# I SPY

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Department of Primary Industries and Regional Development

# SECTION 4

# Common Pest, Beneficial and Exotic Species



## Legend

### Crop type

- Cereals
- Canola (& Brassicas)
- Pulses & legumes
- Pasture

### Monitoring type

- Observation
- Sweep net
- Yellow sticky trap
- Yellow pan trap
- Digging
- Pitfall trap
- Pheromone trap
- Light trap

### Insect status

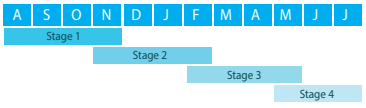
pest = blue
beneficial = green
biosecurity = red

**F = Family**
**SF = Superfamily**

### Scale bar


*Maximum size shown for larva and adult*

### Lifecycle (starting August)



# MOTHS & BUTTERFLIES (Order Lepidoptera)

## Lepidoptera - *scale (lepi); covering wing (ptera)*

In Australia there are about 20,800 lepidopteran species divided into over 80 families.

### Main characteristics

#### Larva

Larvae or grubs are generally elongated in form, with three pairs of true (thoracic) legs directly behind the head. Larvae have a well-developed and hardened (sclerotised) head capsule and chewing (mandibulate) mouthparts. On the front of the head is a groove (suture) shaped like an inverted 'V' and a second suture (adfrontal) just under the 'V'. Most have ventral and anal prolegs as well as crochets (small hooks) on the base of the prolegs. These hooks help the larva hold on to the surface. Most larvae feed on foliage or stored products.

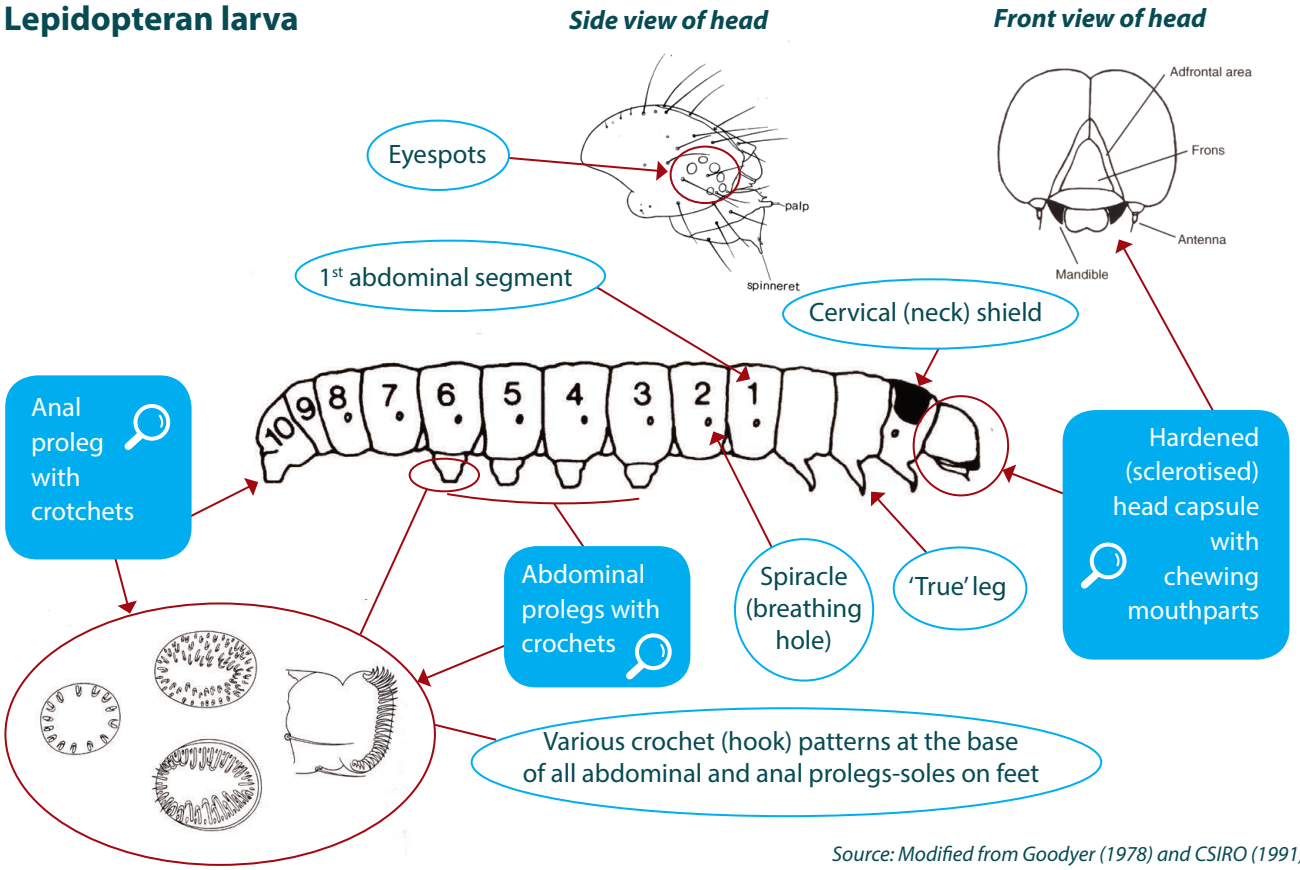
#### **Adult** (moths)

Adults have two pairs of large membranous wings that are completely covered with scales in regular, overlapping rows on both surfaces. They have hairy bodies, a small head covered in scales and large eyes. Adults have a long, thin, coiled sucking tube (proboscis) which they use to feed on liquid sugar sources. They have multi-segmented antennae (comb-like in male moths, thread-like in female moths). Moths usually shelter by day and fly at night, unlike butterflies, which are mostly active during the day.

### Lifecycle

Complete metamorphosis. Depending on the species, females may lay a few or tens of thousands of eggs (several hundred is typical). Larvae develop through 4-7 instars (taking a few weeks or up to a few months) before pupating. Pupation can occur on vegetation, in the soil or leaf litter and even inside wood. Many lepidopterans have one or two generations per year, some breed continuously and others may take years to develop (e.g. Cossidae).

### Lepidopteran larva




*Source: Modified from Goodyer (1978) and CSIRO (1991)*

## Groups (families) relevant to broadacre cropping

**Cutworms, armyworms and native budworm** (F: Noctuidae): The larvae of this family are among the most damaging crop pests and are covered in this section on page 4-12.

**Looper caterpillars** (F: Geometridae): Larvae have a reduced number of prolegs (i.e. two or three pairs of prolegs towards their rear end) and move by a characteristic looping action when walking. The brown pasture looper, *Ciampa arietaria* is an example. This looper undergoes one generation per year with the moths flying in autumn. Refer to Ute Guides, Southern (p. 36)/Western (p. 28) for more detail. Loopers are not just confined to the Geometridae family. A minor spring pest of canola and pulses, *Chrysodeixis* spp. (Noctuidae) also move with a characteristic looping action and have a reduced number of prolegs. For further information, refer to Ute Guides, Southern (p. 37)/ Western (p. 34).

**Diamondback moth** (F: Plutellidae): This is a pest of canola and is covered in this section on page 13.

**Grass moths** (F: Pyralidae): These are generally small moths (most <15 mm long) with characteristic 'beak-like' protrusions on their heads. Legs are usually long relative to the body. Larvae are often web-spinners creating shelters or joining plant and debris together. Lucerne seed web moth is covered in detail on page 15. Other examples include pasture webworm, *Hednota* spp., and weed web moth, *Achyra affinitalis*. For further information refer to Ute Guides, Southern (pp. 30-33)/Western (pp. 24, 25 & 29).

**Day moths** (F: Agaristidae): These moths usually fly by day and have visually striking colours of dark brown to black, yellow and orange. A common pest is the pasture day moth, *Apina calisto*, usually seen in autumn. For further information refer to Ute Guides, Southern (p. 34)/Western (p. 33).

**Tiger moths** (F: Arctiidae): Usually brightly coloured moths with markings of orange, red, black and/or white. Some larvae have a dense covering of tightly packed upright hairs and are known as woolly bears. They are not usually economic pests in broadacre agriculture but are occasionally seen in large numbers.

**Hawk moths** (F: Sphingidae): Larvae have a characteristic spine that rises up from the rear. These are not economic pests in broadacre agriculture but are occasionally seen in large numbers on autumn weeds.

Butterflies (various families): Two of the most widely known pest butterflies found in broadacre cropping are the cabbage white butterfly, *Pieris rapae*, and the grass blue butterfly, *Zizina labradus*. For further information refer to Ute Guides, Southern (pp. 42-44)/Western (p. 35,36).

# ARMYWORMS, CUTWORMS, BUDWORMS & SEMI-LOOPERS

## Lepidoptera: Noctuidae

### Key noctuid characteristics and biology

#### Larvae

- have four pairs of abdominal prolegs;
- have anal prolegs;
- crochet (soles of prolegs) arrangement is a row on one side (mesoseries);
- usually have a stripe on cervical shield;
- usually smooth, lacking obvious dense hairs;
- can vary widely in colour and this variation sometimes depends on the food source. Larvae are often green, brown or yellow in colour and striped longitudinally;
- mostly feed at night on a variety of crops.

Most fully mature noctuid larvae burrow into the soil to pupate, although a few species pupate in a sparse cocoon under a leaf of the host plant. Depending on the species, pupation can take place over a short or long time before moths emerge.

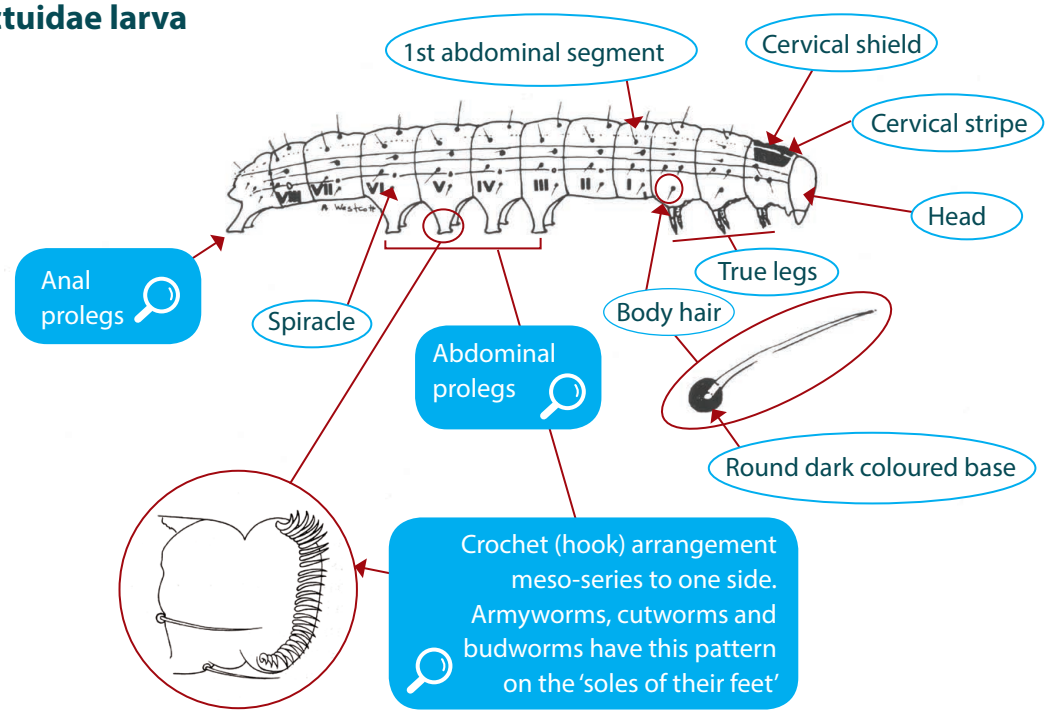
There are many noctuid species that lack some abdominal prolegs and these are known as semi-loopers. They loop their bodies when moving and are often mistaken for a 'true' looper (Geometridae family). Semi-looper species are not covered in this manual.

#### Adults

- are generally dull coloured moths but some have metallic-looking markings on their wings;
- generally have stout bodies covered in dense long scales;
- feed on nectar from flowers;
- mainly fly at night.

Many species are able to migrate long distances aided by wind currents. This enables them to exploit abundant plant growth after rain.

### Noctuidae larva

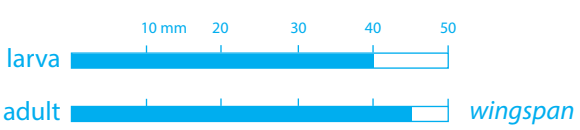



*Source: Modified from Goodyer (1978)*

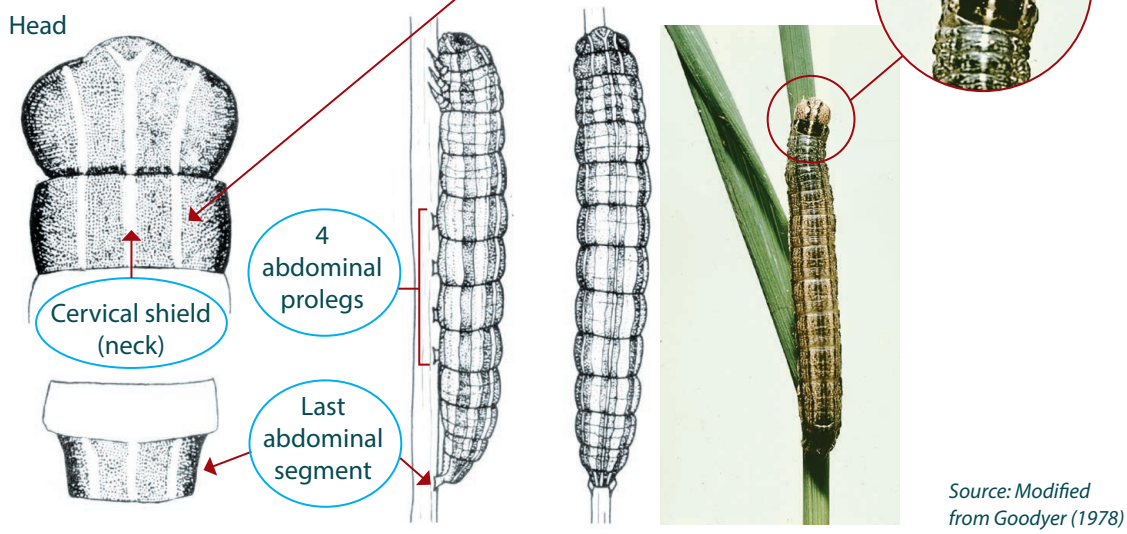
# ARMYWORMS Lepidoptera: Noctuidae

**Common armyworm (*Leucania convecta*), Southern armyworm or barley grub (*Persectania ewingii*), Inland armyworm (*Persectania dyscrita*) and Sugarcane armyworm (*Leucania stenographa* - WA only)**

## Distinguishing characteristics/description



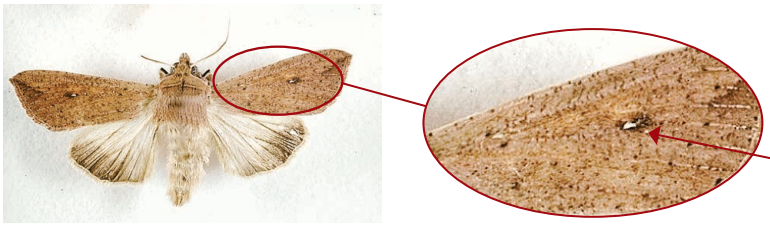

### Larva



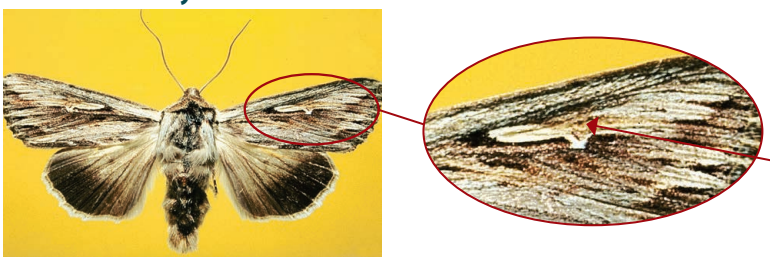

*Source: Modified from Goodyer (1978)*

### Adult

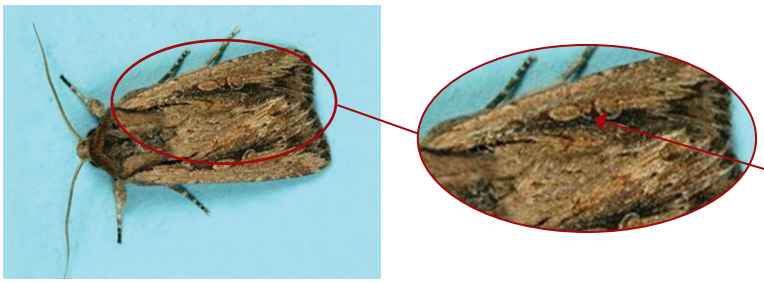
**Common armyworm**




**Southern armyworm**




**Inland armyworm**



**Larvae** are mostly nocturnal. They burrow into the soil or hide under leaf litter during the day. They may sometimes be found feeding during the day on the leaves, stems and heads of cereal crops.

## Confused with/similar to

Larvae of these main pest species are very similar to each other and distinguishing characters are obscure. They can be distinguished by the position of the breathing holes (spiracles) in relation to a band on the side of the body.

## Distribution, pest status and risk period

Armyworm populations are often sporadic. They may build up in an area over time in response to favourable seasonal conditions or suddenly migrate into an area on prevailing winds from a remote location.

Armyworms can be in damaging numbers at any time of year if growing conditions allow. They are occasionally a pest on seedling crops and pastures in autumn but more commonly cause damage to maturing cereal crops.

There can be 3-4 generations per year.

## Crops attacked/host range

Armyworms are pests of cereal crops and pastures. They prefer to feed on ryegrass and will often feed until it is depleted before turning to other grasses or cereals. Larvae do not feed on broad leaf and legume crops.

Barley is the most susceptible cereal crop. Wheat crops are less frequently attacked.

## Damage symptoms

Younger larvae feed on cereal or grass leaves. They are at their most damaging when large larvae (25-40 mm) attack barley crops nearing maturity in late spring. As barley matures, part of the stem often remains green and is appetising to larvae after other plant parts have dried. The caterpillars chew through the stem causing heads to fall to the ground. In oat crops, the larvae bite off pieces of the panicle, causing grain to fall.

When in large numbers, armyworm larvae can eat their way across a paddock like an army on the march. This is occasionally seen in establishing pastures in autumn.

## Monitoring/sampling

Assessing the numbers of armyworms in a cereal crop can be difficult as their movements will vary with weather conditions and feeding preference. Sometimes they are found sheltering on the ground and under leaf litter, while on other days they will be high up on the plants or on the heads, and easily picked up using sweep nets. They often prefer to feed on ryegrass if it is present.

Armyworms may be confined to only small portions of a crop. Several different locations within the crop should be checked for caterpillar numbers before deciding on any control measures.

A suggested monitoring procedure is to:

- look for signs of caterpillar droppings and damaged ryegrass heads;
- look for damage on crop foliage;
- shake the plants and look for caterpillars on the plants and on the ground. Search leaf litter between rows;
- check frequently for the first signs of head-lopping in barley.

## Management options

Some threshold guidelines available indicate spraying may be worth considering if 3 larvae/$m^2$ are present in barley crops that are still more than a week away from harvest, and 10 larvae/$m^2$ in other cereals. If the barley crop is almost dry, continue checking daily until fully mature, as sudden head-lopping requires immediate action. For more specific thresholds, go to the PestNotes webpage and search 'armyworm.'

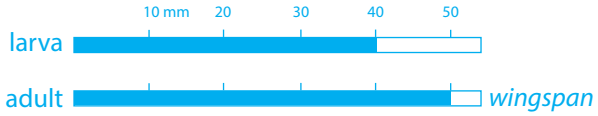
| Biological | Cultural | Chemical |
|---|---|---|
| Naturally occurring biological control agents are important in keeping armyworm populations below damaging levels in some years. These include parasitic flies and wasps, predatory beetles and diseases. | Use of herbicide or grazing to control weedy paddocks several weeks before sowing pastures or cereals will starve out caterpillars.<br><br>Desiccating or swathing crops close to harvest may have the added benefit of minimising armyworm damage. | Registered rates of synthetic pyrethroids are usually adequate for control. See the APVMA website for current chemical options.<br><br>Applications should be carried out in the later afternoon or early evening. Increased spray volumes may be required in high-yielding bulky crops.<br><br>*Bacillus thuringiensis* (Bt) is effective on armyworms and is also 'soft' on natural enemies. Follow Bt checklist section 5 page 13. |

*Ute Guides, Southern (pp. 21-22)/Western (pp. 20-21).*
*http://cesaraustralia.com/sustainable-agriculture/pestnotes/*
*http://ipmguidelinesforgrains.com.au/wp-content/uploads/BestBet_WinterCereals-North2014.pdf*

# CUTWORMS Lepidoptera: Noctuidae

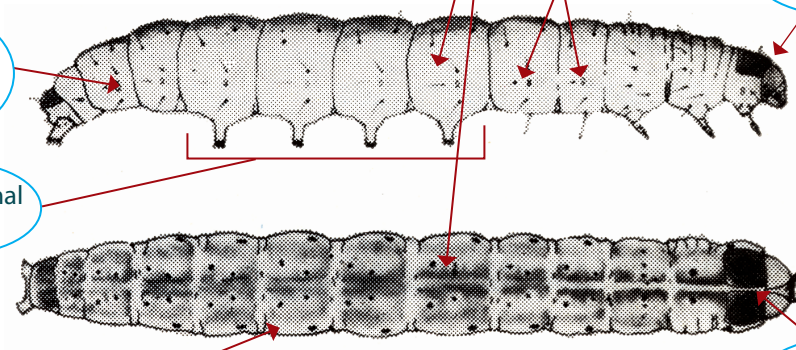
## Common cutworm or Bogong moth (*Agrotis infusa*), Brown or Pink cutworm (*Agrotis munda*) and Black cutworm (*Agrotis ipsilon*)

### Distinguishing characteristics/description

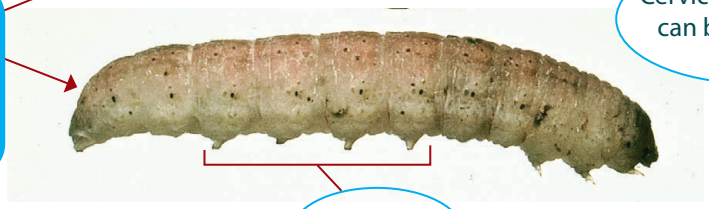



No distinct lines on sides of body and subtle longitudinal line may be present along midline upper (dorsal) surface

### Larva

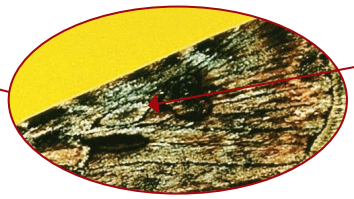



Plump, smooth, and greasy appearance with relatively few stout hairs with dark pigmentation at their base




### Adult

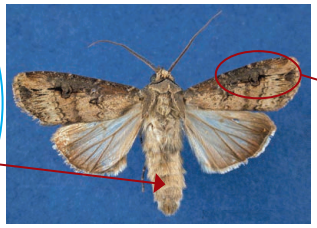
**Pink cutworm**

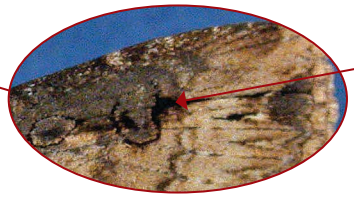


Forewing: brownish with darker markings and streaks. Large inner light mark and darker outer mark. Hindwing: pale with dark edging

Stout bodies covered with dense scales

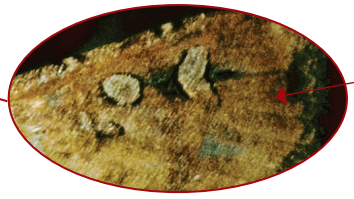
**Black cutworm**





Forewing: brown or grey-black. Dark arrow-mark streak broken by 2 dark ringed dots. Outer margin is streaked. Hindwing: pale with darker edging

**Bogong moth**



Forewing: Dark brown or grey black. Dark arrow-mark streak broken by 2 light dots. Hindwing: pale with darker edging

**Adult** colouration can be highly variable.

**Larvae** are plump and smooth (greasy appearance) and will vary in colour depending on the instar and species. The larva of the pink cutworm is usually found in sandy soils and is grey-green with a pink tinge. The larva of the bogong moth is dark grey.

Larvae are mostly nocturnal. They generally hide under the soil surface or litter and come out at night to feed, although at least one species may be found feeding above ground during the day. The caterpillars often curl up when disturbed.

## Confused with/similar to

Larvae of these three main pest species are very similar to each other and distinguishing characters are obscure.

They may also be confused with the biosecurity threat, the turnip moth (*Agrotis segetum*).

## Distribution, pest status and risk period

Widely distributed with various other species. They are most damaging when caterpillars transfer from summer and autmun weeds onto newly emerged seedlings. They can have several generations per year.

## Crops attacked/host range

Cutworms will attack all crops and pasture plants (polyphagous) but are at their most damaging when they feed on newly-emerged cereal and pasture seedlings.

## Damage symptoms

Large caterpillars will chew through or cut off the stems of young seedlings, hence the name cutworm.

Whole paddocks of cereal or legume seedlings may be destroyed or severely thinned in the presence of high populations of large cutworm larvae early in the season. Larvae feed at or near ground level. When small, the larvae feed on the surface tissues of the tender foliage. This surface feeding may be confused with damage caused by lucerne flea or other small caterpillars.

## Monitoring/sampling

A suggested monitoring procedure is to:

- look for patches of newly emerged crops with seedlings cut off;
- scratch the soil layers close to recently damaged seedlings to reveal hidden larvae;
- use a shovel to sample for grubs by scraping off the top 50 mm of soil near freshly damaged plants. Flick the soil off the shovel so that it spreads in a thin layer, revealing the grubs. Do this in several places near damaged areas;
- use a backpack sprayer to spray out small areas. Check the following morning for dead grubs which can be found on the soil surface.

## Management options

These are not regular pests, but large areas may be affected in some seasons. Extensive damage can occur if more than 3 larvae/$m^2$ are found. Spot spraying, or spraying a 20 metre buffer around the infestation, may provide adequate control. Spraying in the evening is likely to be more effective.

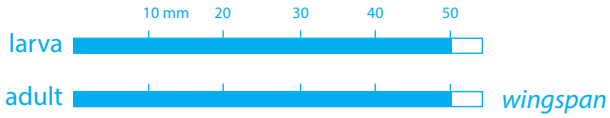
| Biological | Cultural | Chemical |
|---|---|---|
| Naturally occurring insect fungal diseases are successful in some seasons. Wasp and fly parasites are also very active in preventing more frequent and serious outbreaks. Parasites include the orange and two-toned caterpillar parasite, (*Heteropelma scaposum*) and the orchid dupe (*Lissopimpla excelsa*). Refer to Southern (pp. 120 & 122)/ Western (pp. 96-97) Ute Guides for more detail. | Prolonged autumn green feed in many areas may allow larvae to develop to a large size by the time crops emerge. Early control of this plant material (green bridge) using a herbicide to create a complete brown-out for two weeks pre-planting, will minimise larval survival. | Cutworm caterpillars are usually easy to control with label rates of synthetic pyrethroid chemicals. Several chemicals are registered for controlling cutworms (refer to state and crop type for currently registered products).<br><br>Spot spraying often provides adequate control. |

*Ute Guides, Southern (p.23, 24)/Western(p22, 23)*
*http://cesaraustralia.com/sustainable-agriculture/pestnotes/*
*http://ipmguidelinesforgrains.com.au/wp-content/uploads/BestBet_EstablishmentNorth2014.pdf*

# Cutworm - Turnip moth (Agrotis segetum)

**BIOSECURITY THREAT**
NOT PRESENT IN AUSTRALIA

## Distinguishing characteristics/description




4 abdominal prolegs

### Larva

Greyish-brown in colour with a greasy appearance and a reddish or brownish-black head capsule

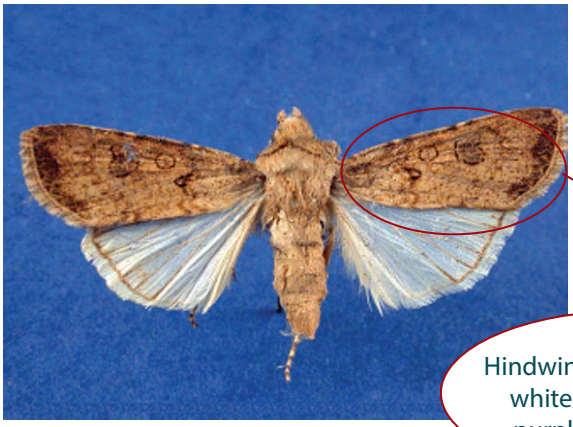
Two broad and light longitudinal bands running along the midline (that can have a very thin white line cutting through)

On each body (abdominal) segment, there are 4 black spots each bearing a small bristle

Narrow dark band with white line inside

Broad light bands

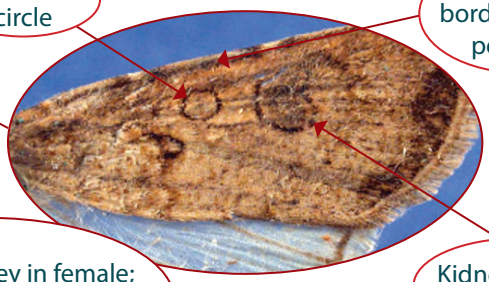
### Adult



Stout bodies covered in dense long scales. Antennae: threadlike in females; feather-shaped in males

Uniform circle

Thin black border on wing periphery



Hindwings: grey in female; white/silver with light purple tinge in males

Kidney-shaped marking

All cutworm caterpillars are plump and smooth (greasy appearance), and can vary in colour depending on the instar.

Larvae are mostly nocturnal and often burrow during the day, hiding under the soil surface or litter.

More than one generation per year.

## Confused with/similar to

Turnip moth can be confused with other cutworms present in Australia.

## Distribution and potential spread

Europe, Africa, northern Asia including China. Turnip moths are strong flyers and dispersal is aided by wind currents. This species is not known to migrate over large distances. Incursion and dispersal could occur through the transportation of plant and soil material.

## Crops attacked/host range

Turnip moth is a highly polyphagous pest in its current distribution, attacking wheat, barley, oats, brassicas, vegetables and weeds.

## Damage symptoms

All cutworm larvae are most damaging when they feed on newly emerged seedlings and cause plant death. Large caterpillars will chew through or cut off the stems of young seedlings. When small, the larvae feed on the surface tissues of the foliage resulting in very small round 'window panes'. This surface feeding may be confused with damage caused by lucerne flea or other small caterpillars.

## Surveillance

Turnip moth is likely to be misidentified as other cutworm species already present in Australia due to the difficulty of distinguishing between species.

**Early detection of plant pests can greatly increase the chance of successful eradication and reduce the cost and social impact of an incursion.**

Incorporate surveillance for exotic pests when undertaking routine crop monitoring and other crop detection and measurement activities.

## Reporting protocol

A rapid response to detection of potential exotic pests can be the key to containment, eradication or management.


If you see anything unusual, call the Exotic Plant Pest Hotline on 1800 084 881.

Speak to your department of primary industries or department of agriculture before sending any samples.

It is essential that the correct sampling protocol is followed including packaging, handling and transport to the laboratory assigned for diagnosis. Incorrect handling could spread the pest further or render the samples unfit for identification.

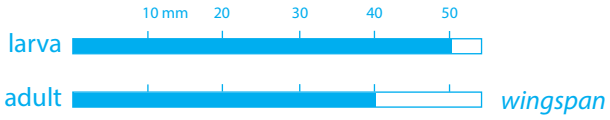
Stop the movement of people, vehicles and equipment in the detected area until a confirmation can be made.

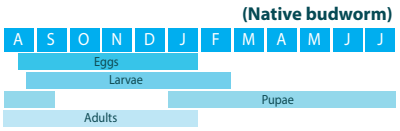
**More information**
Plant Health Australia website
**www.planthealthaustralia.com.au/biosecurity/grains**

# BUDWORMS Lepidoptera: Noctuidae

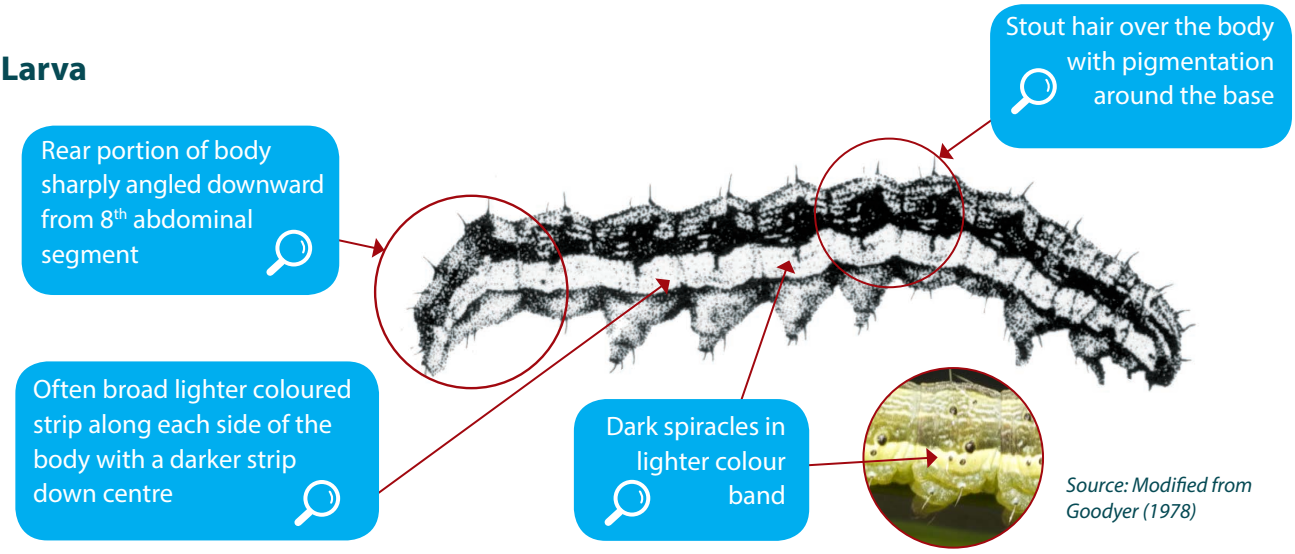
## Native budworm (*Helicoverpa punctigera*), Lesser budworm (*Heliothis punctifera*) and Corn earworm/cotton bollworm (*Helicoverpa armigera*)

### Distinguishing characteristics/description

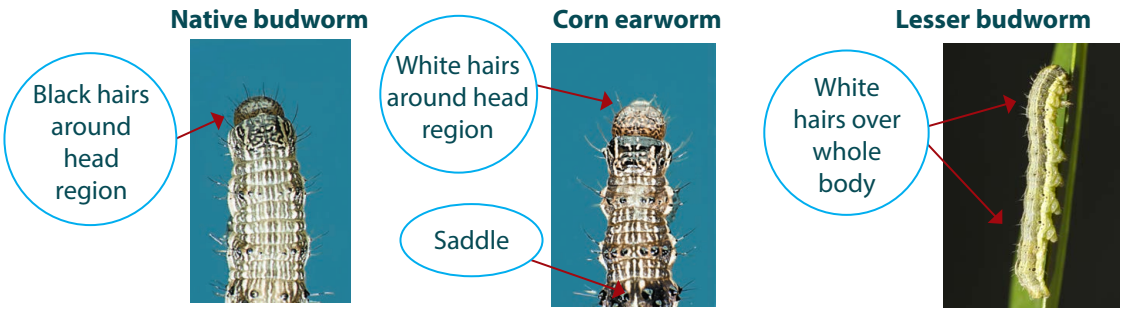


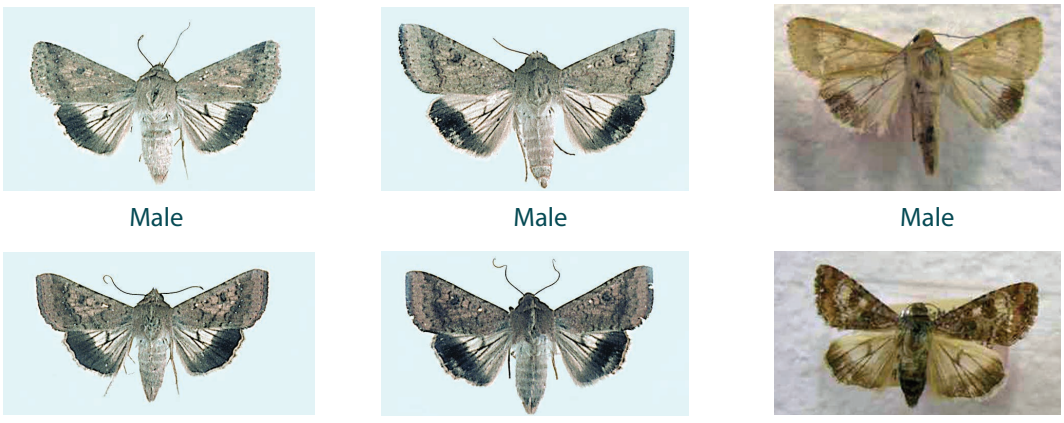

### Larva




*Source: Modified from Goodyer (1978)*




### Adult



Male | Male | Male

Female | Female | Female

### Confused with/similar to

Armyworm and cutworm in general appearance and size.

## Distribution, pest status and risk period

**Native budworm:** Occurs in most years and often migrates into agricultural areas from nearby pastoral areas. It is a native species and is usually easily controlled with insecticides.

**Lesser budworm:** Infrequent pest.

**Corn earworm/cotton bollworm:** Less inclined than native budworm moths to undertake long-distance migratory flights, problems in spring and summer generally arise from local populations that survive over winter as diapausing pupae in winter crops. This pest is known to develop strong resistance to insecticides and can be difficult to control.

