EcoVineyards
GROWING RESILIENCE NATURALLY

FIELD GUIDE

BIOCONTROL OF COMMON GRAPEVINE INSECT PESTS

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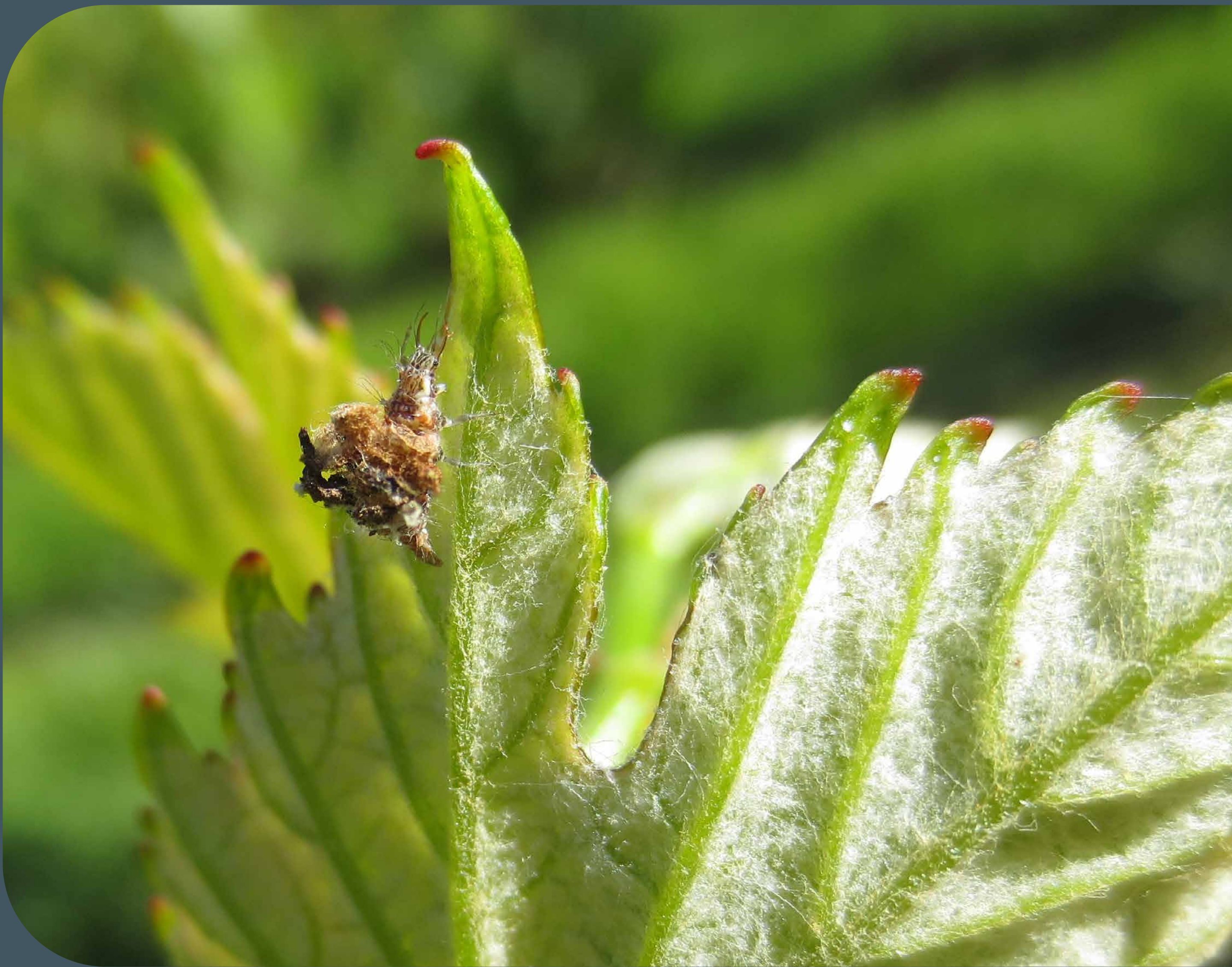

Wine Australia

retallack viticulture

FINDING THE BALANCE... NATURALLY!

Healthy and diverse populations of predatory arthropods (insects and spiders) and parasitoids (wasps and flies) can help prevent grapevine pests from reaching economically damaging thresholds.

Growers can support healthy predator populations by providing a habitat that provides food, shelter and alternative prey/hosts and minimise the use of pesticides that are toxic to natural enemies.

Biocontrol options for common Australian grapevine pests are explored in this field guide. For a broader discussion about functional biodiversity please see the EcoVineyards best practice management guide on functional biodiversity in Australian vineyards and to read individual fact sheets in this series please visit the EcoVineyards knowledge hub.

FAMILY TORTRICIDAE

Epiphyas postvittana, light brown apple moth (LBAM)

DESCRIPTION: Light brown apple moth (LBAM) is an Australian native leafroller belonging to the Lepidopteran (moth) order and Tortricidae (leafroller) family. LBAM is the principal insect pest that causes economic damage in Australian vineyards.

LBAM causes damage to flower clusters, resulting in yield losses and damage to berry skins. Damaged skins provide infection sites for *Botrytis cinerea* and other bunch moulds, which may result in a reduction in fruit quality and yield losses (Ferguson, 1995).

Annual losses from Botrytis and other bunch rots and LBAM were estimated at $52 million and $18 million, respectively, with a combined national economic impact of $70 million per annum. (Scholefield and Morison, 2010).

