insects

Parasitoids: Natural enemies of helicoverpa

Introduction

Helicoverpa caterpillars (often called heliothis) are serious pests of many crops in Australia. A range of parasitoid and predatory insects attack helicoverpa. Identifying and conserving these beneficial insects is fundamental to implementing pest management with a reduced reliance on chemical insecticides. This brochure describes the most important parasitoids of helicoverpa in Australian broadacre crops.

Figure 1. Netelia producta *is one of the most commonly encountered parasitoids of helicoverpa. Females lay their eggs onto caterpillars, and the hatching wasp larva feeds on its host, eventually killing it. Parasitoids such as* Netelia *can be important biological control agents of helicoverpa in crops. (Photo: K. Power)*

Parasitoids versus parasites: What's the difference?

Parasitoids kill their hosts; parasites (such as lice and fleas) do not. All the insects in this brochure are parasitoids. Despite this difference, the terms *parasitoid* and *parasite* are often used interchangeably, if inaccurately.

All comments about parasitoid abundance in this publication are based on field observations in southern Queensland farming systems. These patterns may not occur in all parts of Australia.

Queensland Government
Department of Primary Industries and Fisheries

About parasitoids

What is a parasitoid?

A parasitoid is an insect that kills (parasitises) its host – usually another insect – in order to complete its lifecycle. In Australia, helicoverpa are parasitised by many species of wasps and flies. All helicoverpa immature stages are parasitised (that is, egg, caterpillar and pupa), but adult moths are not.

How parasitoids kill pests

All fly and wasp species that parasitise helicoverpa have an egg, larval, pupal and adult stage.

Depending on the species, adult female parasitoids lay their eggs on, or inside, the stage of helicoverpa that they are attacking. After hatching, the parasitoid larva begins feeding on its host. This can occur either internally (i.e. inside the helicoverpa egg, larva or pupa) or externally, as in the larval parasitoid, *Netelia*.

When fully fed the parasitoid larva spins a cocoon and pupates. As with larval development, parasitoid pupae can form either externally (*Microplitis*) or internally (*Trichogramma*).

In the pupal stage, the larval parasitoid changes into its adult form (wasp or fly). The adult parasitoid emerges from its pupal stage to feed, mate and, if female, locate helicoverpa hosts to continue the life cycle.

How do parasitoids find their hosts?

Many adult parasitoids find their host by smell. They can detect the direct odour of the host itself, or odours associated with host activity, such as plant damage or caterpillar frass (dung). Parasitoids learn and remember these associations, which makes them efficient at finding hosts.

What do adult parasitoids eat?

Adult parasitoids feed on sugars, including those found in flower nectar and aphid honeydew (Figure 2). Adult parasitoids with access to these sugary food sources generally live longer and the females will lay more eggs, allowing them to parasitise more hosts.

Some adult parasitoids also 'host feed'. This involves feeding on fluids that exude from a host's puncture wound, caused by the wasp's ovipositor ('stinger'). Host feeding supplements the nutrition of the adult parasitoid, and odours detected while host feeding may assist the wasp with host searching. Female *Trichogramma*, *Netelia* and *Ichneumon* wasps host feed.

Figure 2. *A wasp feeding on nectar. Many parasitoid wasps and flies feed on various sugar sources, including nectar and aphid honeydew. (Photo: J. Hopkinson, DPI&F)*

Parasitoid life cycle and terminology

Entomologists describe parasitoids according to the life stage of the host that they attack. For example, **egg parasitoids,** such as the tiny *Trichogramma* wasp, parasitise helicoverpa eggs. *Microplitis* is called a **larval parasitoid** because it attacks helicoverpa caterpillars (larvae).

Some parasitoid species attack one stage but do not emerge from their host until much later. An example of this is the **larval–pupal parasitoid** *Heteropelma* wasp that lays its eggs inside the helicoverpa caterpillar, but the adult wasp does not emerge until after the caterpillar has pupated.

Why are parasitoids important?

- Pest management with parasitoids costs nothing!
- At low pest densities, parasitoids can suppress helicoverpa infestations to below economic thresholds.
- Parasitoids reduce the number of helicoverpa surviving to the next generation.
- Parasitoids are compatible with other biological control agents (diseases and predators).
- Some parasitoids can spread helicoverpa diseases, for example, *Microplitis* and *Heteropelma* transmit ascovirus.
- Parasitoids are host specific – the parasitoids in this brochure only target helicoverpa and some related caterpillar pests.
- Some parasitoid species can affect caterpillar behaviour – a caterpillar parasitised by *Microplitis* eats less food than a healthy caterpillar.
- Parasitoids are efficient host searchers – they can find hosts when pest densities are low.