## Crops attacked/host range

**Native budworm:** Broad leaf and legume crops such as field pea, faba bean, lentil, chickpea, lupin and canola. Pastures such as pasture serradalla, lucerne, annual medic and clovers. Only occasionally feeds on cereals and some grasses.

**Lesser budworm:** Wide host range, will feed on both broad leaf grasses and cereals.

**Corn earworm/cotton bollworm:** Wide host range. Can attack all field crops, particularly cotton, sorghum, maize, sunflowers, chickpeas, lupins and lucerne. The species is also occasionally found grazing on wheat and barley heads. They can cause damage to foliage, flowers and pods on canola.

## Damage symptoms

Holes or chewing damage may be seen on pods and/or seed heads. Grubs may be seen occasionally.

All budworms are at their most damaging when they feed on the fruiting parts and seeds of plants.

Losses attributed to budworms come from direct weight loss through seeds being wholly or partly eaten. Grain quality may also be downgraded through unacceptable levels of chewed grain.

## Monitoring/sampling

The quickest and easiest method to sample most crops is sweep netting. Multiples of 10 sweeps should be taken in several parts of the crop and larval numbers averaged. The use of pheromone traps (which attract male moths) can provide an early warning of moth arrival to an area or their emergence from local winter diapause. These traps should be set up in early spring.

Caterpillars eat increasing quantities of seed and plant material as they grow. The last two growth stages (5$^{th}$ & 6$^{th}$ instar) account for over 90% of their total grain consumption.

Field pea, chickpea, lentil and faba bean crops are very susceptible to all sizes of native budworm caterpillars during the formation and development of pods. Small caterpillars can enter emerging pods and damage developing seed while larger caterpillars may devour the entire pod contents. Narrow-leafed lupin and canola crops will not be damaged by native budworm until they are close to maturity and leaf fall commences. For lesser budworm, the same principles as native budworm can be applied.

For detailed economic threshold guidelines, go to the PestNotes webpage and search 'native budworm' and 'corn earworm.'

## Management options

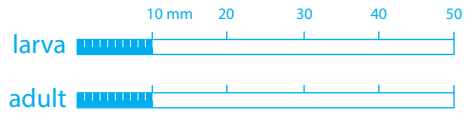
| Biological | Cultural | Chemical |
|---|---|---|
| Naturally-occurring insect fungal diseases and viruses can be very successful in some seasons. Predatory shield bugs, damsel bugs and fly parasites may also be active in preventing serious outbreaks. Parasites include the orange and two-toned caterpillar parasite (*Heteropelma scaposum*), the orchid dupe (*Lissopimpla excelsa*) and *Trichogramma ivalae.* Refer to Southern (pp. 120 & 122) and Western (pp. 96-97) Ute Guides for more detail. | Swathing canola or desiccating pulse crops such as field peas may be an option to advance the drying of crops when small/medium size larvae are present. | Native budworm and lesser budworm are easily controlled by synthetic pyrethroids.<br><br>Corn earworm populations are resistant to endosulfan, synthetic pyrethroids and carbamates, as well as lower levels of resistance to organophosphates, spinosad and indoxacarb. In cotton, a comprehensive resistance management framework exists (see link below).<br><br>Use of Bt and NPV biological insecticides are important IPM options.<br><br>Timing of chemical applications and coverage are critical. Target small larvae up to 7 mm in length and apply insecticides before larvae move into flowering pods. |

*Ute Guides, Southern (pp. 18-20)/Western (pp. 17-19).*
*http://ipmguidelinesforgrains.com.au/workshops/resources/#bestbet : Canola , Sorgum North, Summer Pulses, Winter Cereals North, Winter Pulses South*
*http://www.cesaraustralia.com/sustainable-agriculture/pestnotes/*
*http://www.cottoninfo.com.au/publications/cotton-pest-management-guide*

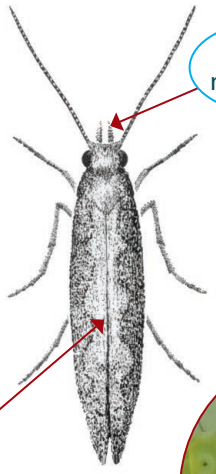
# Lepidoptera: Plutellidae

## Diamondback moth - DBM (*Plutella xylostella*)

### Distinguishing characteristics/description




### Adult



Beak-like mouthpart

'Diamond'- shape pattern on wings at rest

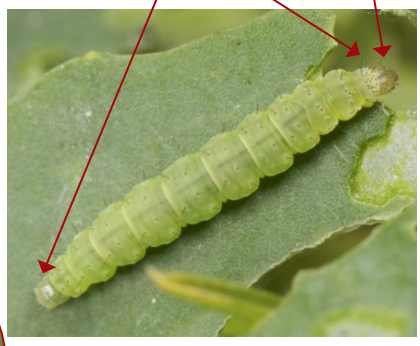
Mesh-like pupal casing

Leaf mine of 1st larval instar

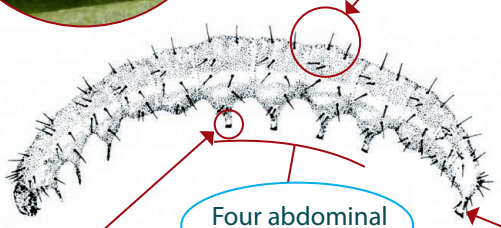
### Larva

Head capsule lightens as matures

Larvae slightly tapered at each end. Pale yellowish green in colour

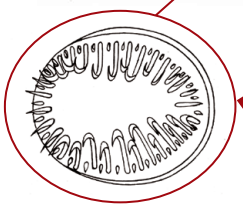


Body covered in coarse black hairs



Four abdominal prolegs

Anal prolegs



Nearly complete crochet arrangement at base of prolegs

**Eggs** are pale yellow, oval and about 0.5 mm in length. Eggs are laid singularly or in clusters along the leaf margins.

**Larvae** develop through four instars. The first two instars have a dark head, but the first instar is not visible as it lives and feeds inside leaf tissue (its presence is indicated by a leaf mine). Larvae wriggle vigourously when disturbed and often drop from the plant on a silken thread.

The **pupal** casing is mesh-like in appearance and the pupa inside is cream-green initially, but darkens before the adult emerges.

### Confused with/similar to

Diamondback moth (DBM) larvae can be confused with young cabbage white butterfly (*Pieris rapae*) and cabbage centre grub (*Hellula* sp.) larvae.

### Distribution, pest status and risk period

DBM is a worldwide pest with a high propensity to evolve insecticide resistance. DBM is widely distributed in southern Australia.

DBM has no diapause phase in Australia and has overlapping generations. All life stages can be present at any one time. Adults are active flyers but usually do not move far within a crop.

They are capable of long distance migration on prevailing winds, particularly when host material has died off. Weather conditions can impact dramatically on DBM populations. Development is faster in warm weather and slower in cool weather. For example, at 15 °C the life cycle takes approximately 36 days to complete, but at 28°C it takes approximately 11 days to complete.

## Crops attacked/host range

DBM feeds on canola and all *Brassica* plants, including weeds.

The availability of *Brassica* host plants can influence outbreaks. Summer rainfall can also provide a green bridge of summer weeds.

DBM adults migrate from summer weed sources into canola crops in autumn and winter. Significant rainfall events (greater than 8 mm) can reduce larval abundance by drowning or dislodging larvae or facilitating death by disease.

## Damage symptoms

Larvae can cause damage to all growth stages of the canola plant. They feed on the foliage before flowering and, as flowering progresses, an increasing proportion of the larvae move to the floral buds, flowers and pods. Maturing pods are surface grazed or scarred by the larvae. They are not as damaging as native budworm as they do not chew into the pods. Premature shattering of pods rarely occurs.

Larger larvae feeding on the underside of leaves can create holes, often with the upper surface intact, producing a window effect.

Canola can tolerate considerable foliar feeding damage before crop yield is affected. Severe feeding damage can cause complete defoliation resulting in yield reduction.

## Monitoring/sampling

Crops should be monitored using a sweep net at the first sign of damage and throughout the growing season from late winter to late spring.

Take a minimum of five sets of 10 sweeps and calculate the average number of larvae per 10 sweeps.

If spraying, it is important to monitor 5-7 days after spray application to assess the effectiveness of treatment.

## Management options

Threshold guidelines indicate spraying is recommended when:

- 50 larvae are collected per 10 sweeps for pre-flowering unstressed crops.
- 30 larvae are collected per 10 sweeps for pre-flowering stressed crops.
- 100-200 larvae are collected per 10 sweeps for unstressed crops with the majority of plants in flower.

If monitoring detects a rapid increase in DBM larvae and numbers exceed spray thresholds, a two-spray policy is thought to be more effective than a single spray. The second spray should be applied approximately seven days after the first if more than 20% of the initial population remains. **Good spray coverage is critical for effective DBM control** as more than 20% of the larvae reside in the bottom third of the plant. You should consider the size of the majority of the larvae before making a management decision. Target treatment at larvae <5 mm in length (2nd & 3rd instar) to achieve more effective control. Chemical resistance to synthetic pyrethroids and organophosphates is widespread in DBM populations on *Brassica* vegetable crops throughout Australia, and to a lesser and varying extent, in many canola cropping regions.

| Biological | Cultural | Chemical |
|---|---|---|
| The most important natural enemies are small wasp parasitoids (*Diadegma semiclausum, Apanteles ippeus* and *Diadromus collaris*).<br><br>Predators such as brown lacewings, spiders, damsel bugs and other predatory bugs can contribute to DBM mortality.<br><br>Naturally-occurring insect fungal diseases may also be very successful in some seasons under ideal conditions (i.e. a combination of rainfall, high humidity and warm temperatures). | Summer weed control close to crop areas will help break the 'green bridge'.<br><br>Area wide management. | This species is difficult to control with insecticides and evolves resistance readily. A resistance management strategy for DBM has been developed and is available on the GRDC webpage.<br><br>*Bacillus thuringiensis* (Bt) is the softest insecticide on natural enemies and very effective on DBM. Correct application is critical to achieve effective control. Refer to Bt checklist, section 5 page 13. |

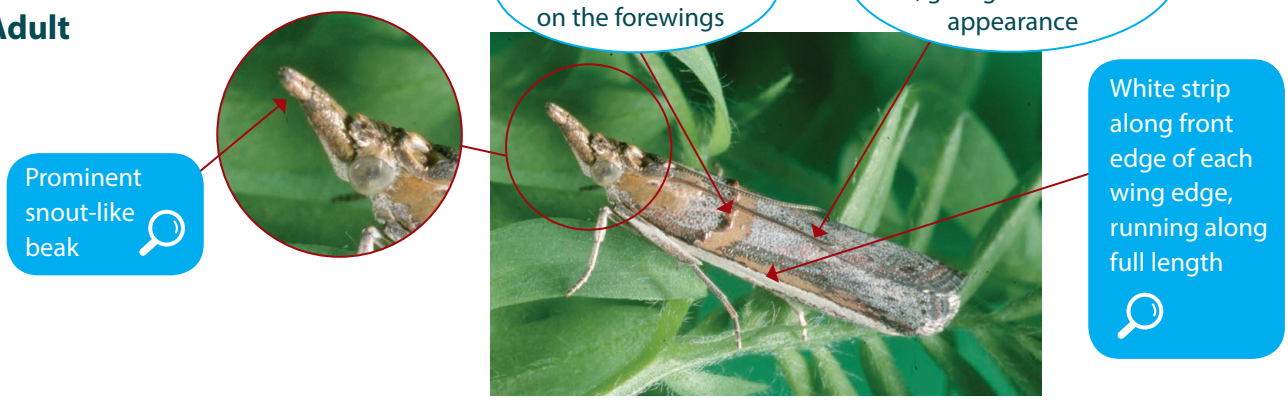
*Ute Guides, Southern (pp. 25-26)/ Western (pp. 26-27).*
*http://cesaraustralia.com/sustainable-agriculture/pestnotes/*
*http://ipmguidelinesforgrains.com.au/wp-content/uploads/BestBet_Canola2014.pdf*
*https://grdc.com.au/fs-resistancestrategydiamondbackmoth*

# Lepidoptera: Pyralidae

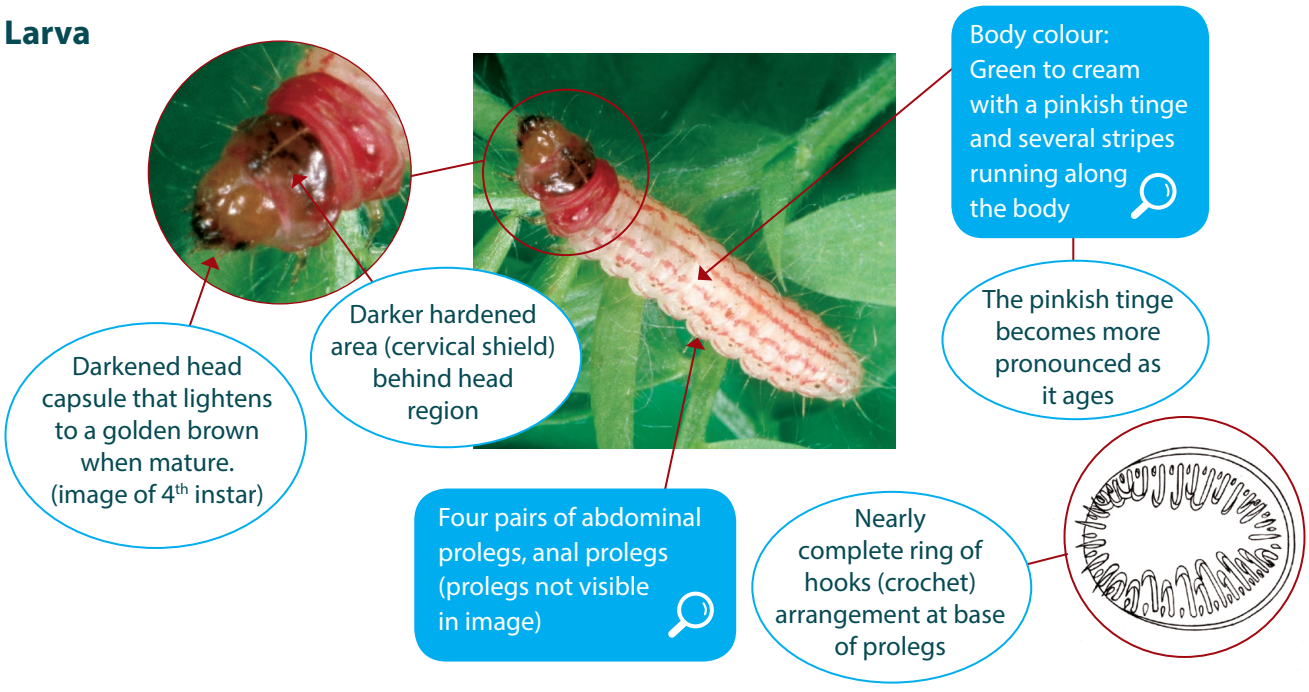
## Lucerne seed web moth (*Etiella behrii*)

### Distinguishing characteristics/description


### Adult




### Larva




### Confused with/similar to

Lucerne seed web moth can be confused with other snout moths (Pyralidae), such as weed web moth. Larvae can be confused with podding pests such as budworms. Lucerne seed web moth larval damage is associated with characteristic webbing of pods and flowers - budworms do not web.

### Distribution, pest status and risk period

Lucerne seed web moth is widespread throughout Australia but it is generally only a major and irregular pest in lucerne-growing areas of southern Australia.

The highest risk period is when pods mature prior to harvest in summer. Seed damage is sporadic over seasons, varying from light to severe infestations when an outbreak occurs.

Lucerne seed web moth can have 2-3 generations per year depending on the temperature, location and host plant availability. In southern Australia, adults are first seen in late September with a second peak (generation) in November/early December. A third generation often occurs in late December/early January.

## Crops attacked/host range

Lucerne seed web moth has been found on a wide range of native and introduced legume plants that include lucerne, lentils, lupins, field peas, medics, clovers and soy beans.

## Damage symptoms

Larvae can feed in the growing points, buds, flowers and inside pods, where there are few signs of damage during the early stages of attack, and internal larvae feeding can go unnoticed. Each larva usually damages more than one pod and several pods are often webbed together - this is characteristic of lucerne seed web moth.

Female moths lay their eggs under the calyx or on the pod surface and these eggs hatch within 4-7 days, depending on the temperature. Newly hatched larvae bore into immature pods within a very short period after hatching, to begin feeding on developing grain. This results in inferior quality lentils and yield losses due to a reduction in grain weight and grain breakage. Once inside the pods, larvae are protected from insecticide sprays and damage is usually only identified at harvest.

## Monitoring/sampling

Successful lucerne seed web moth control relies on thorough crop monitoring in order to correctly time insecticide applications. In southern Australia, adults are first seen in mid to late September which usually coincides with early pod development.

The degree-day model (*Etiella* management in lentils) can be used to help identify the onset of significant lucerne seed web moth flight activity within crops and when in-crop monitoring should commence. To access the model, go to the PIRSA or PestNotes website and search 'etiella' or 'lucerne seed web moth.'

Suggested monitoring procedures

- Sweep netting is a common method used for estimating moth numbers. Susceptible crops should be sampled at least once a week during podding for evidence of lucerne seed web moth activity. A minimum of three groups of 20 sweeps should be randomly undertaken within each field.
- Pheromone trapping requires a minimum of two to three traps to be placed within a crop approximately 25 cm above the canopy.
- Light trapping is used at night to detect lucerne seed web moth moths in spring but a range of other insects will be collected and checking specifically for the lucerne seed web moth can be difficult.

Check for the presence of young larvae and eggs on maturing seed pods when moths are present.

Examine damaged growing points or pods particularly where webbing is seen. It is too late to prevent damage when webbing by mature larvae is detected.

## Management options

Lucerne seed web moth management is based on timing spray applications to target adult moths before egg laying commences. Sprays are ineffective against lucerne seed web moth eggs and when larvae bore into pods they are physically protected from sprays.

Recommended action threshold for lucerne seed web moth in lentils is 1-2 larvae collected in 20 sweeps. In lucerne, control may be warranted if about 5% of seed pods contain small larvae.

| Biological | Cultural | Chemical |
|---|---|---|
| Predatory bugs such as glossy shield bug (*Cermatulus nasalis*)can attack lucerne seed web moth. A number of parasitic wasps and flies have also been recorded from larvae and pupae. | Delay harvest or grazing period to prevent these coinciding with moth flights.<br><br>Control volunteer legumes and other host plants. | Chemical control with synthetic pyrethroids should aim to kill the adults before egg laying commences. Once eggs have been laid and larvae have bored into seed pods, insecticide applications are mostly ineffective.<br><br>Insecticides with short withholding periods should be used later in the season.<br><br>Insecticide sprays applied to control native budworm early in the podding period may provide some control for lucerne seed web moth if present. Lucerne seed web moth monitoring should recommence no later than one week after spraying.<br><br>Insecticides with a fumigant action may kill some larvae but control may not always be achieved. |

*Ute Guides, Southern (pp. 27-28)/Western (pp. 30-31)*
*http://cesaraustralia.com/sustainable-agriculture/pestnotes/*
*http://pir.sa.gov.au/research/ (search for 'etiella' or 'lucerne seed web moth')*

# BEETLES (Order Coleoptera)

## Coleoptera - *sheath (koleos); wing (ptera)*

Beetles are the largest order of insects, including about one quarter of all the known insects in the world. There are around 28,200 described beetle species in Australia, divided into 113 families.

### Main characteristics

#### Larva

There are four major morphological types of larvae; eruciform, scarabaeiform, campodeiform and apodous (see p. 18). All have chewing (mandibulate) mouthparts and a hardened (sclerotised) head capsule. Many larval stages are considered to be the pest phase of beetles. Three pairs of legs (with the exception of weevil larvae) are present. The absence of prolegs with crotchets (specialised hooks) distinguishes beetle larvae from moth larvae.

#### Adult

Forewings are hardened into sheath-like wing covers (elytra) and they have a hardened body. All have chewing (mandibulate) mouthparts.

#### Lifecycle

Complete metamorphosis.

### Groups (families) relevant to broadacre cropping

**Cockchafers and dung beetles** (F: Scarabaeidae): Mixed group with some larval pests and adult beneficials. Some adults are also pests. All larval stages are curl grubs, 'C'-shaped larvae. Cockchafers are covered in detail in this section on page 19.

**True wireworms or click beetles** (F: Elateridae): These soil-dwelling larval pests are covered in detail in this section on page 24.

**False wireworms** (F: Tenebrionidae): These soil-dwelling larval pests are covered in detail in this section on page 26.

**Weevils** (F: Curculionidae): Adults have a snout (rostrum). All weevil larval stages are legless (apodous) and maggot-like in shape. Both adults and larvae can be damaging to plants. Weevils are covered together in this section on page 28.

**Ladybirds** (F: Coccinellidae): These predatory beetles are covered in detail in this section on page 31.

**Ground beetles** (F: Carabidae): These predatory beetles are covered in detail in this section on page 33.

**Bruchid/seed beetles** (F: Chrysomelidae): Bruchids are small beetles that feed on a range of seeds, especially pulse crops. They are pests in the larval stage where they feed inside developing seeds. The pea weevil (*Bruchus pisorum*) belongs in this family but it is not a true weevil, not having a weevil snout. This introduced pest beetle is one of a number of common worldwide pests in field pea and bean growing areas. This pest has an interesting lifecycle with the larvae beginning life in the growing pod and completing it in the dry seed. For further information on pea weevil refer to Ute Guides, Southern (p.55)/Western (p.44).

Several Bruchid species are present in Australia, however this subfamily also includes many biosecurity threats such as Mediterranean pulse beetle (*Bruchus emarginatus*) and Mexican bean weevil (*Zabrotes subfasciatus*). For more information refer to **http://www.planthealthaustralia.com.au/pests/bruchids/**

## Eruciform

Cylindrical elongated body.
Short legs.
Head & mouthparts oriented downwards.
Less active and mobile.

**Groups**
**False wireworms** (Tenebrionidae)
**True wireworms** (Elateridae)
Many non-target species

## Scarabaeiform

'C' - shaped body.
Relatively short functional legs.
Swollen lower abdomen.

**Groups**
**Cockchafers and dung beetles** (Scarabaeidae)

## Campodeiform

Tapering body.
Well-developed legs.
Large mouthparts directed forward.
Highly mobile and active.

**Groups**
**Ladybirds** (Coccinellidae)
**Carabids** (Carabidae)
**Rove beetles** (Staphylinidae)

## Apodous

Legless.
Reduced mouthparts and antennae.
Adapted to living in confined spaces.

**Groups**
**Weevils** (Curculionidae)

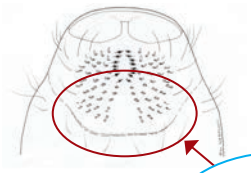
*Source: Modified from CSIRO (1991)*

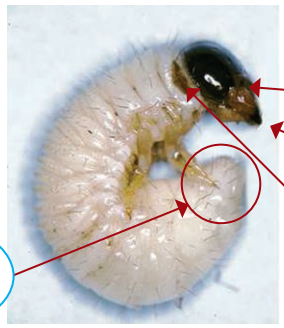
# COCKCHAFERS Coleoptera: Scarabaeidae

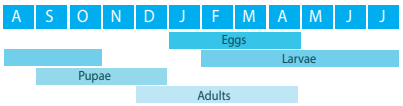
## Blackheaded pasture cockchafer (*Acrossidius tasmaniae*), Yellowheaded cockchafer (*Sericesthis* sp.), Redheaded pasture cockchafer (*Adoryphous coulonii*) and African black beetle (*Heteronychus arator*)

### Distinguishing characteristics/description: larvae

#### Blackheaded pasture cockchafer NOT IN WA






Black head capsule

*Short functional legs

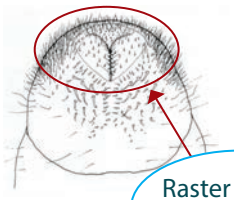
*Mouthparts oriented downwards

*Abdomen swollen distally

*Spiracle behind head capsule

Raster of larva 'U'-shaped lower groove

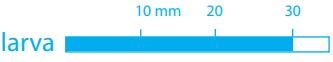
#### Yellowheaded cockchafer NOT IN WA

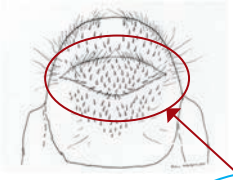



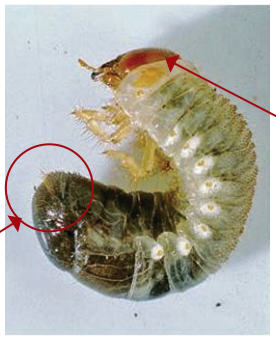
Yellow head capsule

Raster of larva 'Y'-shaped groove

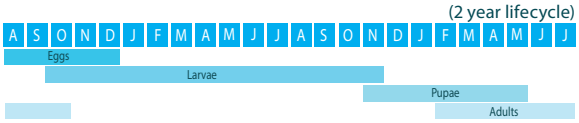
#### Redheaded pasture cockchafer NOT IN WA





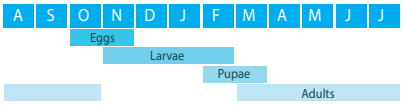
(2 year lifecycle)




Pitted red head capsule

Raster of larva open groove

#### African black beetle NOT IN TAS

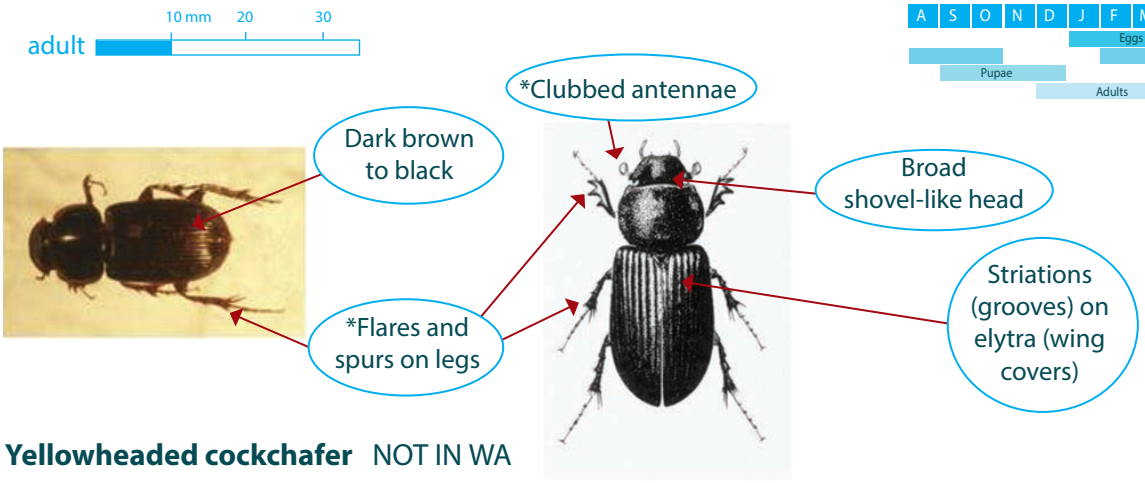

Smooth brown head capsule

Raster of larva open groove

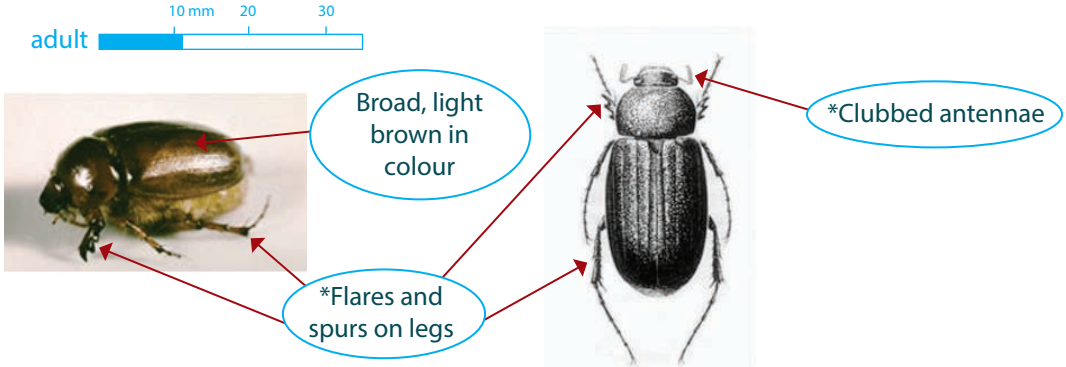
** indicates character for all species*

## Distinguishing characteristics/description: adults

### Blackheaded pasture cockchafer NOT IN WA

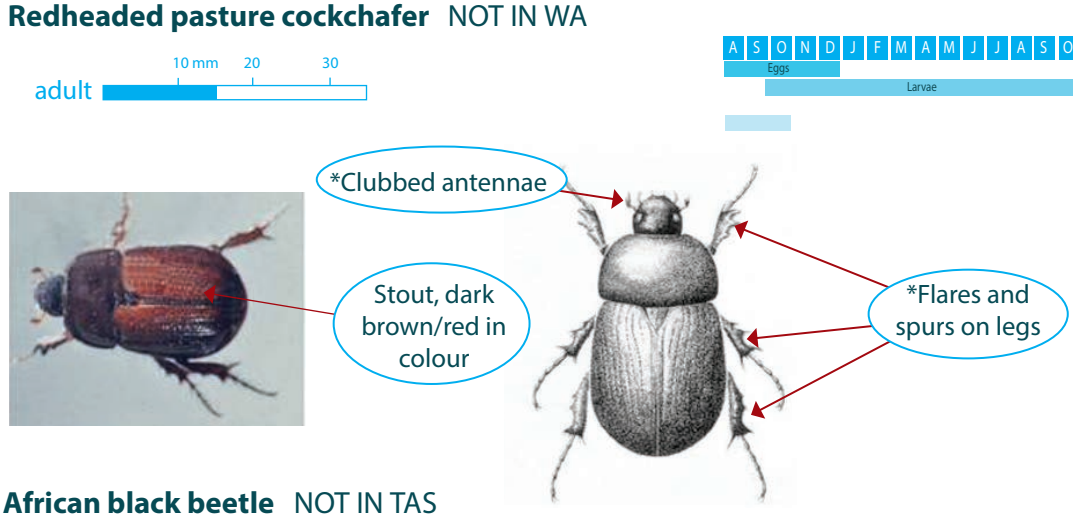



### Yellowheaded cockchafer NOT IN WA




### Redheaded pasture cockchafer NOT IN WA

(2 year lifecycle)




### African black beetle NOT IN TAS


** indicates character for all species*

The larval stages of all cockchafers and dung beetles are 'C'-shaped grubs that curl up when disturbed or handled. They have relatively short functional legs, the abdomen is swollen distally and their mouthparts are oriented downwards.

Cockchafer species usually live in vertical tunnels in soil and are free-living. The presence of tunnels can sometimes make the soil appear spongy.

**WA Cockchafers**
Species of cockchafers found in Western Australia and eastern Australia differ. Although many WA species appear similar to those found in eastern Australia, most are not damaging. A few species (e.g. *Heteronyx obesus*) can cause extensive below-ground damage in some seasons. Larvae are soil-dwelling root feeders that do not come to the surface. Refer to Western Ute Guide (p. 46) for more detail.

**Blackheaded (BH) pasture cockchafers** are foliage feeders and the presence of green material in tunnels is also a good indicator of this species.

**Yellowheaded (YH) cockchafer** and **Redheaded (RH) pasture cockchafer** larvae are soil-dwelling (root feeders). Newly-hatched larvae are about 5 mm long.

**African black beetle (ABB)** are pests as both larvae and adults. Larvae are soil-dwelling (root feeders). Adults chew plants at or just beneath ground level.

## Confused with/similar to

Similar to all other Scarabaeidae 'C'-shaped larvae (e.g. dung beetles). Distinguishing between most species at the larval stage is difficult and generally only possible using a microscope to compare hair (setae) structure.

The Scarabaeidae family includes other beneficial species such as beneficial dung beetles. In general, beneficial dung beetles are found with brood balls. Brood balls are balls of dung on which dung beetles lay eggs. Eggs hatch into larvae which feed on the dung of the brood ball. Refer to Ute Guides, Southern (p. 150) / Western (p. 125) for more detail.

## Distribution, pest status and risk period

**WA Cockchafers** are found throughout the state. Their presence in the soil does not always mean that damage will occur. The larval stages feed underground and are most damaging to seedling crops during autumn/winter. Damage may occur every second year as some species have a two year lifecycle.

**BH pasture cockchafers** are found in higher rainfall areas in southeastern Australia (not WA). Larval growth rates depend on the number of rainy days during autumn and winter, which is when pastures and crops are most at risk. Pupation occurs towards the end of October with adults emerging during January to March. Their emergence and activity is dependent on the frequency of rainfall events. Adults live for several weeks and will lay egg batches on bare earth. One generation per year.

**YH cockchafers** are found across southeastern Australia (not WA), including New South Wales, Victoria and South Australia. Larvae live in the soil until mid-late summer when they emerge as adult beetles. Cereal and pasture plants are most likely to be damaged from emergence to late autumn or early winter. The biology of these species is not well understood; some species are thought to have two-year lifecycles.

**RH pasture cockchafers** are found throughout south-eastern Australia (not WA), but are most common in south-west and central Victoria, the southern tablelands of New South Wales, south-eastern South Australia and northern Tasmania. Although they are typically found in higher rainfall zones, RH pasture cockchafers tend to be more numerous and problematic in drier years. Pastures are most likely to be damaged from emergence to late autumn or early winter. Although RH pasture cockchafers have a two year life cycle, they can be problematic every year if generations overlap. Larvae are present from autumn to spring and pupation occurs over summer. Adults remain in the soil until the following spring when they emerge, fly off, and then lay their eggs in the soil.

**ABB** are found throughout Australia, but have not been recorded in Tasmania. Outbreaks are associated with warm springs, as the developing larvae do not tolerate temperatures below 15°C. High soil moisture is also detrimental to larval development. Larvae reach their most damaging lifestage between January and March. Adults may continue to feed on crops throughout autumn, winter and spring.

## Crops attacked/host range

Cockchafers are important pests of pastures and cereals. Crops sown into long term pasture paddocks are most at risk of attack. Adults do not feed on crops.

**BH pasture cockchafer** larvae feed on the foliage of annual pasture species (e.g. subterranean clover), and occasionally perennial pasture species and cereal crops.

**YH cockchafer** larvae mainly attack the roots of cereal crops but can also attack pastures.

**RH pasture cockchafer** larvae attack the roots of clovers and a range of annual and perennial grasses, typically in the top 10 cm of soil. They also occasionally attack wheat.

**WA cockchafer** larvae attack a range of crops and pastures. They can cause extensive damage to wheat crops.

**ABB** attack long-term pastures and grasses, turf and some horticulture crops. Preffered pasture species include ryegrass, tall fescue, kikuyu, and paspalum. ABB also attack several cereal crops including barley, triticale and wheat. Legume species are considered unfavourable.

## Damage symptoms

**BH pasture cockchafer** larvae usually only come to the surface to feed after rain and they take enough food into their tunnels for 7-10 days. Most damage occurs to pastures during late winter and at the seedling stage in cereals when larvae eat all the leaves. The amount of damage varies from year to year.

**YH cockchafers** are primarily cereal root feeders and they will damage roots of young plants while foraging for soil organic matter. Damaged plants initially grow normally but wither and die at tillering, resulting in bare patches in the crop. Damage is worse under drought conditions as the plant's capacity to replace severed roots is reduced.

**RH pasture cockchafers** are primarily root feeders. Moisture stimulates the larvae to move closer to the soil surface in autumn where they feed on roots of newly emerging seedlings. High numbers of grubs sever the roots of pasture plants below the soil surface, which allows the pasture to be rolled back like a carpet. Damage can also result in completely bare regions within a paddock, ranging in size from small isolated patches to very large areas.

**ABB** larvae are primarily root feeders and can prune or completely sever roots of perennial grasses. In severe cases, pasture becomes patchy and can be rolled back like a carpet. ABB adults feed on the stems of young plants either underground or just above the soil surface, often killing growing points so that the central shoots wither and the plants die. They may sever the stem or cause 'ring barking' on larger plants. Older plants usually survive, but remain weak.

## Monitoring/sampling

Inspect susceptible paddocks prior to sowing. Check established and newly sown pastures or weed growth in autumn to early winter, particularly in areas where bare batches were present over summer. For ABB, also monitor crops and pastures in late spring to mid-summer for larval damage. Dig to a depth of 10-20 cm with a spade and count the number of larvae present. This should be repeated 10 times across the paddock to get an estimate of larval numbers. Summing the number of larvae found across the ten samples and multiplying the sum by 2.5 will give approximate number of pests per $m^2$ .

For **BH cockchafers**, control is warranted If densities exceed 30 per $m^2$. An average infestation of 30-40 larvae per $m^2$ can cause a 50-70% reduction in winter pasture production and a 40-50% loss of desirable pasture species production in spring.

For **ABB**, densities in excess of 10 per $m^2$ during September may result in significant summertime crop damage. In early February, densities in excess of 15-20 per $m^2$ are considered damaging.

No economic thresholds have been established for **YH cockchafers** nor for **RH pasture cockchafers**.

For more information, go to the PestNotes webpage and search by pest name.

