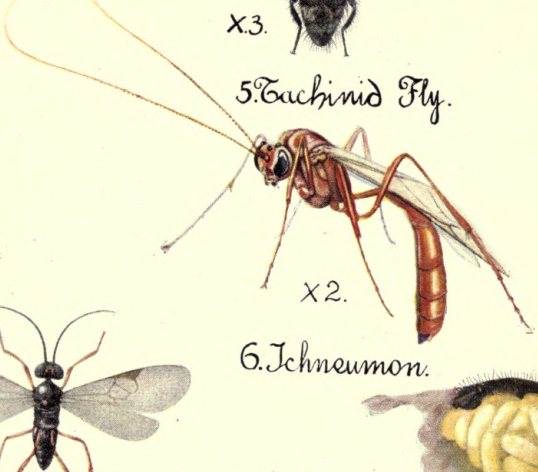
1. Lady Bird

4 Lady Bird Pupa,

2. Lady Bird Eggs.

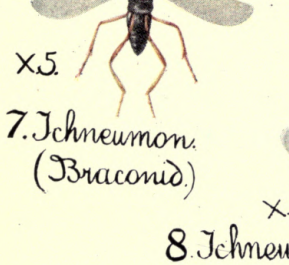
X.3.

5. Tachinid Fly.



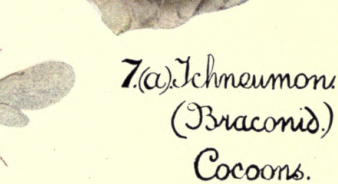
X 2.

6. Ichneumon.



X.5.

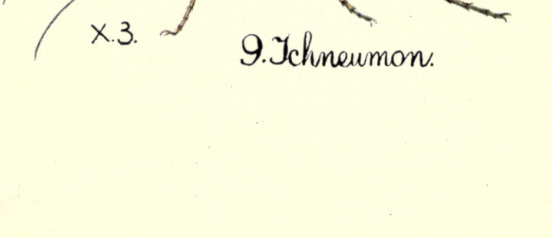
7. Ichneumon. (Braconid.)



7.(a). Ichneumon. (Braconid.) Cocoons.

X.12.

8. Ichneumon. (Chalcid.)



X.3.

9. Ichneumon.

ICHNEUMON FLIES.*

Under this popular designation may be included several thousand allied species of insects, examples of which are shown on Plate I., Figs. 6, 7, 8 and 9. They are not flies in the zoological sense, but are all close relations of the bees and wasps, albeit not necessarily like them in appearance. They range in size from extremely minute insects, hardly visible to the naked eye, up to as long or even longer than the Hornet, though less heavily built. They have jaws, long antennæ, and four wings, which are always carried along the back and are small in proportion to the creature with few ribs in the supporting framework. In habit they are very active and energetic. Ichneumons probably comprise (with the possible exception of adverse weather conditions) the most potent of all the forces operating to keep in check an overwhelming increase in other insects—a misfortune which always threatens. They do not achieve this by devouring them outright as the Ladybird does, but are parasitic and lay their eggs in or upon the insects they attack. The Ichneumon grubs then feed upon the juices of their victims and come to maturity in their stead. Practically all the other orders of insects are laid under contribution. It would be quite impossible to enter here fully into the immense activities of Ichneumon Flies; suffice it to say that most of the grubs and caterpillars that destroy cultivated crops are known to be attacked. The dried skins of Aphides containing the parasitic grub and forming a covering for it, can always be found in considerable numbers. In fact, practically all the more serious pests are destroyed by Ichneumons.

Unlike the Ladybirds and Lacewings, of which the grubs are too frequently destroyed in ignorance, the large group of parasitic insects here called Ichneumon Flies need no special plea for their preservation, for in the early stages they are out of sight or not prominently noticeable, and as adults are active, watchful and able to take care of themselves.

Description and Life History.—*The Eggs* are deposited in or upon (usually in) the bodies of other insects by means of a special egg-laying apparatus. It is usually the egg, grub or pupa stage which is attacked.

The Grub, with a few exceptions, is a whitish, legless maggot, like its cousin the wasp-grub in appearance but differing in size according to the species. In the case of the internal feeders, it lives on the juices of its prey which it eventually destroys, but not before it has itself become full-fed. In some cases, it leaves its prey and spins a cocoon itself; in others it waits until its victim has spun a cocoon before killing it and then merely

* For the purposes of this publication the designation "Ichneumon Flies" is made to cover the greater part of the *Hymenoptera Parasitica* as well as the *Ichneumonidæ*, viz., *Braconidæ*, *Proctotrypidæ*, *Chalcididæ*, &c.

lies naked in that. A small minority of species feed on the outside of their prey, sucking the juices through the skin.