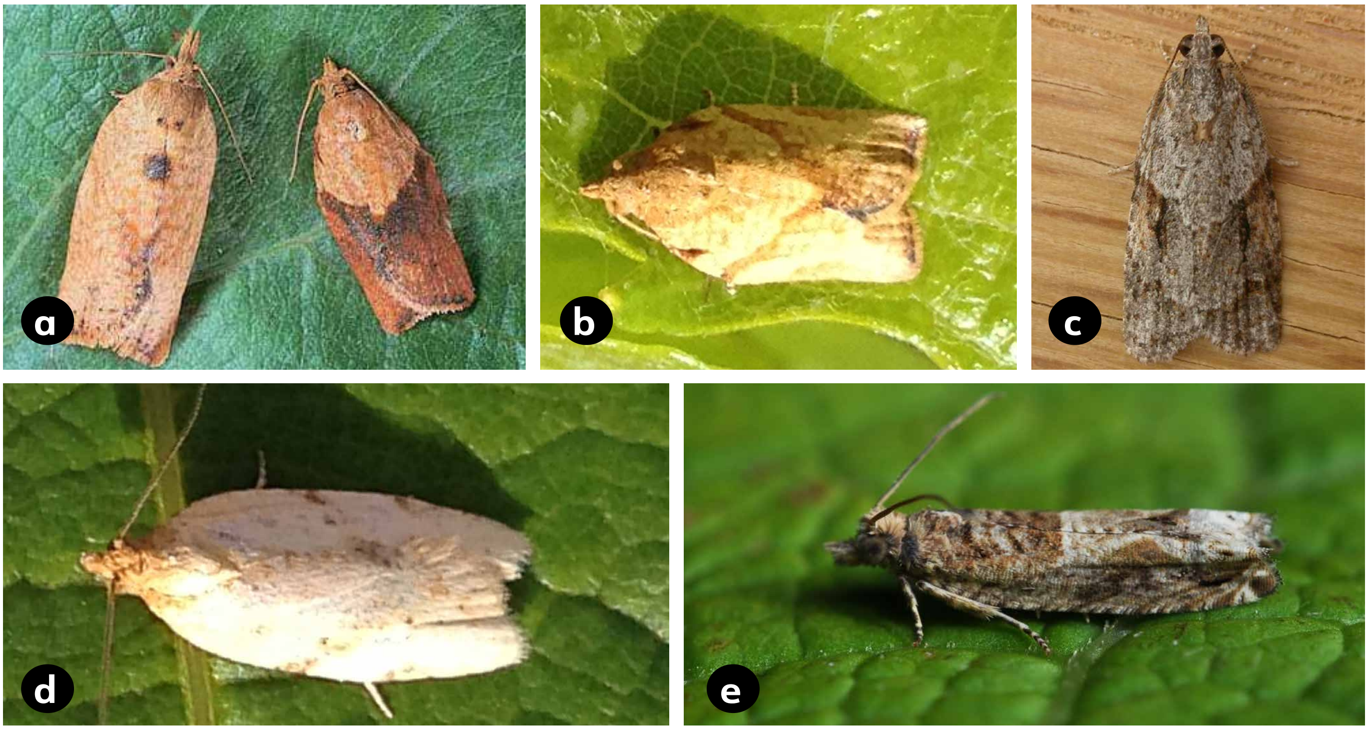

Figure 1. (a) Light brown apple moth female (L) and male (R) [Photo: Greg Baker], (b) male LBAM [Photo: Mary Retallack], (c) *Acropolitis rudisana* [Photo: D Hobern], (d) *Merophyas divulsana*, lucerne leafroller [Photo: Mary Retallack], (e) *Crocidosema plebejana*, cotton tipworm [Photo: uncredited at http://revtangen.blogspot.com.au/2016/09/].

DISTINCTIVE FEATURES: Adult moths are variable in colour and may be confused with other leafroller moths and similar species. Typically, males have a forewing length of 6 to10 mm with a light brown area at the base, which is distinguishable from a much darker, red-brown area above. The latter may be absent, with the moth appearing uniformly light brown, as in the case of females, which have only slightly darker, oblique markings distinguishing the area at the tip of the wing. Females have a forewing length of 7 to 13 mm.

The larvae of Tortricidae have no defining morphological features and molecular methods are required to determine with confidence the species identity. A practical alternative is to rear larvae in containers to adulthood. However, specialist knowledge is still required to ensure correct identification of adult moths.

Recent research found that other species of leafrollers from the tortricid family may also be present in grapevine canopies including *Acropolitis rudisana*, *Merophyas divulsana*, lucerne leafroller and *Crocidosema plebejana*, cotton tipworm,(Retallack et al., 2018).

BREEDING CYCLE: Typically, there are three (spring, summer and autumn-winter), and occasionally four LBAM generations.

WHEN TO MONITOR: Monitor for the presence of egg masses, larvae, and adult moths from early spring onwards with close inspection required in the lead up to flowering and fruit set. Pheromone traps and port lures can be used to trap adults.