## Management options

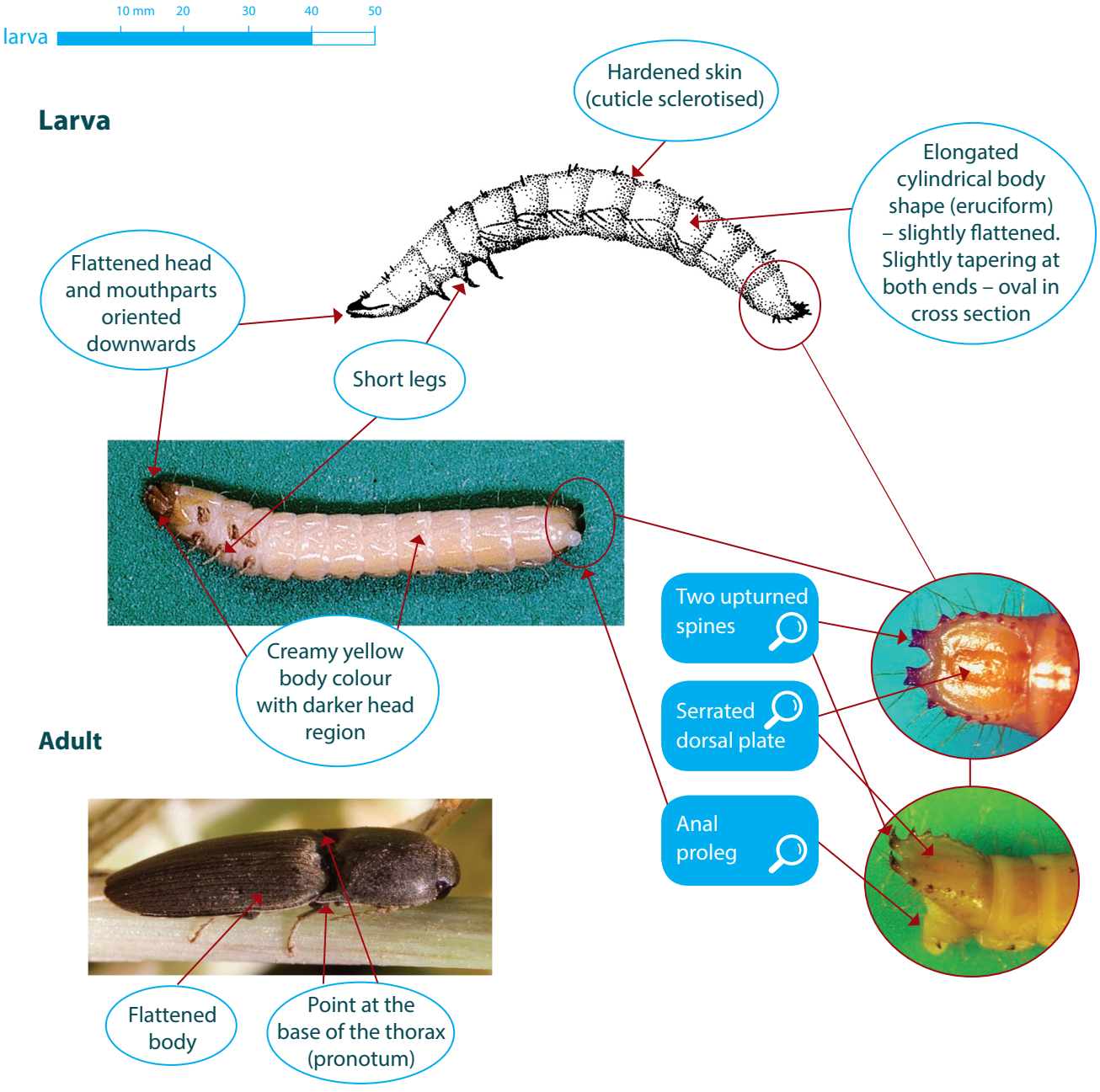
| Biological | Cultural | Chemical |
|---|---|---|
| For all cockchafers<br>• Birds prey upon grubs and are most effective after cultivation or tillage.<br>• Several predatory and parasitic flies and wasps.<br>• Other general predatory invertebrates.<br>• Existing on-farm native vegetation should be preserved, and breeding habitats for birds and parasitic insects should be maintained.<br>• Fungal pathogens *Metarhizium* spp. and *Cordyceps gunnii* attack pasture cockchafers and can have a devastating influence on local populations.<br><br>For RH<br>• There is an entomopathogenic nematode, *Heterorhabitis zealandica*, which is used for control in turf and nurseries, but these are unlikely to be cost effective in broad acre crops. | For WA cockchafers<br>• If damage is anticipated, increase sowing rate for higher plant density.<br><br>For BH<br>• Avoid overgrazing of pastures as bare batches are more attractive to adults laying eggs during summer and early autumn. If possible, maintain pasture cover at 400-600kg DM/ha or 5 cm in height.<br><br>For RH and YH<br>• Cultivation<br>• Grazing of pasture during late spring, summer and autumn (for YH) and heavy grazing in spring (for RH).<br>• Re-sow affected areas using a higher seeding rate.<br>• Re-sowing is best done using a method which disturbs the soil surface, leaving grubs vulnerable to predation.<br>• Sowing less palatable crops (e.g. oats).<br>• Spring-prepared fallows will help reduce damage in the following year.<br>• Intensive crop rotations and short pasture rotations can also be used to prevent future damage.<br><br>For ABB<br>• Delay autumn sowing until May.<br>• Sow less favourable pastures and crops such as legumes, oats and lucerne. ABB-resistant endophytes are now available in perennial ryegrass, such as AR37 (follow recommendations to avoid stock performance issues).<br>• Increase seeding rates in paddocks where the pest is anticipated to cause damage.<br>• Keep the paddock as bare fallow for as long as is feasible prior to planting. | For WA cockchafers<br>• Surface applications of insecticides are not effective.<br>• Chemical seed treatments or insecticides incorporated during seeding can assist in control.<br><br>For BH<br>• Foliar application of an insecticide is effective, particularly on young larvae before they begin to feed on green plant material. For best results insecticide sprays should be applied before June.<br><br>For RH<br>• Surface-applied insecticides are generally not effective given the subterranean feeding habits of larvae.<br>• There are currently no synthetic insecticides registered.<br><br>For YH<br>• Surface-applied insecticides are generally not effective given the subterranean feeding habits of larvae.<br>• A mixed formulation product has been registered as a seed protectant in pastures. Control is expected for 3-4 weeks after sowing, but will not control heavy populations.<br><br>For ABB<br>• Surface-applied insecticides are generally not effective given the subterranean feeding habits of larvae.<br>• A mixed formulation product has been registered as a seed protectant in pastures. Control is expected for 3-4 weeks after sowing, but will not control heavy populations.<br>• Chlorpyrifos is registered in maize however no other foliar insecticide is registered for broadacre crops. |

*Ute Guides, Southern (pp. 61-63)/ Western (p. 46).*
*http://cesaraustralia.com/sustainable-agriculture/pestnotes/*
*http://ipmguidelinesforgrains.com.au/wp-content/uploads/BestBet_EstablishmentSouth2014.pdf*

# TRUE WIREWORMS or CLICK BEETLES Coleoptera: Elateridae

## Various species

## Distinguishing characteristics/description




There are numerous true wireworm species in Australia but they are not described in detail here and are only discussed at the family level.

Adults make a click sound when they flick themselves over after being placed on their backs.

The lifecycle of many true wireworm species is not fully understood. The lifecycles of most pest species probably take more than a year to complete.

## Confused with/similar to

Larvae are similar to those of false wireworms (Tenebrionidae) but are flatter in appearance and can grow larger. The predatory larvae of carabid beetles (Carabidae) are also easily misidentified as wireworms and may be found in similar environments.

## Distribution, pest status and risk period

True wireworms are more common on wetter soils and are found under plant debris and in the soil. They can be found together with false wireworms and, when this occurs, true wireworms are usually more numerous than false wireworms in some regions.

Larvae are soil-dwelling pests that can be very damaging to cereals during crop emergence. This is rarely the case in WA and sporadic in other southern states.

## Crops attacked/host range

Germinating cereals are most at risk. Crops following long term pasture (fallow for 4-5 years) as well as crops sown on recently cultivated land are more susceptible. Stubble retention and trash can also favour these pests.

## Damage symptoms

Larvae feed on seed and bore into the underground stems of cereal plants. They may also damage the roots of seedlings. Germinating seedlings can be ring-barked and hypocotyls severed just below the soil surface. Plants wither and die after emergence and damage can result in a thinned crop or bare patches, which become visible shortly after crop emergence.

## Monitoring/sampling

Check under stubble prior to sowing, especially if coming out of long term pasture.

Early identification and detection of these pests prior to seeding and applying a treatment at seeding will prevent additional costs of re-sowing damaged areas.

Germinating seed baits can be used immediately following the autumn break. Soak wheat seed in water to initiate germination, then bury several seeds under 1 cm of soil at each corner of a 5 x 5 m square grid, marking each with a flag. Immediately after seedling emergence, re-visit the bait site, dig up the plants and count the number of larvae present. Repeat this at 5 locations per 100 ha to obtain an reasonable estimate of numbers.

As a threshold guide, around 10 larvae/$m^2$ may warrant control. Average densities of approximately 40 larvae/$m^2$ can cause enough damage to necessitate re-sowing.

## Management options

| Biological | Cultural | Chemical |
|---|---|---|
| Carabid beetle larvae feed on soil-dwelling insects, including wireworms, but are usually not in high enough numbers to effectively control large pest populations.<br><br>There are no other known parasites, predators or pathogens that effectively control wireworms in cereal crops. | Removing excess stubble and trash is an effective strategy where this resident pest is a problem in continuous years.<br><br>Re-sow affected areas using a higher seeding rate.<br><br>Using a re-sowing method that disturbs the soil surface, leaving larvae vulnerable to predation, is recommended. | Insecticidal seed dressings may offer some protection from moderate larval numbers.<br><br>Several insecticide seed treatments are registered for true wireworm control in certain broadacre crops in some states. In addition, chlorpyrifos and some other products have general registration against true wireworms in certain broadacre crops in some states.<br><br>Effective control of wireworms is generally not possible after sowing. The insecticide needs to be applied in furrow.<br><br>See the APVMA website for current chemical options. |

*Southern Ute Guide (p. 60).*
*http://cesaraustralia.com/sustainable-agriculture/pestnotes*
*http://ipmguidelinesforgrains.com.au/wp-content/uploads/BestBet_EstablishmentSouth2014.pdf*

# FALSE WIREWORMS or MEALWORMS Coleoptera: Tenebrionidae

## Various species

### Distinguishing characteristics/description

**Larva**

*Head and mouthparts oriented downwards

*Elongated cylindrical body shape (eruciform) with ring like segmentation – round in cross section

*Short legs (stronger pair of front legs)

*Hardened skin (cuticle sclerotised)

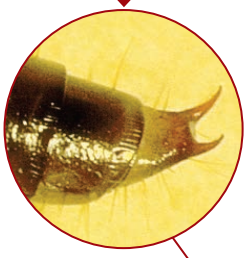
**Adult**

*Simple (thread-like) antennae

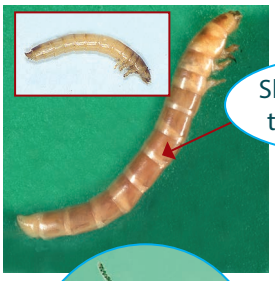
*Two upturned spines

*Dome-shaped body usually brown in colour and covered in soil

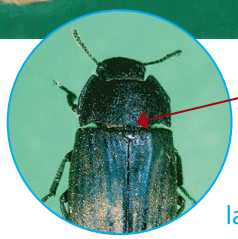
*Striations (pits) on elytra (wing covers)



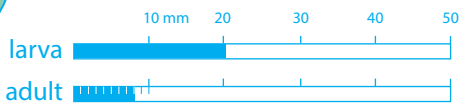
**Vegetable beetle**
***Gonocephalum* spp.**



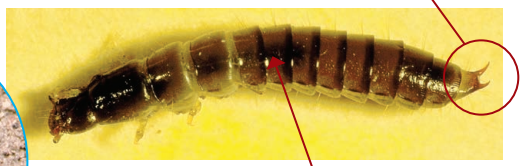
Shiny creamy-tan in colour



Dark grey to black in colour

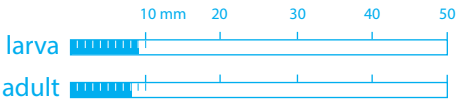



**Grey false wireworm**
***Isopteran* sp.**

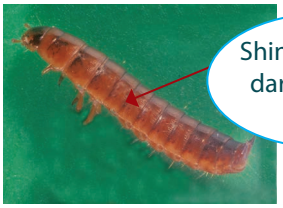


Flattened and dull brown in colour

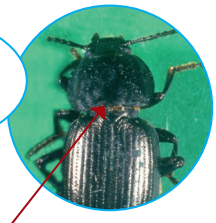
Shiny brown-greyish in colour with paler under parts




**Bronzed field beetle**
***Adelium brevicorne***



Shiny uniformly dark brown in colour

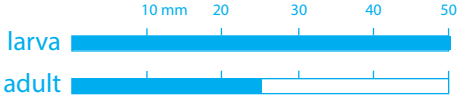


Shiny black to bronze in colour


**Eastern false wireworm**
***Pterohelaeus* sp.**

Cream-tan to yellow-orange in colour with darker rings

Dull black in colour with flanged edges




** indicates character for all species*

## Confused with/similar to

Larvae are similar to those of the true wireworm (Elateridae) but are rounder in cross-section and not flattened or tapered. The predatory larvae of carabid beetles (Carabidae) are also easily misidentified as false wireworms and may be found in similar environments.

## Distribution, pest status and risk period

False wireworms are common in fine textured soils, with high levels of organic matter. They are not usually a problem on compacted soil (e.g. tyre tracks).

Stubble retention and trash can favour these pests and some species can attack successive crops. Both the larvae and adults may cause damage depending on the crop and time of year.

## Crops attacked/host range

**Vegetable beetles** are minor pests that attack summer (e.g. sunflowers) and winter crops (e.g. emerging canola and cereals).

**Bronzed field beetle** larvae and **grey false wireworms** can attack canola at emergence in some seasons.

## Damage symptoms

**Vegetable beetle** larvae bore into germinating cereal seeds (especially when swelling) and chew on seedlings below ground level. Adults sometimes attack germinating canola at ground level, which results in ring-barking or completely cut stems.

**Bronzed field beetle** larvae attack germinating canola above the ground and at the base of seedlings. Ring-barking and death of plants may occur.

**Grey false wireworm** larvae attack germinating canola just below the ground, which results in damage to the crown and roots.

## Monitoring/sampling

Check under stubble prior to sowing, particularly if the paddock is coming out of long term pasture. Early identification and detection of these pests (possibly using germinating seed traps prior to seeding) is important. Seed treatments can be applied to prevent damaged areas when pest numbers are high.

It is important to be aware of the crop growth stage as cotyledons are most susceptible, whilst advanced plants will be able to out-grow moderate pest pressure.

Specific economic thresholds for eastern false wireworm, grey false wireworm, vegetable beetle and bronzed field beetle can be found by going to the PestNotes webpage and searching by pest name.

## Management options

| Biological | Cultural | Chemical |
|---|---|---|
| Carabid beetle larvae feed on soil-dwelling insects, including wireworms, but are usually not in high enough numbers to effectively control large pest populations.<br><br>Fungal diseases caused by *Metarhizium anisopliae* and *Beauveria bassiana* can attack false wireworm populations but their effectiveness in the field is not fully understood.<br><br>There are no other known parasites, predators or pathogens that effectively control wireworms in crops. | Removing excess stubble and trash is an effective strategy where this pest is a problem in successive years.<br><br>Early sowing and crop establishment prior to egg hatching may result in plants being able to outgrow damage.<br><br>Re-sow affected areas using a higher seeding rate.<br><br>Using a re-sowing method that disturbs the soil surface, leaving larvae vulnerable to predation, is recommended.<br><br>Compacting soils post sowing to improve seedling vigor has been shown to have some benefit against grey false wireworm. | Insecticidal seed dressings may offer some protection from moderate larval numbers.<br><br>False wireworm cannot be controlled by applying chemicals after sowing; monitoring before sowing is recommended.<br><br>A foliar application can be used for partial control of bronzed field beetle larvae as they attack crops above ground. Chlorpyrifos is registered as a foliar spray against false wireworms in certain broadacre crops in some states.<br><br>See the APVMA website for current chemical options. |

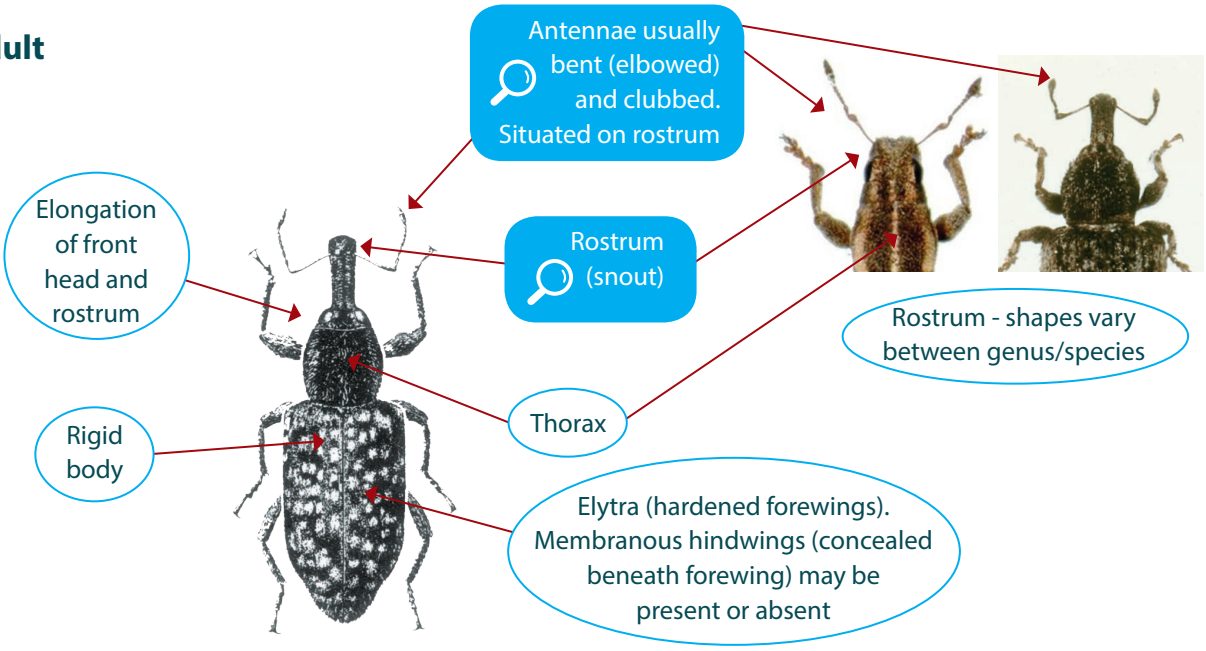
*Ute Guides, Southern (pp. 56-59)/ Western (pp. 43, 45).*
*http://cesaraustralia.com/sustainable-agriculture/pestnotes/*
*http://ipmguidelinesforgrains.com.au/wp-content/uploads/BestBet_EstablishmentSouth2014.pdf*

# WEEVILS Coleoptera: Curculionidae

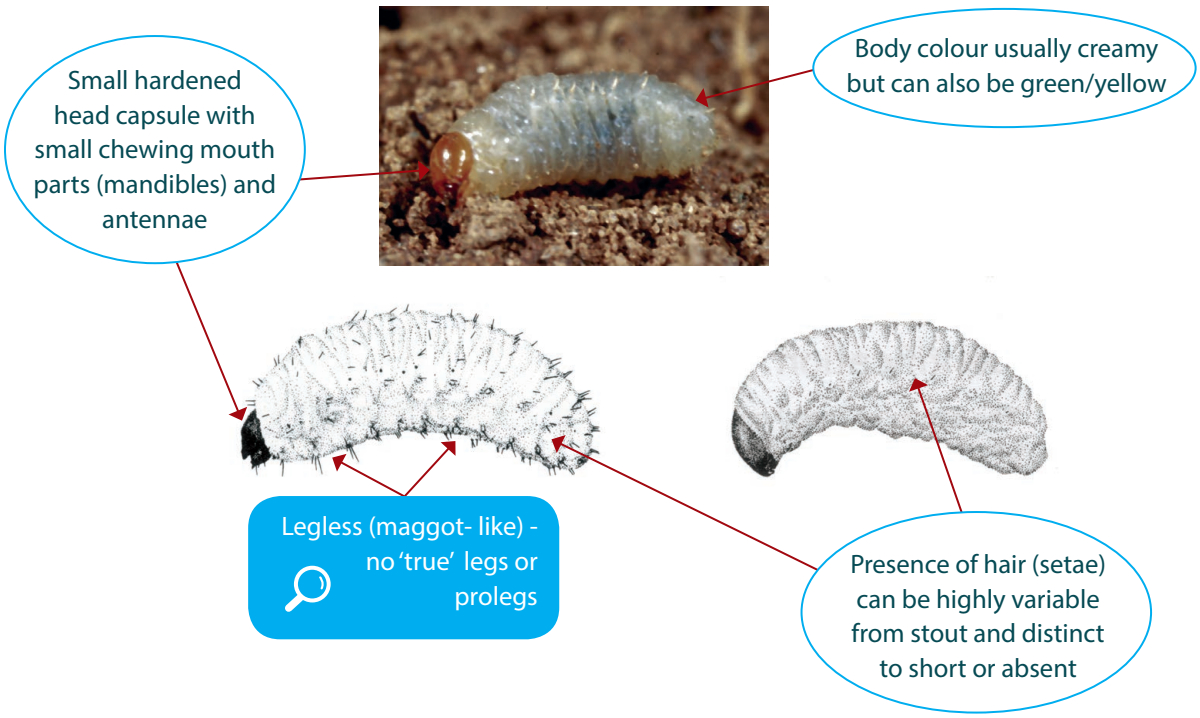
**The largest family of beetles. There are over 6,000 described species in Australia.**

## Distinguishing characteristics/description

### Adult




### Larva




As there are so many species, weevil identification is only discussed here at the family level.

Broadacre weevil pests are not covered in detail in this manual. Only adult size differentiation and key field identification characters are shown.

## Confused with/similar to

It is difficult to distinguish between the larval stages of weevil species. Larval stages are legless (apodous), maggot-like in shape and may be confused with fly larvae which are also legless. Unlike weevils, most fly larvae do not have a well-defined head capsule.

| Cabbage seedpod weevil<br>NOT PRESENT IN AUSTRALIA | *Sitona* weevil | *Mandalotus* weevil | *Polyphrades* weevil | Spotted vegetable / *Desiantha* weevil | Spine-tailed weevil | Grey-banded leaf weevil | Fullers rose weevil | Vegetable weevil | Small lucerne weevil | White fringed weevil |
|---|---|---|---|---|---|---|---|---|---|---|
|  |  |  |  |  |  |  |  |  |  |  |
| BIOSECURITY THREAT<br>NOT PRESENT IN AUSTRALIA | | | | | | | | | | |
| **2-3.5 mm** | **3-5mm** | **3-5mm** | **4mm** | **7mm** | **7mm** | **8mm** | **8mm** | **8mm** | **10mm** | **10-13mm** |
| Distinctive long narrow downward curved rostrum | 3 stripes on thorax | Covered in dirt Paddle-shaped setae (hairs) on elytra (wing covers) | Limited distribution (Eyre Pen.) | Spotted abdomen | Females: two spines on end of abdomen | Paler banding on rear abdomen | White stripe on side of first two segments | V-shaped mark on back of abdomen | Grey with short broad rostrum | White stripe down sides of body |
| Ute Guide<br>WA p. 143<br>SA p. 176 | Ute Guide<br>WA p. 40<br>SA p. 50 | Ute Guide<br>SA p. 52<br>Not in WA | Ute Guide<br>SA p. 53<br>Not in WA | Ute Guide<br>WA p. 38<br>SA p. 48 | Ute Guide<br>SA p. 49<br>Not in WA | | Ute Guide<br>WA p. 42<br>SA p. 54 | Ute Guide<br>WA p. 37<br>SA p. 47 | Ute Guide<br>WA p. 39 | Ute Guide<br>WA p. 41<br>SA p. 51 |

Increasing in size





The distinctive appearance of adult weevils make them unlikely to be confused with other beetles. However, distinguishing between the many species of weevils can be difficult. *Mandalotus* weevil (*Mandalotus* spp.) adults in particular are highly variable in appearance.

## Distribution, pest status and risk period

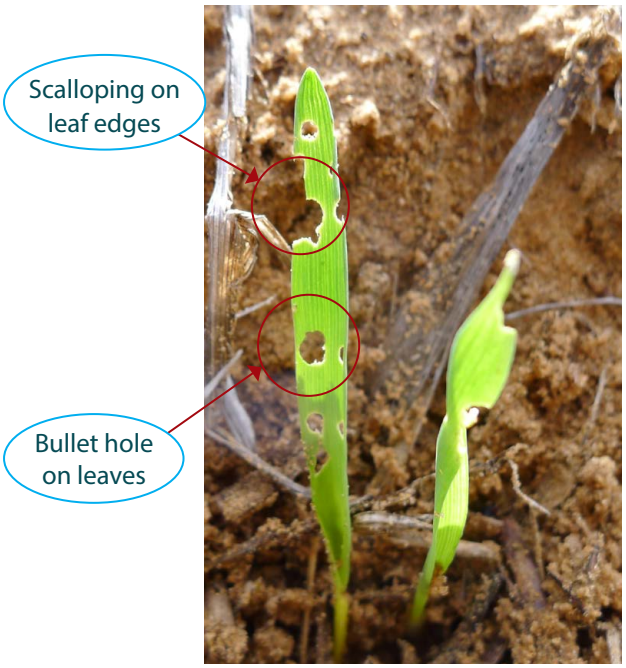
Weevils can be found in a wide range of habitats and many are known as pests of agriculture, stored products, horticulture and forestry. They feed on vegetable parts including shoots, buds, leaves, roots, wood and bark. Some also feed on stored grain and vegetable products.

As larvae are legless, they are restricted in their movement and distribution. They may be restricted above ground (e.g. vegetable weevil) or confined underground (e.g. *Desiantha* weevil). Adults are more mobile and can be winged and active flyers, or wingless and walk or march *en masse*. Adults and larvae can both cause damage depending on the crop and time of year.

## Monitoring/sampling

A variety of sampling techniques can be used depending upon the habitat. For example, pitfall traps can be used to sample ground-dwelling weevils. For above-ground species, visual direct searches are appropriate. Often, direct searches may need to be undertaken at night when many species are active.

## Damage symptoms





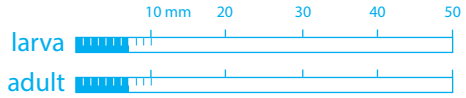
# LADYBIRD BEETLES Coleoptera: Coccinellidae

**Various species - approximately 500 Australian species.**

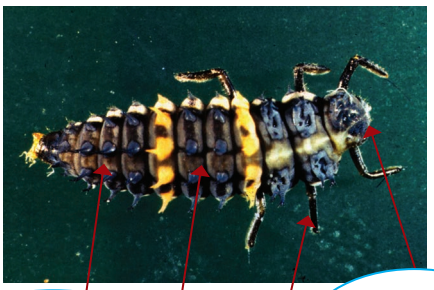
***Generalist and transient***

BENEFICIAL

## Distinguishing characteristics/description




### Larva



Elongated and tapered at rear

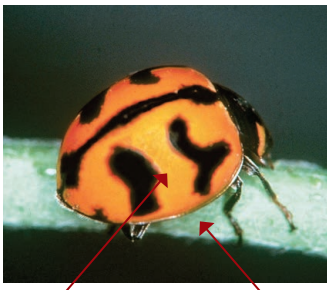
Well-developed mandibulate mouthparts

Well-developed blackish legs

Grey-black with orange-yellow markings across body. May have spines or white fluffy material

### Pupa

### Adult



Transparent hindwing concealed underneath elytra (forewing). Patterns of black over red, orange or yellow

Round to oval shaped

## Colour and pattern variations of different species

**Black ladybird**
***Rhyzobius* sp.**

**Striped ladybird**
***Microspis* sp.**

**Minute two-spotted ladybird**
***Diomus notescens***

**White-collared ladybird**
***Hippodamia variegata***

**Common spotted ladybird**
***Harmonia conformia***

**Transverse ladybird**
***Coccinella transversalis***

There are numerous species, but three species commonly found are the white collared ladybird, the common spotted ladybird and the transverse ladybird. Adults are round to oval shaped, with black spots on red, orange or yellow shells. Larvae have grey/black elongated bodies with orange markings and may be covered in spines or white fluffy wax material. Ladybird eggs are generally yellow, spindle 'football' -shaped and laid standing on end in clusters on plants.

## Lifecycle

Complete metamorphosis.
Ladybird beetles can be found throughout the year. The highest numbers are observed in spring to early summer when they can undergo several generations. Each generation takes approximately one month (depending on the species) under ideal conditions. Female ladybird beetles can lay up to 200-1000 eggs in a lifetime, which may span several months.

## Confused with/similar to

The larger more colourful (contrasting patterns/spots) ladybird adults are readily identifiable but smaller drab species can be confused with other oval-shaped beetles such as leaf beetles (Chrysomelidae).

Predatory ladybirds can be confused with the 28-spot ladybird (*Henosepilachna vigintioctopunctata*), which is a large (8 mm) leaf-eating pest species found in horticultural areas, but rarely seen in broadacre.

## Distribution/habitat

Ladybirds are common throughout Australia and can be found in almost all habitats, particularly in canola and wheat crops during spring, where there has been a large build-up of aphids. They may also be seen on some native vegetation and in domestic gardens.

They are most prevalent in spring and seen occasionally in autumn when large populations move to areas rich in prey.

## Pests attacked/impact on pests

Most ladybird adults and larvae are predatory and prey on a range of pests including aphids, leafhoppers, thrips, mites, moth eggs and small larvae. They are particularly voracious feeders on aphids and in some seasons the increase in ladybird populations (often in combination with lacewings and other beneficial insects) will be sufficient to keep aphid numbers below economically damaging levels.

Many adults supplement their diet with pollen and a sugar source (e.g. nectar).

*Ute Guides, Southern (pp. 132-133)/Western (pp. 106-107).*

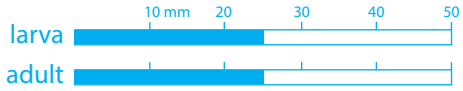
# CARABID BEETLES or GROUND BEETLES
# Coleoptera: Carabidae

BENEFICIAL

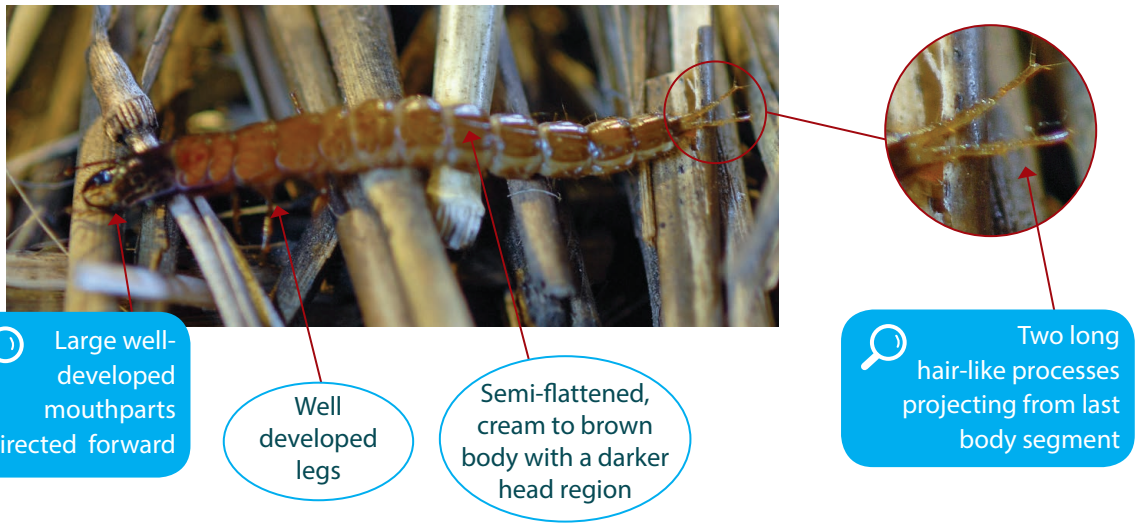
**Various species - approximately 2,500 Australian species.**

***Generalist and residential***

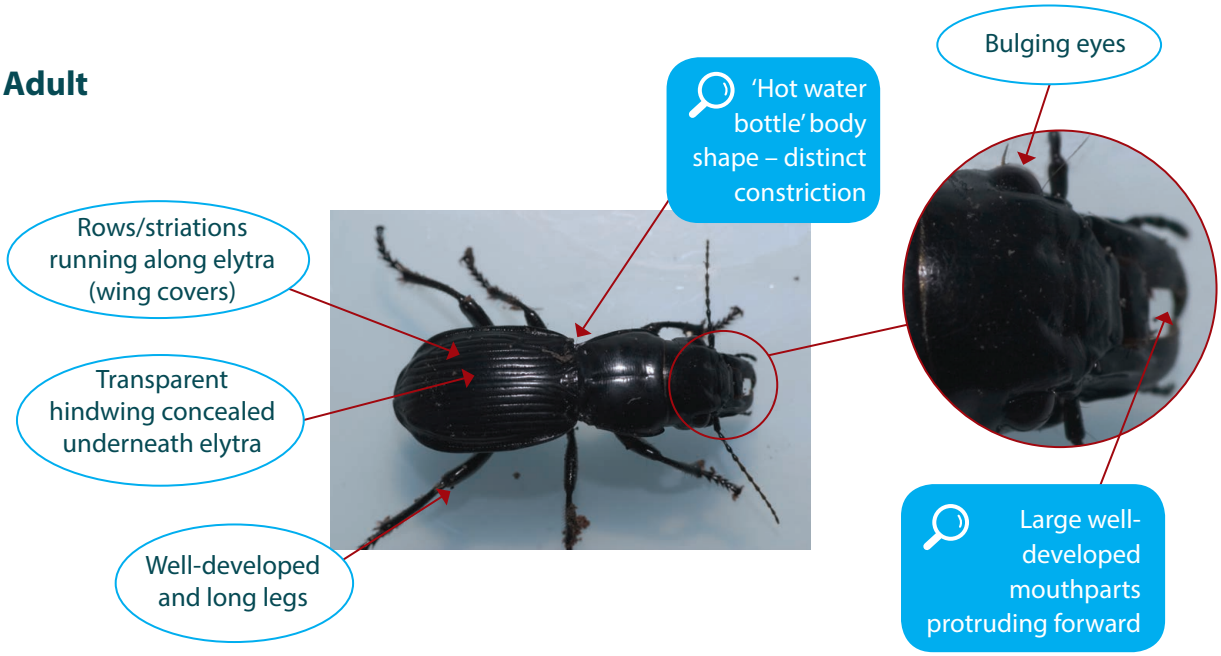
## Distinguishing characteristics/description




### Larva




### Adult




## Colour and pattern variations of different species

Most species are soil-dwelling and move rapidly.

## Lifecycle

Complete metamorphosis.
There are many different species and their lifecycles can differ greatly. Most species have a one or two year lifecycle. Some breed in late summer and autumn and then hibernate as larvae through winter. Others hibernate as adults and reproduce in spring or early summer, after which the beetles usually die off, and a new generation appears in autumn.

## Confused with/similar to

All carabids can be distinguished by their large mouthparts that are directed forward.

Larvae may be mistaken for larvae of true wireworms (Elateridae) or false wireworms (Tenebrionidae) as they are similar in shape and soil-dwelling. However, carabid larvae have very prominent mouthparts in keeping with their predatory lifestyle. They also have processes projecting from their last abdominal segment, which are hair-like in structure and usually longer than those in true and false wireworms.

Carabid beetles are also often confused with true and false wireworm beetles. Many adults have a characteristic flattened 'hot water bottle'–shaped body, with pitted groove lines running along the wing covers. They also possess large bulging eyes. Some carabid beetles such as *Calosoma* spp. are conspicuous due to their bright metallic green colour. Carabid beetles usually move faster than wireworms and can be shinier.

## Distribution/habitat

Carabid beetles are widespread across Australia. Many species are nocturnal and can only be found during the day under tree bark, logs or among rocks. Some species have been found to increase in numbers in paddocks practicing minimum/no-till and stubble retention.

Refuges (beetle banks) are considered beneficial in fostering carabids to help control pests in broadacre crops.

## Pests attacked/impact on pests

Adults and larvae both feed mostly on ground-dwelling invertebrates. This includes a wide range of soft-bodied pests including wireworms, cockchafers, caterpillars, earwigs and slugs. Most carabid species are useful in suppressing pest populations, while a small number also feed on plant vegetation.

*Ute Guides, Southern (p. 139)/ Western (p. 115).*

# BUGS (Order Hemiptera)

## Hemiptera - *half (hemi); wing (ptera)*

The order Hemiptera is divided into three groups (suborders) each with distinct features:

- **Auchenorrhyncha** (leaf hoppers) - pairs of wings similar in structure (not shape);
- **Heteroptera** (e.g. nabids, assassin bugs and shield bugs) - forewings have half of the wing thickened (hardened) to form a hard leathery cover and a softer membranous rear wing;
- **Sternorrhyncha** (e.g. aphids, scale insects, lerps and mealy bugs) - pairs of wings similar in structure (not shape). Some can be wingless.

There are 6,000 hemipteran species described in Australia, in 100 different families.

### Main characteristics

#### Nymphs

Most resemble adults but are smaller, wingless and less developed.

#### Adult forms

While the appearance of bugs varies widely, most bugs have two pairs of wings. Some adult forms are wingless (e.g. aphids). Bugs have piercing and sucking mouthparts which are often modified to form a hardened stylet/rostrum/proboscis or beak. The proboscis of bugs contains cutting blades and a two-channelled tube.

Bugs feed by cutting into a plant or animal and sending saliva down one of the tubes to begin digestion. The liquid food is then sucked up the other tube. When insects are resting, the proboscis is often tucked up under the body between the legs.

#### Lifecycle

Incomplete metamorphosis.

### Groups (families) relevant to broadacre cropping

**Aphids** (F: Aphididae): There are many pest aphid species. They are covered in detail in this section on page 36.

**Leafhoppers** (F: Cicadellidae): Leafhoppers are typically small, green insects that puncture leaves and may leave a pattern of bleached marks. They are minor and sporadic pests in broadacre crops. Leafhoppers are not covered in this manual. For further information refer to Ute Guides, Southern (p. 80)/Western (p. 61).