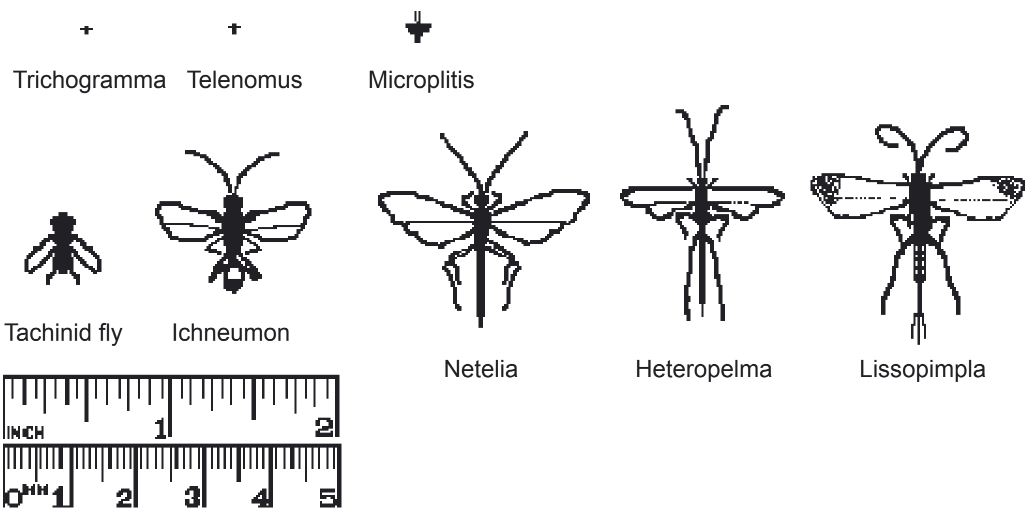

Figure 3: *Relative sizes and shapes of the key helicoverpa parasitoids referred to in this publication.*

Egg parasitoids

Egg parasitoids kill their hosts before they hatch, thus preventing crop damage by emerging caterpillars. Egg parasitoids are difficult to see because of their small size. The best way to find and identify them is to collect brown helicoverpa eggs and store them in a clear container. If parasitised, these eggs will turn black and adult wasps will emerge in about 10 days. Unparasitised eggs will produce helicoverpa larvae.

Trichogramma and *Telenomus* wasps

Trichogramma and *Telenomus* are minute wasps (shorter than 1 mm) that parasitise helicoverpa eggs. *Trichogramma* and *Telenomus* are active in most summer crops, particularly sorghum, maize and cotton. Egg parasitoids are very rare in chickpea crops.

Lifecycles

Between one to four *Trichogramma* wasps develop within one helicoverpa egg. *Trichogramma* uses its antennae to measure the size of the host egg in order to determine the number of eggs it will lay in it. In contrast, only one *Telenomus* wasp develops per helicoverpa egg. For both species, it will take about 10 days at 25°C for an adult wasp to emerge from a parasitised egg.

Trichogramma wasps

The *Trichogramma* wasp is yellow - brown with red eyes (Figure 4). Numbers increase from low densities in spring to become very abundant in late summer.

Figure 4. *Female* Trichogramma *wasp stinging a helicoverpa egg. Helicoverpa eggs measure about 0.5 mm across but* Trichogramma *adult females are even smaller. (Photo: B. Scholz, DPI&F)*

Telenomus wasps

The *Telenomus* wasp is black with black eyes (Figure 5). Numbers are most abundant in spring and early summer.

Figure 5. *The small egg parasitoid* Telenomus. *(Photo: B. Scholz, DPI&F)*

Larval parasitoids

Helicoverpa caterpillars are parasitised by several small to medium-sized wasps and a group of specialised flies (tachinids).

Wasps

There are a number of wasps that parasitise helicoverpa larvae. Only the species thought to be most important for pest management are mentioned here.

Microplitis demolitor

Microplitis is a small (3 mm) black wasp with an orange abdomen and black wings (Figure 6). Encountered in all summer field crops, *Microplitis* is particularly abundant in sorghum and cotton. Although *Microplitis* is small, if you look at the top of the crop canopy you will often see *Microplitis* wasps slowly flying along searching for helicoverpa caterpillars. Another way to find *Microplitis* is to look for its fawn-coloured cocoon attached to dying helicoverpa caterpillars (Figure 7).