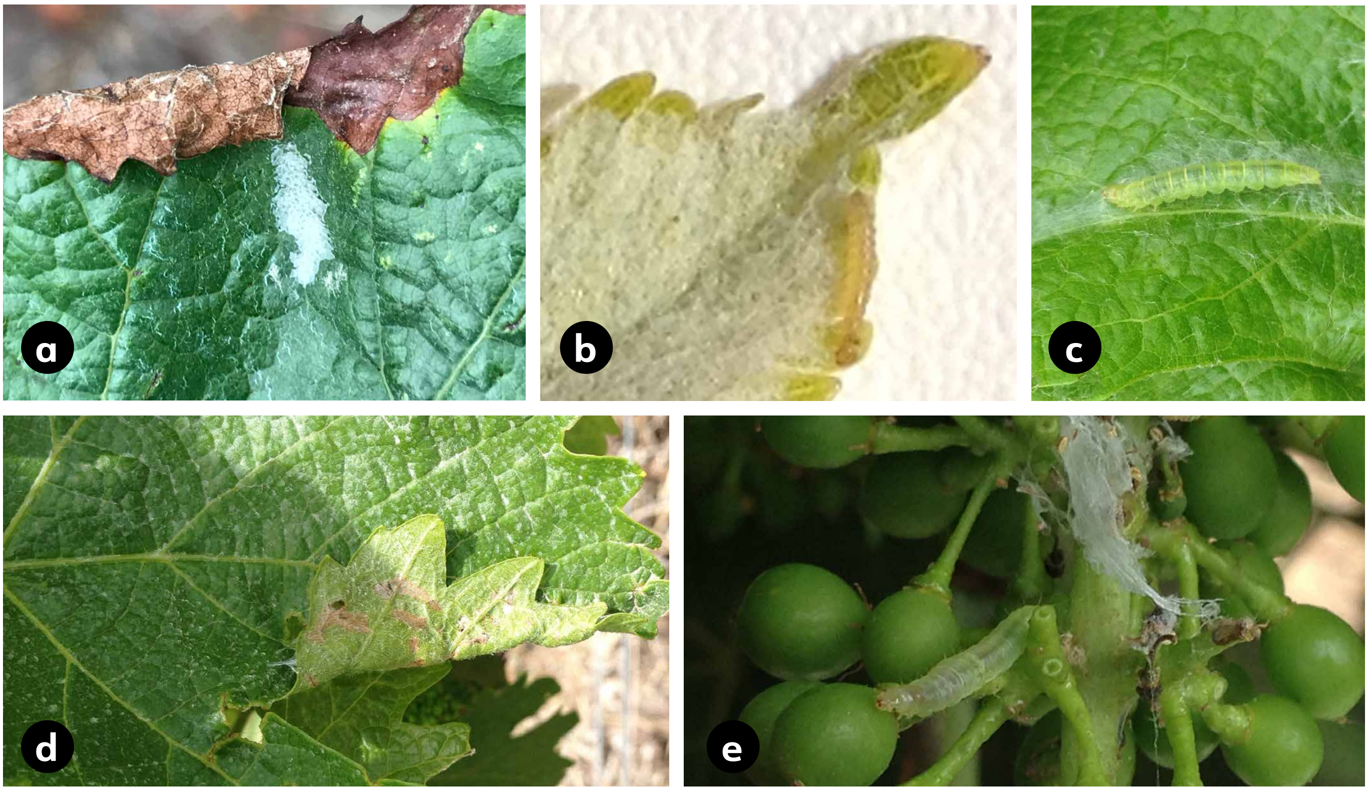

Figure 2. (a) leafroller egg mass, 1st or 2nd instar, (b) tortricid larva on a leaf tip, (c) 5th or 6th instar inside a silk refuge, (d) folded grapevine leaf providing shelter, and (e) larva inside a developing bunch of grapes [Photos: Mary Retallack].

CORRECT IDENTIFICATION OF LEAFROLLERS: Research has demonstrated that light brown apple moth is a key tortricid pest of South Australian vineyards. However, low densities of *Acropolitis rudisana*, *Merophyas divulsana* and *Crocidosema plebejana* have also been found on the canopies of grapevines (Retallack, 2019; Retallack and Keller, 2018; Retallack et al., 2018). As these additional species are closely related to LBAM it is anticipated they can be managed through existing IPM strategies (Retallack and Keller, 2018; Retallack et al., 2018).

Australian vineyard managers often scout broadleaf weeds, including plantain and capeweed, in the mid-row for the presence of moth larvae to provide an indication of leafroller activity early in the growing season. *Acropolitis rudisana*, *Merophyas divulsana* and *Crocidosema plebejana* may also provide alternative hosts for parasitoids and prey for predators when they are in vineyard mid-rows and don't migrate to the canopy.

This is especially important during the winter period and early in the growing season when alternative prey is needed to boost the presence of key predators of LBAM so they can provide natural biological control before LBAM populations reach damaging levels in the canopy.

The removal of broad-leaved weed monocultures is recommended to reduce breeding and overwintering locations for LBAM larvae.

Figure 3. Growers can rear leafroller larvae and determine the species once they emerge as adults [Photo: Mary Retallack].

SUGGESTED ACTION THRESHOLDS: Growers are encouraged to develop their own action thresholds based on data collected from monitoring and damage assessments at harvest over several seasons.

Monitor shoots for the presence of larvae on a weekly to fortnightly basis, scanning 100 shoot replicates from tip to base. Suggested action threshold levels that have been developed in cooler regions with higher Botrytis pressure (Braybrook, 2013), are:

- more than 3 viable egg masses per 1,000 leaves
- more than 10 caterpillars per 100 shoots
- more than 10 caterpillars per 100 bunches.

Biocontrol options

There are many species that can contribute towards biological control of LBAM, including microbats and insectivorous birds. Important parasitoids and predatory arthropods are discussed below.

PARASITOID WASPS: There are at least 28 species of parasitic wasps of LBAM in Australia (Paull, 2007). The most common parasitoids of LBAM in Australia are *Gonozius jacintae*, bethylid wasp, *Dolichogenidea tasmanica*, braconid wasp, *Australoglypta latrobei*, *Exochus* sp., and *Xanthopimpla rhopaloceros*, ichneumonid wasps, and *Brachymeria rubripes*, chalcid wasp (Suckling and Brockerhoff, 2010).

A specific strain of *Trichogramma carverae* wasp can parasitise LBAM eggs (Glenn et al., 1997; Glenn and Hoffmann, 1997) but no other life stage. This, along with low levels of parasitism and late season activity, may naturally limit their ability to control LBAM in isolation (Bernard et al., 2006a).

However, young LBAM instars can be parasitised by *Dolichogenidea tasmanica*, but parasitism is only possible up to and including the third instar (Yazdani et al., 2015). Whereas, *Goniozus* ssp. (Hymenoptera: Bethylidae) can parasitise third and fourth stage instars (Danthanarayana, 1980).

Interestingly, research in Coonawarra also found a novel interaction between *Dolichogenidea tasmanica*, a parasitoid wasp that renders larval LBAM more susceptible to attack by *Anystis baccarum*, a predatory mite species (Paull, 2007).

Figure 4. (a) parasitised egg mass [Photo: Mary Retallack], (b) *Dolichogenidea tasmanica*, braconid parasitoid wasp parasitising a LBAM larva [Photo: Michael A Keller], (c) a parasitic wasp, silk cocoon [Photo: Mary Retallack].

Previously, a strain of *Trichogramma carverae* was isolated that could parasitise flat LBAM egg masses (in preference to round eggs) and was made available for biocontrol (Glenn and Hoffmann, 1997).

The strain of *T. carverae* that parasitises flat LBAM egg masses has not been commercially available recently, but the producer is willing to culture *T. carverae* if there is a regular commitment from the wine community. Please contact Dan Papacek from Bugs for Bugs for more information.

Work done in collaboration with AgVic suggests that *Trichogramma pretiosum* is as efficient (perhaps more so) as *T. carverae* for management of LBAM (Dan Papacek, pers. comm. 4 October 2024).

PREDATORY ARTHROPODS: A range of generalist predators contribute to the control of LBAM (Bernard et al., 2006b). The main predators of LBAM include neuropteran larvae (lacewings), spiders, earwigs, ladybird, carabid and rove beetles, predatory Hemiptera (shield and damsel bugs), and predatory Diptera (hover flies and robber flies) (Bernard et al., 2006b; Frank et al., 2007; Thomson and Hoffmann, 2009; Thomson and Hoffmann, 2010).

Some predators feed on LBAM eggs (Danthanarayana, 1980; Paull and Austin, 2006). It is reported that up to 90% of newly hatched leafroller larvae may be killed by predators in the absence of toxic chemicals (Helson, 1939). A range of predators and parasitoids are available commercially as biocontrol agents, including green lacewings and common spotted ladybirds.