The grubs of the Ichneumon Flies being for the great part internal feeders, are naturally very seldom seen; the case most often observed, perhaps, is when a large number of small white maggots are found emerging through the skin of a Cabbage Butterfly caterpillar to spin a bunch of white or yellowish-white cocoons (Plate I., Fig. 7*a*) on the leaf near-by, from each of which will emerge in due course a small black Ichneumon (*Braconid*) (Plate I., Fig. 7).

The Pupa is like the perfect insect to be, but covered with a fine white skin on all its parts, the whole creature being white until some days before emergence from this pupal covering, when the colours it will eventually assume gradually appear, starting with a darkening of the eyes.

The Perfect Insect.—On the pupal skin splitting and being worked off backwards like a glove, the perfect insect is disclosed with all its parts free. At first it is soft and does not come forth like a butterfly to dry, but remains some time within the cocoon until all its parts have hardened, when it eats a way out, and, having paired, the female begins to hunt for the prey to which she is attached and in or upon which she lays eggs. The structure of the adult Ichneumon Fly varies according to the kind of insect in which the early stages are spent. The difference is most marked in the length of the egg-laying apparatus or ovipositor. There are some species in which this has been carried to an extreme degree, where it is necessary to reach caterpillars in such places as their burrows in the interior of a tree; in other species (Plate I., Fig. 9) it is of medium length and stout for piercing through cocoons and into the chrysalid contained therein. Parasites such as these never see the hidden victim that is to contain their egg, but, nevertheless, are marvellously acute in " sensing " all about it, detecting at once its age, position, and whether it already contains an egg from another individual. Parasites of caterpillars met with in the open, and directly upon which the insect settles to lay its egg, naturally have quite short ovipositors (Plate I., Fig. 6).

Ichneumons, which are parasites of the eggs of other insects, are, of course, very small, the tiny egg serving as a cocoon. It is not uncommon for a small Ichneumon to emerge from every egg in a batch of the Vapourer Moth. It was once thought that every insect had its Ichneumon parasite attached to it and that the Ichneumon confined itself to that one species, but now quite long lists of different victims are accredited to single species of Ichneumon Flies. This does not mean that any Ichneumon parasitises any other sort of insect it comes across—far from it. The parasite's life-history is very closely bound up with that of its victim, and it is only such insects as will so accord with its own life-history and its own peculiar

structure that it will prey upon. It apparently never makes a mistake, but how it knows amongst the diverse insects met with which are suitable to it and which are not is still somewhat of a mystery.

TACHINID FLIES.

Though Tachinid Flies (Plate I., Fig. 5) do immense good in destroying caterpillars, it would be serving no useful purpose to deal with them fully with a view to preventing their destruction, for they can only be recognised by the expert entomologist. Superficially, they are much like the common House-Fly, an appearance which is also shared by several other flies which are troublesome pests. Many species of Tachinid Flies are larger than the House-Fly. A close examination of all would show them to be covered with strong bristles. Their habits are akin to those of the Ichneumon Flies, but the egg or eggs are deposited either upon the skin of the grub they attack or upon its food plant. The resulting maggots eat their way into the interior of the creature and feed there, or possibly in certain cases the Tachinid eggs may be eaten by the grub with its food, and reach its body in that way. The grubs feed within the bodies of their hosts. On becoming full-fed they eat their way out and form a puparia, very much like those of the House-Fly, and on emerging from them the flies again deposit their eggs.

These insects are true flies, not like the Ichneumons, which are related to the bees. They possess but two wings, and the mouth is formed for sucking.

HOVER FLIES.

Syrphid Flies, or Hover Flies as they are also called, belong to the true flies, though many present a somewhat close superficial likeness to certain bees and wasps. They, nevertheless, have but two wings and sucking mouths, the main characteristics of their whole Order. The Syrphid group is a large one which comprises some pests (*e.g.*, the Narcissus Flies), many kinds which are neutral, and a number which are beneficial to a high degree.

The grubs of the latter, together with the Ladybird and the Lacewing, comprise a trio of voracious devourers of Aphides or Greenfly, and are frequently found in company. There is little danger of the very active-winged adult falling a victim to the destroying hand or foot, though undoubtedly the misguided zeal of the gardener only too often finds vent against his good friend in the grub or maggot stage.

Description and Life-History.—*The Egg* of the Syrphid Fly is cylindrical and pale yellow in colour. It is deposited amongst Aphides on the stem or leaf of a plant.