Some *Microplitis* wasps also transmit ascovirus, which kills helicoverpa caterpillars. *Microplitis* mainly attacks helicoverpa.

For more information, see the DPI&F brochure 'Microplitis demolitor *and a*scovirus*: important natural enemies of helicoverpa'*.

Lifecycle

Female *Microplitis* wasps sting second instar (4–7 mm) helicoverpa caterpillars. The parasitoid larva then feeds internally and chews a hole in the side of its host to emerge and pupate externally. Host caterpillars are killed before they do much feeding damage. The whole *Microplitis* lifecycle (egg–adult) takes about 10–12 days.

Figure 6. Microplitis *adult resting on a sorghum leaf (Photo: B. Scholz, DPI&F)*

Figure 7. Microplitis *cocoon attached to its host (Photo: B. Scholz, DPI&F)*

Orange caterpillar parasite *(Netelia producta)*

Netelia is a slender, medium-sized (18 mm) orange wasp that is often seen in winter cereals at harvest (Figure 8). It can be regularly found in summer crops, but one of the best places to see *Netelia* is at night around outdoor lights.

Netelia attacks both helicoverpa and armyworm caterpillars.

Figure 8. *Adult* Netelia *wasp parasitising a paralysed helicoverpa larva (Photo: J. Hopkinson, DPI&F)*

Lifecycle

Netelia wasps attack helicoverpa caterpillars from third instar (8–13 mm) and older, but large fifth and sixth instars (24–30+ mm) may be the preferred hosts. When attacking its host, *Netelia* temporarily paralyses the caterpillar by stinging it. With the host paralysed, the wasp moves in and lays a brown egg onto the skin of the caterpillar, close to its head. These eggs can be seen with the naked eye (Figure 9).

Figure 9. Netelia *eggs are laid close to the head of the host caterpillar. (Photo: L. Turton, NSW DPI)*

The immature *Netelia* larva hatches from the egg and develops externally, hanging on behind the head of the caterpillar. The parasitoid does not complete its larval development until the helicoverpa caterpillar has tunnelled into the soil and formed its pupation chamber. After the host forms its chamber, parasitoid feeding kills the host and the *Netelia* larva spins a black furry cocoon within this chamber (Figure 10).

Figure 10. *An emerged* Netelia *pupal case (20 mm). These pupal cases are found in the underground pupal chambers of parasitised helicoverpa. (Photo: B. Scholz, DPI&F)*

Tachinid flies

Most types of tachinid larva kill their host when it is either a pre-pupa or pupa. The fly larva then pupates inside the underground pupal chamber formed by its host. Because tachinid flies do not kill the host until after the caterpillar has finished feeding, helicoverpa crop damage is not prevented. However, tachinid flies can help reduce the size of following helicoverpa generations and thus reduce future damage.

Some tachinid species are also important parasitoids of armyworms.

Tachinid flies are found in all summer crops and some species are active in winter crops like chickpea, wheat and barley. Most tachinid flies that attack helicoverpa are the same size and general appearance as a blowfly (7–10 mm) (Figure 11).

Figure 11 . *An adult tachinid fly (10 mm) (Photo: B. Ingram, DPI&F)*

Figure 12. *A tachinid pupa lies next to the shrivelled remains of its dead caterpillar host within an excavated helicoverpa pupal chamber. (Photo: M. Miles, DPI&F)*

Tachinid flies use three main strategies to parasitise their caterpillar hosts.

Method 1: Planidia

Carcelia illota and *Chaetophthalmus dorsalis* lay their mature eggs close to where a host caterpillar is feeding. Soon after being laid, the eggs hatch into leech-like larvae (planidia). These larvae remain stationary in an upright position waiting for the caterpillar to pass by (Figure 13). When a larva (planidium) detects movement, it stretches out its body and latches onto the passing caterpillar's body. The planidium then quickly burrows through the skin of the caterpillar and feeds on its host's internal tissues.

Figure 13 . *Tachinid planidia (2 mm) on a leaf waiting to latch onto a host caterpillar (Photo: C. Mares, CSIRO)*

Method 2: External eggs attached to caterpillar

The tachinid fly *Exorista curriei* lays eggs (measuring 2 mm each) directly onto the host caterpillar, usually on or just behind the head (Figure 14). The eggs are glued onto the host and do not readily dislodge. When the egg hatches, the larva burrows through the skin of the host and feeds internally.