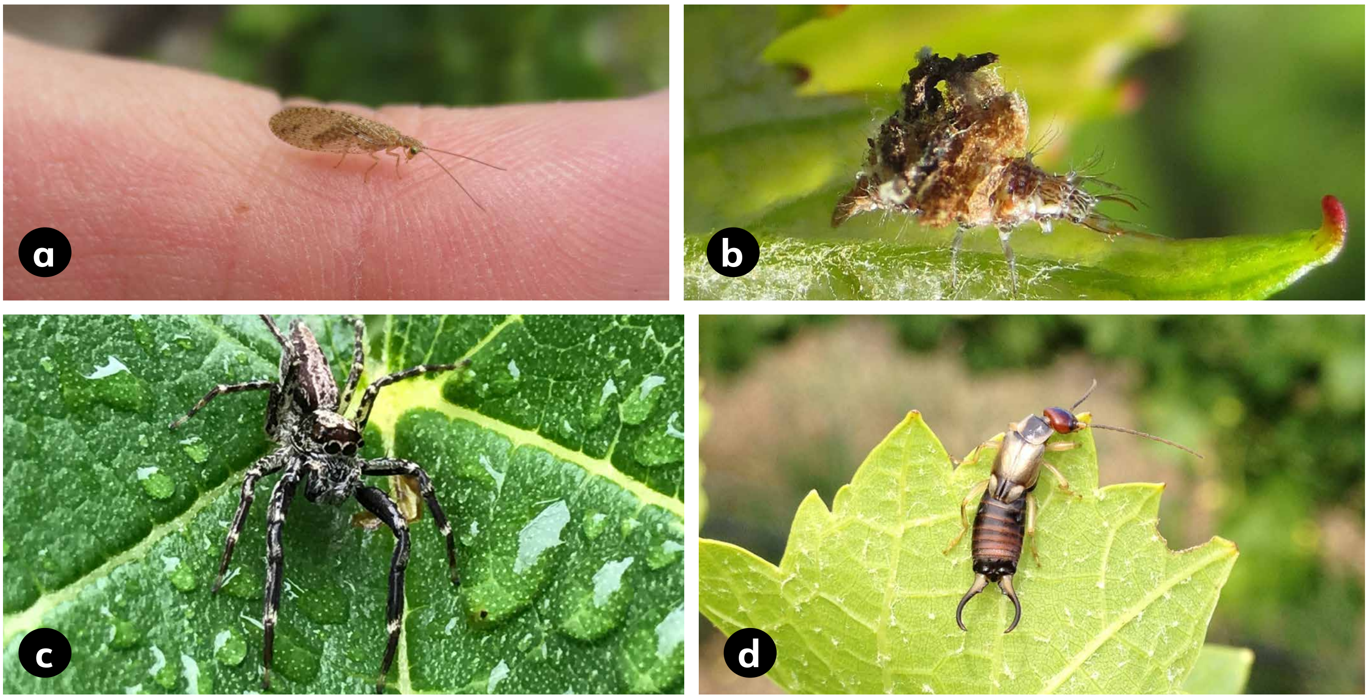

Figure 5. (a) *Micromus tasmaniae*, brown lacewing, (b) *Mallada signatus*, green lacewing larva, (c) jumping spiders (Salticidae) are active hunters, (d) *Forficula Auricularia*, European earwig [Photos: Mary Retallack].

Figure 6. (a) *Cermatulus nasalis*, glossy shield bug [Landcare Research CC-BY 4.0], (b) *Oechalia schellenbergii*, predatory shield bug, (c) *Harmonia conformis*, common spotted ladybird beetle, and (d) *Nabis kinbergii*, Pacific damsel bug [Photos: Mary Retallack].

***Bacillus thuringiensis* (Bt):** *Bt* products can be used anytime throughout the growing season. The *Bt* bacterium is toxic to moth larvae and, once consumed, it results in the paralysis of the digestive tract and larvae starve to death.

PHEROMONES FOR MATING DISRUPTION: Pheromone-infused twist ties have been used successfully in large-scale mating disruption trials in south-eastern Australia to confuse the male moth's ability to track the female scent (Mo et al., 2006). However, they are not currently widely employed by vignerons in Australia.

Specialised pheromone and lure application technology (SPLAT): provides an alternative to existing pheromone application. SPLAT LBAM™ technology (available via the USA) provides a similar efficacy to pheromone-infused twist ties in disrupting the mating of light brown apple moth while streamlining the application of pheromones via manual or mechanical application (Suckling et al., 2012a; Suckling et al., 2012b).

A recent EcoVineyards trial in the Mornington Peninsula demonstrated the capacity for SPLAT to control LBAM below economically damaging thresholds when compared to the untreated control.

For more information see the EcoVineyards fact sheet: Specialised pheromone and lure application technology (SPLAT) control of LBAM.

FURTHER READING

For general information see the Wine Australia website page on light brown apple moth and AWRI website page on LBAM.

For more information on natural enemies, please see natural predators of vineyards insect pests booklet and associated articles and fact sheets on the EcoVineyards knowledge hub.

FAMILY NOCTUIDAE

Phalaenoides glycinae, Australian grapevine moth

DESCRIPTION: The Australian grapevine moth is a moth belonging to the family Noctuidae. The larvae may cause feeding damage to developing bunches and/or defoliation of grapevine leaves if populations are left unchecked. It is reported if caterpillars are accidentally fermented during the winemaking process, the resulting wine may have an elevated cineol (eucalyptol) concentration if the caterpillars have been eating Eucalyptus leaves.

DISTINCTIVE FEATURES: Grapevine moth eggs are commonly laid on the underside of leaves and resemble spherical domes. They are slightly ribbed and have a diameter of about 0.3 mm. The caterpillars grow to about 40 mm. They have striking black, white, yellow, and orange markings with a light brown head capsule and a big red rump. Adult moths have tufts of orange hair projecting from their abdomen and the base of their legs, contrasting with the black and white markings of their wings and body. The wingspan is about 50 mm.

Figure 7. (a) *Phalaenoides glycinae*, grapevine moth egg, (b) larva, and (c) adult [Photos: Mary Retallack].

BREEDING CYCLE: Moths emerge from over-wintering pupae in early spring and lay eggs on stems and leaves. There are two to three annual generations with larvae first typically appearing on vines in October, and the second generation of moths appearing in December. In areas with warm to hot summers, a third generation may occur between late summer and autumn.

WHEN TO MONITOR: Monitor from late October onwards.

SUGGESTED ACTION THRESHOLDS: Growers are encouraged to develop their own action thresholds based on data collected from monitoring and damage assessments at harvest over several seasons to reduce the likelihood of defoliation (especially later in the season leading up to harvest).