The Grub (Plate II., Fig. 2) is an unprepossessing-looking maggot, dirty-white or greenish in colour, more pointed at the

head end and without legs. It is to be seen moving about with an undulating motion on roses, cabbages, and most other plants infested by Aphides. On meeting with one, it seizes it with its mouth, having a peculiar habit of raising it in the air while its juices are extracted. Any maggot resembling that shown by the figure and found crawling on the surface of Aphid-infested plants, is almost sure to prove a Syrphid Fly grub, and as such should always be allowed to continue its way in peace. Some species are marked with a diamond-shaped pattern along the back, and some have a pinkish hue showing through from the interior.

The Pupa (Plate II., Fig. 3).—When the maggot is full-fed, a semi-transparent case (Puparium) is formed on the plant, from which the fly emerges in due course.

The Perfect Insect (Plate II., Fig. 1).—Few can have failed to observe on a sunny day numbers of black and yellow striped flies of fair size hovering and darting in the air and anon settling on the leaves of some plant. These are usually Hover Flies, the parents of the Aphis-eating maggot. The commonest and perhaps most beneficial species is figured.

LACEWING FLIES.

Lacewing Flies belong to the same class as the Dragon-Flies, have biting jaws, " feelers " or antennæ, and four wings which, with their many fine supporting ribs, have the appearance of net or lace—hence the popular name of the group. The wings, which are large, are carried flat when at rest against the sides of the body, extending beyond it and obscuring the whole hinder portion. The most familiar members of the group are beautiful green insects with golden eyes. Other species are of the same form, but smaller and a plain brown in colour.

Many Lacewings, when in the grub stage, are sometimes confused with Ladybird grubs, and are not inferior to them in their inexhaustible appetite for Aphides. They may also attack Scale Insects or other pests, and some have the remarkable habit of covering themselves with small pieces of lichen, bark, &c., or even with the empty skins of their victims. All Lacewings are valuable and should on no account be destroyed.

Description and Life-History.—*The Eggs* (Plate II., Fig. 5) are easily recognisable, being laid in groups of fifty or less on leaves, &c., and are attached by long, hair-like stalks or pedicles. This peculiar stalk attachment is of value, as the young grub is so extremely voracious that, were not the remainder of the batch of eggs out of reach, it would, on hatching, certainly devour them, together with any other grubs that were emerging.

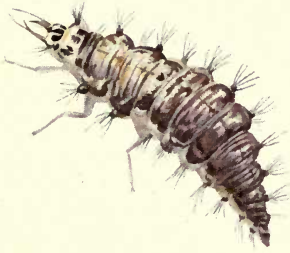
The Grub or *Larva* (Plate II., Fig. 6) is sometimes supposed to resemble that of the Ladybird, but is dark-brown, more pointed towards the " head " end, while the large sharp mandibles or jaws are a prominent feature.

2. Hover Fly Larva.

3.
Hover Fly Pupa.

x.6.

1. Hover Fly.



5.
Lacewing Eggs

6. Lacewing Larva. & (7.) Pupa.

4. Lacewing Fly.

x.4

The Pupa.—When the grub is full-fed it spins a cocoon (Plate II., Fig. 7), composed of semi-transparent silk, usually in some crevice or cranny or down a hollow stem. Inside the cocoon it turns to a pupa.

The Perfect Insect or *Imago* (Plate II., Fig. 4).—The illustration shows one of the brilliant green Lacewings which may be found alike in town and country, and is probably familiar to most. Its delicate appearance and beautiful coloration will readily distinguish it from all other insects likely to be met with. Those in search of it should look specially in the neighbourhood of buds covered with Greenfly, and it may often be seen flying rather slowly at sundown; later it sometimes comes to lights in houses.

ARTIFICIAL ENCOURAGEMENT OF BENEFICIAL INSECTS.

Five kinds of insects extremely beneficial to the farmer, gardener and fruit-grower—in fact, to all whose activities take them amongst plants for their cultivation—have been touched upon. The five taken do not exhaust the list but are chosen as being by far the most important.

Apart from the obvious duty of avoiding their destruction whenever possible, the question naturally arises as to whether beneficial insects can be increased or encouraged artificially. In this connection there are two distinct possibilities: (1) the introduction of new kinds of parasitic insects into countries in which they do not already exist; (2) the increase by artificial means of parasites already established in a country. With regard to the first possibility, it has been clearly demonstrated that where a foreign pest has been introduced into a country without its parasites, then great good may result if such parasites are brought in and released. Thus, if England is so unfortunate as to be colonised by a foreign insect, one of the methods of defence will be to make sure that all the invader's parasites and diseases are introduced as well. An instance in which this method of pest control has proved a great success is that of the destructive Australian Scale Insect (*Icerya purchasi*, Mask.), which has spread from Australia to other countries. It is difficult to control by artificial means, but is kept down completely by its natural enemy, a Ladybird (*Vedalia cardinalis*, Muls.), which is now introduced to any country in which the Scale Insect obtains a foothold. In the same way Ichneumons have been introduced into America and other countries to combat foreign insect enemies which have already established themselves.