Figure 14. *Tachinid eggs (2 mm) on the head of a helicoverpa caterpillar (Photo: D. Ironside, DPI&F)*

Method 3: Microscopic eggs

The tachinid fly *Goniophthalmus australis* lays microscopic eggs (measuring 0.2 mm each) onto the plant surface close to where a helicoverpa caterpillar is feeding so that the caterpillar eats the eggs and becomes a host. Once inside the host, the egg hatches and the larva penetrates the gut wall and feeds on tissues within the body cavity.

Conserving parasitoids

The following points are important if you want to encourage parasitoids in your crop.

- Know what parasitoids look like and which pests (and which pest lifestages) they attack.
- Avoid killing them with broad-spectrum insecticides (e.g. synthetic pyrethroids). See the annual *Cotton pest management guide* for more detailed information on the impact of particular insecticides on wasp and fly parasitoids.
- Look for trends in crop scouting data. Lower than expected numbers of medium larvae coming through from eggs/small larvae indicates parasitoid and/or predator activity. Only parasitoids that kill eggs and small larvae (*Trichogramma, Telenomus* and *Microplitis*) can reduce crop damage immediately.
- Monitor parasitism levels by collecting pest eggs, larvae and pupae. Observing levels of parasitism can increase confidence in using parasitoids.

Larval–pupal parasitoids

These two larval-pupal parasitoids attack helicoverpa caterpillars, but their larvae do not complete development until after the host caterpillar has pupated underground.

Two-toned caterpillar parasite

Heteropelma scaposum

Heteropelma is a medium-sized (20 mm), slender, black wasp with an orange abdomen, yellow legs and clear wings (Figure 15). You may see *Heteropelma* flying above sorghum, cotton and other summer crops in summer. Like *Microplitis, Heteropelma* carries ascovirus. *Heteropelma* parasitises both helicoverpa and armyworm caterpillars.

Lifecycle

Heteropelma stings caterpillars at third instar stage and older, although third and fourth instars (8–23 mm) are preferred. After being parasitised, the host caterpillar continues growing and pupates in the soil as normal. However, shortly after pupation, parasitoid feeding kills the host. When the *Heteropelma* larva is fully developed, it pupates within the helicoverpa pupal case. The adult wasp emerges by chewing open the pupal case and exits the pupal chamber by crawling up the emergence tunnel.

Throughout winter *Heteropelma* diapauses (hibernates) within its host. In spring, the parasitoid starts developing, the wasps emerging soon after the emergence of the overwintering *Helicoverpa armigera* moths.

For more information on helicoverpa diapause and the biology of helicoverpa, see the DPI&F brochure '*Understanding helicoverpa ecology and biology in southern Queensland: Know the enemy to manage it better*'.

Figure 15. *Two-toned caterpillar parasite,* Heteropelma scaposum, *so-called because of the adult wasp's two-toned body colouring: black in the front (head and thorax) and orange at the back (abdomen) (Photo: P. Reid, CSIRO)*

Identifying parasitised helicoverpa pupae

Parasitised host pupae become stiff, while healthy helicoverpa pupae wiggle their abdomens freely. Use this information to identify parasitised pupae during pupae sampling. Adult wasps emerge from host pupal cases by chewing the head end off the case. This feature distinguishes parasitised pupal cases from pupal cases from which moths have emerged. *Heteropelma scaposum*, *Ichneumon promissorius* and *Lissopimpla excelsa* wasps emerge in this way.

Figure 16. *A helicoverpa pupal case after the moth has emerged (left); a pupal case after the parasitoid* Heteropelma scaposum *has emerged (right). (Photo: B. Scholz, DPI&F).*

Orchid dupe
(Lissopimpla excelsa)

Lissopimpla is a stout, medium-sized wasp (25 mm) with an orange body, black wings and the abdomen has a chequered pattern of black and white spots on the upper surface (Figure 17). Although encountered in all summer crops, *Lissopimpla* appears to be less abundant than *Heteropelma*.

Lissopimpla also parasitises armyworms.

Lifecycle

Lissopimpla has a similar lifecycle to *Heteropelma*: the adult wasp inserts her eggs inside the helicoverpa larva using her ovipositor. The developing *Lissopimpla* larva feeds inside its host and does not kill it until after the caterpillar has pupated underground.

Male *Lissopimpla excelsa* wasps are commonly called the orchid dupe because they are tricked into pollinating orchids. Orchid flowers mimic the odour and appearance of female *Lissopimpla* wasps. Male *Lissopimpla* wasps mistake the flowers for females and attempt to mate with the flower, pollinating it in the process (Figure 18).