**Mirids** (SF: Miridae): Mirids are similar to leaf hoppers. Some mirids are predatory. Mirids are not covered in this manual. For further information refer to Ute Guides, Southern (p. 69)/Western (p. 51).

**Seed Bugs** (SF: Lygaeoidea): Rutherglen bug (*Nysius vinitor*) belongs to this family and it is a common but sporadic native pest in broadacre crops. It can breed abundantly, if rain allows flowering and seed set of plants in warm weather. Nymphs are different in colour and shape to adults. Seed bugs are not covered in this manual. For further information on Rutherglen bugs refer to Ute Guides, Southern (p. 65)/Western (p. 49) and the PestNotes webpage.

**Shield and stink bugs** (F: Pentatomidae): This family contains both beneficial insects (e.g. the glossy shield bug, *Cermatulus nasalis)* and some sporadic pests, which are more common in warmer climates (e.g. the green vegetable bug, *Nezara viridula*). Shield and stink bugs are not covered in this manual. For further information refer to Ute Guides, Southern (pp. 66-68)/Western (p. 50, 117, 118).

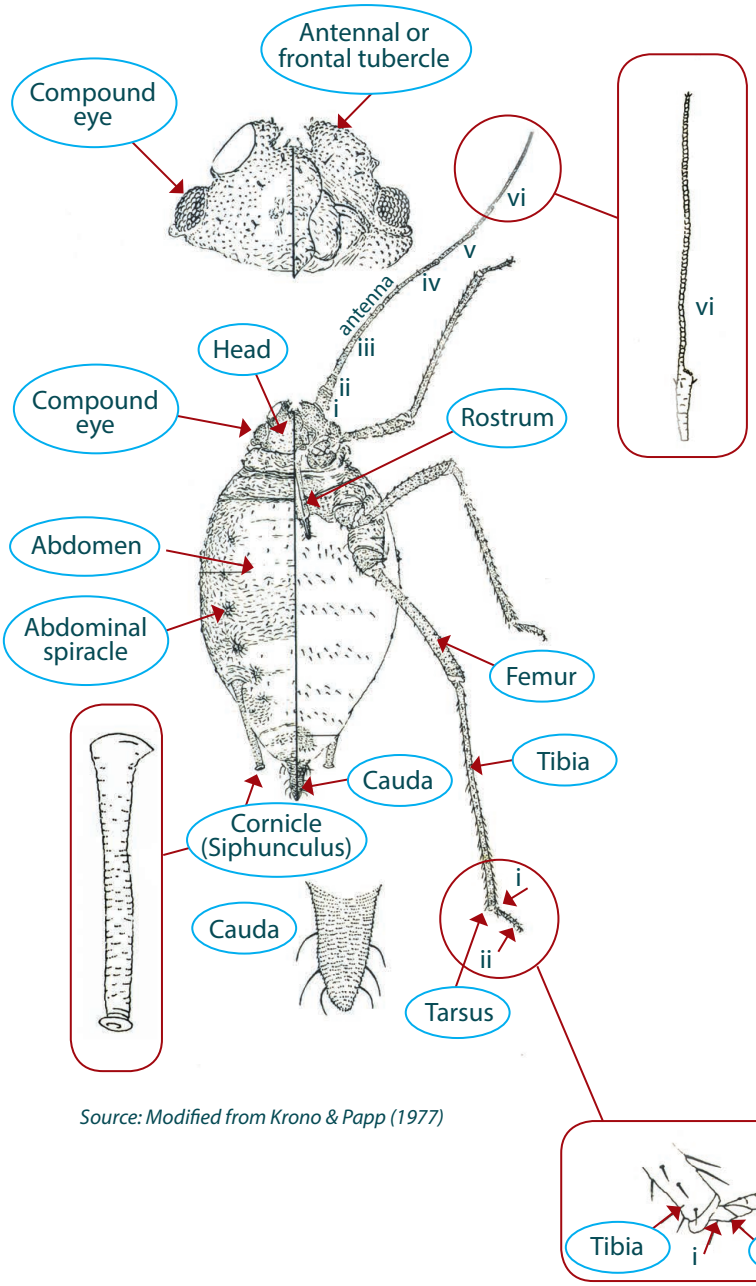
**Nabids** (F: Nabidae): These bugs are predators, attacking a wide range of prey. Nabids are also called damsel bugs and tend to be more delicate in structure than assassin bugs. Nabids can also eat plants and are regarded as omnivores. They are covered in this section on page 49.

**Assassin bugs** (F: Reduviidae): These bugs are predators, attacking a wide range of prey. Assassin bugs are not covered in this manual. For further information refer to Ute Guides, Southern (p. 142)/Western (p. 120).

# CROP APHIDS
# Hemiptera: Aphididae

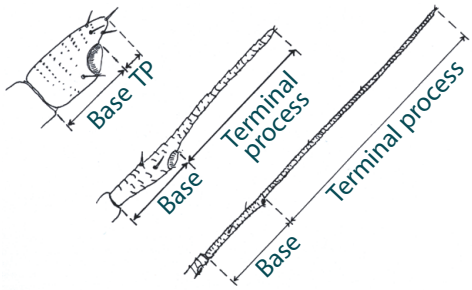
## Key aphid characteristics

- ***Piercing sucking mouthpart*** - needle-like mouthpart (stylet/proboscis) on the underside of the body.
- ***Siphuncles*** (cornicles) - paired tube-like projections (on 5th abdominal segment); wax secreting structures; characteristic shape and size.
- ***Cauda*** - tail-like process terminating the abdomen; characteristic size, shape and hair pattern.
- ***Segmented antennae*** – 4 to 6 segments; last antennal segment can be characteristic (e.g. length of terminal segment relative to the base segment).
- ***Tubercle*** - small humps on the forehead between antennae.
- ***Wings*** **-** adults can have wings or be wingless.



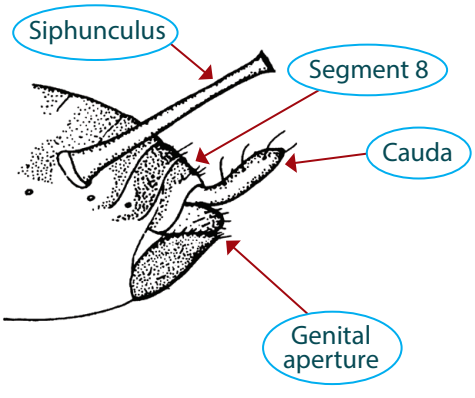

*Source: Modified from Krono & Papp (1977)*

### Variations in last antennal segment




*Source: Modified from Krono & Papp (1977)*

### Side view of abdomen




*Source: Modified from Blackman and Eastop (2000)*

## General aphid lifecycle and biology

In Australia, most pest aphid species only produce females, which may be winged (alates) or wingless (apterae), and these give birth to live young. In other countries some aphid species have different (or altered) lifecycle phases (e.g. sexual/asexual) that are initiated by host-insect interactions and/or environmental conditions. Many aphids are plant host (crop) specific.

Some aphids are vectors of crop diseases that can be detrimental to growth and limit yield. These diseases include barley yellow dwarf virus and turnip yellows virus (also known as beet western yellows virus), in cereals, cucumber mosaic virus in lupin, and pea seed borne mosaic virus in field peas. These viruses have the largest yield impact when they are introduced early in the life of the crop, usually within the first ten weeks of growth. Aphids are efficient in spreading diseases due to their sap-sucking mouthparts. Transmission occurs via feeding on the vascular tissue (phloem) of infected plants. Once the virus is picked up, it can be carried in the salivary glands or restricted to the stylet of the aphid. The virus can be carried for a long (persistent transmission) or short (non-persistent) period of time after aphids feed on infected plants. These different modes of transmission influence the effectiveness of chemical sprays against virus spread.

### Summer/autumn

Aphids require specific host plants for their survival. Aphid populations usually decline over summer. The availability of suitable host plants (e.g. specific weed families on roadsides and verges) allows populations to survive and increase. Winged aphids move into crops in autumn and aphid numbers will usually start to build up along crop edges. The formation of winged aphids and aphid movement generally increases when host plants are dying or when overcrowding occurs with high populations.

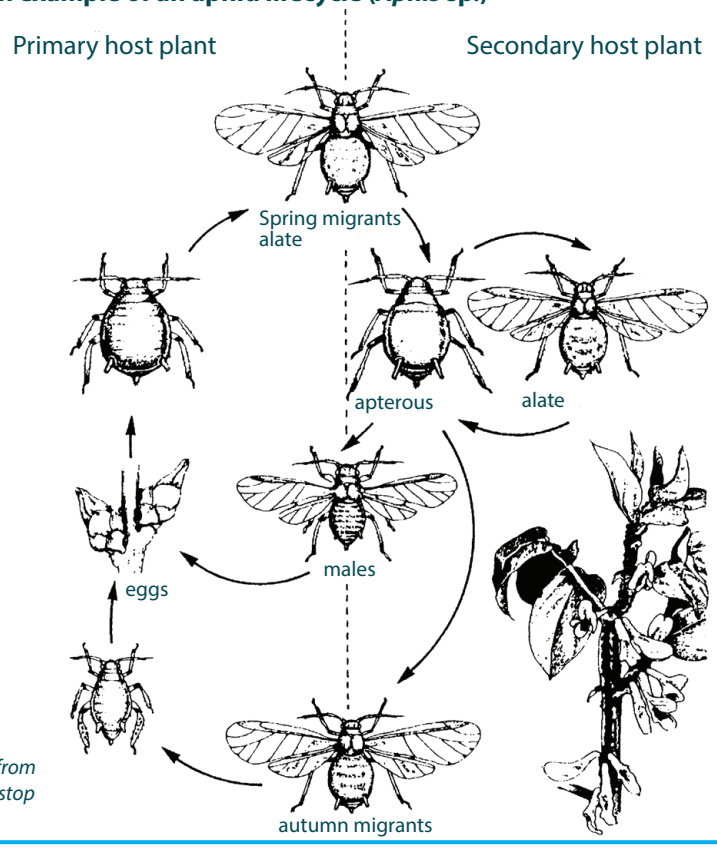
### Winter

Low temperatures and heavy rainfall in winter often limit aphid populations. Nymphs go through several growth stages, moulting at each stage into a larger individual. Sometimes the delicate pale aphid skins or casts (the exoskeleton they have shed) can be seen. Nymphs do not have wings.

### Spring

Spring often triggers a rapid increase in aphid numbers as increasing temperatures and flowering crops provide favourable breeding conditions. Most aphids form dense colonies before winged aphids are produced. These move onto surrounding plants further into the crop creating hot spots. In some seasons, aphids form large colonies (especially at flowering) and heavy infestations may produce large amounts of a sticky secretion (honeydew).

**Figure 4.1 An example of an aphid lifecycle (*Aphis* sp.)**




*Source: Modified from Blackman and Eastop (2000)*

# APHID VIRUSES

## Aphids as virus vectors in pulse crops

There are many aphid species that transmit viruses in pulse crops (**Table 4.1**). The major species are green peach aphid, cowpea aphid, pea aphid and blue-green aphid but this list is not exclusive. Aphids spread viruses between plants by feeding and probing when they fly during autumn and spring.

The ability to transmit particular viruses differs with each aphid species and viruses may be transmitted in a persistent or non-persistent manner. This influences the likelihood of plant infection (**Figure 4.2**).

For non-persistent transmission, the virus is usually restricted to the stylet of the insect. This means virus spread generally only occurs over short distances and aphids only remain infective for periods from a few minutes up to a few hours. For persistently transmitted viruses, the virus is ingested, passes through the gut and then moves to the salivary glands where it can potentially be transmitted to other plants. The aphid retains the virus for the remainder of its life.

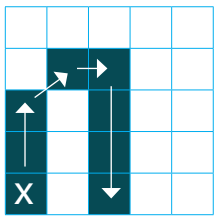
**Table 4.1 Some aphids known to transmit viruses in pulse crops**

| Aphid Species | Common Name | Cucumber Mosaic Virus (CMV) | Pea Seed-borne Mosaic Virus (PSbMV) | Beet Western Yellows Virus (BWYV) |
|---|---|---|---|---|
| *Acyrthosiphon kondoi* | Blue green aphid | ✓ 6.1% | | |
| *Acyrthosiphon pisum* | Pea ahid | ✓ | ✓ 50% | |
| *Aphis craccivora* | Cowpea aphid | ✓ 9.4% | ✓ | ✓ |
| *Aphis gossypii* | Melon or cotton aphid | ✓ | ✓ | |
| *Aulacorthum solani* | Foxglove aphid | ✓ | ✓ | ✓ |
| *Brachycaudus helichrysi* | Leafcurl plum aphid | | | ✓ |
| *Brevicoryne brassicae* | Cabbage aphid | ✓ | ✓ | ✓ |
| *Hypermyzus lactucae* | Sowthistle aphid | ✓ | | |
| *Lipaphis erysimi* | Turnip aphid | ✓ 3.9% | | |
| *Macrosiphum euphorbiae* | Potato aphid | | ✓ | ✓ 14% |
| *Myzus ascalonicus* | Shallot aphid | | | ✓ |
| *Myzus ornatus* | Ornate aphid | ✓ | | ✓ |
| *Myzus persicae* | Green peach aphid | ✓ 10.8% | ✓ | ✓ 96% |
| *Rhopalosiphum maidis* | Corn aphid | ✓ (in glasshouse) | | |
| *Rhopalosiphum padi* | Oat aphid | ✓ (in glasshouse) | ✓ | |
| *Therioaphis trifolii* | Spotted alfalfa aphid | ✓ | | |
| *Uroleucon sonchi* | Brown sowthistle aphid | ✓ | | |

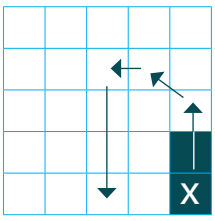
*Note that many more vectors are listed for PsbMV and/or CMV.*
*% is the virus transmission rate for various species*

**Figure 4.2 Persistent versus non-persistent transmission of viruses**

Persistent transmission
1-2 hours feeding e.g. BWYV




Non-persistent transmission
Instant transmission e.g. CMV, AMV




Aphicides for non-persistent transmission are likely to be ineffective. Early management strategies are important.

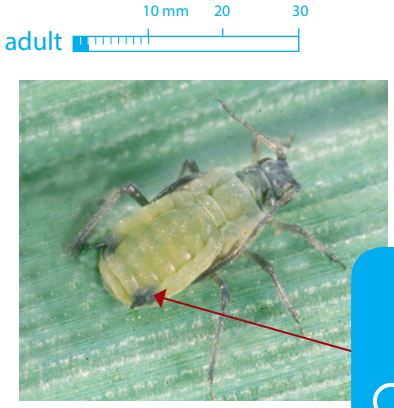

***References and further reading:***
***Aftab and Freeman*** *(2006) Temperate Pulse Viruses: Pea Seedborne Mosaic Virus (PSBMV) AG1267 DPI-Victoria*
***Coutts and Jones*** *(2006) Aust J Ag Res 57,975-982*
***Freeman and Aftab*** *(2006) Temperate Pulse Viruses: Cucumber Mosaic Virus (CMV) AG1207 DPI- Victoria*
*ICTVdB Virus Descriptions*
***Jones and Proudlove*** *(1991) Ann App Biol 118, 319-329*
***Jones et al.*** *(2008) Plant Path 57, 842-853*
***McKirdy et al.*** *(2005) Viruses diseases of chickpea Farmnote 16/97 www.agricwa.gov.au*
***Nault et al.*** *(2009) Environ Entomol 38, 1347-1359*

# CEREAL APHIDS

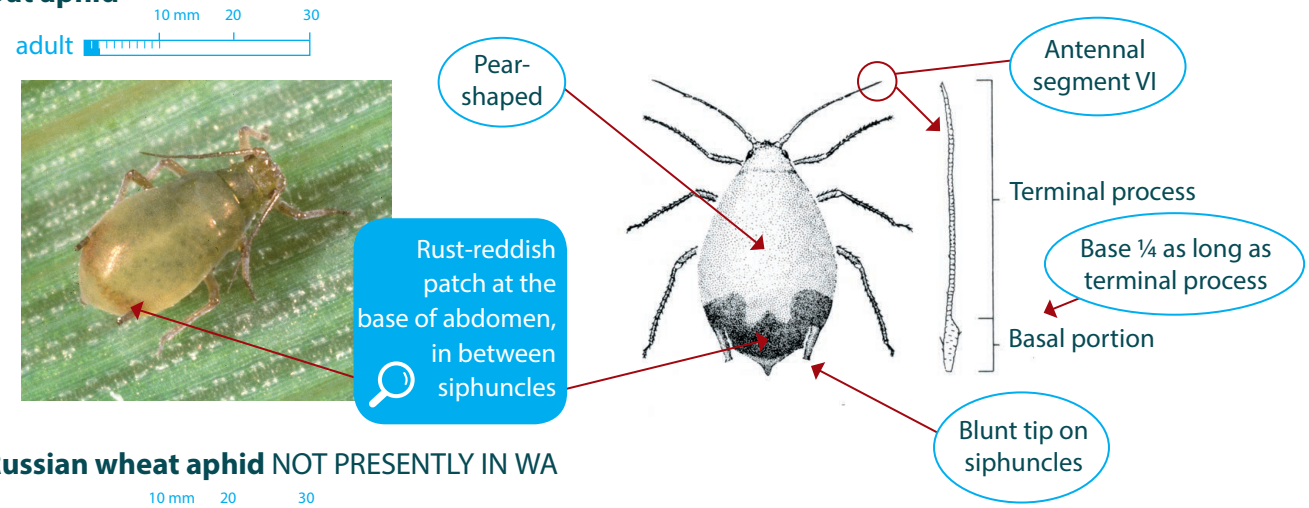
## Corn aphid (*Rhopalosiphum maidis*), Oat aphid (*Rhopalosiphum padi*), and Russian wheat aphid (*Diuraphis noxia*)

### Distinguishing characteristics/description

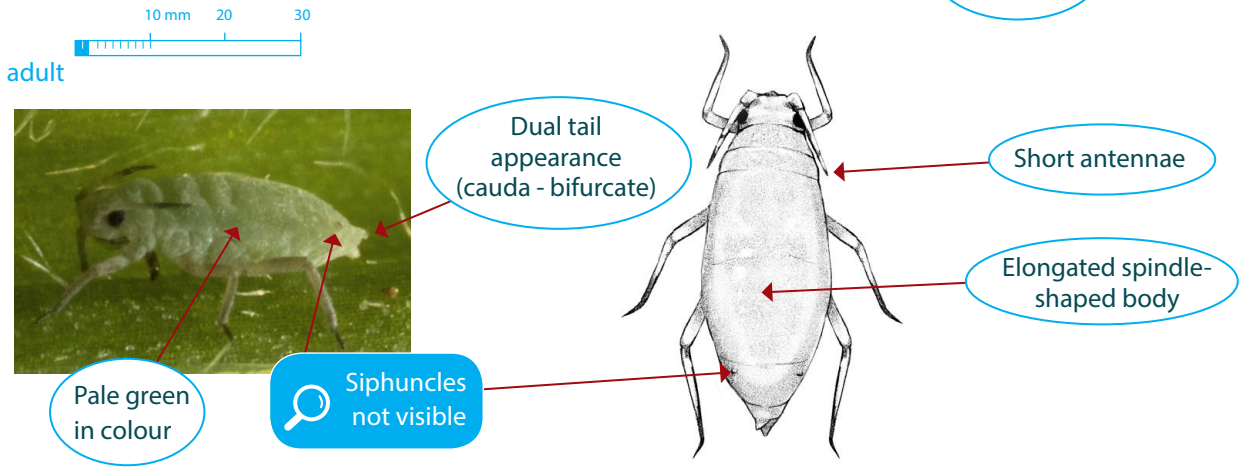
**Corn aphid**




**Oat aphid**




**Russian wheat aphid** NOT PRESENTLY IN WA




### Confused with/similar to

These aphids can be confused with each other and other minor cereal aphids (e.g. rose-grain aphid, grain aphid and rice root aphid).

Corn aphids tend to be light green to dark olive in colour and oat aphids olive-green to black in colour. A definitive diagnostic character to distinguish between oat and corn aphids (both adults and nymphs) is the length of the terminal part of the antennae relative to the base of the antennae (see diagram above). Russian wheat aphid (RWA) are pale green in colour, often with a fine dusting of whitish wax. A lack of visible siphuncles distinguishes Russian wheat aphid from other cereal aphids.

## Distribution, pest status and risk period

Cereal aphids can be found all year round and on all cereal crop growth stages. They sometimes cause feeding damage to cereals when there is a rapid increase in their reproduction and populations rise above economically damaging levels, usually in spring.

**Oat and corn aphids** can vector plant diseases such as barley yellow dwarf virus (BYDV). This is more common in high rainfall cropping zones where virus-infected self-sown cereals and grasses are present, along with large numbers of aphids during the early growth stages of new season crops.

**Russian wheat aphid (RWA)** is present in parts of South Australia, Victoria, New South Wales and Tasmania, but is not presently found in Western Australia or Queensland. Growers in Western Australia and Queensland are encouraged to report suspected new infestations to either the Exotic Plant Pest Hotline (1800 084 881) or using the state-specific contacts provided at: **http://www.planthealthaustralia.com.au/russian-wheat-aphid-management/**

Crops can become infested by RWA under warmer conditions in autumn, during the early stages of establishment, from wingless aphids walking off nearby senescing hosts. Populations frequently start to increase as temperatures warm in spring or typically from tillering onwards.

## Crops attacked/host range

Oat aphids mainly attack oats and wheat, but can occur on all cereals and grasses.

Corn aphids mainly attack barley, but can also attack other cereals and grasses.

RWA can attack most cereal crops. Wheat and barley are most susceptible, while most other hosts, such as triticale, oats and rye, seem to be inferior in comparison.

All three aphids may be found during summer/early autumn on a range of volunteer grasses (alternate host plants) and self-sown cereals.

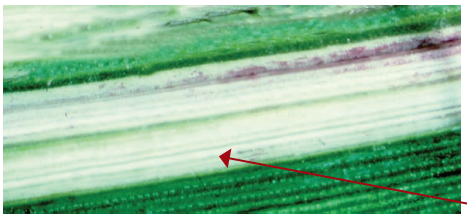
## Damage symptoms

**Oat and corn aphids** cause direct feeding damage by large numbers of aphids on plants can result in sap removal that can cause nutrient loss and plant-wilting. Visual symptoms are usually not very obvious until close inspection of leaf whorls and sheaths, where dark-coloured masses of aphids may be seen. In some cases, aphid colonies infest the seed heads and congregate in large numbers.

Large amounts of honeydew (aphid exudates) and black sooty mould may be seen in prolonged, severe cases.

Oat and corn aphids cause indirect damage by spreading plant viruses.

**RWA** cause plant damage symptoms including leaf curl and discolouration, as well as white and purple streaks along the veins. RWA prefers to live in leaf whorls and tightly rolled leaves, thus damage begins at the base and progresses towards the tip of the leaves. Often the leaves will lay prostrate on the ground. Later infestations can cause damage to the flag leaf which curls, trapping the awn and preventing the head from completely emerging. This produces a 'gooseneck' head and as a result, the grain does not properly mature. Heads can also appear bleached. There is little evidence of significant transmission of plant viruses where RWA occurs overseas.



**Russian wheat aphid damage**

Early feeding damage: streaking along plant veins (white and purple in colour)

Later feeding damage: flag leaf curling and immaturity of grain head; prostrate appearance

These symptoms can also be caused by other diseases and disorders such as herbicide and virus damage, nutrient deficiencies and frost. It is important to identify these symptoms in conjunction with the presence of aphids to be more confident in the diagnosis.

## Monitoring/sampling

Direct visual searches and/or sweep netting.

Regular monitoring for cereal aphids should start in late winter and continue through to early spring with more frequent monitoring at the most vulnerable crop stage (stem elongation to late flowering). Check at least five points over the entire paddock including representative parts. Visually search for aphids on a minimum of 20 plants at each point and count the number of tillers infested with aphids.

For aphid-prone areas (high rainfall), regular monitoring is recommended from crop emergence in autumn, to detect aphids moving into crops, particularly along paddock edges. Very few aphids are required to transmit BYDV from infected to healthy seedlings. If aphids are seen, it may be too late for control unless plants are at the early seedling stage.

When widespread early infection occurs, BYDV can reduce grain yields by up to 50%. More commonly, the disease is confined to patches close to crop edges, where early aphid disease transmission occurred.

Western Australian and NSW recommendations for aphid feeding damage action thresholds on cereals at tillering is to consider control if aphid populations exceed 15 aphids/tiller on 50% of tillers for crops expected to yield 3 t/ha or more.

Western Australian research on aphid feeding damage in the absence of BYDV demonstrated variable yield losses up to 10% and reduction in seed size with aphid infestations at these levels.

**RWA** can be effectively controlled chemically, however decisions on the need for foliar treatments are based on the proportion of seedlings or tillers infested. Chemical control is warranted if infestations exceed thresholds of 20% of seedlings infested up to the start of tillering and 10% of tillers infested thereafter. Damage may be minimised through protection of the top three (major yield contributing) leaves.

## Management options

| Biological | Cultural | Chemical |
|---|---|---|
| Hover fly, lacewing larvae and ladybirds are known predators that help suppress populations.<br><br>Aphid parasitoid wasps, evident by the presence of 'mummies'.<br><br>Naturally occuring aphid fungal diseases can dramatically affect populations. | Summer/autumn pre-season weed control by heavy grazing or herbicides to control alternate host plants (e.g. volunteer grasses and cereals).<br><br>Where feasible, sow into standing stubble and use a high sowing rate to achieve a dense crop canopy, which will assist in deterring aphid landings (as studies have shown aphids land in greater numbers when more bare ground is exposed). | BYDV control:<br>• Use of appropriate insecticide seed dressings and/or synthetic pyrethroid sprays in the first eight weeks of crop development.<br><br>Aphid feeding damage:<br>• Seed treatments delay colonisation.<br>• Border spraying (e.g. autumn/ early winter) when aphids begin to colonise crop edges may provide sufficient control.<br><br>Selective chemicals (i.e. pirimicarb) should be considered because they are effective against aphids but relatively harmless to beneficial species and other non-targets.<br><br>Avoid prophylactic insecticides<br><br>**RWA** have cryptic feeding habits, and therefore complete coverage and use of an insecticide with fumigant or systemic activity is required. See the APVMA website for current chemical options. |

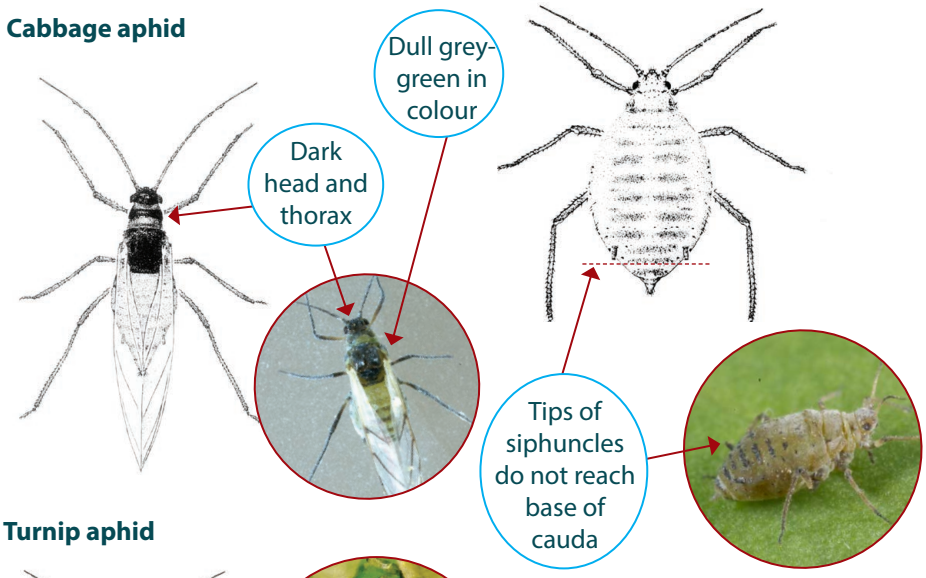
*Ute Guides, Southern (pp. 70-71, 171)/ Western (pp. 52-53, 138)*
*http://cesaraustralia.com/sustainable-agriculture/pestnotes/*
*http://ipmguidelinesforgrains.com.au/wp-content/uploads/BestBet_Canola2014.pdf*
*http://ipmguidelinesforgrains.com.au/wp-content/uploads/BestBet_WinterCereals-North2014.pdf*

# CANOLA APHIDS

**Cabbage aphid (*Brevicoryne brassicae*), Turnip aphid (*Lipaphis erysimi*) and Green peach aphid (*Myzus persicae*)**

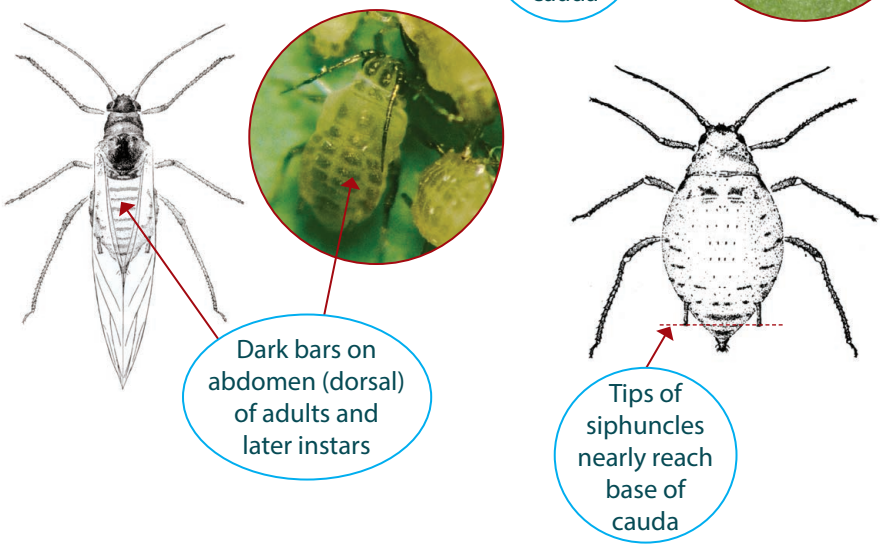
## Distinguishing characteristics/description


### Cabbage aphid



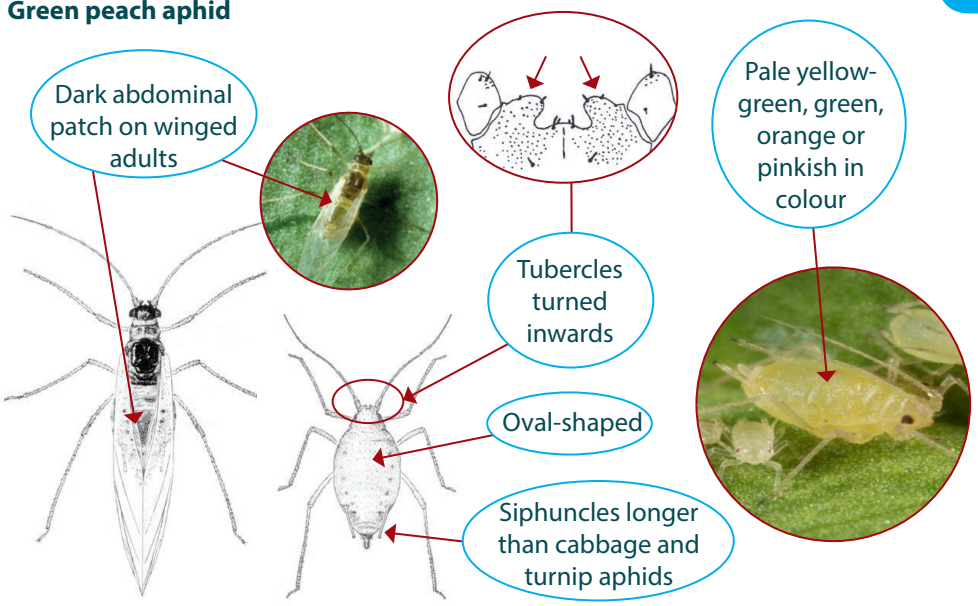

Form dense colonies (appear bluish grey) with a fine, whitish powder covering. Often found on flowering spikes and early pods

### Turnip aphid




Form dense colonies with a WAXY covering (less pronounced than powdery cover of cabbage aphids). Often found on flowering spikes and early pods

### Green peach aphid




Mainly found sparsely distributed on undersides of leaves

## Confused with/similar to

Cabbage, turnip and green peach aphids can be confused with each other and some pulse aphids.

## Distribution, pest status and risk period

Cabbage and turnip aphid infestations occur most frequently from early flowering to late pod development. They are most prolific in autumn and spring when the warm weather enables them to rapidly multiply. Rates of development reduce over winter. Canola is most vulnerable to aphid damage during bud formation through to late flowering. The cabbage aphid is more tolerant of cold weather than the turnip aphid and will continue to develop slowly at temperatures around 5-9° C.

Green peach aphids are most common in autumn and seldom cause economic loss to canola crops.

## Crops attacked/host range

Cabbage and turnip aphid host plants are generally restricted to the crops and weeds belonging to the cruciferous plant family.

Green peach aphids will attack many plant families (including broad leaf pastures, pulse crops and oilseeds).

## Damage symptoms

Aphids can cause direct feeding damage to plants, when in large numbers, as they remove sap. This reduces nutrient flow and can cause plant wilting.

Heavy infestations, particularly at flowering, can lead to large amounts of honeydew and black sooty mould.

**Cabbage and turnip aphids** usually form dense colonies on the floral parts, especially at the maturing, terminal flowering spike. Colonies on leaves often become evident by the distortion and discoloration (yellowing) of infested parts. Younger developing plant parts are preferred to older senescing parts.

**Green peach aphids** are usually found on the lower surface of basal, senescing leaves. They do not generally form dense colonies or cause leaf distortion. Large numbers occasionally occur on young, vegetative canola.

Cabbage aphids, turnip aphids and green peach aphids are all important vectors of plant diseases including turnip yellows virus (also known as beet western yellows virus), cauliflower mosaic virus and turnip mosaic virus all of which cause damage in canola. Turnip aphids also transmit cucumber mosaic virus. Green peach aphids transmit also transmit cucumber mosaic virus and bean yellow mosaic virus (see p. 38).

## Monitoring/sampling

Direct visual searches, sweep netting, yellow sticky traps or yellow pan traps.

Monitoring for aphids should start in late winter and continue through early spring with regular checks at the most vulnerable crop stage (bud formation to late flowering).

For disease-prone areas (high rainfall), regular aphid monitoring from autumn onwards is recommended to detect aphids moving into crops, particularly along paddock edges.

Check at least five points over the entire paddock, including representative parts. Visually search for aphids on a minimum of 20 plants at each point and count the number of plants infested with aphids.

Generally, if more than 20% of plants are infested, control measures should be considered to avoid yield losses. Specific economic thresholds for cabbage and turnip aphids can be found by going to the PestNotes webpage and searching by pest name.

Economic thresholds for direct feeding damage have not been established for green peach aphids.

Thresholds for managing aphids to prevent the incursion of aphid-vectored virus have not been established and will be much lower than any threshold to prevent yield loss via direct feeding, as virus can be transmitted by relatively few individuals, even prior to their detection within a crop.