Biocontrol options

Many natural enemies, including insectivorous birds, microbats, predatory arthropods, and parasitic wasps, attack grapevine moth. Because it causes damage to vine foliage very rapidly once it is established, this pest is unlikely to be controlled satisfactorily through the reactive use of commercially available biological control agents. However, a functional diversity of predators will help to reduce the likelihood of populations reaching damaging levels. Alternatively, the strategic use of *Bt* sprays coupled with a feeding attractant may provide effective control.

PARASITOIDS: Parasitoids, such as tachinid flies and parasitoid wasps, contribute towards biocontrol. *Euplectrus agaristae*, chalcid wasp, is a parasitoid of the Australian vine moth larvae (Bernard et al., 2006a) and is present in Coonawarra vineyards along with *Echthromorpha intricatoria*, cream-spotted ichneumon, and *Lissopimpla semipunctata*, orchid dube wasp (Thomson and Hoffman, 2006).

PREDATORY ARTHROPODS: Important predators include *Cermatulus nasalis*, glossy shield bug, and *Oechalia schellenbergii*, predatory shield bug (Cordingley, 1981), ladybird larvae and spiders.

***Bacillus thuringiensis* (*Bt*):** Bt products can be used anytime throughout the growing season. The *Bt* bacterium is toxic to moth larvae and, once consumed, it results in the paralysis of the digestive tract and larvae starve to death.

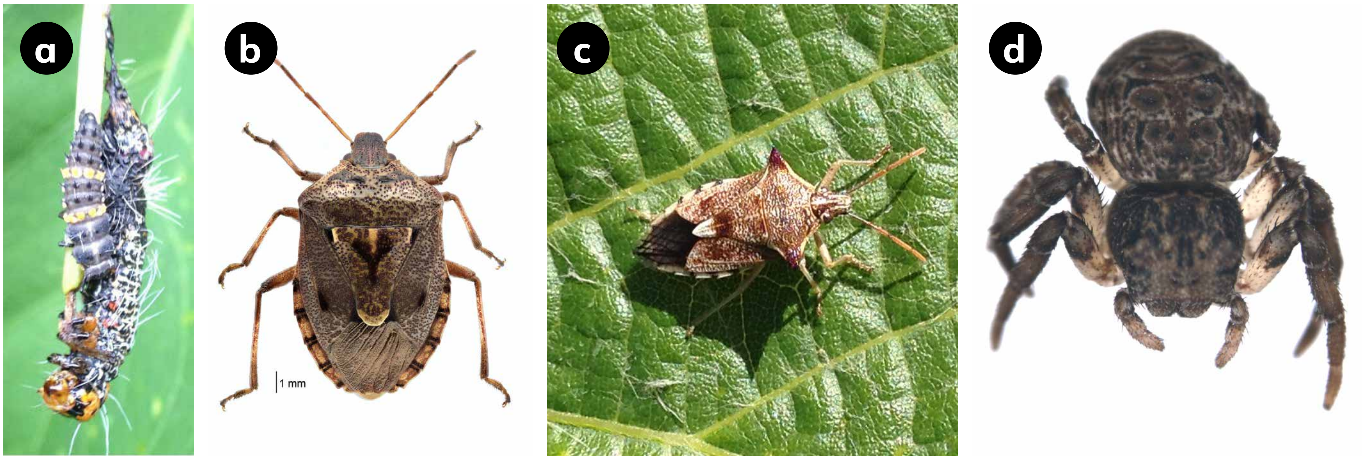

Figure 8. (a) ladybird beetle larva feeding on the Australian grapevine moth [Photo: Mary Retallack], (b) *Cermatulus nasalis*, glossy shield bug, [Landcare Research CC-BY 4.0], (c) Oechalia schellenbergii, predatory shield bug, and (d) *Cymbacha* sp., crab spider [Photos: Mary Retallack].

FURTHER READING

For more information on natural enemies, please see natural predators of vineyards insect pests booklet and associated articles and fact sheets on the EcoVineyards knowledge hub.

FAMILY PSEUDOCOCCIDAE

Pseudococcus longispinus, long-tailed mealybug

DESCRIPTION: The long-tailed mealybug is a common pest of grapevines. It feeds on sap and produces honeydew that encourages the growth of damaging sooty mould. Mealybugs are often tended by ants that feed on their excreted honeydew. Mealybugs prefer humid, sheltered situations and favour conditions that promote vigorous vine growth and dense foliage. Mealybugs also have the capacity to transmit grapevine viruses.

Figure 9. (a) *Pseudococcus longispinus*, long-tailed mealybug, (b) on the back of a grapevine leaf, (c) on a developing bunch of grapes and at harvest [Photos: Mary Retallack].

DISTINCTIVE FEATURES: Adults are 3 to 4 mm long with a mealy wax cover and long tail filaments (as long, or longer than the body). When squashed the body fluids appear pale yellow.

BREEDING CYCLE: Mealybugs overwinter in cracks and crevices under vine bark, then migrate to new vine growth in spring. Three to four generations of mealybugs develop each year, with major population peaks in spring and autumn. During summer the life cycle is completed in around 6 weeks (about 12 weeks in winter). The adult females produce several hundred eggs at a time. These hatch into crawlers immediately after being laid.

WHEN TO MONITOR: By late spring/early summer, mealybugs can be found on the backs of leaves, especially in the centre of the vine where they are more sheltered.

SUGGESTED ACTION THRESHOLDS: Growers are encouraged to develop their own action thresholds based on data collected from monitoring and damage assessments at harvest over several seasons. Intervention may be required if infestation levels exceed a threshold of 10% of the 100 leaves or bunches sampled.

Biocontrol options

PARASITOID WASPS: A range of parasitoid wasps contribute to biocontrol of mealybugs, including *Anagyrus fusciventris*, *Tetracnemoidea brevicornis*, *Tetracnemoidea sydneyensis*, *Leptomastix* ssp., *Ophelosia* ssp., and *Coccophagus gurneyi*.

PREDATORY ARTHROPODS: A range of predators feed on soft-bodied pests, including ladybird beetles (*Cryptolaemus montrouzieri*, mealybug destroyer, *Coccinella transversalis*, transverse ladybird beetle, *Harmonia conformis*, common spotted ladybird beetle, *Rhyzobius lophanthae*, scale-eating ladybird), spiders, as well as lacewing and hoverfly larvae.

Biological controls, such as the mealybug destroyer ladybird beetle and green lacewing, are commercially available for release. The mealybug destroyer is a voracious feeder of the pest in both the larval and adult stages. Its larvae resemble the mealybug (a case of mimicry).