Figure 17. *Female* Lissopimpla excelsa *resting on a leaf. Note the dark coloured wings and long black ovipositor. (Photo: K. Power)*

Figure 18. *Duped! This male* Lissopimpla *is attempting to mate with an orchid. (Photo: R. Peakall, ANU)*

Pupal parasitoid

Even after a helicoverpa caterpillar has eaten through a crop and pupated underground, it is not safe from parasitoids.

Banded caterpillar parasite *(Ichneumon promissorius)*

Ichneumon is a pupal parasitoid of helicoverpa and some armyworms. It is a medium-sized (14 mm) wasp, predominately black, with orange and white markings (Figure 19).

Ichneumon is less commonly seen in crops than *Heteropelma,* perhaps because it spends most of its time flying close to the soil surface. *Ichneumon* wasps are active in all summer crops. *Ichneumon* does not diapause with its host, and so is generally active throughout winter. Unlike other wasps, *Ichneumon* is active in chickpea crops.

Figure 19. *A female* Ichneumon promissorius. *Note the white band in the antennae. Male* Ichneumon promissorius *have orange and black antennae. (Photo: J. Hopkinson, DPI&F)*

Lifecycle

Ichneumon locates it host by searching over the soil surface. When the wasp finds the thin, silken cap that covers the helicoverpa pupal chamber, it digs through and enters the chamber. The wasp then lays an egg in the pupa and host feeds on the fluids that leak out from the puncture wound. After being parasitised, the host pupa dies and the pupal case stiffens as the wasp larva consumes the tissues. The adult wasp emerges from the pupal case by chewing off the head section and leaves the pupal chamber via the emergence tunnel.

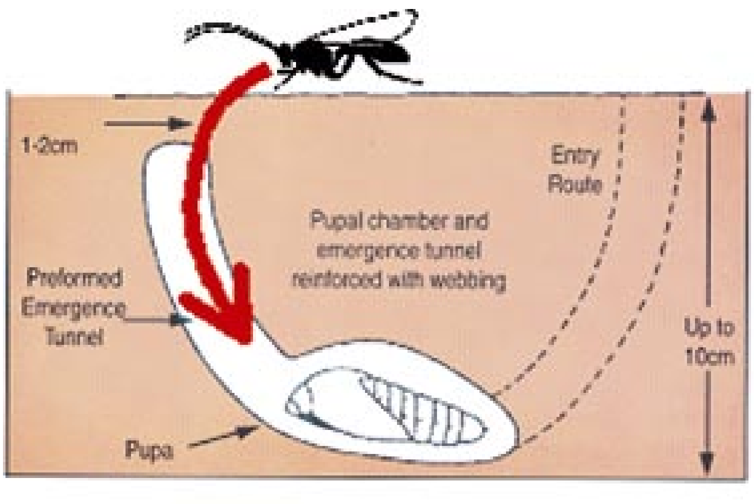

Figure 20. *Pupal chamber of a helicoverpa pupa. The pre-formed emergence tunnel was made by the helicoverpa caterpillar to assist its emergence as an adult moth. However, this tunnel is also used by searching* Ichneumon *females to gain access to host pupae.*

Further information

DPI&F information

To obtain copies of DPI&F publications, contact the DPI&F Call Centre on 13 25 23 or via the DPI&F website www.dpi.qld.gov.au.

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Nancy Schellhorn (2001), 'Parasitoids in cotton', *The Australian Cottongrower.* Vol 22 No.1 pp 44–47.

Cotton pest management guide (annual publication). NSW Department of Primary Industries, Australian Cotton CRC. ISSN 1442–8792.

ENTOpak – A compendium of information on insects in cotton. Available from the Technical Resource Centre at the Australian Cotton Research Institute, Narrabri. Telephone: (02) 67991534.

Online Information

The DPI&F web site www.dpi.qld.gov.au/fieldcrops is constantly updated with the latest pest management information.

The Australian Cotton CRC website www.cotton.crc.org.au has a variety of information related to integrated pest management including:

Online version of *The Cotton Pest and Beneficial Guide*

Impact of insecticides and miticides on predators in cotton

Integrated Pest Management Guidelines for Cotton Production Systems in Australia

Current Insecticide Resistance Management Strategy

About the authors

The DPI&F Entomology team is a leader in the science of managing insect pests and their natural enemies in broadacre farming systems.

Information series ISSN 0727-6273 QI04081
Agdex No. 612 2005

This work has been supported by these organisations

Grains Research & Development Corporation

Cotton CRC

Australian Government
Cotton Research and Development Corporation