Under these conditions, artificial encouragement of parasites is a proved success, but the case is far otherwise when attempts are made to increase artificially the numbers of a parasite already plentiful. It cannot be said that attempts to this end have been generally successful, and it is only under special circumstances that even hopeful results can be claimed. The

most usual condition for success—and no case exists in Britain—is where there are great climatic differences between different parts of a country. Thus, in certain parts of the U.S.A., Ladybirds migrate to the mountains in the autumn and spend the winter in large colonies, only working down to the low ground again when warmed by the spring weather. Naturally the warm weather first reaches the valleys—while the mountains are still cold—and thus pests, which have spent the winter in the valley, get a start and can breed for a time free from their Ladybird enemies. By collecting the Ladybirds from the hills, where they occur together in millions, they can be brought to the valleys and sold by the pound! They are then released as soon as the pests begin to appear in spring.

A second case in which artificial assistance can be given to the control of pests by parasites is where it is necessary to collect by hand large numbers of the pest. The best instance of this is shown by the Apple Blossom Weevil* (*Anthonomus pomorum*, L.), which causes "capped blossom," and is one of England's most serious apple pests. If the capped blossoms are collected before the beetles have emerged, many of the blossoms will contain, not weevils, but an Ichneumon parasite (*Pimpla pomorum*, Ratz.) which has killed the weevil. In the case of one Cambridge orchard, Imms† has shown that as many as 26 per cent. of the destroyed blossoms contained Ichneumons. Now, if instead of burning the collected blossoms, they are placed in a muslin cage, the Ichneumons can all be released and the weevils killed, with the result that far more parasites should be available next year to kill a smaller number of pests. This method of dealing with Blossom Weevil has never been tried in England, but in France, in one case at all events, success is claimed.

Yet another condition favourable to the encouragement of parasites is sometimes found when pest and parasites leave their pupæ at different seasons. In the case of the Gout Fly, for instance, it appears that whereas the fly comes out about harvest time, the parasites remain within their pupæ in the barley, which are threshed out in the drum and appear in the "cavings." If the latter are burned, the parasites only are destroyed, while, if left, they will come out later and assist in controlling the fly.

Lastly, conditions for success may be found in the case of plants grown under glass. If a really destructive parasite of any of the more serious glass-house pests—such as the White Fly—can be discovered it would pay to keep a stock going to distribute when needed in any infested house. The discovery of the parasite in this case is of course the first step.

These cases are all mentioned to show that while it is necessary to be sharply on the look-out for any means of

* *See* Leaflet No. 15, to be obtained from the Ministry and also included in Sectional Volume No. 2, price 10*d.*, post free.

† (*Annals of Applied Biology*, Vol. IV., p. 211).

encouraging parasites, yet, in Britain at all events, the chances are not very many. We can be thankful for the help already given by them, which is inestimable, but we cannot yet manage that they shall do all the work, and artificial control measures are therefore needed.

Nevertheless recognition of Beneficial Insects should be widespread and their destruction avoided wherever possible, for all alike ultimately share the benefits they confer. Without Beneficial Insects cultivation would be impossible.

TECHNICAL DESCRIPTION OF PLATES.

Plate I.

Fig.

1 *Adalia bipunctata*, Linn. (Coleoptera, Coccinellidæ).

2 Ova of do. do.

3 Larva of do. do.

4 Pupa of do. do.

5 *Compsilura* (*Phorocera*) *concinnata*, Mg. (Diptera, Tachinidæ).

6 *Ophion luteus*, Linn. (Hymenoptera, Ichneumonidæ).

7 *Apanteles glomeratus*, Linn. (Hymenoptera, Braconidæ).

7a Cocoons of do. do.

8 *Blastothrix sericea*, Dalm. (Hymenoptera, Chalcididæ).

9 *Pimpla instigator*, Fab. (Hymenoptera, Ichneumonidæ)

Plate II.

Fig.

1 *Syrphus balteatus*, De G. (Diptera, Syrphidæ).

2 Larva of do. do.

3 Cocoon of do. do.

4 *Chrysopa vulgaris*, Schn. (Neuroptera, Chrysopidæ).

5 Eggs of do. do.

6 Larva of do. do.

7 Pupa of do. do.

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