Release biocontrol agents early (mid to late spring) before pest populations increase and become difficult to control.

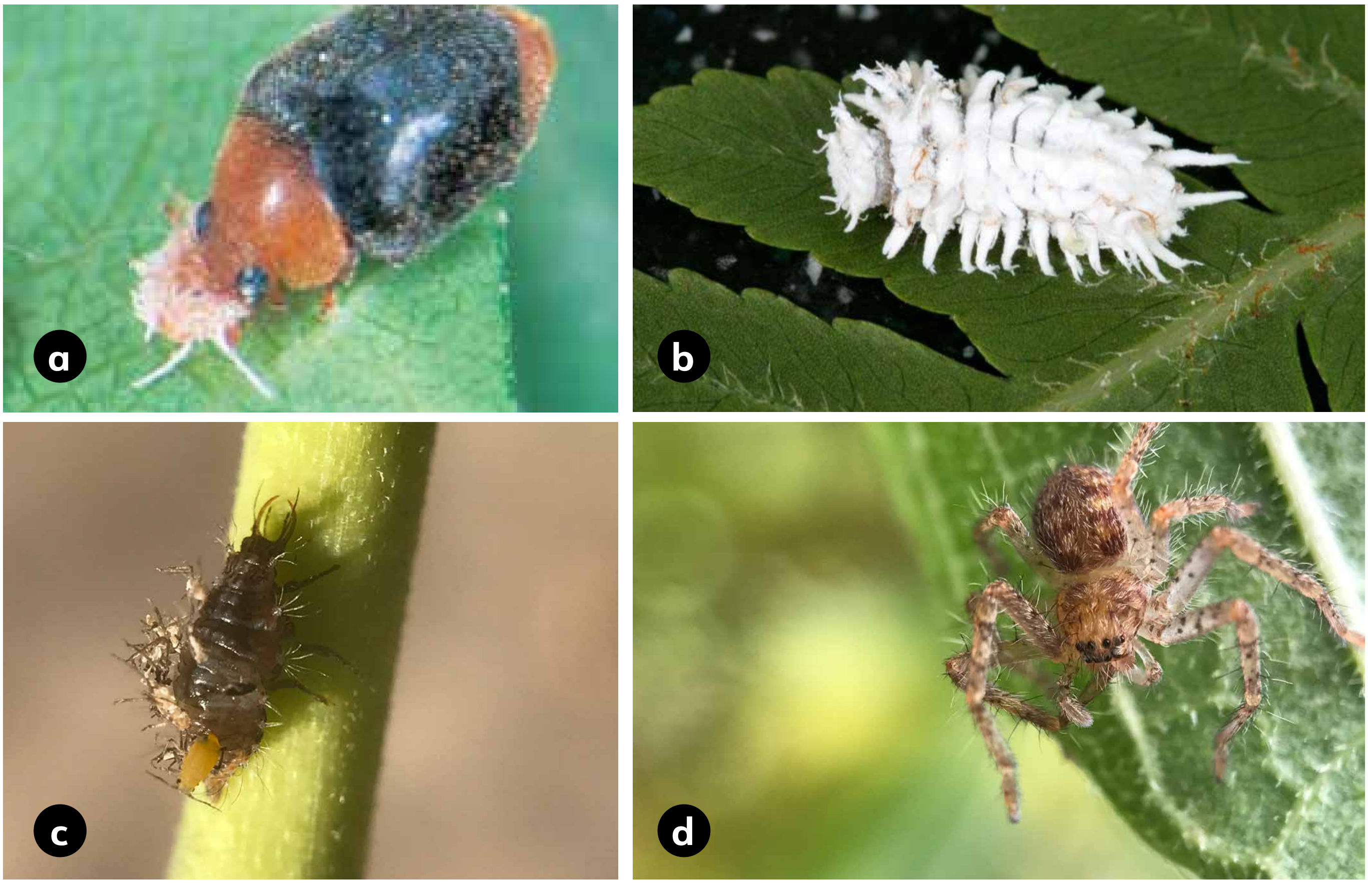

Figure 10. (a) *Cryptolaemus montrouzieri*, adult mealybug destroyer, [Photo: David Madge], (b) C. montrouzieri larva [Photo: David Cappaert], (c) green lacewing larva (aka 'junk bug'), and (d) huntsman spider [Photos: Mary Retallack].

Two other species of mealybug may also be found in Australian vineyards, *Pseudococcus calceolariae*, citrophilus mealybug, and *Pseudococcus affinis*, obscure mealybug.

FURTHER READING

For general information on mealybugs see the Wine Australia website page on mealybugs and AWRI website page on mealybugs.

For more information on natural enemies, please see natural predators of vineyards insect pests booklet and associated articles and fact sheets on the EcoVineyards knowledge hub.

FAMILY COCCIDAE

Parthenolecanium persicae, grapevine scale

DESCRIPTION: Grapevine scale is the most prevalent species of scale insect found in vineyards, and *Parthenolecanium pruinosum*, frosted scale, is also found on some sites. Their life cycles are very similar, and control methods are the same.

Indirect damage is caused by scale insects when the secreted honeydew is colonised by microorganisms and results in sooty mould. Scale insects are sap sucking bugs and can also transmit grapevine viruses. The presence of sooty mould can result in the downgrade of fruit quality. Ants feed on the honeydew and help protect the scale insects from attack by predatory arthropods.

DISTINCTIVE FEATURES: Grapevine scale is a small, oval-shaped, sucking insect up to 6 mm long that lives beneath a protective dark brown wax cover. Grapevine scale produces pink eggs (compared to frosted scale that produces cream-coloured eggs).

Figure 11. Examples of grapevine scale [Photos: Mary Retallack].

BREEDING CYCLE: There is one generation of soft scales per year.

WHEN TO MONITOR: Check underneath bark on spurs, canes and cordons during winter, and again during late spring and summer when mature scales deposit hundreds of eggs under their bodies and then die.

Scale insects are difficult to detect at low densities, but the presence of ants is often a good indicator that they are present. The presence of sooty mould also indicates the possible presence of scales and/or mealybugs.

SUGGESTED ACTION THRESHOLDS: Once an infestation is found, mark the area in case future action is required. If sooty mould has caused economic loss in the previous season, then intervention may be warranted the following season.

Biocontrol options

PARASITOID WASPS: *Metaphycus maculipennis* is a common parasitoid of grapevine scale *Parthenolecanium persicae* (Rakimov et al., 2015), as well as *Cheiloneurus* ssp. and *Coccophagus lymnia* (Thomson and Hoffman, 2006).