## Management options

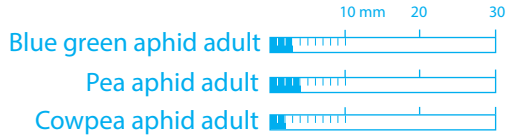
| Biological | Cultural | Chemical |
|---|---|---|
| Hover fly, lacewing larvae and ladybirds are effective predators and can help suppress populations.<br><br>Aphid parasitoid wasps (evident by the presence of 'mummies').<br><br>If the parasitism trend increases over time, there are good prospects that aphid populations will be controlled naturally.<br><br>Naturally occurring aphid fungal diseases (e.g. *Pandora neoaphidis* and *Conidiobolyus obscurus*) can also suppress aphid populations. | Implementing early summer weed control in areas where aphids build up on alternate host plants (e.g. cruciferous weeds).<br><br>Sow crops early where possible to enable plants to begin flowering before aphid numbers peak.<br><br>Where feasible, sow into standing stubble and use a high sowing rate to achieve a dense crop canopy, which will assist in deterring aphid landings.<br><br>Select cultivars that are less susceptible to aphid-feeding damage where possible. | Seed treatments and border spraying (autumn/early winter) when aphids begin to colonise crop edges may provide sufficient control.<br><br>Selective foliar spray.<br><br>**Cabbage and turnip aphids** have not been found to have evolved resistance to any insecticides in Australia.<br><br>Imidacloprid is registered as an insecticide seed treatment against turnip aphids, however there are no foliar sprays registered specifically for this species.<br><br>**Green peach aphid** (GPA) populations in Australia have evolved resistance to synthetic pyrethroids, carbamates (e.g. pirimicarb), organophosphates and neonicotinoids (e.g. imidacloprid).<br><br>A sulfoxaflor foliar insecticide remains an effective means to control GPA in canola crops, and should be used judiciously.<br><br>To reduce the risk of resistance to any insecticide group, it is important to rotate insecticides with different modes of action, avoid the use of broad-spectrum insecticides, and apply appropriate insecticides only after careful monitoring and correct identification of species. |

*Ute Guides, Southern (pp. 73-75)/Western (pp. 54-56).*
*http://cesaraustralia.com/sustainable-agriculture/pestnotes/*
*http://ipmguidelinesforgrains.com.au/wp-content/uploads/BestBet_Canola2014.pdf*
*http://ipmguidelinesforgrains.com.au/wp-content/uploads/BestBet_WinterPulsesSouth2014.pdf*

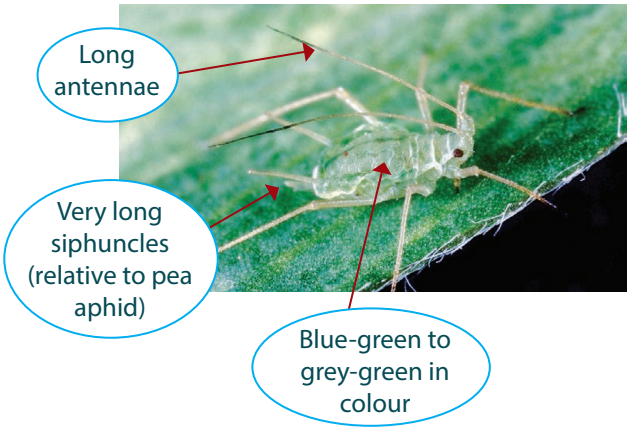
# PULSE APHIDS

## Blue green aphid (*Acyrthosiphon kondoi*), Pea aphid (*Acyrthosiphon pisum*), Cowpea aphid (*Aphis craccivora*) and Green peach aphid (*Myzus persicae*)

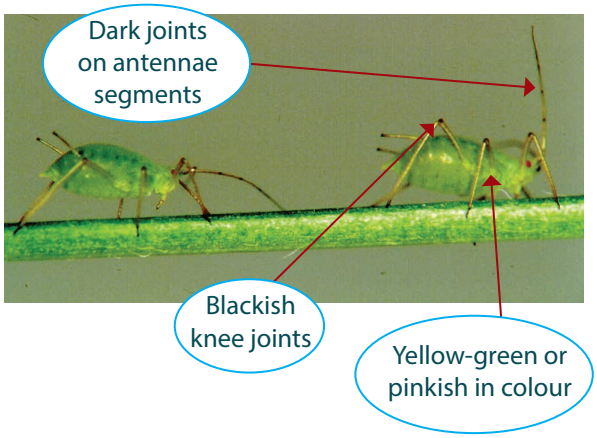
### Distinguishing characteristics/description



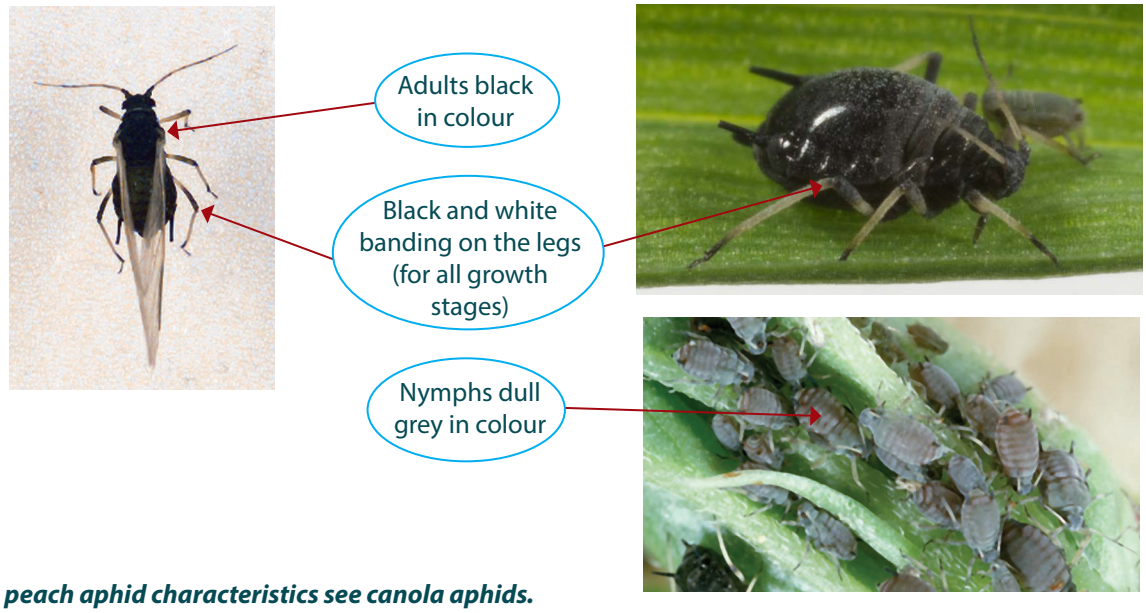

#### Blue green aphid




#### Pea aphid




#### Cowpea aphid




***For green peach aphid characteristics see canola aphids.***

### Confused with/similar to

Can be confused with other pulse and canola aphids. Currently there are no aphid biosecurity threats for pulses.

### Distribution, pest status and risk period

Pulse aphids are common in winter and spring and are usually found on the upper part of the plants, particularly growing points.

Virus management is critical for disease-prone areas (see monitoring/sampling overleaf) as these pulse aphids can transmit plant viruses and diseases.

## Crops attacked/host range

These aphids are commonly found on all pulses including field peas, lupins, lentils, faba beans and other legumes.

Blue green aphids are also found on annual medic, subterranean clover pastures and vetch.

## Damage symptoms

Aphids can cause direct feeding damage to plants when in large numbers as they remove sap, which can cause wilting of plants. Aphids also cause indirect damage by spreading plant viruses that they take up and pass on when sucking sap from infected plants and then feeding on uninfected plants.

Bluegreen aphids, cowpea aphids, and pea aphids all transmit important plant viruses including cucumber mosaic virus and bean yellow mosaic virus. Cowpea and pea aphids also transmit alfalfa mosaic virus and pea seed-borne mosaic virus.

Heavy infestations deform leaves, growing points and stunt plants. At flowering, heavy infestations can lead to large amounts of honeydew and black sooty mould.

## Monitoring/sampling

Direct visual searches and counts, sweeping netting, yellow sticky traps or yellow pan traps (can assist in early aphid detection).

For disease-prone areas (high rainfall), regular monitoring for virus management is critical in pulses. Minimising the virus source, sowing seed that is virus-free, managing crop agronomy (to reduce aphid landing sites) and monitoring for early detection are some key management strategies.

Regular monitoring for aphids should start in autumn and continue through to early spring with several checks a week at the most vulnerable crop stage (bud formation to late flowering).

Check at least five points over the entire paddock including representative parts. Visually search for aphids on a minimum of 20 plants at each point and count the number of plants infested with aphids.

Generally, if more than 20% of plants are infested, control measures should be considered to avoid yield losses. Specific economic thresholds for bluegreen aphids, cowpea aphids and pea aphids can be found by going to the PestNotes webpage and searching by pest name.

Thresholds for managing aphids to prevent the incursion of aphid-vectored virus have not been established and will be much lower than any threshold to prevent yield loss via direct feeding, as virus can be transmitted by relatively few individuals, even prior to their detection within a crop.

## Management options

| Biological | Cultural | Chemical |
|---|---|---|
| Hover fly, lacewing larvae and ladybirds are effective predators and can help suppress populations.<br><br>Aphid parasitoid wasps (evident by the presence of 'mummies').<br><br>If the parasitism trend increases over time, there are good prospects that aphid populations will be controlled naturally. | Implementing early summer weed control on your property where aphids build up on alternate host plants (e.g. broad leaf weeds).<br><br>Sow crops early where possible to enable plants to begin flowering before aphid numbers peak.<br><br>Select cultivars that are less susceptible to aphid feeding damage.<br><br>Ensuring rapid development of dense crop canopy so that bare ground is covered will assist in deterring aphid landings.<br><br>Narrow rows with high seeding rates can assist. | Selective foliar spray (e.g. pirimicarb).<br><br>Seed treatments.<br><br>Border spraying (autumn/early winter) when aphids begin to colonise crop edges may provide sufficient control.<br><br>**Green peach aphid** populations in Australia have evolved resistance to several insecticides (see canola aphids management options). Chemical rotation of insecticide groups will minimise the risk of further resistance issues. |

*Ute Guides, Southern (pp. 75-78)/Western (pp. 54, 57, 58, 60).*
*http://cesaraustralia.com/sustainable-agriculture/pestnotes/*
*http://ipmguidelinesforgrains.com.au/wp-content/uploads/BestBet_SummerPulses2014.pdf*
*http://ipmguidelinesforgrains.com.au/wp-content/uploads/BestBet_WinterPulsesSouth2014.pdf*

# Hemiptera: Scutelleridae

***Sunn pest (Eurygaster integriceps)***

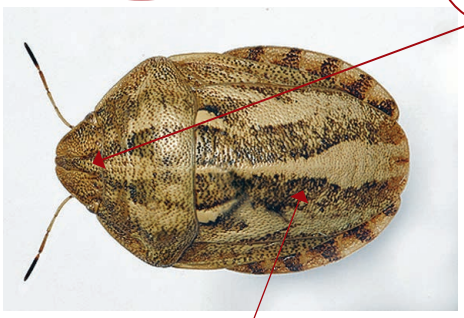
**BIOSECURITY THREAT**
NOT PRESENT IN AUSTRALIA

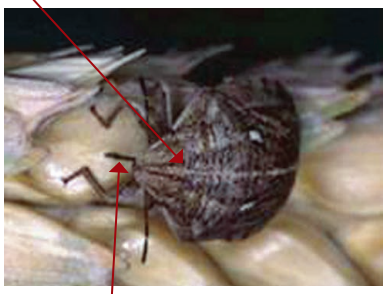
## Distinguishing characteristics/description


### Adult

Colour varies from greyish-brown to reddish-brown

Wide oval-shaped body with a wide triangular head





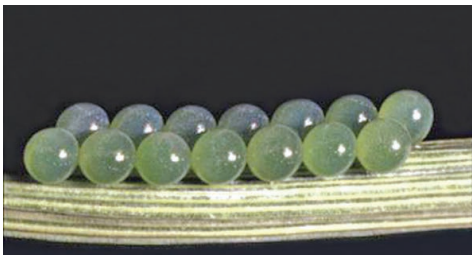
Wings completely covered by a hardened shield (scutellum) with a rounded bottom edge

Piercing and sucking mouthpart

### Eggs

**Nymphs**

Rounder in shape than adults, five nymphal stages



Spherical (about 1 mm in diameter). Shiny light green in colour, laid in two even rows (raft)

## Confused with/similar to

The Sunn pest can be confused with other true bugs such as stink bugs (Pentatomidae), seed bugs (Lygaeidae) and other shield bugs such as the predatory glossy shield bug (*Cermatulus* sp.). A distinctive character of the Sunn pest is the wing covering (scutellum) which completely hides the wings. This feature is not seen in the other two bug families nor in predatory shield bugs.

## Distribution and potential spread

The Sunn pest is widespread in Bulgaria, Greece, Romania, Southern Russia, Iran and Israel. It is also present in other European and Asian countries.

Adults have functional wings and can actively disperse and migrate long distances (>250 km).

The Sunn pest has one generation per year and individuals can survive for up to one year depending on temperature and fat reserves.

The egg and diapause stages can survive without host plants for long periods in cracks in the soil and therefore can be spread through soil contamination in machinery and equipment.

## Crops attacked/host range

The Sunn pest attacks a variety of cereal crops such as wheat, barley, oats, sorghum, rye, durum millet and corn. It can also feed on wild cereal grasses.

## Damage symptoms

Sunn pests predominantly attack leaves, stems and grain, reducing yield and quality. Young instars feed on buds and leaves, hiding deep in the plant canopy. Older instars and adults feed on developing grain and are capable of feeding on dry grain if water is available.

Infested cereal crops display yellowing and dieback of the leaves, stems and entire plant. Stunting and abnormal flower formation and discolouration (whitening) can also occur. Cereal grains may be aborted if feeding occurs before grain development. Feeding on developing seeds can result in shrivelled, discoloured (white) and empty heads. The Sunn pest injects toxic enzymes into the seed during feeding and, as a result, the grain flour has a foul smell and the quality of baking dough is substantially reduced.

## Surveillance

Winter and spring cereals should be targeted for surveillance of the Sunn pest.

Any insect that resembles this bug must be sent to a specialist for identification.

**Early detection of plant pests can greatly increase the chance of successful eradication and reduce the cost and social impact of an incursion.**

Incorporate surveillance for exotic pests when undertaking routine crop monitoring and other crop detection and measurement activities.

## Reporting protocol

A rapid response to detection of potential exotic pests can be the key to containment, eradication or management. If you see anything unusual, call the Exotic Plant Pest Hotline on 1800 084 881.


Speak to your department of primary industries or department of agriculture before sending any samples.

It is essential that the correct sampling protocol is followed including packaging, handling and transport to the laboratory assigned for diagnosis. Incorrect handling could spread the pest further or render the samples unfit for identification.

Stop the movement of people, vehicles and equipment in the detected area until a confirmation can be made.

More information
Plant Health Australia website
**www.planthealthaustralia.com.au/biosecurity/grains**

*Ute Guides, Southern (p. 181)/ Western (p.148).*

# DAMSEL BUGS OR NABIDS Hemiptera: Nabidae

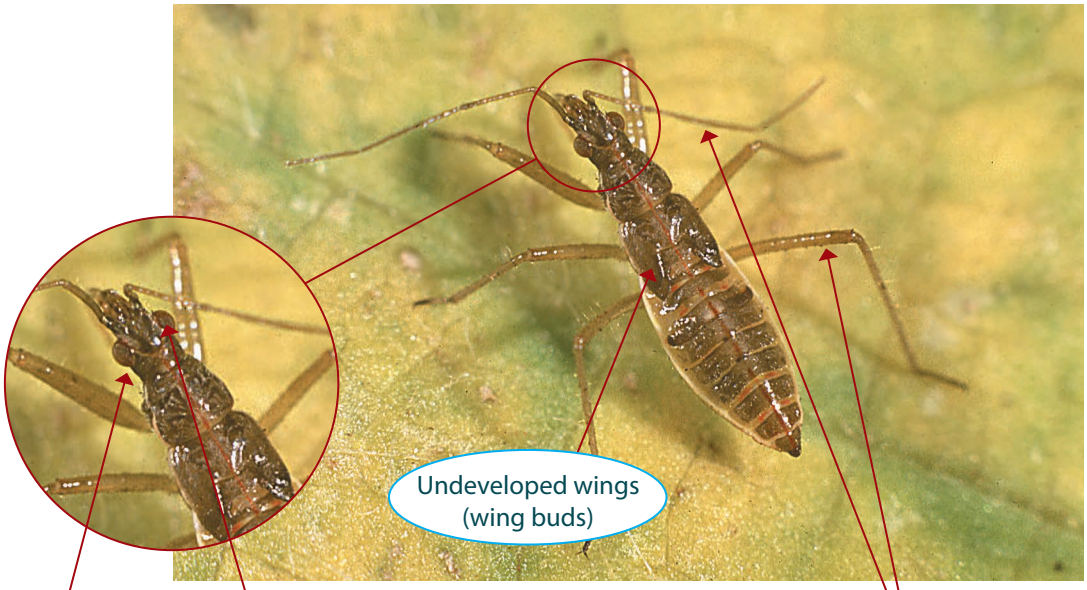
## Damsel bugs or Nabids (*Nabis kinbergii)*

***Generalist and transient***

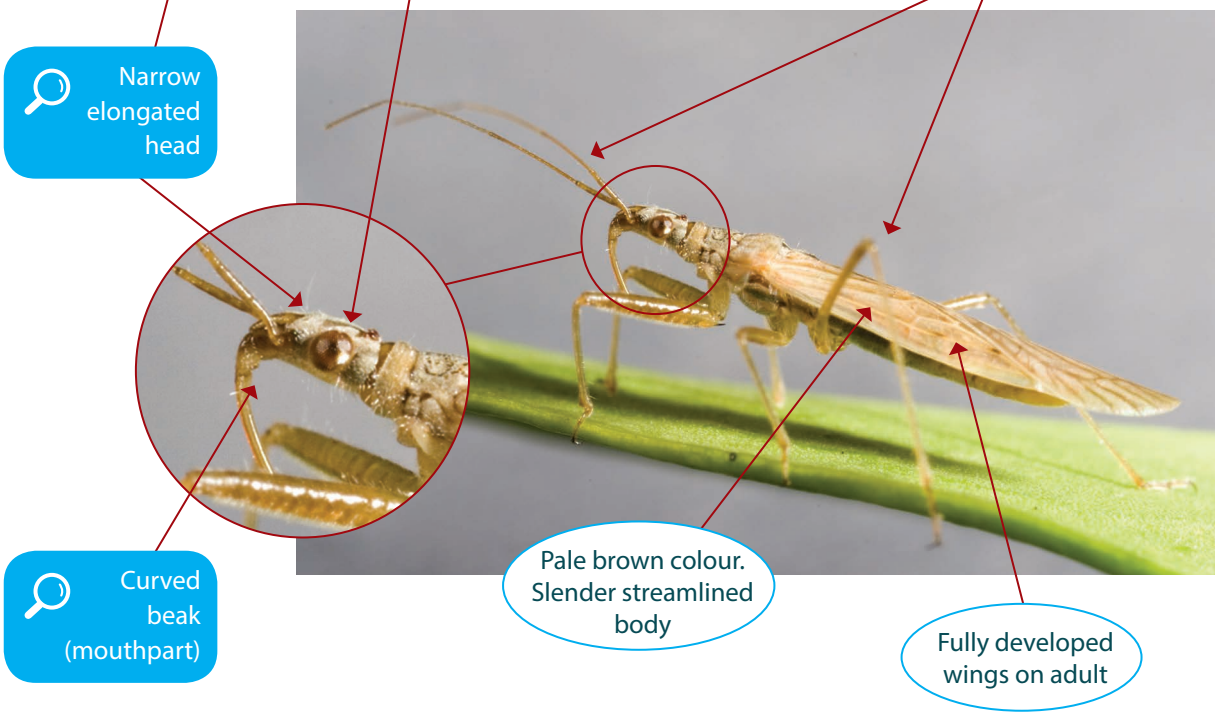
BENEFICIAL

### Distinguishing characteristics/description


### Nymph




### Adult



## Lifecycle

Incomplete metamorphosis.

Adults have a slender pale brown body with a narrow head, large protruding eyes and long antennae. Damsel bugs move quickly when disturbed. Juveniles are similar but smaller in size.

Damsel bugs can have multiple generations per year with each generation lasting around 4-5 weeks in warm conditions.

Females insert their eggs into leaves or plant stems.

## Confused with/similar to

Damsel bugs can sometimes be mistaken for other bugs such as mirids but they differ by having a long snout (proboscis) that is fine, curved and carried under the body when not feeding. They also appear similar to assassin bugs, although these have a concave abdomen (when viewed from above) and are less widely distributed than damsel bugs.

The mouthparts fit into a groove under the body.

## Distribution/habitat

Damsel bugs are common throughout most of Australia and can generally be found in the canopy of crop plants with an abundance of prey. They are prevalent in spring to autumn and adults can live for a few weeks.

## Pests attacked/impact on pests

Adults and nymphs are predatory and feed on a range of prey including caterpillars, aphids, leafhoppers, mirids and moth eggs. In particular, damsel bugs are considered to be effective predators of diamondback moth.

*Ute Guides, Southern (p. 141)/Western (p.119).*

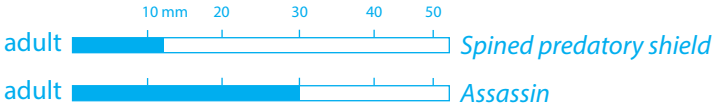
# PREDATORY BUGS Hemiptera: Heteroptera

BENEFICIAL

## Predatory shield bugs (Pentatomidae)
## Assassin bugs (Reduviidae)

***Generalist and transient***

## Distinguishing characteristics/description




### Spined predatory shield bug

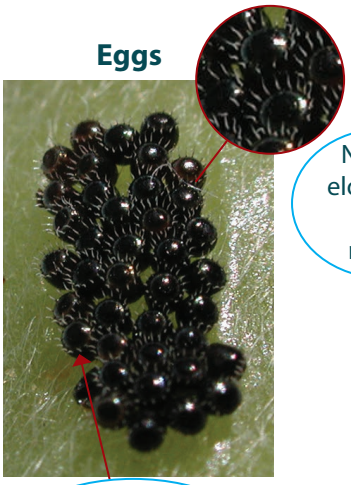
**Adult**

Prominent spines on shoulders (thorax)

**Nymph**

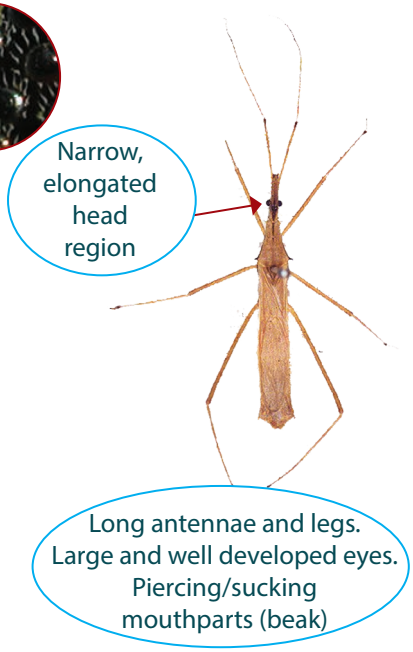
Lack of wings in nymph

**Eggs**



Eggs have 'eye-lashes' and laid in batches

### Assassin bug




## Lifecycle

Incomplete metamorphosis.

There are many different species and although these differ widely in their lifecycles, most species have multiple generations per year. Species that may be found in broadacre crops are assassin bugs, the glossy shield bug (*Cermatulus nassalis*) and the spined predatory shield bug (*Oechalia schellenbergii*).

Predatory bugs are typically prevalent in spring through to autumn. Adults usually live for several months. They lay their eggs in batches or rows on plant material or the soil surface.

## Confused with/similar to

Predatory shield bugs can easily be mistaken for pest shield bugs, such as the brown shield bug. Shield bugs are larger in size than other pest sucking bugs such as rutherglen bugs and mirids. The spined predatory shield bug is easily recognised by the large spines on its thoracic region. Assassin bugs are similar to damsel bugs.

## Distribution/habitat

Predatory shield bugs are common throughout most of Australia and are often found in the canopy where there is an abundance of prey. Assassin bugs are more common in tropical crops.

## Pests attacked/impact on pests

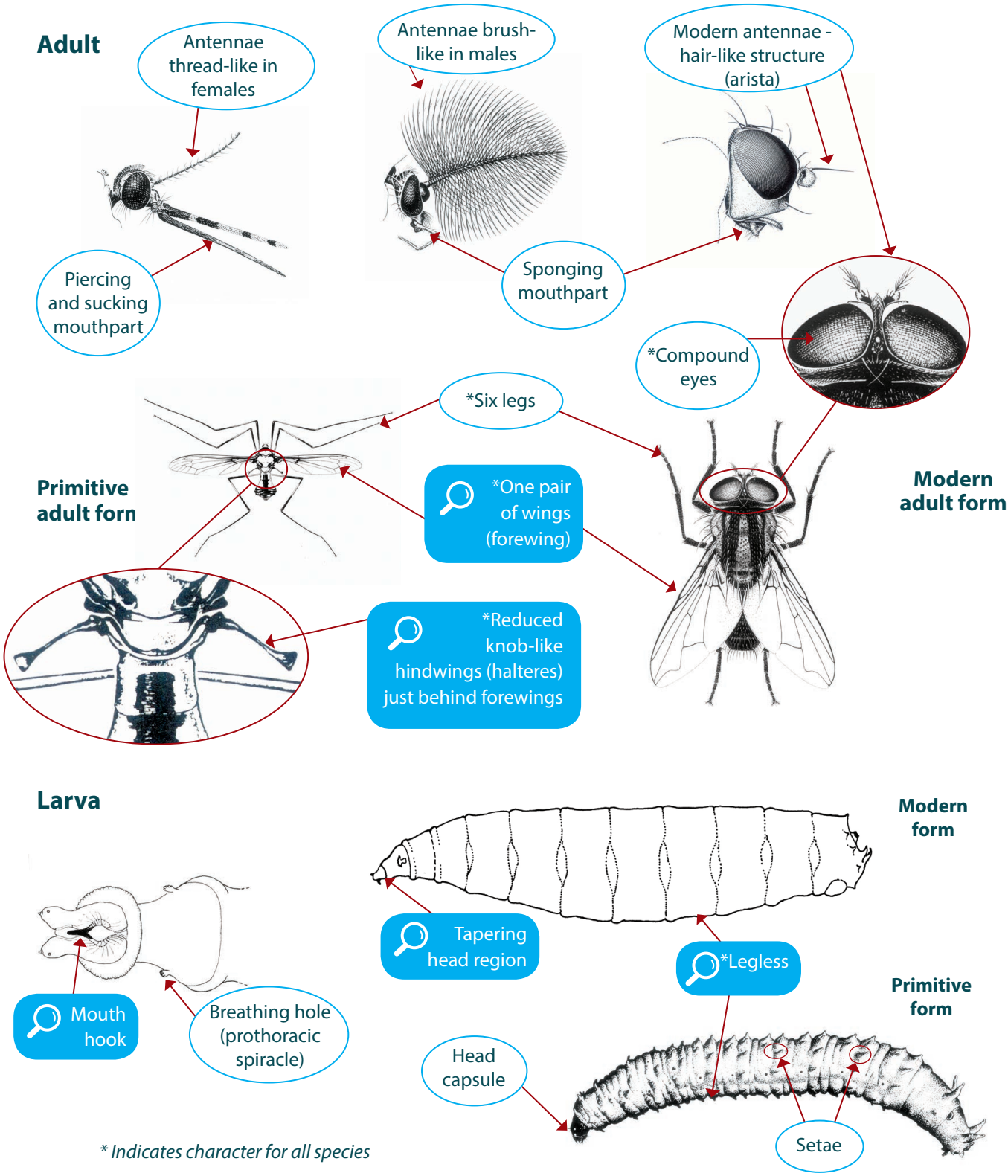
Adults and older nymphs are predatory, feeding on a range of prey including moth larvae, eggs, aphids, mites and other insects. Some assasin bugs just attack spiders. Species vary in the size and type of prey they are able to capture, but all use piercing mouthparts to suck out the body contents of their prey. Some inject a toxin to help break down the cellular material.

*Ute Guides, Southern (pp. 142-144)/Western (pp. 117, 118, 120).*

# FLIES (Order Diptera)

## Diptera - *di (two); ptera (wings)*

### Distinguishing characteristics/description




** Indicates character for all species*

*Source: Modified from Peterson (1960) and CSIRO (1991)*

### Larvae

Larvae are legless and can be variable in form. Primitive forms can have a sclerotised head capsule and non-jointed legs. Larvae of more evolved fly groups do not have a distinct head capsule and the head region has mouth hooks.

### Adult

Small to medium in size, only one set of wings (forewings) and hindwings reduced to halteres (balancing organs).

### Lifecycle

Complete metamorphosis.
The eggs are usually laid into a suitable food source. The larvae complete their development and pupate in the substrate where eggs were laid. This can be soil, organic matter, water, plant tissue or animal tissue.

### Feeding

Adult mouthparts vary from sucking and/or piercing to biting. Most adults ingest liquid foods and digestion is partially external (e.g. salivary secretions are used to liquefy food and then the softened product is ingested). Some flies (e.g. mosquitoes and March flies) pierce the skin of their prey and suck up blood.

Fly larvae generally feed on moist, decomposing food items such as carrion, fungi and rotting vegetable matter, although some are predators (e.g. Syrphidae) and parasites (e.g. Tachnidae) of other insects and animals.

## Groups (families) relevant to broadacre cropping

**Gall midges or gall gnats** (F: Cecidomyiidae): This family includes the biosecurity threats, Hessian fly and Barley stem gall midge. These are covered in this section on page 54. Some gall midges predate on aphids and mites.

**Leaf miners** (F: Agromyzidae): This family includes several biosecurity threats: the American serpentine leaf-miner, the pea leaf-miners, the chickpea leaf-miner and the vegetable leaf-miner. These are covered in this section on page 56.

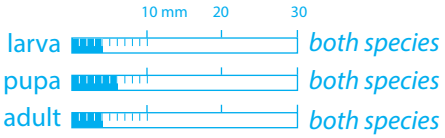
**Hoverflies** (F: Syrphidae): Resemble bees superficially but adults have a characteristic hover behaviour in flight. Hoverfly larvae are predators of soft-bodied insects, particularly aphids. Hoverflies are discussed in this section on page 59.

# GALL MIDGES OR GALL GNATS
# Diptera: Cecidomyiidae

**BIOSECURITY THREAT**
NOT PRESENT IN AUSTRALIA

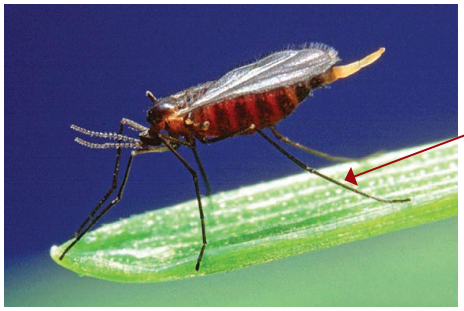
## Hessian fly (*Mayetiola destructor*) &
## Barley stem gall midge (*Mayetiola hordei*)

### Distinguishing characteristics/description

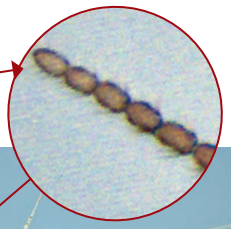



### Adult

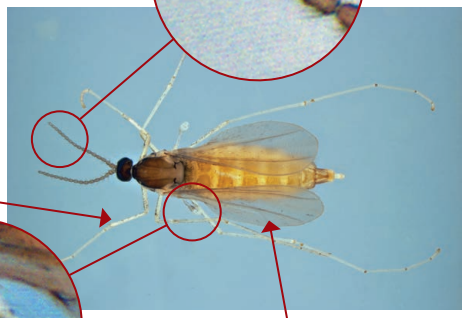
#### Hessian fly



Long filiform (bead-like) antennae

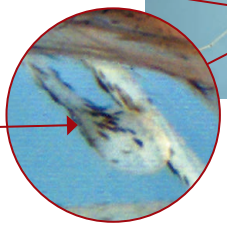


Resemble mosquitoes - slender body

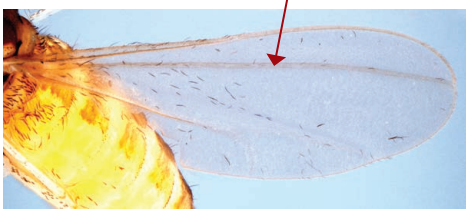


Long legs

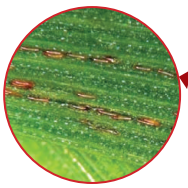
Halteres (reduced hindwing)



Wing venation consists of a few weak veins



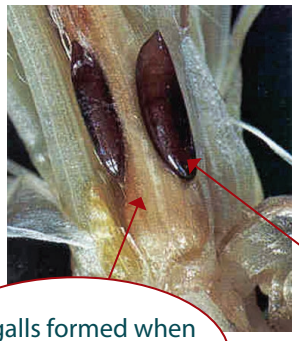
**Larvae of both species**
Legless (maggot-like) with 13 body segments.
Cylindrical and tapered to one end.
**Barley stem gall midge larvae** - pale red initially and turn white as they mature.
**Hessian fly larvae** - initially white then turn brown.



**Hessian fly eggs**
Approx. 0.5 mm long.
Elongate with rounded ends.
Initially red in colour, then darken with age. Laid on upper leaf surface in lines parallel with leaf veins.

### Pupae

#### Hessian fly pupae



No galls formed when Hessian fly larvae reside within host plant

Larvae produce a pea-sized stem gall while residing inside the stem and feeding internally

Pupae of both species known as 'flax-seeds'. Dark brown in colour. Tapered to one end. Present towards harvest at base of host plant

#### Barley stem gall midge pupae

## Confused with/similar to

These two closely-related species are difficult to identify without specialist knowledge.

The brown 'flax-seed' pupae can be diagnostic in the field. The presence of a gall produced by *M. hordei* is also characteristic.

**Larvae** can be confused with other legless maggots but there are no major fly larvae pests above ground on plants in broadacre crops in southern Australia.

**Adults** can also be confused with other midges and mosquitoes.

## Distribution and potential spread

**Hessian fly** is widespread in Europe and has been recorded in the USA. It has also been detected in other countries including New Zealand, Africa and Russia.

**Barley stem gall midge** has been recorded in Europe, USA, Canada and Africa.

These species actively fly and can disperse on wind currents more than nine kilometres. All life stages (larvae, pupae and adults) can achieve long distance dispersal by hitchhiking on plant material (e.g. straw). Pupae are able to survive over long periods.

## Crops attacked/host range

These exotic fly pests impact on market access and production costs. Crop losses of up to 40% have been recorded for Hessian fly.

**Hessian fly:** Wheat is the primary host capable of supporting the whole lifecycle. Alternate host plants include wheatgrass, rye, barley, grass weed species and broome.

**Barley stem gall midge:** Found almost exclusively on barley but occasionally recorded on oat, wheat and rye.

**Due to the difficulty in distinguishing between these two species, the information on distribution and host types are limited and not absolute.**

## Damage symptoms

Hessian fly larvae feed on leaves, stems and plant heads resulting in leaf discolouration (dark green to bluish-green), stunted growth and reduced grain quality and yield. Larvae lodge themselves between leaf sheaths above nodes, while pupae are found at the base of plants at harvest. Control of these flies would rely on cultural methods and plant host resistance as most chemical controls are ineffective.

Barley stem gall midge larvae feed at the base of barley between the leaf sheath and the stem, producing small characteristic pea-shaped galls. Galls are an abnormal outgrowth of the plant in response to barley stem gall midge feeding. Infestations can lead to weakened stems, stunted plant growth and a loss of grain quality and yield. Infested plants are a darker green than undamaged plants.

The adults do not feed. There may be 2-3 generations each year.

## Surveillance

On a symptomatic plant, separate the sheath at the base of the stem. You may find maggot-like larva feeding on the stem surface. Look carefully for a pea-shaped gall formation caused by Barley stem gall midge. Carefully split the gall and you may find the larvae inside.

**Early detection of plant pests can greatly increase the chance of successful eradication and reduce the cost and social impact of an incursion.**

Incorporate surveillance for exotic pests when undertaking routine crop monitoring and other crop detection and measurement activities.

Any insect that resembles these flies must be sent to a specialist for identification.

## Reporting protocol

A rapid response to detection of potential exotic pests can be the key to containment, eradication or management. If you see anything unusual, call the Exotic Plant Pest Hotline on 1800 084 881.


Speak to your department of primary industries or department of agriculture before sending any samples.

It is essential that the correct sampling protocol is followed including packaging, handling and transport to the laboratory assigned for diagnosis. Incorrect handling could spread the pest further or render the samples unfit for identification.

Stop the movement of people, vehicles and equipment in the detected area until a confirmation can be made.

**More information**
Plant Health Australia website
**www.planthealthaustralia.com.au/biosecurity/grains**

*Ute Guides, Southern (pp. 169, 170, 175)/Western (pp. 136, 137, 142).*

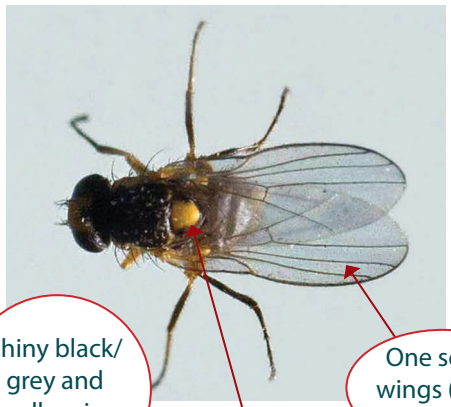
# EXOTIC LEAF MINERS

# Diptera: Agromyzidae

**BIOSECURITY THREAT**
NOT PRESENT IN AUSTRALIA

## Distinguishing characteristics/description


### Adult



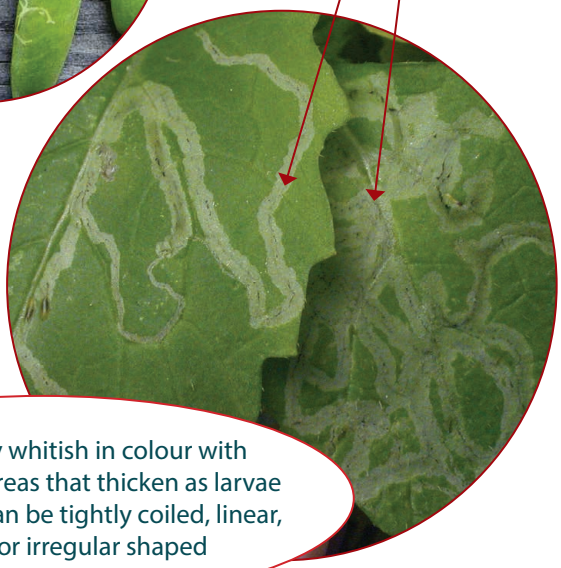
Shiny black/ grey and yellow in colour

One set of wings (fore-wings)

Bright yellow marking on base of thorax (scutellum) in most species

### Larval damage

Characteristic leaf mining (tunnelling) from larvae feeding in plant tissue



Tunnels usually whitish in colour with dried cut brown areas that thicken as larvae mature. Tunnels can be tightly coiled, linear, serpentine or irregular shaped

The Agromyzidae family are a well-known group of small flies whose larvae feed internally on living plant tissue, often as stem and leaf-miners. Within Australia there are approximately 147 Agromyzidae species in 16 genera. Many Australian species are still undescribed.

Nearly all Agromyzidae species are host-specific but a few species are highly polyphagous and have become important pests of agriculture and horticulture in many parts of the world.

**Key exotic agromyzid species for Australian agriculture include:**

American serpentine leaf-miner ***(Liriomyza trifolii)***
Pea or serpentine leaf-miner ***(Liriomyza huidobrensis)***
Pea leaf-miner ***(Chromatomyia horticola)***
Chickpea leaf-miner ***(Liriomyza cicerina)***
Vegetable leaf-miner ***(Liriomyza sativae)*** *

* detected within Australia, but currently not present beyond Northern Peninsula Area (Far North Queensland)

Diagnostic characteristics are dealt with at the family level due to the difficulty in separating these species.

Eggs are laid just below the leaf surface and larvae feed internally on the plant in which the eggs were laid. The number of eggs laid varies according to the host plant and temperature.

**Larvae** (maggots) are legless, typically cylindrical in shape and tapering at the head region. There are three larval stages that feed within the leaves (beneath the surface) creating a winding tunnel or 'mine'. They occasionally feed on the outer surface of young pods.

The larvae of *Liriomyza* spp. leave the plant to pupate, so pupae may be found in crop debris, in the soil or sometimes on the leaf surface. In contrast, pea leaf-miner (*C. horticola*) larvae pupate inside the leaf at the end of the larval mine.

These closely-related species are difficult to tell apart and identification requires specialist knowledge.

These biosecurity threats can be confused with native leaf-miner species. Most of these are host-specific but they are not well known, and as many species remain undescribed, they should be sent for identification.

The occurrence of leaf mining (tunnelling) can be easily recognised in the field.

## Distribution and potential spread

***L. trifolii*** is present in Europe, Asia, Africa, Central America and the Caribbean, North and South America and Oceania.
***L. huidobrensis*** is widespread through Africa, Asia, Central America, Europe, Canada and the USA.
***C. horticola*** is widespread in Africa, Asia and Europe.
***L. cicerina*** is found in Africa and Europe.
***L. sativae*** is present in Africa, Asia, Oceania, Central America, Europe, Canada and the USA. It was detected in the Torres Strait in 2008, and in April 2015, the first detection was made in Australia, in the Northern Peninsula Area.

Agromyzid flies are not very active flyers and tend to remain close to their target crops, often only moving very short distances between host plants within a crop. They can move longer distances if carried by wind.

Entry of these invasive agromyzids (apart from *L. cicerina*) is likely to be via imported plant material containing leaves, particularly seedlings or propagation material where eggs have been deposited.

If eggs have not yet hatched and no signs of mining are visible, the eggs may survive treatment at port of entry. Initial incursions are likely to arise from horticultural areas, and grains industries will face secondary attack from these horticultural incursions if eradication is not achieved.

## Crops attacked/host range

***L. trifolii:*** beans, peanuts, soybeans, lentils, lupins, faba beans and chickpeas.
***L. huidobrensis:*** beans, lupins, field peas and faba beans.
***C. horticola:*** sunflower, field peas, canola, lentils, lupins, chickpeas and other Brassicaceae, Fabaceae and Asteraceae plants.
***L. cicerina:*** chickpea, sweet clovers, disk trefoil and *Ononis* species.
***L. sativae:*** recorded from nine plant families, although preferred hosts tend to be in the Cucurbitaceae (pumpkin), Fabaceae (pulses) and Solanaceae (tomato) families.

## Damage symptoms

Typical leaf miner damage includes leaf destruction (leaf wilt, desiccation and premature fall) and retarded plant growth. Plant damage in the form of stippling can also be caused by females puncturing leaves for sap-feeding and egg-laying (oviposition). Plants can also suffer from secondary attack when pathogenic fungi enter the leaf through puncture wounds. Mechanical transmission of plant viruses can also occur. Severe infestations can lead to total crop loss due to both larval-mining and leaf-puncturing.

Most leaf mines are greenish in colour at first, turning whitish over time. Leaf mines wind irregularly through the leaf and increase in width as larvae mature.

Mine shapes in the leaf tissue can vary depending on the species and can be narrow and linear with anterior spiracles (e.g. *C. horticola*), tight and convoluted and often appearing blotch like (e.g. *L. trifolii*), serpentine in shape (e.g. *L. cicerina*), or irregularly serpentine in shape (e.g. *L. huidobrensis* and *L. sativae*). Mines often have distinctive trails of frass deposited in broken black strips along the mine.

## Surveillance

While fully-formed leaf mines should be readily visible to quarantine officials, signs of early infestations are much less obvious and can be easily overlooked.

Any leaf-mining damage or insect that resembles these flies must be sent to a specialist for identification.

**Early detection of plant pests can greatly increase the chance of successful eradication and reduce the cost and social impact of an incursion.**

Incorporate surveillance for exotic pests when undertaking routine crop monitoring and other crop detection and measurement activities.

## Reporting protocol

A rapid response to detection of potential exotic pests can be the key to containment, eradication or management. If you see anything unusual, call the Exotic Plant Pest Hotline on 1800 084 881.


Speak to your department of primary industries or department of agriculture before sending any samples.

It is essential that the correct sampling protocol is followed including packaging, handling and transport to the laboratory assigned for diagnosis. Incorrect handling could spread the pest further or render the samples unfit for identification.

Stop the movement of people, vehicles and equipment in the detected area until a confirmation can be made.

**More information**
Plant Health Australia website
**www.planthealthaustralia.com.au/biosecurity/grains**

*Ute Guides, Southern (p. 179)/Western (p. 146).*

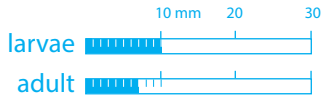
# HOVERFLIES Diptera: Syrphidae

**Various species - approximately 170 species.**

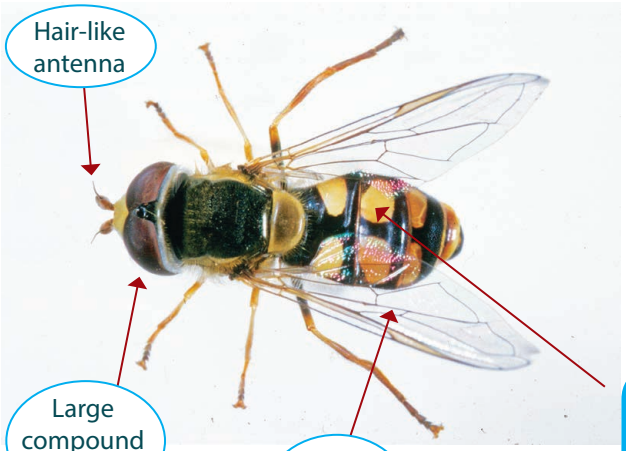
***Generalist and transient***

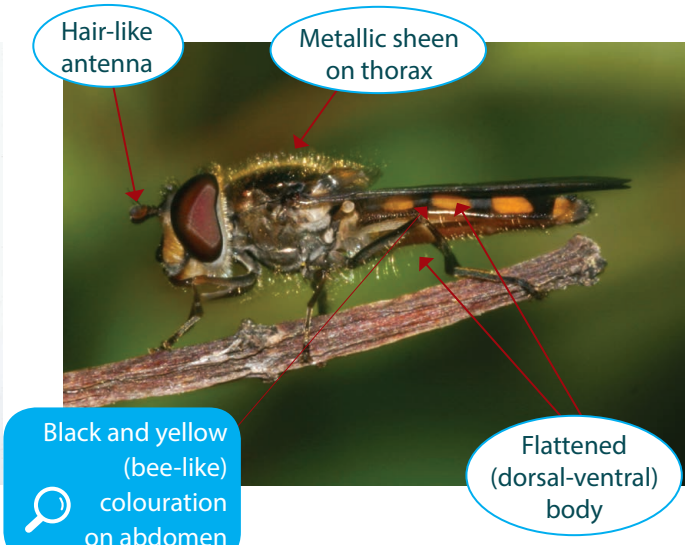
BENEFICIAL

## Distinguishing characteristics/description

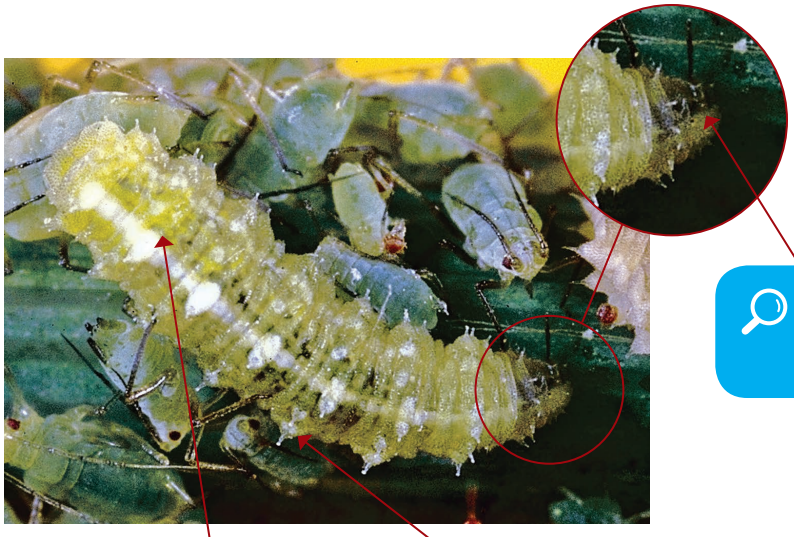



### Adult




### Larva



## Lifecycle

Complete metamorphosis.

Adult hoverflies have dark-coloured flattened bodies with black and yellow markings.

Larvae are legless, green in colour and appear grub-like.

## Confused with/similar to

Some species superficially resemble bees as they hover near plants and have similar colouration. They differ from bees in having only one set of developed wings and their movement is faster and more direct than bees. They can also be confused with other flies.

## Distribution/habitat

Hoverflies are common throughout most of Australia, can be found in a variety of habitats and are often associated with aphid populations. They are common in flowering crops such as canola, pasture paddocks and on some flowering roadside weeds. Some species can be found throughout summer months in irrigated paddocks. They are most prevalent in spring.

## Pests attacked/impact on pests

Larvae attack a range of soft-bodied insects but prefer aphids. They spear prey with their mouth hooks, often holding them upright and sucking out the body contents. Adults feed on pollen and honeydew and are not predatory.

The adult fly can often be seen hovering near flowers searching for nectar and a place to lay eggs. These are usually placed near prey (e.g. aphid colonies) for the newly hatched larvae to feed on.

*Ute Guides, Southern (p.140)/Western (p.116).*

# EARWIGS (Order Dermaptera)

## Dermaptera - *derma (skin or covering); ptera (wing)*

There are at least 63 species of earwigs present in Australia.

### Main characteristics

#### Adult and juvenile forms

Earwigs are a distinctive group of insects of small to medium size (5-50 mm in length) that are mostly dark coloured (brown to black), have chewing (mandibulate) mouthparts and moderately long bead-like (filiform) antennae. Both adults and nymphs are similar in appearance but nymphs are smaller and paler than adults.

Earwigs are usually easily identified by their hardened pincers (cerci) or claw-like structures at the rear of their flattened, elongated bodies. Both sexes have these pincers, but in males they are large and curved whereas in females they are mostly straight with slightly inward pointing tips. These sexual characteristics relate to all earwig species.

Most species of earwigs are wingless. Those with wings have clear (membranous) hind wings folded in a fan-like way and hidden beneath a protective, hardened and short covering (forewing or tegmina).

### Lifecycle

Incomplete metamorphosis.
Earwigs mate end to end, often grasping each other's pincers. Unlike most insects, female earwigs have a maternal instinct and care for their young. They lay 20-80 white eggs in clusters, usually within tunnels dug especially for this purpose. The eggs hatch over a 2-3 week period before turning into nymphs. Immature nymphs are paler in colour and take four or more moults before developing into an adult.

### Habitat

Earwigs are nocturnal but are attracted by lights and can become unwelcome visitors to houses. The majority of earwigs are found during the day in dark, sheltered environments and are common under rocks, wood, tree bark, stones, stubble or other plant residues.

Most species are omnivores, feeding mainly on decaying plant material but occasionally on dead creatures. They sometimes feed on live insects and can be seen using their rear pincers to carry their prey after it has been killed.

### Earwig families relevant to broadacre

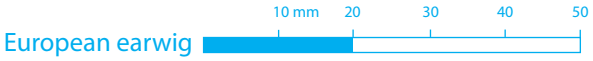
**Forficulidae:** This family has three native Australian species and the introduced European earwig *Forficula auricularia,* which has become a troublesome pest within localised areas.

**Labiduridae:** This family consists of relatively primitive earwig species that are generally red-brown in colour and range from 10-45 mm in length. Members of this family are found all over Australia. The native earwig, *Labidura truncata,* is by far the most common species, particularly in sandy habitats.

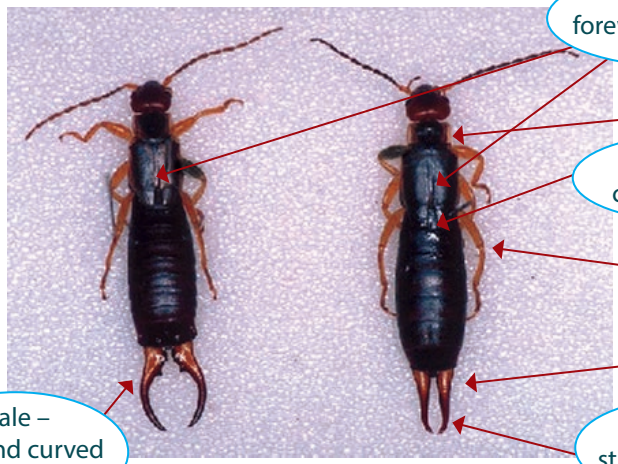
# EARWIGS Dermaptera

## European earwig (*Forficula auricularia*) and Native earwigs (*Labidura truncata, Gonolabis michaelseni, Forniculina* spp. and others)

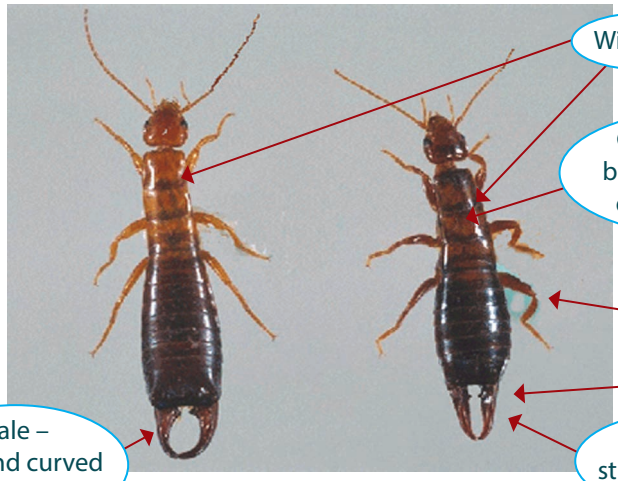
### Distinguishing characteristics/description




**European earwig**




**Native earwig**




**Native earwig**

**Damage symptoms:** shredded leaf tips or jagged holes in the leaves are typical of earwig damage.

## Confused with/similar to

Native earwigs and the European earwig are similar to other earwig species. Earwigs are sometimes confused with staphylinid beetles, but they can be distinguished from the latter by the presence of pincer-like cerci.

## Distribution, pest status and risk period

European earwigs are an introduced pest into Australia and were first recorded around 1930. They were recorded as crop pests in WA in the early 1990's and have since been spreading, although their distribution appears to be patchy and isolated. They are also commonly found in eastern Australia.

The European earwig's native climate is cool and relatively humid. Although adults have wings, they rarely fly and are mainly spread to new areas and crops by human activity. They can be transported in contaminated seed, pot plants, cardboard boxes, machinery and vehicles. Once introduced, earwigs slowly spread from the original infestation to neighbouring properties.

Crop and pasture residues on the soil surface enhance earwig survival and breeding, allowing large populations to build up during autumn and early winter. Crops and pastures sown into these high risk paddocks are most vulnerable to attack by pest earwigs.

Native earwigs are widespread throughout Australia. They are generally found either individually or in low numbers under rocks or wood. This contrasts to the European earwig which is more commonly seen congregating in high numbers. Native species rarely exceed 40 mm long and are generally elongated, flattened and have smooth, shiny bodies that are mainly brown to black in colour.

*Labidura truncata* is a common large native earwig (about 35 mm) that is considered beneficial because of it's preference to feed on caterpillars and other soft-bodied invertebrates. It captures prey with its pincers and holds them while feeding.

## Crops attacked/host range

European earwigs attack a variety of crops. Crop seedlings, particularly canola, cereals and pulse crops are the most susceptible.

Native earwigs are omnivorous, eating a wide variety of plant and animal material and they are rarely known as crop pests. Many species live primarily on a diet of plant matter, both living and decaying. They also consume dead insects and other organisms.

## Damage symptoms

European earwigs often feed at night, starting along paddock edges and moving deeper into the crop with time. Shredded leaf tips or jagged holes in the leaves are typical of earwig damage. In severe infestations, European earwigs can completely defoliate young seedlings leaving only stems or bare ground in the crop (which corresponds to the highest earwig populations).

European earwigs may become a contaminant of harvested grain. They shelter in crop windrows (swaths) and may be collected with the seed at harvest. If earwig numbers are high, the harvested grain may be rejected or require cleaning, ultimately reducing profits.

Native earwigs are not believed to be damaging to southern Australian grain crops.

## Monitoring/sampling

Inspect establishing crops with bare or thinning patches. Look under wood, rocks and plant residues for earwigs. Inspect paddocks on warm, moist nights using a torch to detect feeding earwigs. Carpet squares, tiles or terracotta pots can be left out for several nights in suspected risk areas and then inspected for earwigs that may shelter beneath these refuges.

## Management options

| Biological | Cultural | Chemical |
|---|---|---|
| All earwigs will predate on themselves.<br><br>Pest numbers of earwigs may be controlled by high populations of carabid beetles.<br><br>Various vertebrate pests such as birds and lizards will feed on earwigs. | Stubble management and cultivation will reduce earwig breeding sites.<br><br>Burning stubbles has shown some success. Early season burning is preferable. Aim for an even paddock burn or patch burn known affected areas.<br>Note: burning may not be the preferred option because of the risk of wind erosion.<br><br>Grazing pasture paddocks to below 1.5 t/ha of feed on offer in spring will reduce earwig numbers.<br><br>Early season weed control of affected paddocks, fence-lines, rock-heaps or other habitats will help to minimise survival. | There are no foliar insecticides currently registered for European earwigs in broadacre crops, however, insecticide seed dressings may give some control of moderate pest levels.<br><br>Baiting with a mixture of cracked wheat, sunflower oil and chlorpyrifos has had some success. Best results are obtained in autumn before alternative food sources are available. |

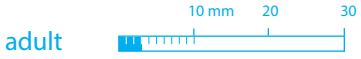
*Ute Guides, Southern (p. 88)/ Western (p. 69).*
*http://cesaraustralia.com/sustainable-agriculture/pestnotes/*

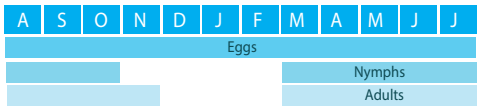
# SPRINGTAILS (Class Collembola)

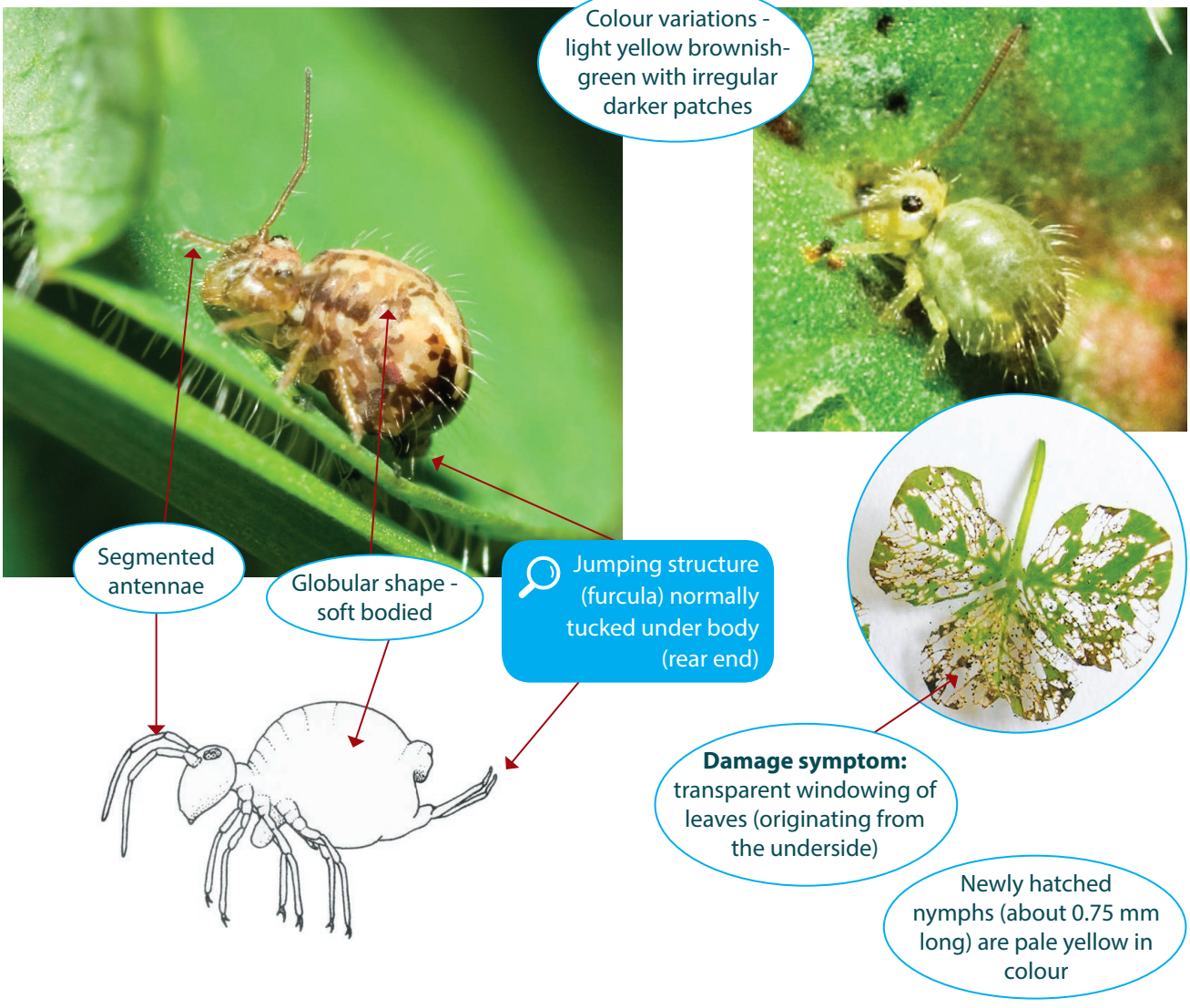
## Collembola: Sminthuridae

### Lucerne flea (*Sminthurus viridis*)

### Distinguishing characteristics/description




The lucerne flea is a collembolan (springtail), included in a group of arthropods that have six or fewer abdominal segments and possess a tubular appendage. In sheer numbers, Collembola are one of the most abundant of all macroscopic animals.

They are frequently found in leaf litter and other decaying material, where they are primarily detritivores. Only a few species, including the lucerne flea, are regarded as crop pests around the world.

## Confused with/similar to

Lucerne flea can be confused with other globular type springtails.

## Distribution, pest status and risk period

Typically found throughout the winter rainfall areas of southern Australia, including Tasmania. Although lucerne fleas are widespread and commonly encountered, they are often sporadically distributed within a particular region.

Lucerne flea are commonly observed in paddocks with a heavy soil type (e.g. clay/loam) and are less frequently found on sandy soils.

Crops and pastures are most susceptible around the time of emergence.

## Crops attacked/host range

Lucerne fleas have a tendency to feed on broadleaf plants including clovers, medics, lucerne, serradella and capeweed. They can also cause damage to canola, ryegrass, wheat and barley but these appear to be non-preferred hosts.

## Damage symptoms

Lucerne fleas feed by removing the epidermal cells of plants and feeding on the soft tissue underneath, leaving behind the fibrous veins joined by a thin layer of leaf membrane. This results in the characteristic appearance of feeding 'windows'.

## Monitoring/sampling

Lucerne fleas are easily detected as they spring off vegetation when disturbed. Feeding damage is very noticeable when lucerne fleas are present in high numbers. Susceptible crops and pastures sown in paddocks where lucerne fleas have previously been a problem should be checked regularly between autumn and spring.

As a guide, an average of 20 small holes per trifoliate legume leaf may warrant chemical control. If pasture is severely damaged it may be cost effective to spray.

## Management options

| Biological | Cultural | Chemical |
|---|---|---|
| Pasture snout mite (*Bdellodes lapidaria*) and the spiny snout mite (*Neomulgus capillatus*).<br><br>Several ground beetles and spiders are also known to prey upon lucerne fleas. | Grazing management in spring.<br><br>Weed control (particularly cape-weed), cultivation and crop rotations can prevent build up of lucerne flea numbers. | Spot spraying or border sprays.<br><br>Avoid most synthetic pyrethroid sprays as these are ineffective against lucerne flea.<br><br>Control lucerne flea in the season prior to sowing susceptible crops. |

*Ute guides, Southern (p. 89)/ Western (p. 70).*
*http://cesaraustralia.com/sustainable-agriculture/pestnotes/*
*http://ipmguidelinesforgrains.com.au/wp-content/uploads/BestBet_EstablishmentSouth2014.pdf*

# SLUGS & SNAILS (Order Pulmonata)

## Gastropod - *gastro (stomach); pod (foot)*

The phylum Mollusca is divided into six classes of which the Gastropoda contains the only land-based molluscs. There are about 36 gastropod families in Australia.

### Main characteristics

#### Adult and juvenile forms

Gastropods have an unsegmented soft-body that commonly has an external (or internal) calcareous shell. All gastropods have a well-developed head at one end of the foot with eyes and 1-2 pairs of tentacles. The body and internal organs are twisted back so that the stomach lays above the large fleshy foot, hence the name 'stomach foot'. Gastropods move by gliding along a surface of mucus or slime that is produced from glands on the foot.

All gastropods feed using a radula, which is a tongue-like structure covered by rows of rasping teeth. Most gastropods feed on fungi, algae and dead organic matter but some can also damage young crops and pastures. A few are carnivorous and may prey on other snails.

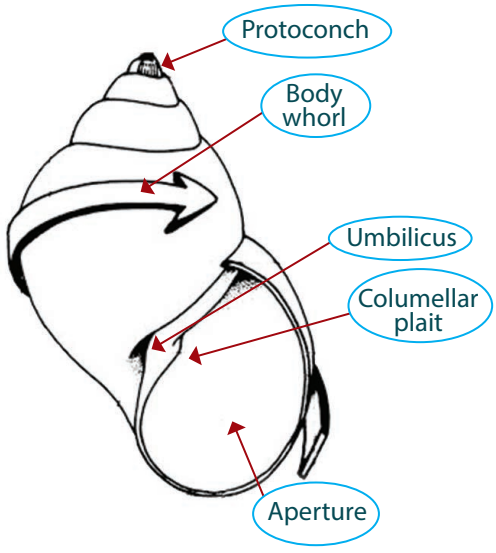
### Lifecycle

Most gastropods are hermaphrodites, which means they have both male and female reproductive organs within the same body. Eggs are usually laid in crevices in the soil or under rocks but some species dig holes in the soil, lay eggs into the cavern, then cover the hole with soil.

### Habitat

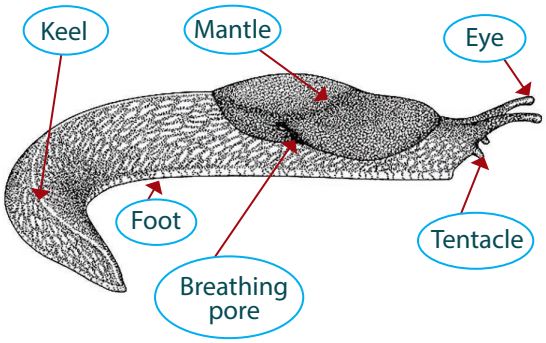
Gastropods favour moist environments and are usually found under logs and rocks, in leaf litter or under tree bark during the day, and move about and forage in more favourable conditions at night. Slugs are particularly susceptible to drying out and some snails enter aestivation (shell sealed with a thickened mucus layer to conserve moisture ) to survive hotter periods.

### Generalised shelled gastropod




*Source: Modified from Smith and Kershaw, 1979*

### Generalised slug

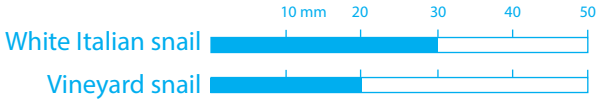



*Source: Modified from Smith Lucid Key*

# ROUND SNAILS Helicidae

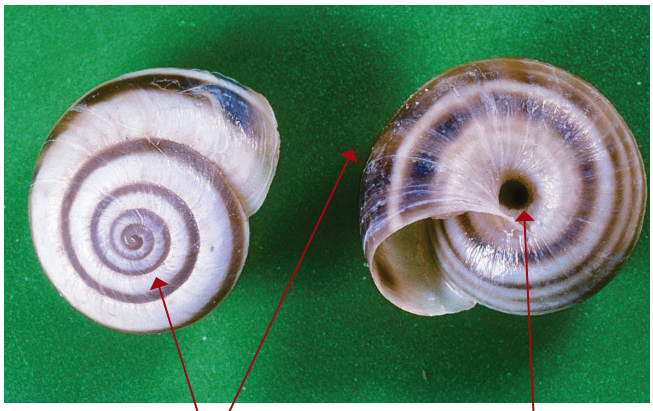
## White Italian snail (*Theba pisana*) and Vineyard or common snail (*Cernuella virgata*)

### Distinguishing characteristics/description




#### White Italian snail


#### Vineyard or common snail




### Confused with/similar to

These snails are similar to and can be easily confused with other round snail species.

### Distribution, pest status and risk period

Round snails are an important pest of crops and pastures across southern Australia, particularly where conservation farming involves stubble retention, reduced burning and reduced tillage. Crops and pastures grown on calcareous and highly alkaline soils are highly susceptible. Crops are most vulnerable at emergence and early development.

Snails can be active all year round with a small amount of moisture and cool conditions. Snails are least likely to be active in hot, dry conditions, particularly in late spring and early summer.

Round snails are a grain contaminant.

### Crops attacked/host range

All crops and pastures can be attacked. Emerging and young plants of crops and pastures. Barley, canola, and pulse crops are most susceptible.

### Damage symptoms

Round snails can shred leaves and defoliate young plants, due to their rasping action when feeding. During extended periods of inactivity (aestivation) snails can be found resting above ground on stems, stubble and fence posts.

### Monitoring/sampling

Monitor all year round to allow for full use of all available control options. Monitor using a 0.1 $m^2$ quadrat, counting all the live snails found within the quadrat on the ground. Separate round from conical snails and split snails into two size groups, 7 mm and larger and < 7 mm, using a sieve. Snails < 7 mm in diameter are unlikely to be controlled successfully by baits.

Suggested key monitoring times are:

- Jan-Feb, assess stubble management options
- Mar-April, assess for burning and/or baiting
- 3-4 weeks prior to harvest, assess for header alterations

## Management options

Several cultural control options, and assoicated economic thresholds, appear in detail in *Bash'Em Burn'Em Bait'Em – Integrated snail management in crops and pastures*. Thresholds can be misleading because populations cannot be accurately estimated.

**Good snail management requires population reduction at every opportunity.** This includes tactics for minimising snail contamination of grain at harvest.

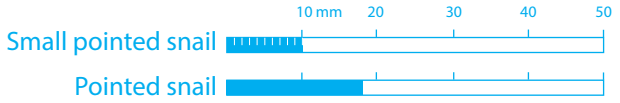
| Biological | Cultural | Chemical |
|---|---|---|
| Carabid beetles are known predators and can help suppress populations. | Stubble management includes rolling, cabling and slashing. Use these techniques post harvest, after mid-morning on hot days over 35°C. Ideally this should be done when several hot days will follow. Around 50-90% kill can be achieved when temperatures are over 35° C. This is less effective in dense cereal stubbles.<br><br>Burning is best undertaken early in the burn season. Aim for an even paddock burn. Around 80-100% kill can be achieved with an even burn and about 50-80% kill with a patchy burn.<br><br>Note the potential risk for soil erosion with these methods.<br><br>Summer weed control especially along fence lines and borders, and prior to stubble management.<br><br>Snails have been found along all major transport routes between South and Western Australia, suggesting snails are moving between regions on transport. Maintaining good farm biosecurity practices around hygiene and movement can reduce the risk of moving snails from infested to clean areas. Farm machinery and produce such as hay should be inspected and if necessary cleaned of snails. | Molluscicide baiting of fence lines and borders can be effective after autumn rains when snails are moving from aestivation sites.<br><br>To achieve optimal baiting results across the whole paddock get your spreader professionally calibrated with your preferred bait product.<br><br>Bait when autumn moisture triggers snail activity and before egglaying commences. Ensure at least 30 bait points per square metre for good results.<br><br>Repeat applications may be needed after monitoring. Commonly used bran baits need to be re-applied within 2 weeks. More expensive products will last 3-4 weeks.<br><br>Baiting in winter is less effective.<br><br>Many bait products are degraded by rain. Avoid applying baits before significant rain events.<br><br>For further bait guidelines and bait product comparison chart, refer to the snail and slug baiting guidelines (pdf) on the pirsa.sa.gov.au website. |

*Ute Guides, Southern (pp. 92-93)/ Western (pp. 72-73).*
*http://cesaraustralia.com/sustainable-agriculture/pestnotes/*
*www.grdc.com.au/GRDC-Snails-BashBurnBait*

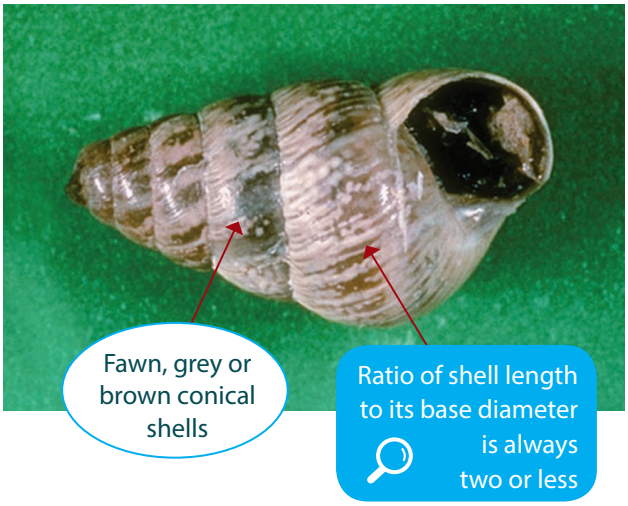
# CONICAL SNAILS Helicidae

## Small pointed snail (*Prietocella barbara*) and Pointed or conical snail (*Cochlicella acuta*)

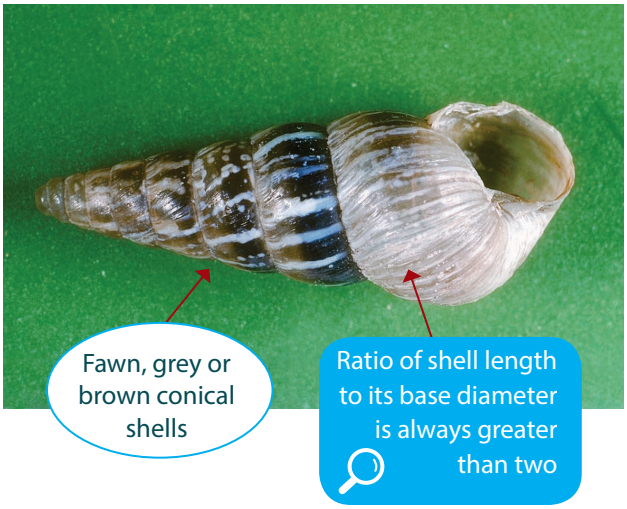
### Distinguishing characteristics/description




**Small pointed snail**




**Pointed or conical snail**




### Confused with/similar to

These snails can be confused with each other as well as native conical snail species.

### Distribution, pest status and risk period

Small pointed snails favour areas of rainfall higher than 500 mm. Crops and pastures grown on calcareous and highly alkaline soils can be highly susceptible. Numbers can build up in the pasture phase of cropping rotations. They are most active under cool conditions and may move over crops at night or during cool days. Conical snails are more likely than other snail species to be found intact in harvested grain, as their size and shape makes them difficult to dislodge from grain heads. Conical snails over-summer under stones and stumps, and on posts and vegetation.

Conical snails are found in the highest concentration on the Yorke Peninsula, SA but scattered populations can be found in other parts of SA, Victoria, NSW and WA.

The pest status of this species comes from being a contaminant of grain, particularly barley. Smaller snails can be a contaminant of canola and cereal grains. Their presence could cause rejection of grain at receival points, posing a serious risk to grain exports.

### Crops attacked/host range

Conical snails are mainly a pest of crops at harvest when they can contaminate grain and seed.

Small pointed snails are a pest of pastures, lucerne, canola, and some pulses across southern Australia, particularly where conservation farming involves stubble retention, reduced burning and reduced tillage.

Conical snails are rarely recorded directly feeding on crops and pasture as these snails prefer dead organic material.

### Damage symptoms

Small pointed snails may eat seedlings off at ground level when snail numbers are very high.

Conical snails prefer dead organic material and therefore have limited impact on the crop directly.

### Monitoring/sampling

Monitor all year round to allow for full use of all available control options. Monitor using a 0.1 $m^2$ quadrat, counting all the live snails found when the quadrat is placed on the ground. Separate round from conical snails and split snails into two size groups, 7 mm and larger and < 7 mm, using a sieve. Snails < 7 mm in diameter are unlikely to be controlled successfully by baits.

## Management options

Several cultural control options, and assoicated economic thresholds, appear in detail in *Bash'Em Burn'Em Bait'Em – Integrated snail management in crops and pastures*. Thresholds can be misleading because populations cannot be accurately estimated.

When temperatures are high, conical snails are more likely to seek shelter in cool locations, such as under stubble. Harvesting at hottest time of the day can thereby reduce conical snail contamination. Post harvest grain cleaning can be a last opportunity to remove snails.

**Good snail management requires population reduction at every opportunity.** This includes tactics for minimising snail contamination of grain at harvest.