PREDATORY ARTHROPODS: Predators such as ladybird beetles (*Rhyzobius pulchellus, Rhyzobius forestrii, Cryptolaemus montrouzieri, Coccinella transversalis, Hippodamia varigata*), predatory moths (*Mataeomera dubia* and *Stathmopoda melanochra*), carabid beetles, soft-winged flower beetles, and lacewings all contribute to the control of grapevine scale (Rakimov et al., 2015).

The predatory mite *Anystis baccarum* is a predator of the eggs and crawlers of soft scales (Bernard et al., 2004; Winter et al., 2018). Green lacewings and ladybird beetles are available for release commercially.

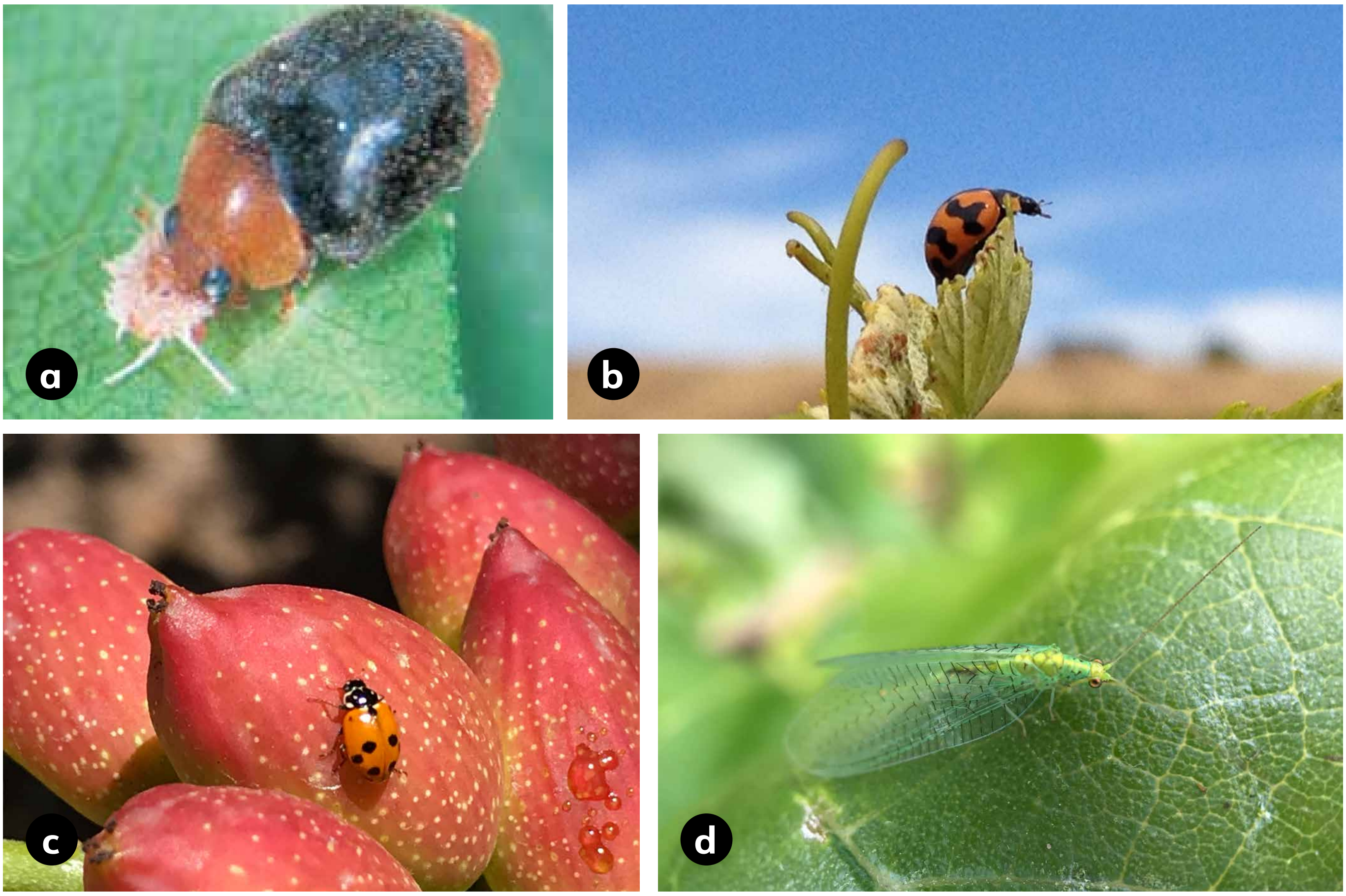

Figure 12. (a) Adult mealybug destroyer, *Cryptolaemus montrouzieri* [Photo: David Madge], (b) transverse ladybird beetle, *Coccinella transversalis*, (c) spotted amber ladybird beetle, *Hippodamia variegata*, (d) and green lacewing adult [Photos: Mary Retallack].

FURTHER READING

For more information about scale insects found in vineyards see the Wine Australia website page on grapevine scale and sooty mould and AWRI website page on scale insects.

For more information on natural enemies, please see natural predators of vineyards insect pests booklet and associated articles and fact sheets on the EcoVineyards knowledge hub.

FAMILY JULIDAE

Ommatoiulus moreleti, Portuguese millipede

DESCRIPTION: The invasive *Ommatoiulus moreleti*, black Portuguese millipede, is an unwelcome pest in vineyards, especially at harvest. It may damage the skins of berries by feeding on them, thereby predisposing the bunches to Botrytis cinerea and other bunch rots.

Their presence in grape ferments often results in wine taint as the defensive excretions produce unpleasant flavour compounds. Several species of native millipede occur in southern-Australia, but they are found infrequently in agricultural environments. The black Portuguese millipede is tolerant of much drier conditions than native species (Paoletti et al., 2007).

DISTINCTIVE FEATURES: The black Portuguese millipede has a smooth, cylindrical body measuring 30 to 45 mm. Adult millipede bodies consist of up to 50 segments with each segment having two pairs of legs. When disturbed, they either curl up in a tight spiral or thrash to escape.

Figure 13. (a) Black Portuguese millipede [Photo: Stuart Pettigrew], (b and c) millipedes in a grape bin at vintage.

BREEDING CYCLE: Black Portuguese millipedes lay most of their eggs in April and May. They usually mature after two years when they are in the tenth or eleventh stage of growth.

WHEN TO MONITOR: Throughout the year, especially in the lead up to harvest.

SUGGESTED ACTION THRESHOLDS: None established.