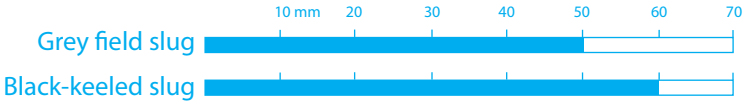
| Biological | Cultural | Chemical |
|---|---|---|
| Carabid beetles are known predators and can help suppress populations.<br><br>A parastic fly, *Sarcophaga villeneuveana* (previously known as *S. penicillata)*, is the only currently available biological control for the conical snail. Flies were released on the Yorke Peninsula, SA, however parasitism rates on SA conical snails have been extremely low, and attempts to explain the lack of parasitism have been as yet inconclusive. | Stubble management includes rolling, cabling and slashing. Use these techniques post harvest, after mid-morning on hot days over 35°C. Ideally this should be done when several hot days will follow. Around 50-90% kill can be achieved when temperatures are over 35° C. This is less effective in dense cereal stubbles.<br><br>Burning is best undertaken early in the burn season. Aim for an even paddock burn. Around 80-100% kill can be achieved with an even burn and about 50-80% kill with a patchy burn.<br><br>Note the potential risk for soil erosion with these methods.<br><br>Summer weed control especially along fence lines and borders, and prior to stubble management.<br><br>Snails have been found along all major transport routes between South and Western Australia, suggesting snails are moving between regions on transport. Maintaining good farm biosecurity practices around hygiene and movement can reduce the risk of moving snails from infested to clean areas. Farm machinery and produce such as hay should be inspected and if necessary cleaned of snails. | Molluscicide baiting of fence lines and borders can be effective after autumn rains when snails are moving from aestivation sites.<br><br>To achieve optimal baiting results across the whole paddock get your spreader professionally calibrated with your preferred bait product.<br><br>Bait when autumn moisture triggers snail activity and before egglaying commences. Ensure at least 30 bait points per square metre for good results.<br><br>Repeat applications may be needed after monitoring. Commonly used bran baits need to be re-applied within 2 weeks. More expensive products will last 3-4 weeks.<br><br>Baiting in winter is less effective.<br><br>Many bait products are degraded by rain. Avoid applying baits before significant rain events.<br><br>For further bait guidelines and bait product comparison chart, refer to the snail and slug baiting guidelines (pdf) on the pirsa.sa.gov.au website. |

*Ute Guides, Southern (pp. 94-95)/ Western (p. 74).*
*http://cesaraustralia.com/sustainable-agriculture/pestnotes/*
*www.grdc.com.au/GRDC-Snails-BashBurnBait*

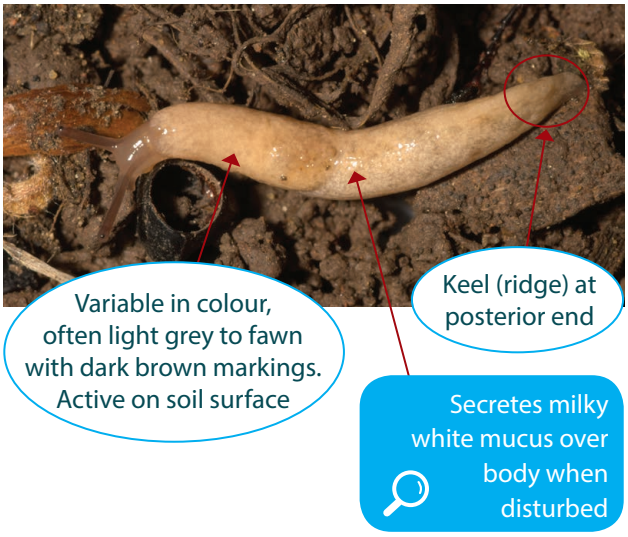
# SLUGS Eupulmonata: Agriolimacidae and Milacidae

## Reticulated or grey field slug (*Deroceras reticulatum*) and Black-keeled slug (*Milax gagates*)

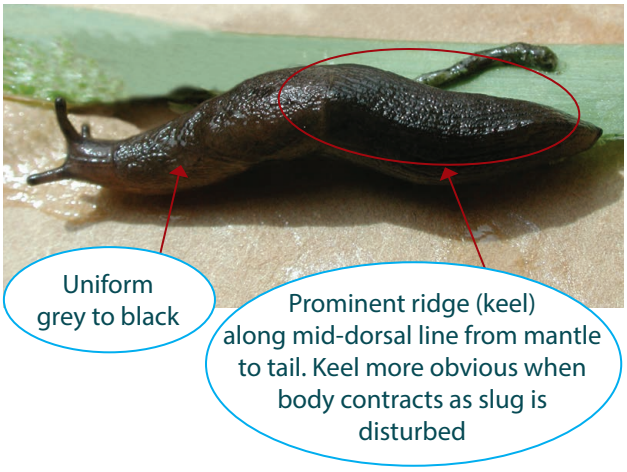
### Distinguishing characteristics/description




#### Reticulated or grey field slug




#### Black-keeled slug




### Grey field slug

This slug secretes a sticky milky-white coloured mucus over their body when disturbed (i.e. when touched). This can be used to distinguish them from other slugs. Grows up to 50 mm long.

### Black-keeled slug

The body size, colour and extended keel are distinguishing features.

## Confused with/similar to

Other slugs. See the Slug Control Factsheet (GRDC 2013) and the PestNotes webpage.

## Distribution, pest status and risk period

The grey field slug is a major pest of crops and pastures across southern Australia. Like all slug species it requires moist habitats for survival and is more likely to be a problem in higher rainfall areas. Crops are most vulnerable at establishment and damage may be more severe if cool wet weather slows crop growth. Heavy soil types, summer rains and reduced tillage are all factors which promote the build up of slug populations.

The black-keeled slug is a burrowing species and as a result can be a more serious pest than other slug species in drier areas, such as South Australia, Western Australia and western Victoria.

## Crops attacked/host range

Grey field slugs attack all crops and pastures but broadleaf plants such as canola and clovers are the most susceptible.

Black-keeled slugs attack all crops and pastures but young canola seedlings are particularly vulnerable.

## Damage symptoms

Grey field slugs are mainly active on the soil surface and may eat plants off at ground level or remove irregular shaped areas from leaves, due to their rasping action when feeding. If the apical meristem and cotyledons of broad-leaf crops are damaged, the plants may not recover.

Black-keeled slugs feed on the soil surface, as well as below the ground where they burrow down and attack germinating seeds. Feeding can result in the failure of seedlings to emerge, plants eaten off at ground level and irregular shaped pieces removed from leaves. In cereals, strips can be removed from the leaves.

## Monitoring/sampling

The most important time to monitor is the previous spring to understand where problems might occur, then after rain prior to seeding.

Check paddocks prior to sowing or before crop emergence. This can be done by placing refuges which retain moisture, such as tiles, on the soil surface at multiple sites across the paddock. Look for slugs underneath refuges on moist mornings or alternatively monitor slugs directly in emerging crops at night when conditions are damp.

Despite being developed, thresholds can be misleading because populations cannot be accurately estimated. Cereal seedlings are more tolerant than canola.

## Management options

| Biological | Cultural | Chemical |
|---|---|---|
| Carabid beetles are known predators and can help suppress populations. | Cultivation.<br><br>Summer and autumn weed control.<br><br>Seed bed consolidation (rolling).<br><br>Rotate susceptible crops with those less prone to slug damage.<br><br>Early sowing canola can help reduce damage. | Molluscicidal baits can be used prior to or at sowing when slug numbers are high, and must be applied prior to crop emergence, when conditions are cool and damp. Good timing and attention to detail is required to achieve good results.<br><br>Drilling of baits will only protect seed but not seedlings, hence a follow up surface application is recommended. 30 pellets per $m^2$ are needed to ensure adequate chance of encounter.<br><br>There are several molluscicidal baits registered against slugs in broad-acre crops with guidelines for effective usage being updated regularly. Iron III and metaldehyde formulated baits are effective in providing seedling protection against slugs and have limited effects on natural enemies.<br><br>Re-baiting may be required under high slug infestations or split emergence of populations due to different species co-occurring in the same field. |

*Ute Guides, Southern (pp. 90- 91)/ Western (p. 71).*
*http://cesaraustralia.com/sustainable-agriculture/pestnotes*
*http://ipmguidelinesforgrains.com.au/wp-content/uploads/BestBet_EstablishmentSouth2014.pdf*
*www.grdc.com.au/GRDC-FS-SlugControl*

# MITES (Order Acarina)

## *Acarina - (akari)*

Mites are among the most diverse and successful of all the invertebrate groups. They have exploited an incredible array of habitats and, because of their small size (most are microscopic), go largely unnoticed. Many live freely in the soil or water, but there are also a large number of species that live as parasites on plants, animals and some that feed on mould. It is estimated that over 50,000 Acarina species have been described and that a million or more species are currently living.

### Main characteristics

#### Nymphs

Most resemble adults but are smaller. Some juveniles only have three pairs of legs, gaining a fourth pair with their first moult.

#### Adult forms

While the appearance of mites varies widely, all mites are wingless. The mouth parts of mites may be adapted for biting, stinging, sawing, snipping or sucking. Predatory mites often use their chelicerae to cut through webbing of spider mites. Mites have four pairs of legs, no external segmentation of the abdomen and individuals appear as a single body mass. Mites do not have antennae, they use their pedipalps and front legs for probing.

### Lifecycle

Incomplete metamorphosis.
They can range in size from minute (0.08 mm) up to 20 mm in length.

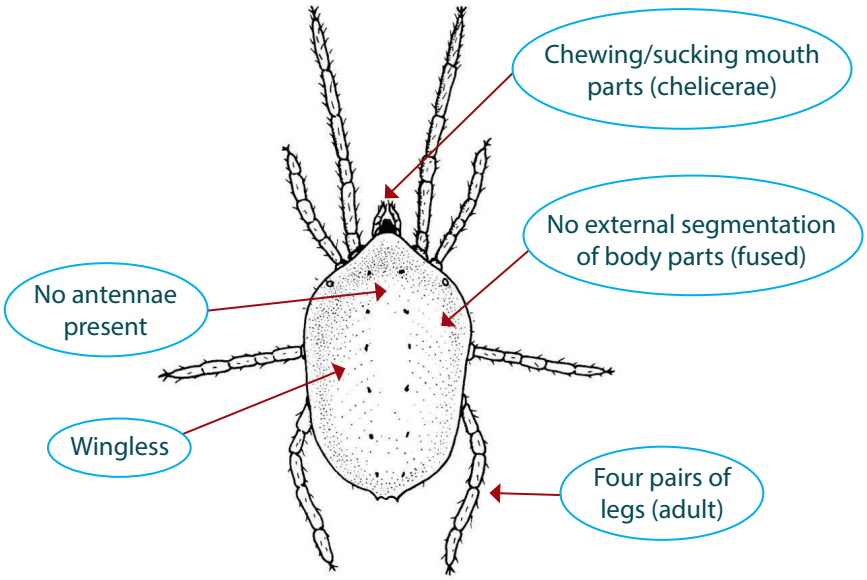
### Groups (families) relevant to broadacre cropping

**Redlegged earth mites and blue oat mites** (F: Penthaleidae): These are among the most important pests of grain crops and pastures in southern Australia. They are covered in detail in this section on pages 75-79.

***Balaustium* mite** (F: Erythraeidae): The *Balaustium* mite attacks a variety of crops and pastures and is covered in detail in this section on page 80.

***Bryobia* mites, two-spotted mite and the brown wheat mite** (F: Tetranychidae): These are important pests of various crops. The two-spotted mite (*Tetranychus urticae*) and brown wheat mite (*Petrobia latens*) are small mites (< 1 mm in length) that are sporadic pests of cotton, cereals and lucerne. For further information on the two-spotted mite refer to the Southern Ute Guide (p. 102). *Bryobia* mites are covered in detail on page 81.

**Wheat curl mite** (F: Eriophyidae): The wheat curl mite (*Aceria tosichella*) is a tiny cigar-shaped mite that is the principal vector of the damaging cereal virus, wheat streak mosaic virus. For further information, refer to the Southern Ute Guide (p. 103).



# Acarina: Penthaleidae

## Redlegged earth mite - RLEM (*Halotydeus destructor*)

### Distinguishing characteristics/description


Eight red-orange legs

Globular shaped, velvet black body

Newly-hatched RLEM larvae are pinkish-orange with six legs

Usually found in groups (up to 30 individuals) in pasture

**Damage symptom:** silvering leaves (similar to frost damage)

Newly-hatched redlegged earth mite (RLEM) larvae are only 0.2 mm long and are generally not visible to the untrained eye. In the following three nymphal stages, mites have eight legs and resemble adults, but are smaller and sexually undeveloped.

### Confused with/similar to

Other mite pests, in particular blue oat mites and the *Balaustium* mite, are sometimes confused with RLEM in the field. Unlike other species that tend to feed singularly, RLEM generally feed in large groups of up to 30 individuals.

## Distribution, pest status and risk period

The RLEM is widespread throughout most agricultural regions of southern Australia. They are found in southern NSW, on the east coast of Tasmania, the south-east of SA, the south-west of WA and throughout Victoria.

RLEM are active from autumn to late spring. They are most damaging to newly-establishing pastures and emerging crops, greatly reducing seedling survival and development. RLEM can also cause significant feeding damage and a reduction in legume seed-set of pastures in spring.

## Crops attacked/host range

All crops and pastures, although canola, lupins, cereals and legume seedlings are most at risk. RLEM also feed on a range of weed species including Paterson's curse, ox-tongue and capeweed. RLEM feeding reduces the productivity of established plants and has been found to be directly responsible for a reduction in pasture palatability to livestock.

## Damage symptoms

Typical mite damage appears as silvering or whitening on the attacked foliage. Mites use scissor-like chelicerae adapted mouthparts to lacerate the leaf tissue of plants and suck up the discharged sap. The resulting cell and cuticle damage promotes desiccation, retards photosynthesis and produces the characteristic silvering that is often mistaken as frost damage. Affected seedlings can die at emergence with high mite populations.

## Monitoring/sampling

Inspect susceptible pastures and crops from autumn to spring for the presence of mites and evidence of damage. It is especially important to inspect crops regularly in the first three weeks after crop emergence. Mites are best detected feeding on leaves in the morning or on overcast days. In the warmer part of the day, redlegged earth mites tend to gather at the base of plants, sheltering in leaf sheaths and under debris. When disturbed during feeding they will drop to the ground and seek shelter.

For crop specific economic thresholds, go to the PestNotes webpage and search by pest name.

## Management options

| Biological | Cultural | Chemical |
|---|---|---|
| French *Anystis* mites can suppress populations in some pastures. | Crop rotations with non-preferred crops, such as lentils and chickpeas.<br><br>Weed control pre-sowing.<br><br>Grazing management of spring pastures in the year prior to cropping. | Resistance to synthetic pyrethroids (including bifenthrin and alpha-cypermethrin) and organophosphates (including omethoate and chlorpyrifos) has been detected for RLEM in Western Australia and recently, South Australia. **Resistance is a risk for all southern grains.**<br><br>Rotate chemical classes.<br><br>For low-moderate populations, seed dressings are effective.<br><br>Avoid prophylactic sprays.<br><br>Pesticides used at or after sowing should be applied within three weeks of the first appearance of mites, before adults commence laying eggs. Insecticides do not kill mite eggs.<br><br>Border spraying.<br><br>Carefully timed spring spraying (e.g. TIMERITE®). |

*Ute Guides, Southern (p. 97)/ Western (p. 75).*
*http://cesaraustralia.com/sustainable-agriculture/pestnotes/*
*http://ipmguidelinesforgrains.com.au/wp-content/uploads/BestBet_EstablishmentSouth2014.pdf*

## Understanding the lifecycle of pests can be important before deciding on control strategies

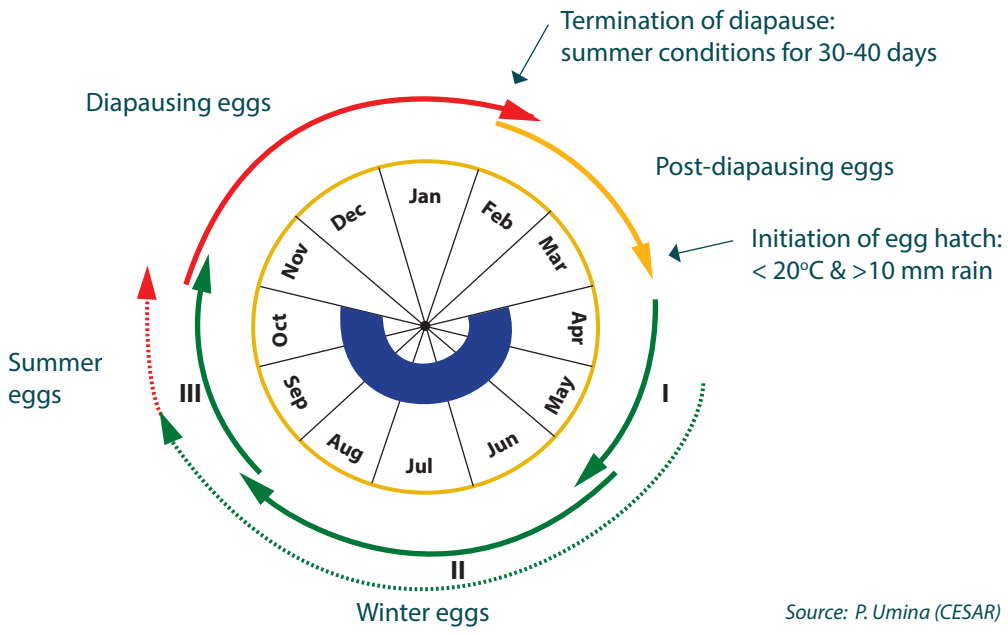
**Example**

Earth mites are active in the cool wet months from April to November. During the winter, they usually pass through three generations, with each lasting about 8-10 weeks depending on the species. During the hotter months of the year, earth mites avoid the hot dry conditions by producing over-summering eggs (diapause).

For redlegged earth mites, the first two generations of mites lay predominantly winter eggs, usually on the under surface of the host plant leaf. In spring, mites stop laying eggs on plants and start producing the over-summering eggs, which are retained in the body (Figure 4.3).

This knowledge can be used to time insecticide applications more strategically. Timerite® is a strategy that works by controlling the number of redlegged earth mites emerging in autumn by minimising the number of diapause eggs produced (through a carefully timed spray in the previous spring) and therefore reducing the number of mites emerging from diapause.

However, this approach is not as effective for other mite species. For blue oat mites and several other crop-emergence pests, a large number of diapause eggs are already present in paddocks by spring - well before the spring spray date recommended by Timerite®.



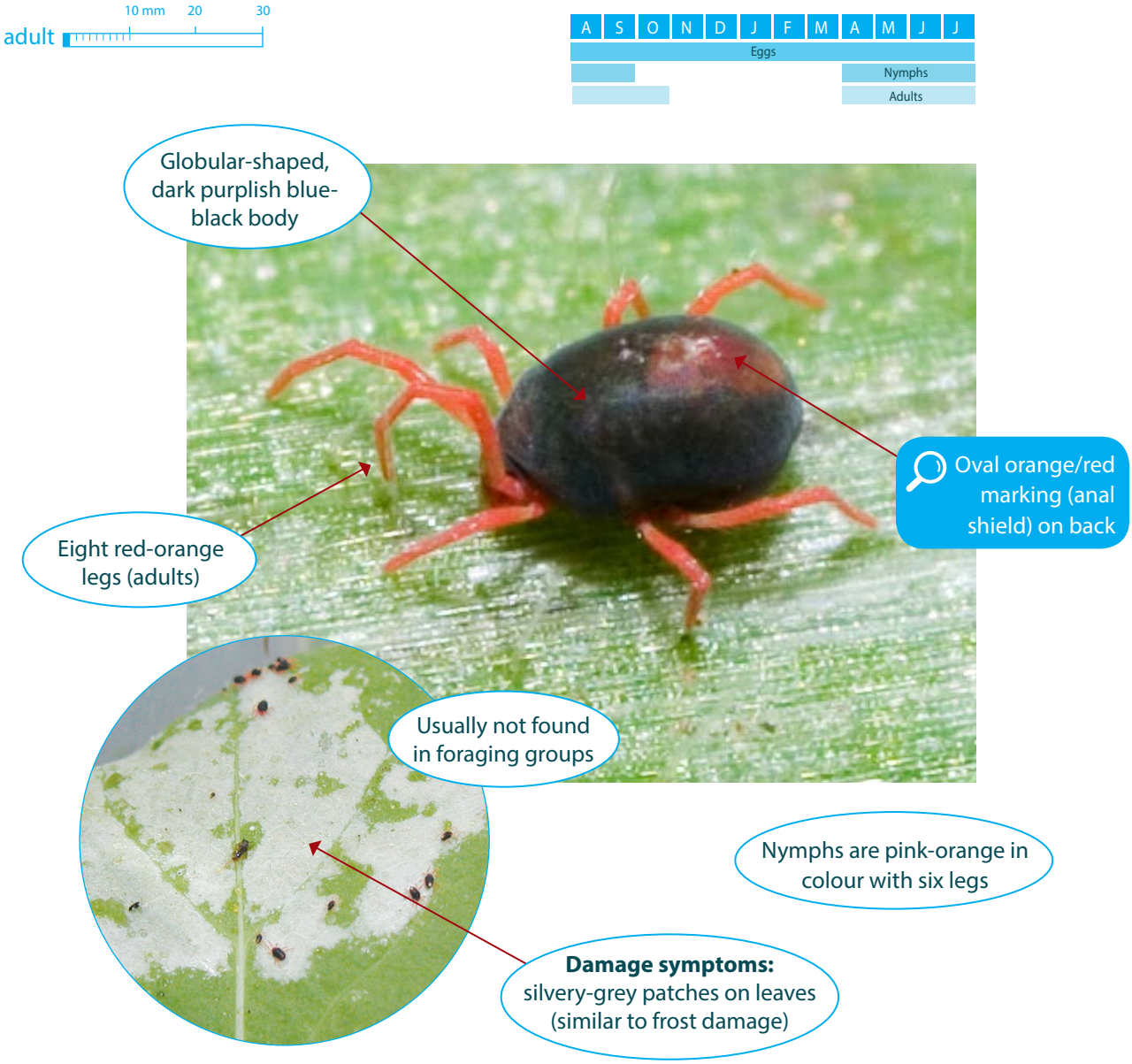

*Source: P. Umina (CESAR)*

**Figure 4.3 Typical lifecycle of redlegged earth mites in southern Australia**

# Acarina: Penthaleidae

## Blue oat mite (*Penthaleus* spp.)

### Distinguishing characteristics/description




### Confused with/similar to

There are three recognised pest species of blue oat mites, but these are morphologically very similar and cannot be identified without the use of a microscope.

Blue oat mites are similar in appearance to redlegged earth mites and may also be confused with other mite pests, such as *Balaustium* mites. The orange-red patch on the back of blue oat mites is unique and generally quite conspicuous when viewed with a hand lens.

### Distribution, pest status and risk period

Blue oat mites are widespread throughout the southern agricultural regions of Australia. They are broadly distributed across Victoria and New South Wales, the eastern half of Tasmania, the southern part of South Australia and the south-west of Western Australia.

Blue oat mites often coexist with redlegged earth mites and both are typically active from autumn to late spring. Feeding damage can occur throughout this period but newly emerging crops and establishing pastures are most at risk.

## Crops attacked/host range

A wide range of agriculturally important plants are attacked, but cereals, canola, lucerne and pastures are most susceptible. The three species differ in their host plant preferences which can sometimes assist identification:

***P. major*** is mainly found on pastures, cereals and pulses. It does not prefer canola.

***P. falcatus*** is mainly found on canola, but also on broad-leaved weeds such as Paterson's curse, bristly ox-tongue, smooth cat's-ear and capeweed. It does not prefer wheat and barley.

***P. tectus*** is mainly found on cereals, but also on pastures and some pulses. It does not prefer chickpeas.

## Damage symptoms

Blue oat mites penetrate the epidermal cells of plants and suck out cellular contents using their specialised mouthparts. This typically results in silvery-grey patches on plants which can sometimes be mistaken for frost damage. Feeding can also lead to distorted and shrivelled leaves, stunted growth and seedling mortality with a heavy infestation.

## Monitoring/sampling

Susceptible crops and pastures should be inspected regularly, particularly around the time of emergence. Mites may be present on the tops and undersides of leaves or on the ground.

There are no economic thresholds established for blue oat mites.

## Management options

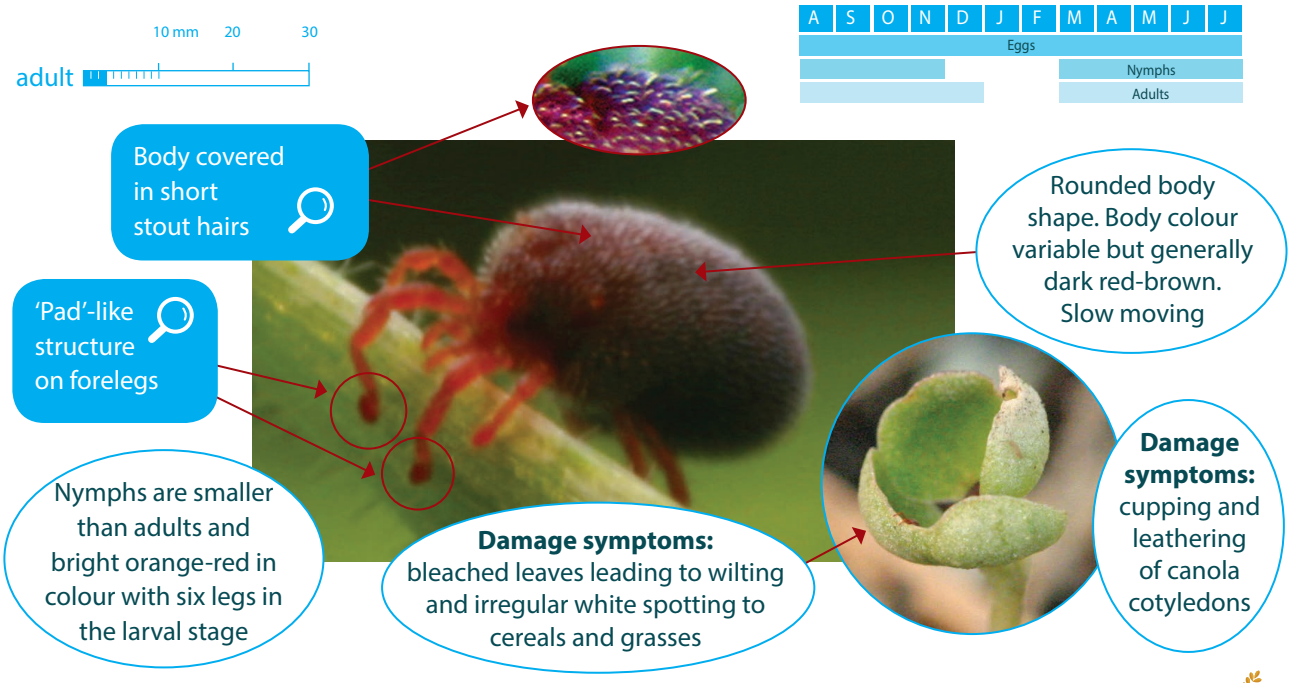
| Biological | Cultural | Chemical |
|---|---|---|
| French *Anystis* mite can suppress populations in some pastures. | Crop rotations with non-preferred crops e.g. chickpeas.<br><br>Cultivation.<br><br>Weed management. | Seed dressings.<br><br>Border spraying.<br><br>Carefully timed autumn sprays usually recommended.<br><br>Spring spraying using TIMERITE® is largely ineffective against blue oat mites.<br><br>While a number of chemicals are registered in pastures and crops, differences in tolerance levels between species complicates management of blue oat mites. *P. falcatus* has a higher tolerance to a range of pesticides and this is often responsible for chemical control failures. *P. major* and *P. tectus* have lower tolerances to pesticides and are more easily controlled. Ensure pesticide sprays are applied at the full registered rate.<br><br>Avoid prophylactic sprays.<br><br>Apply insecticides only if control is warranted and if you are sure of the mite identity.<br><br>Pesticides used at or after sowing should be applied within three weeks of the first appearance of mites, before adults commence laying eggs. Currently registered pesticides are only effective against the active stages of mites; they do not kill mite eggs. |

*Ute Guides, Southern (p. 99)/ Western (p. 76).*
*http://cesaraustralia.com/sustainable-agriculture/pestnotes/*
*http://ipmguidelinesforgrains.com.au/wp-content/uploads/BestBet_EstablishmentNorth2014.pdf*

# Acarina: Erythraeidae

## *Balaustium* mite (*Balaustium medicagoense*)

### Distinguishing characteristics/description




### Confused with/similar to

*Balaustium* mites can be confused with other mite species. Adult *Balaustium* mites are approximately twice the size of adult redlegged earth mites and blue oat mites, and their body is larger and more rounded than *Bryobia* mites.

### Distribution, pest status and risk period

*Balaustium* mites are broadly distributed across the southern coastal regions of Australia. They are found throughout most of Victoria, along the eastern side of New South Wales, in the south-east of South Australia and the south-west of Western Australia. *Balaustium* mites are typically active from March to November, although mites can persist on green feed during summer if available. Crops are most at risk during the seedling stage. Summer eggs hatch in autumn following significant rainfall.

### Crops attacked/host range

*Balaustium* mites have a wide host range and are commonly found attacking canola, lupin and cereal crops. They will also feed on pasture legumes, lucerne, grasses and some broadleaf weeds.

### Damage symptoms

*Balaustium* mite feeding causes leaves to become bleached, which can lead to wilting and plant mortality under high infestations. Feeding results in the 'cupping' and 'leathering' of canola cotyledons and irregular white spotting on cereals and grasses.

### Monitoring/sampling

Monitor susceptible crops and pastures in autumn, particularly those with a history of chemical applications for redlegged earth mites. Established pastures can tolerate moderate numbers of *Balaustium* mites without sustaining significant damage but seedlings can be totally wiped out. *Balaustium* mites tend to be more active during the warmer parts of the day, so monitoring in the early afternoon is best.

### Management options

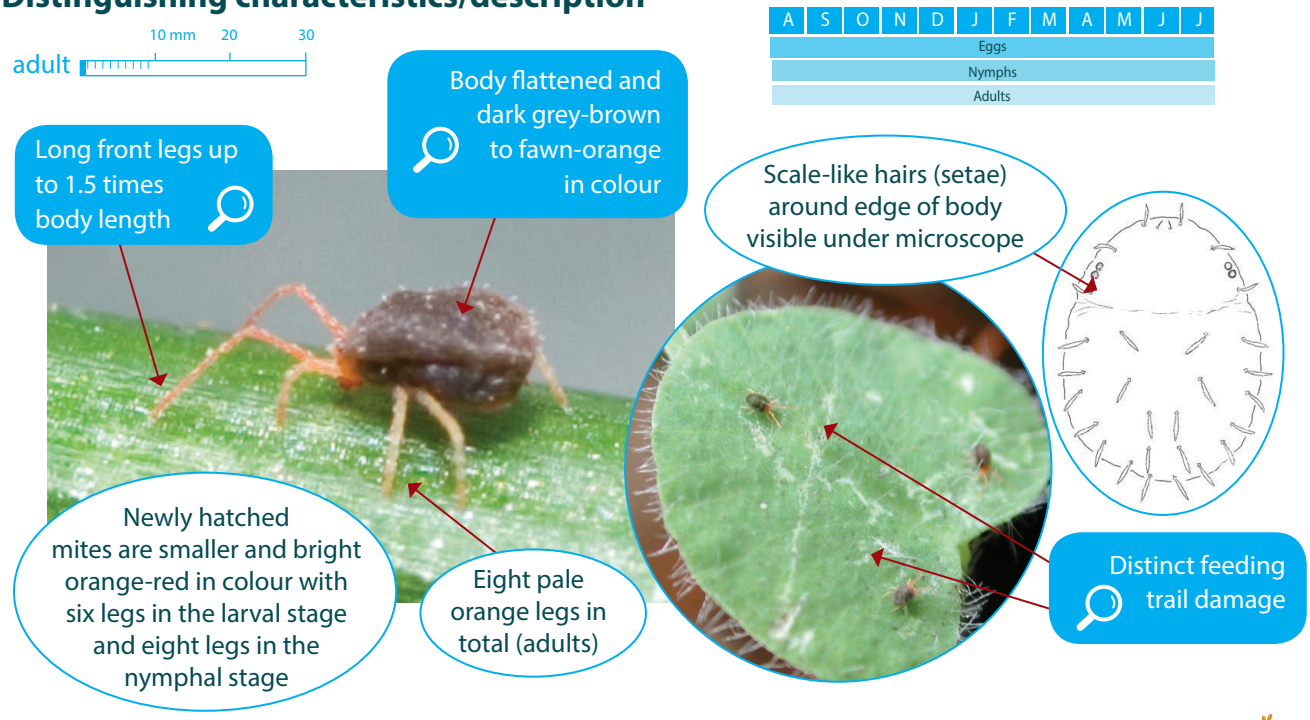
| Biological | Cultural | Chemical |
|---|---|---|
| Unknown. | Control of summer weeds can prevent build up of mite populations.<br><br>Avoid volunteer grasses within susceptible crops, such as cereals and pulses. | *Balaustium* mites have a high natural tolerance to many chemicals. See APVMA website for registered chemicals. A mixed formulation product is registered to control *Balaustium* mites in Australian canola crops.<br><br>Management strategies that are not reliant on chemicals should be considered for the control of *Balaustium* mites. |

*Ute Guides, Southern (p. 101)/ Western (p. 78).*
*http://cesaraustralia.com/sustainable-agriculture/pestnotes/*

# Acarina: Tetranychidae

## *Bryobia* mite or Clover mite (*Bryobia* spp.)

### Distinguishing characteristics/description




### Confused with/similar to

There are over 100 species of *Bryobia* with at least six of these present in Australia. *Bryobia* mites may be confused with other mite species such as redlegged earth mites and blue oat mites. Their long forelegs are quite prominent and *Bryobia* mites are also lighter in colour, smaller and slower moving than other species.

### Distribution, pest status and risk period

Unlike other broadacre mite species which are active from autumn to spring, ***Bryobia* mites prefer the warmer months of the year.** They are generally present from spring until autumn and are unlikely to be problematic in winter. Autumn-sown crops and pastures in paddocks containing summer or early autumn weeds are most at risk.

### Crops attacked/host range

*Bryobia* mites attack a variety of crops including canola, lupins, wheat, lucerne, vetch and clovers.

### Damage symptoms

Mites feed on the upper surface of leaves and cotyledons and leave distinctive trails of whitish-grey spots. When young leaves are affected they become discoloured and may fail to grow. On grasses, *Bryobia* mite feeding can resemble that of redlegged earth mites (leaf-silvering).

### Monitoring/sampling

*Bryobia* mites are active during the warmer parts of the day and may be difficult to detect during the early morning or in wet conditions. Look for mites and evidence of feeding damage in newly-sown crops and on clovers and *Brassica* weeds prior to sowing.

### Management options

| Biological | Cultural | Chemical |
|---|---|---|
| Unknown. | Control of summer and early autumn weeds can prevent build up of mite populations.<br><br>Rotate crops with non-preferred plant types, e.g. chickpeas and oats.<br><br>There is greater risk with rotations following pastures with high clover content. | *Bryobia* mites have a natural tolerance to several chemicals. Many insecticide rates used against other mite species may be ineffective (e.g. alpha-cypermethrin).<br><br>Generally organophosphate insecticides provide better control against *Bryobia* mites than synthetic pyrethroids. |

*Ute Guides, Southern (p. 100)/ Western (p. 77).*
*http://cesaraustralia.com/sustainable-agriculture/pestnotes/*

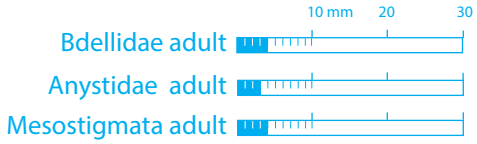
# PREDATORY MITES Acarina: Snout mites (*Bdellidae*), Anystidae and Mesostigmata

BENEFICIAL

**Various species - approximately 30,850 Australian species.**

***Generalist and residential***

## Distinguishing characteristics/description




**Bdellidae**

Very pointed snout

* Well developed legs and fast moving

* Usually brightly coloured

**Anystidae**

Red bodied

Moves in a circular motion, hence the 'common name' whirly gig mite

* Large mouthparts

**Mesostigmata**

Usually brown in colour

* Fused body segments (cephalothorax and abdomen)

** indicates character for all species*

## Lifecycle

Incomplete metamorphosis.

Many species of predatory mites have a lifecycle that coincides with pest earth mites - generally between April and December. Some species can be found throughout summer months in irrigated paddocks. They usually have many generations per year.

## Confused with/similar to

Some predatory mites may be confused with pest earth mite species such as the redlegged earth mite and the *Balaustium* mite. Predatory mites are generally highly mobile (quick-moving) and have more prominent mouthparts than plant-feeding (phytophagous) pest species.

*Ute Guides, Southern (p. 135, 136)/ Western (p. 111, 112).*

## Distribution/habitat

Predatory mites are common throughout most of Australia and can be found in a variety of habitats. They are more likely to be found in under-grazed pasture paddocks where there is an abundance of plant cover and large prey populations. They are also found on weeds along roadside verges where mite prey are plentiful.

## Pests attacked/impact on pests

There are a variety of native predatory species, as well as deliberately introduced species, that are important predators. These can reduce numbers of pest mites, lucerne flea and other springtails (Collembola).

There is evidence that some predatory snout mites prevent damaging outbreaks of earth mites and lucerne flea in pastures and lucerne paddocks.

# WASPS, BEES & ANTS (Order Hymenoptera)

## Hymenoptera - *hymeno (membrane); ptera (wing)*

The Hymenoptera is divided into 71 families and contains about 15,000 species in Australia. The Hymenoptera is divided into two suborders - Symphyta (sawflies), which have no distinct waist and Apocrita (ants, bees and wasps), which have a distinct waist. This order includes harmful, as well as some of our most beneficial insects. Hymenopteran habits can vary considerably: some are predaceous; some parasitic; some cause plant galls; some feed on plant foliage and others, like honey bees, live on plant pollen and nectar.

Wasps are important as parasitoids of broadacre pests and are the only group covered in this section. Bees are well known as important pollinators of crops and are frequently seen in flowering crops, such as canola during spring. Ants may also be abundant, particularly during the warmer months of the year, and may play a role as scavengers or in seed dispersal and burial. Sawflies include the 'spitfire' grubs which can occasionally be seen in clusters feeding on some native trees.

### Main characteristics

#### Larval form

Most are legless (maggot-like) and differ from similar looking fly maggots (Diptera) as they generally have visible chewing mouthparts and a developed head region. Larval forms of the parasitoid wasps are rarely seen in broadacre crops because they are generally concealed within the bodies of the prey from which they are feeding.

Legs are present in some hymenopteran larvae, such as sawflies. Sawfly larvae look similar to moth caterpillars (Lepidoptera) because they have numerous abdominal prolegs, but they are more fleshy in appearance and do not have specialised hooks (crochets) at the base of prolegs.

#### Adult form

Can be winged or wingless insects. Winged species have two pairs of membranous wings with relatively few veins. The forewings are always slightly longer than the hind wings. The body of wasps, bees and ants are usually identified by their characteristic narrow waist or the constricted area that appears to separate the last two body segments (the thorax and the abdomen). Sawflies have wide waists.

Mouthparts are formed for chewing (e.g. adult wasps) or can be modified for sucking (e.g. honey bees). In females, the abdomen ends in an egg laying tube (ovipositor) that is often prominent and can be modified to a stinger or a saw-like organ in some species.

#### Lifecycle

Complete metamorphosis.
Lifecycles can vary considerably between species. Wasp parasitoids have a lifecycle that coincides with their host. In general, eggs are either injected into the host prey or attached to the outer body. The larval stage feeds on their host, which is often killed in the process. Larvae that feed internally either emerge from their host to pupate (e.g. braconid wasps), or emerge from the host as adults (e.g. aphid parasitoids). Different species can attack different stages of the host's lifecycle.

Many species are colonial and are fed by members of the colony. Adult wasps mostly feed on nectar and honeydew.

### Groups (families) relevant to broadacre cropping

**Predatory wasps** (F: Ichneumonidae and Braconidae): Small to large wasps, including *Diadegma semiclausum*, a larval parasitoid of diamondback moth. Most beneficial wasps that attack moth larvae and aphids associated with broadacre crops belong to these two wasp families. Major species are covered in detail in this section on pages 86-90.

**Bees** (F: Apidae): This family includes the introduced honey bee *Apis mellifera*, but also many native species that are important plant pollinators and may be seen visiting flowers.

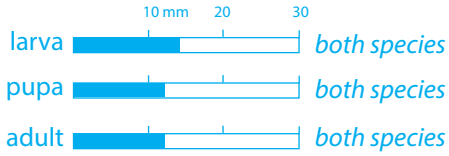
**Ants** (F: Formicidae): All ants belong to the one family. Worker ants, soldiers and males are commonly seen and in some species the queen is also visible. The feeding habits of adult ants can vary and may range from specialist to generalist predators, scavengers and omnivores, to seed-eaters, fungus or honeydew feeders. Some ant species play an important role in seed dispersal.

# Hymenoptera: Cephidae

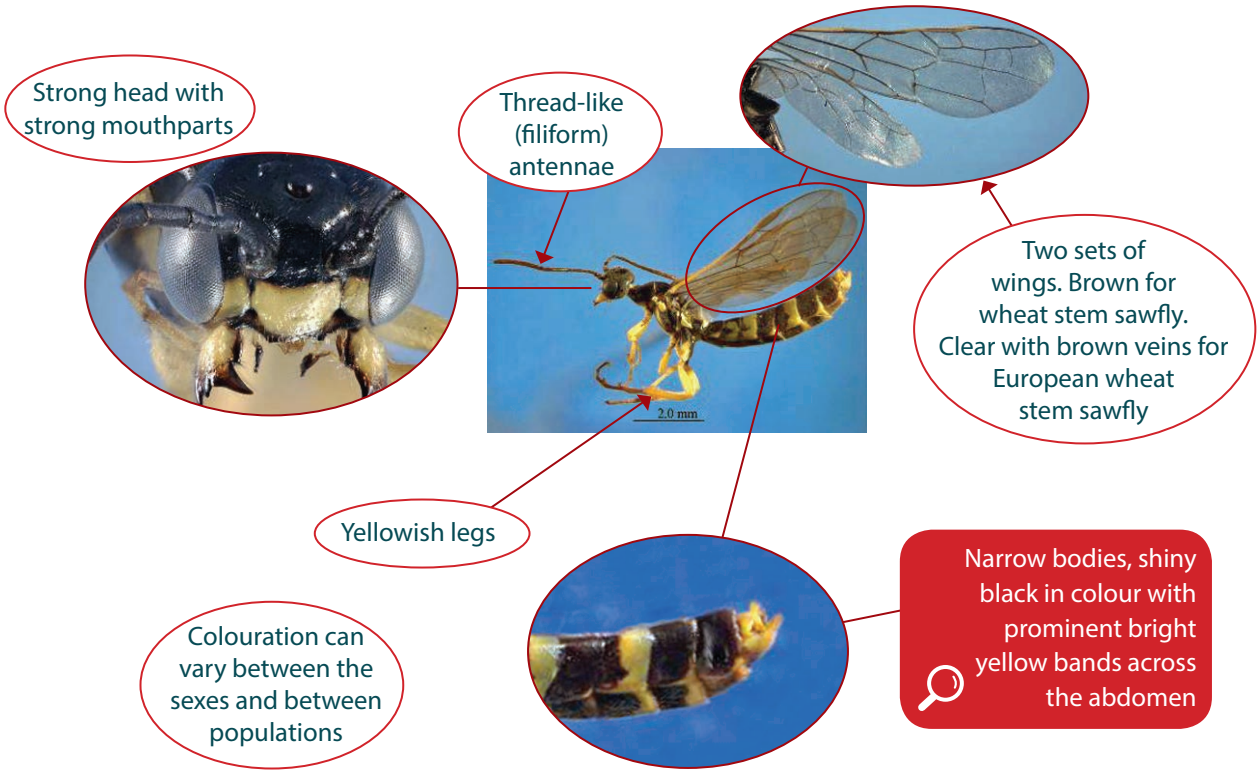
## Wheat stem sawfly (*Cephus cinctus*) and European wheat stem sawfly (*Cephus pygmeus*)

BIOSECURITY THREAT

## Distinguishing characteristics/description




### Wheat stem sawfly




Sawflies are wasps and not flies.

**Larvae** are legless (although European wheat stem sawfly has three pairs of reduced thoracic legs) with a head capsule and prominent mouthparts. They have a horn-like projection at the rear end of the abdomen (tubercule). Newly hatched larvae look transparent with tan-brown head regions.

Sawflies undergo 2-3 moults and darken to a whitish-yellow-green colour when mature.

These species go through one generation per year and larvae overwinter in underground stems. Pupae are white and become darkened before adult emergence.

Pupation occurs within a cocoon inside the stem near the roots or crown of the plant. Adults emerge in spring.

## Confused with/similar to

These closely-related species are difficult to tell apart and identification requires specialist knowledge.

They can also be confused with other wasps.

## Distribution and potential spread

Wheat stem sawfly occurs in North America and the European wheat stem sawfly occurs in Europe, Asia, Africa and North America.

Adults of both these species are weak flyers and transportation of larvae and pupae in straw is the most likely source of long-distance dispersal.

## Crops attacked/host range

Female wasps lay eggs in large, hollow-stemmed grasses such as wheat, rye, triticale, barley, oats and many other cultivated and wild grasses.

Host plants are only susceptible to oviposition after stem elongation.

## Damage symptoms

Larval feeding reduces yield and quality. Larvae bore into stems and nodes, making a discoloured tunnel and leaving frass throughout. Mature larvae cut a notch around the inside circumference of lower stems.

Damage varies depending on the year, locality, host plant and cultivar. The most obvious damage (caused by tunnelling and pupation) is weakening and clean cutting of stems and the subsequent lodging and loss of grain. Darkened spots can be visible on stems below nodes. This is a result of damage to the conducting tissue within the plant and the accumulation of impassable carbohydrates.

## Surveillance

Damaged stems should be cut open to reveal eggs and larvae. **Infested stems will contain saw-like frass inside.** Any insect that resembles these wasps must be sent to a specialist for identification.

**Early detection of plant pests can greatly increase the chance of successful eradication and reduce the cost and social impact of an incursion.**

Incorporate surveillance for exotic pests when undertaking routine crop monitoring and other crop detection and measurement activities.

## Reporting protocol

A rapid response to detection of potential exotic pests can be the key to containment, eradication or management. If you see anything unusual, call the Exotic Plant Pest Hotline on 1800 084 881.


Speak to your department of primary industries or department of agriculture before sending any samples.

It is essential that the correct sampling protocol is followed including packaging, handling and transport to the laboratory assigned for diagnosis. Incorrect handling could spread the pest further or render the samples unfit for identification.

Stop the movement of people, vehicles and equipment in the detected area until a confirmation can be made.

**More information**
Plant Health Australia website
**www.planthealthaustralia.com.au/biosecurity/grains**

*Ute Guides, Southern (p. 173)/Western (p. 140).*

# WASP PARASITOIDS
# Hymenoptera: Ichneumonidae and Braconidae

BENEFICIAL

**Various species - approximately 2000 species in Australia.**

***Specialists (parasites and parasitoids) and transient***

## Distinguishing characteristics/description

### Ichneumonidae

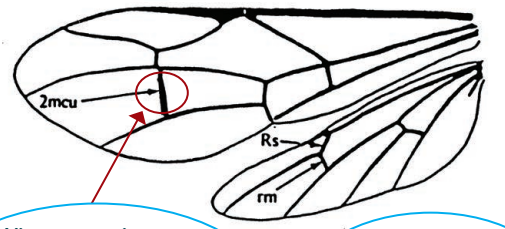
adult 10 mm 20 30 *though can vary from 2-120 mm*

*Diadromus collaris*

*General body appearance: elongated and slender - long antennae (filiform) and legs highly variable in colour from orange to black, with or without markings

*Waist constriction between thorax and abdomen

**Ichneumonidae wing venation to distinguish from braconids**




*Wing venation can vary depending on genera (e.g. fused or no veins). Forewing 2mcu vein is always present

*Wing venation full and many veins usually extend to the wing margin

*Diadegma semiclausum*

*Long and thin exposed ovipositor (females)

Light coloured legs

*Netelia producta*

Orange coloured body and legs

Diamondback moth cocoon (top) and cocoon of *D. semiclausum* inside diamondback moth cocoon (bottom), resulting in darkened cocoon with rounded ends

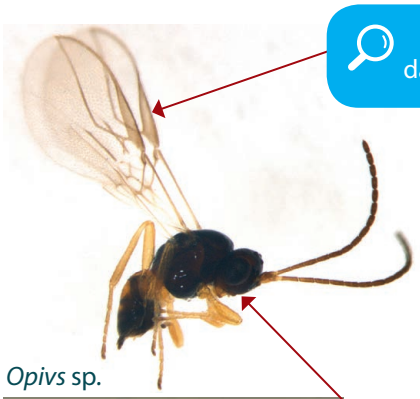
** indicates character for all species*

BENEFICIAL

## Distinguishing characteristics/description

### Braconidae

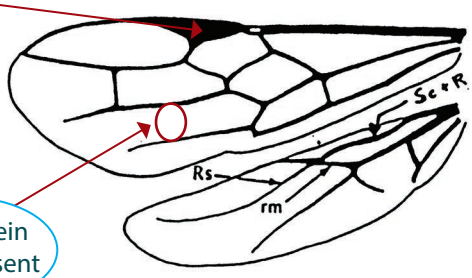
adult 10 mm 20 30 *though some can be up to 80 mm*



*Opivs* sp.

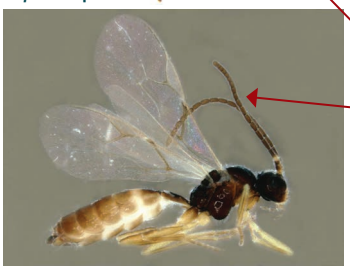
* Strong darkened cell

**Braconidae wing venation to distinguish from ichneumonids**




* Wing venation incomplete and many veins usually terminate before the wing margin

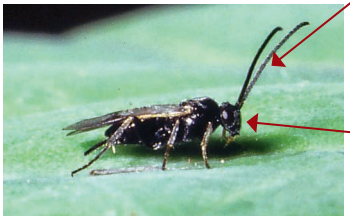
* 2mcu vein always absent



*Aphidiinae*

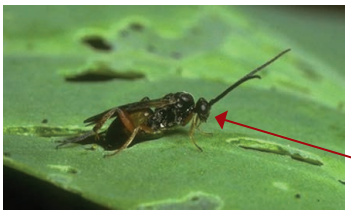
* General body appearance: dark coloured (relatively uniform), long antennae (filiform), shiny body with paler coloured and long legs

* Wing venation can vary depending on genera (e.g. fused or no veins)



*Apanteles* sp. (DBM parasitoid)

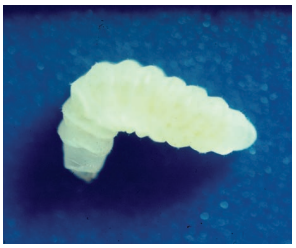
Shiny black colour



*Cotesia* sp. (DBM parasitoid)

Dark co-loured

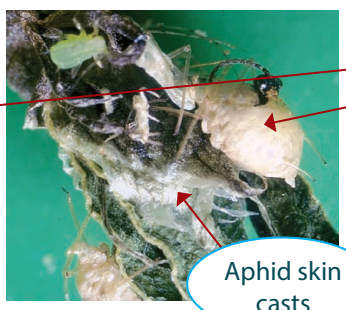
Cocoons of *Cotesia* spp. are usually white/ yellow in colour



Larva are internal in host bodies and legless (maggot like)

Host pupae unparasitised (above) and parasitised (below)

## Aphid mummies - Aphidiinae wasp parasitoids



Aphid skin casts

Wasp exit hole

Distinct bloated appearance. Usually brown/buff/gold or bronze sheen colouring

**indicates character for all species*

## Lifecycle

Complete metamorphosis.
Wasp parasitoids have a lifecycle that coincides with their host. The eggs are either injected into the host prey or attached to the outer body. Larvae feed internally on a host which is often killed in the process. They either emerge from the host to pupate (e.g. braconid wasps) or emerge from the host as adults (e.g. aphid parasitoids).

Different wasp parasitoid species can attack at different stages of the host's lifecycle.

## Confused with/similar to

These wasps resemble small flies but they are usually shiny in colour and have two sets of developed wings. They can be confused with other wasp species, which are hard to distinguish in the paddock and identification often requires specialist knowledge.

## Distribution/habitat

Common throughout most of Australia and can be found in a variety of habitats. Due to their close association with their host, their distribution is usually similar to that of their host.

## Pests attacked/impact on pests

Ichneumonids and braconids attack a range of insects (mainly the larval form) where the developing wasp larvae can grow either inside the host (endoparasite) or externally on the outside of the host (ectoparasite).

Ichneumonid wasps inject their eggs into native budworm or armyworm pupae within the soil. The feeding larvae prevents the moth from emerging, reducing future generations of pests.

Braconids attack a range of caterpillar pests including armyworm, cutworm and budworm. They lay their eggs inside host caterpillars which are often < 10 mm in size. Developing wasp larvae feed internally, before burrowing through the skin of their host and spinning a silken cocoon externally.

Many species are utilised as biological control agents of pest insects as they have a small host range - where a particular wasp attacks only one or several closely related genera.

**Some particular species include:**

*Netelia producta* attacks native budworms and other noctuid moths.

*Diadegma semiclausum* and *Diadromus collaris* attack diamondback moth larvae.

*Ute Guides, Southern (pp. 123-125,127)/Western (pp.98,99,102,103).*

## Evidence of parasitism in aphids: mummies

**Mummies are aphids that have been transformed into juvenile wasp casings and are only evident in the later stages of the wasp's development.**

**Look for:**

- **round, bloated, buff to bronzed coloured aphids that are relatively slow moving or stationary;**
- **emergence (exit hole) in mummies;**
- **aphid skin casts - don't confuse these with mummies or aphids.**

## Evidence of parasitism in some caterpillars: external wasp cocoons

**Some wasp species will:**

- **leave emergence (exit) holes in the caterpillar host and spin a cocoon nearby;**
- **pupate inside the host, resulting in the host pupae differing in some way (e.g. changing colour or shape).**

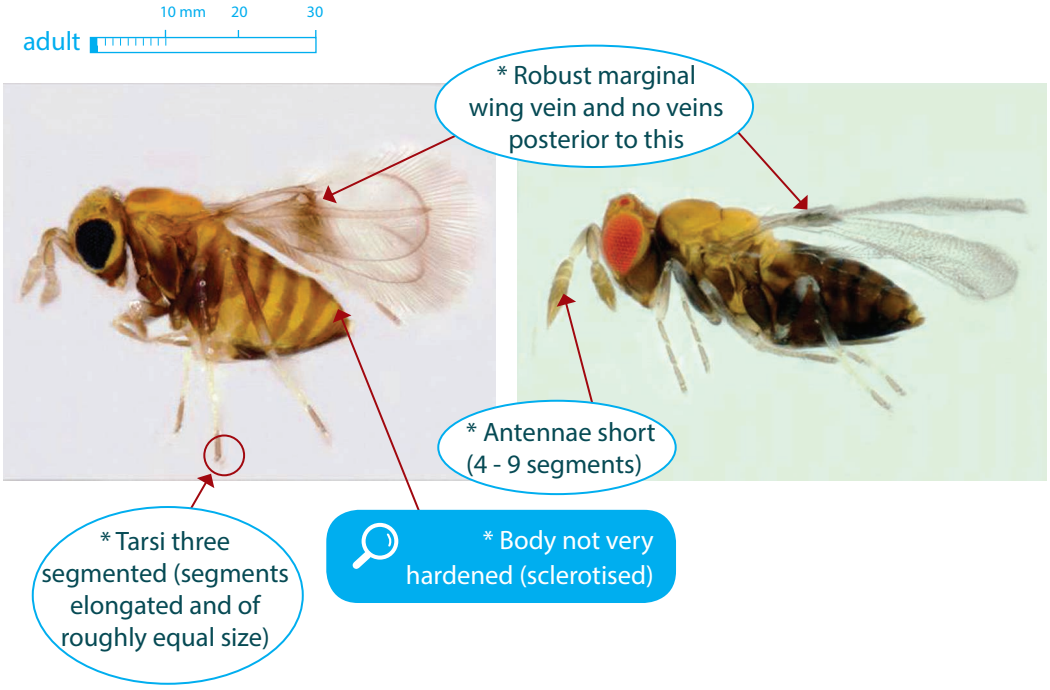
# EGG PARASITOIDS
## Hymenoptera: Trichogrammatidae, Scelionidae and Mymaridae

### Various species

### Specialists (egg parasitoids) and transient

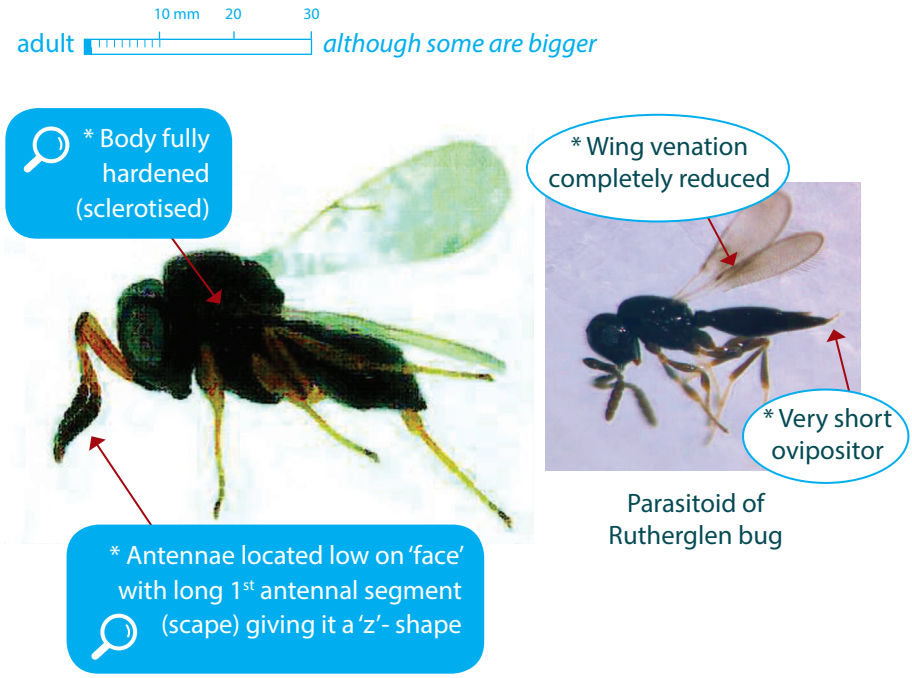
## Distinguishing characteristics/description

**Trichogrammatidae**

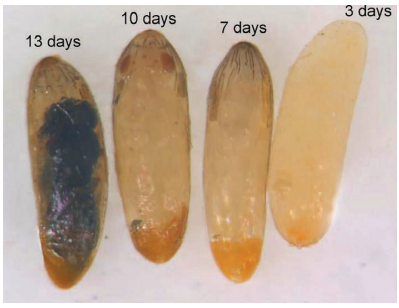



Trichogrammatidae parasitising *Helicoverpa* moth egg

**Scelionidae**
***Telenomus* spp.**




Parasitoid of Rutherglen bug




Wasp development in Rutherglen bug eggs

**indicates character for all species*

## Lifecycle

Trichogrammatidae, Scelionidae and Mymaridae are families of very small parasitic wasps that attack the eggs of insects and spiders.

Wasp parasitoids have a lifecycle that coincides with their host. They lay their eggs inside the egg of a host (e.g. moth egg). The wasp larvae feed inside the host egg until maturity, when one or more new parasitic wasps emerge from the destroyed egg.

## Confused with/similar to

They are confused with other wasp species and are hard to distinguish in the paddock. Identification often requires specialist knowledge.

More often, they go unnoticed due to their small size (usually <1 mm in length). Members of these families are difficult to classify, with many undescribed species likely to exist in Australia.

## Distribution/habitat

Various species can be found on a range of native plants (e.g. saltbush), grasses (e.g. *Enneapogon*) and *Brassica* weeds.

Trichogrammatidae are wind-distributed and are more habitat specific than host specific.

Some species can be purchased and mass-released but this is generally not cost effective in broadacre systems.

## Pests attacked/impact on pests

Trichogrammatidae attack a wide range of host eggs including moths, bugs, thrips and, less commonly, beetles, lacewings, flies, and dragon and damsel flies. *Trichogramma* spp. are biological control agents of *Helicoverpa* species.

*Telenomus* spp. are common egg parasitoids of moths (e.g. Noctuidae, Geometridae, Pyralidae, Lymantriidae, Zygaenidae) and true bugs (e.g. Pentatomidae, Lygaeidae, Reduviidae).

An exit hole in insect eggs is evidence of parasitism. The parasitised egg changes colour in *Helicoverpa* species.

*Ute Guides, Southern (p. 126)/ Western (p. 101).*

# Bees as pollinators

Bees provide a valuable service to agriculture by improving pollination and increasing crop yields, as well as being an important primary industry in the production of honey. It is often necessary to apply insecticides to flowering crops to control pests; but it is important to consider the effects on bees and take steps to reduce the risk of bee poisoning. Bees taking chemicals back to a hive can result in mass bee deaths, devastation of entire hives and contamination of the honey.

## Bee poisoning can occur when:

- Insecticides have been used on flowering crops and foraging bees are subsequently exposed to contaminated foliage, pollen or nectar.
- Insecticides have been used on crops that are not flowering, but other plants in the target area are flowering, causing bees foraging on these plants to become contaminated.
- Insecticides come in direct contact with bees that are present in or flying over the target area.
- Bees access water that contains insecticide residues.
- Spray drift causes direct contamination of bees, hives or flowering plants.

**Communication between crop owners and bee keepers is key to developing a mutually acceptable chemical program and minimising the risk to bees.**

*Photograph courtesy: Susanne Richards*

## Good practices for beekeepers

- Before placing hives, advise all adjoining crop owners and any other persons or authorities likely to be applying insecticides.
- Leave adequate signage in the area, including contact details.
- Place hives in sheltered areas away from crops that are likely to be treated with insecticide.

## Bee-friendly practices for growers

- Advise beekeepers with hives in the area that you intend to spray, giving as much notice as possible (at least 48 hours) to allow time to close down or move hives for the risk period.
- Choose chemicals that are less toxic to bees – carefully read all product labels (particularly 'Protection of Livestock' statements) to check toxicity to bees.
- Avoid applying insecticides at times when bees are foraging. Consider spraying very early in the morning (low hazard/short residual chemicals only) or late in the evening after bees have stopped foraging.
- Take care to avoid spray drift and contamination of water supplies.

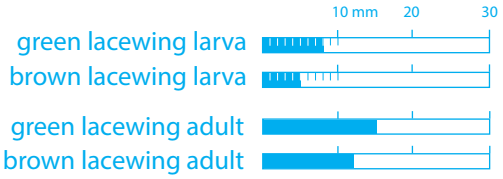
# LACEWINGS & ANTLIONS
## (Order Neuroptera)

BENEFICIAL

**Green lacewings Chrysopidae - approximately 70 Australian species.**
**Brown lacewings Hemerobiidae - approximately 50 Australian species.**

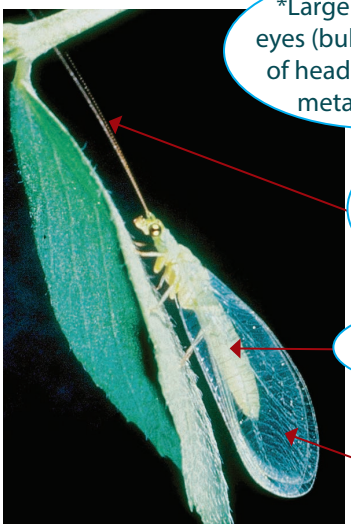
***Generalist and transient***

## Distinguishing characteristics/description




### Adult

**Green lacewing**

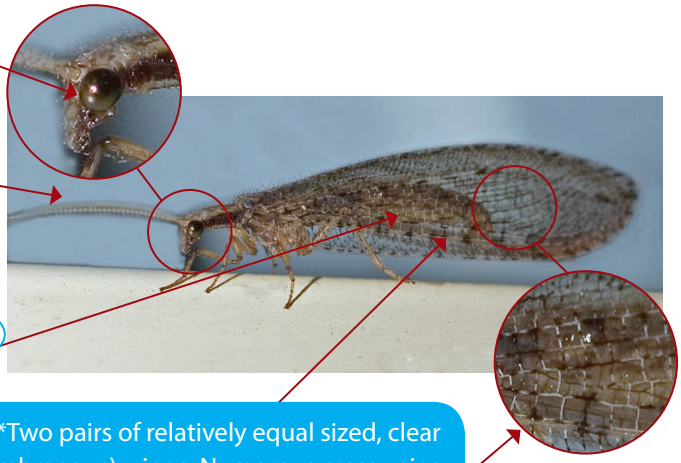


*Large compound eyes (bulging) on side of head. Eyes have a metallic sheen

*Long bead-like (filiform) antennae

*Elongated soft body

**Brown lacewing**

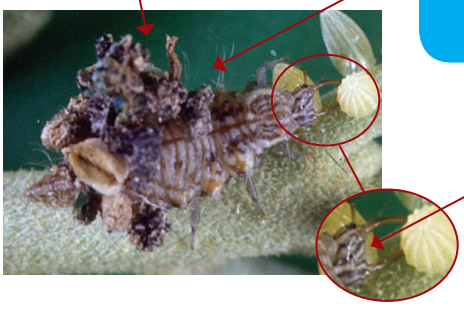


*Two pairs of relatively equal sized, clear (membranous) wings. Numerous cross veins across entire wing surface (lace-like appearance). Wings held tent-like over body when at rest

### Larva

**Green lacewing**

Larvae carry dead prey material on their back



*Tapering body shape with highly mobile legs. Body covered in curved spines

*Large sickle-shaped mouth-parts (modified jaws) projecting from the front of the head

**Brown lacewing**

** indicates character for all species*

## Lifecycle

Complete metamorphosis.
The females of many green lacewing species lay their eggs on the end of thin stalks. These may be attached to wood, leaves or other plant parts. Female brown lacewings lay eggs directly on vegetation. After hatching, larvae moult on average three times (sometimes four or five depending on the species) before they spin a silken cocoon in which they pupate.

Development is usually rapid (approx. three weeks for brown lacewings at temperatures of 25-30°C), with numbers most prevalent in spring and autumn when large populations move to areas rich in prey. Many species of lacewings go through several generations a year.

## Confused with/similar to

Lacewing adults can be distinguished from other winged insects by the presence of numerous veins and forked veins in wings. They can be confused with dragonflies (Odonata) and stoneflies (Plecoptera) but lacewings usually have longer antennae and softer bodies than dragonflies. Lacewings can also be confused with flying termites. Lacewings do not have two thin processes (cerci) at the end of the body (abdomen) as in stoneflies.

Lacewing larvae are easily distinguished by the prominent jaws at the front of their head that take up almost all of the head region. Green lacewing larvae commonly cover themselves in debris and the bodies of their prey as camouflage.

## Distribution/habitat

Lacewings are common throughout most of Australia and can be found in almost all habitats. They are common on native vegetation, such as flowering eucalyptus, and in house gardens. Their numbers increase where there is an abundance of prey, such as aphids.

## Pests attacked/impact on pests

Most larvae are active predators and have large sickle-shaped sucking jaws, which they use to catch small insects and suck out their insides.

Brown lacewing larvae and adults are both predatory, while only green lacewing larvae are predatory. Some adults of lacewing species supplement their diet with pollen and are omnivorous.

Predatory lacewings prefer sap-sucking insects such as aphids, mites, scale insects and moth eggs, but as generalists they will eat a wide range of prey.

*Ute Guides, Southern (pp.137-138)/ Western (pp.113-114)*

# SPIDERS (Order Araneae)

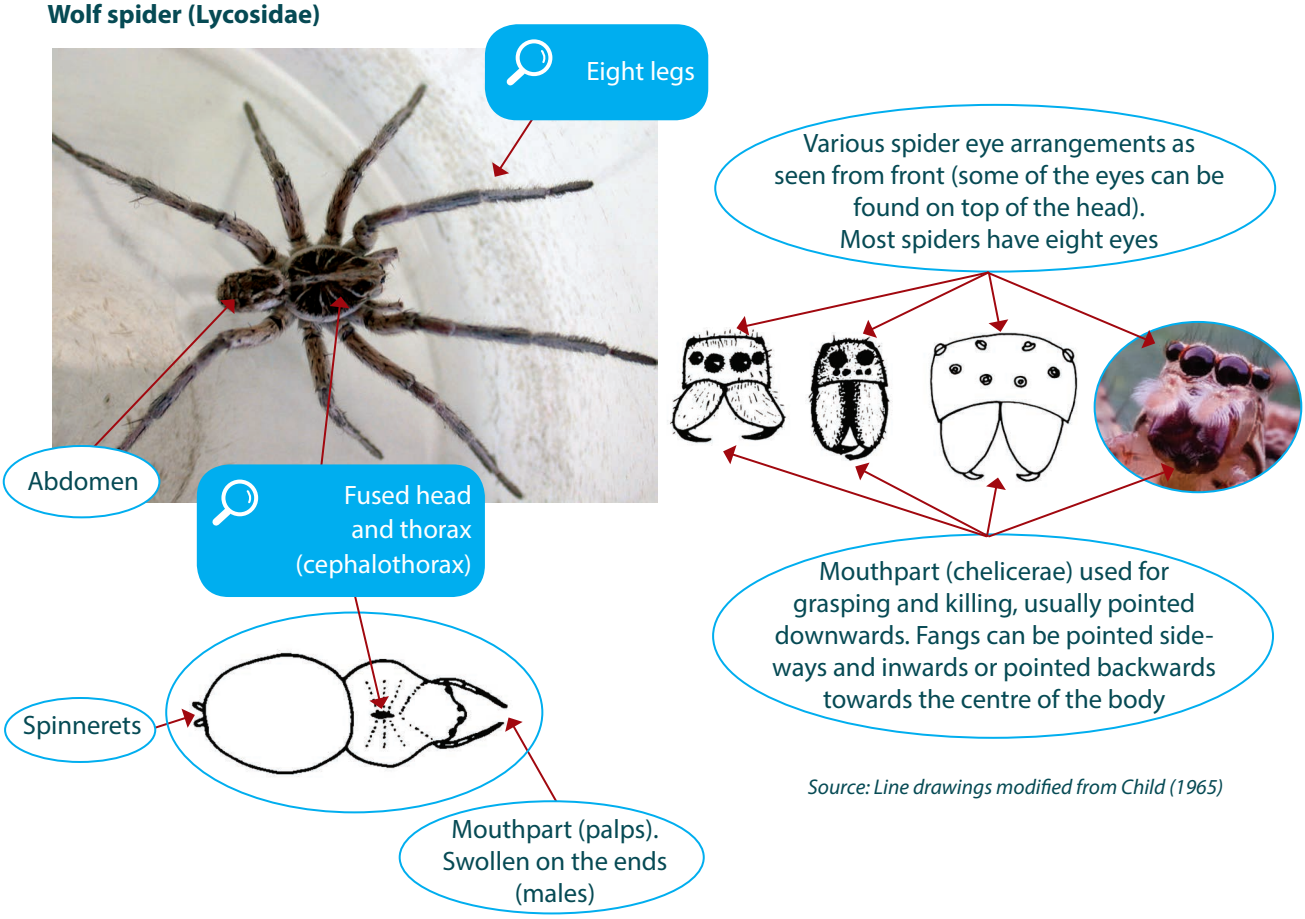
BENEFICIAL

**Various families and species - approximately 2000 Australian species.**

***Generalist and residential***

## Distinguishing characteristics/description

**Wolf spider (Lycosidae)**




*Source: Line drawings modified from Child (1965)*

## Lifecycle

Incomplete metamorphosis.
Most spiders have one generation per year. Spiders are easily recognisable but identification of specific families and species requires specialist knowledge.

All spiders are predatory and use a variety of hunting strategies to capture their prey, therefore it is easier to classify them in their functional group (e.g. web-builders or active hunters).

## Confused with/similar to

Spiders can range from just 0.5 mm in size to large species such as the huntsman with a leg span of over 20 cm. All spiders spin silk from a group of spinnerets at the end of the abdomen, but not all are web building for the purpose of catching prey.

## Distribution/habitat

There are at least six groups of spiders that commonly occur in field crops, with the most common being active hunters (rather than web-building). These include the wolf and huntsman spiders that chase down their prey, and trapdoor spiders that lie in wait to grab prey walking past their burrows. Smaller spiders, such as jumping spiders, are usually well-hidden ambush specialists and, although harder to see, are just as important.

## Pests attacked/impact on pests

Spiders consume a wide range of prey. They are effective predators not only of pests but also on other predators.

*Ute Guides, Southern (pp. 134)/Western (pp. 108-110).*

# More Information

## Website links

| | |
|---|---|
| DPIRD | Department of Primary Industries and Regional Development, Western Australia<br>https://www.agric.wa.gov.au/ |
| CESAR | CESAR<br>www.cesaraustralia.com |
| | PestNotes<br>http://www.cesaraustralia.com/sustainable-agriculture/pestnotes |
| SARDI | South Australian Research and Development Institute<br>www.pir.sa.gov.au/research |
| PIRSA | Department of Primary Industries and Regions, South Australia<br>www.pir.sa.gov.au |
| DEDJTR | Department of Economic Development, Jobs, Transport and Resources, Victoria<br>http://economicdevelopment.vic.gov.au/ |
| QDAF | Department of Agriculture and Fisheries, Queensland<br>https://www.daf.qld.gov.au/ |
| NSW DPI | Department of Primary Industries, New South Wales<br>www.dpi.nsw.gov.au |
| CSIRO | Commonwealth Scientific and Industrial Research Organisation<br>www.csiro.au |
| GRDC | Grains Research and Development Corporation<br>www.grdc.com.au |
| | "Best Bets"<br>http://ipmguidelinesforgrains.com.au/workshops/resources/ |
| PHA | Plant Health Australia: Grains Biosecurity<br>http://www.planthealthaustralia.com.au/biosecurity/ |
| PaDIL | Pest and Disease Image Library<br>www.padil.gov.au |
| APVMA | Australian Pesticides and Veterinary Medicine Authority<br>https://apvma.gov.au/ |

## PestFax/PestFacts services

The PestFax/PestFacts services are free interactive tools designed to keep growers and advisers informed about pest-related issues - and solutions - as they emerge during the growing season.

The services are distributed as electronic newsletters and aim to help growers achieve maximum yield and quality for the lowest cost by providing timely information about pest outbreaks, effective controls and current information about relevant and new research findings.

To provide this service PestFax/PestFacts draws on the field observations of consultants, growers and researchers across southern Australia as they report on the location and extent of invertebrate outbreaks. Growers can access maps through PestFax/PestFacts that show the location of invertebrate crop pests reports.

The PestFax/PestFacts services, part of GRDC's National Invertebrate Pest Initiative (NIPI), also issue warnings (or reminders) for a range of invertebrate pests of broadacre crops, including pulses, oilseeds, cereals and fodder crops.

The PestFax/PestFacts Reporter app can be used to report or identify any broadacre crop pest, unknown invertebrate or beneficial, and is available on iTunes (apple) and Google Play (android).

For further information or to subscribe to these services visit:

PestFax (DPIRD)
https://www.agric.wa.gov.au/newsletters/pestfax


PestFacts SA (SARDI)
http://www.pir.sa.gov.au/research/services/reports_and_newsletters/pestfacts_newsletter


PestFacts South-Eastern (CESAR)
http://cesaraustralia.com/sustainable-agriculture/pestfacts-south-eastern/