Biocontrol options

PREDATORY ARTHROPODS: Highly repellent chemical compounds are ejected by the millipede from its defensive glands when attacked, rendering it inedible to most predatory arthropods and birds. However, *Iridomyrmex* sp., meat ants are one of the few predators that will consume black Portuguese millipedes (Crawford, 2015). Some spiders and beetles will eat millipedes, but these predators will not significantly reduce large populations.

PARASITIC NEMATODES: It is possible to reduce millipede populations in suburban settings via the release of the parasitic nematode *Rhabditis necromena*. They are available commercially and are typically distributed using baiting stations. The nematodes are ingested by millipedes and bore through their gut wall lining. Bacteria from the gut then infect millipedes, which kills them (Bailey and Baker, 2016). It may take several seasons after introduction for the nematodes to reduce millipede populations. It may also provide an effective, long-term, biocontrol option for the suppression of millipedes in vineyards. Further research is required to test this.

Figure 14. An example of a millipede baiting station, and a light trap with water bath, which can be used to prevent millipedes from invading well-lit dwellings, including a winery [Photos: Mary Retallack].

FURTHER READING

For further information see Millipedes! How to manage populations so they do not become damaging at vintage.

For more information on natural enemies, please see natural predators of vineyards insect pests booklet and associated articles and fact sheets on the EcoVineyards knowledge hub.

FAMILY EPIOPHYIDAE

Colomerus vitis, bud and blister mite; *Calepitrimerus vitis*, rust mite

DESCRIPTION: Bud mite and blister mite are two strains of a mite species, *Colomerus vitis*, that only occur on grapevines. They are very similar except for the damage they cause by their feeding activities.

Bud mites feed on and damage young buds, and blister mites cause galling on leaves. *Calepitrimerus vitis*, rust mite, is found in most grape growing areas and causes damage to leaves and bunch stems.

Early spring symptoms of rust mite damage include leaf distortion or crinkling, shortening of growing shoots, and small yellowish or clear spots on crinkled leaves. In summer and early autumn, feeding damage on mature leaves appears as a 'bronzing' effect on leaf surfaces.

DISTINCTIVE FEATURES: Rust mites have a hexagonal-shaped head and are bronze in colour. Bud mites look more like a torpedo with a triangular head that is tapered at both ends. The larval stages of both mite species are very hard to distinguish between. The easiest way to distinguish between the species of mites present on grapevines is by the damage they cause. Microscopic magnification is necessary to identify different mite specimens.

Figure 15. Examples of (a) bud mite damage, (b) blister mite damage, and (c) rust mite damage (L), and a healthy leaf (R) [Photos: Mary Retallack].

BREEDING CYCLE: There are multiple generations of each mite species each year.

WHEN TO MONITOR: Monitor for bud mites in winter using a dissecting microscope (x20 to x40 magnification). Examine inside dormant buds for adult bud mites and monitor in early spring for shoot and leaf symptoms. Trapping for rust mite can be carried out prior to Chardonnay 'woolly bud', until mid-late October. Apply double-sided tape to one-year-old wood below the first node and assess the results using a dissecting microscope. In summer and early autumn, look for distinctive 'bronzing' on leaf blades caused by rust mite feeding damage.

SUGGESTED ACTION THRESHOLDS: If symptoms of bud mite damage were observed in the previous season, fungicide control measures are likely to be required early in the upcoming season though effectiveness is often limited. Rust mite severity depends on the amount of bronzing damage observed on leaves the previous season. If you observed heavy bronzing in autumn (i.e. > 50%) then fungicide application may be required before budburst in the upcoming season.

Biocontrol options

Minimise the use of sprays toxic to predatory mites to achieve a lasting prevention of all pest mite outbreaks, without the need to spray each year (Bernard et al., 2007). Predatory mites are particularly sensitive to chemical sprays, including active constituents emamectin benzoate, mancozeb (Bernard et al., 2004), spinosad, wettable sulfur (≥400 g/100 litre), and pyrimethanil (Bernard et al., 2010).

NB: the sulfur (≥ 400g/100 litres) rate assumes a concentration factor (CF) of 1 or dilute spraying volumes, which have historically been based on 4 kg sulfur per hectare at water application volume of 1,000 L/ha.

PREDATORY ARTHROPODS: Predatory mites contribute to the control of a range of vineyard mite pests. *Phytoseiulus persimilis* is a predatory mite commonly observed on grapevines that contributes to the control of a range of pest mites. *Euseius victoriensis* ('Victoria') and *Typhlodromus doreenae* ('Doreen') contribute to the control of *Colomerus vitis*, grape bud mite, *Colomerus vitis*, blister mite, *Calepitrimerus vitis,* rust mite, and *Brevipalpus lewisi*, bunch mite. *Haplothrips victoriensis* also feeds on rust mite (Bernard et al., 2006b).

Predatory mites can be purchased in Australia for release if needed to augment naturally occurring populations of predatory mites.

FURTHER READING

For more information on natural enemies, please see natural predators of vineyards insect pests booklet and associated articles and fact sheets on the EcoVineyards knowledge hub.

FAMILY FORFICULIDAE

Forficula auricularia, European earwig

DESCRIPTION: The European earwig is an important omnivorous predator of LBAM, mites, and other insect pests (Frank et al., 2007). However, isolated damage may occur to newly emerging leaves and shoots just after budburst (Magarey et al., 1994), although this does not necessarily cause economic damage.

Earwigs are usually considered to cause problems in grapevines only when large numbers are present. It takes more than one season for European earwig populations to build up. Slow-growing vines may sustain more feeding damage than vigorous vines. However, subsequent vegetation growth is normally sufficient to maintain vine health.

In most cases, the risk of minor damage early in the season is likely to be offset by the biological control benefits earwigs provide in vineyards. They are present throughout the year, predominantly from October to December, and this coincides with the period of grapevine flowering and bunch set. They provide valuable pest control in the period leading up to vintage when chemical control options are limited (Retallack, 2019). If numbers are very high at vintage, they may pose a problem if they are fermented with the fruit, resulting in rotten animal/insect taint.

DISTINCTIVE FEATURES: Approximately 12 to 15 mm in length. Earwigs have an elongated and flattened or cylindrical body. They can be winged or wingless. The abdomen is long and flexible. The two forcep-like cerci on the end of the abdomen are heavily sclerotised (hardened) and vary in shape and size between species.

They come in a range of colours, including reddish brown, dark brown, and black. Females can be readily distinguished from males as they are usually smaller, have simple forceps, and eight visible abdominal (hind-body) segments as opposed to males that have ten (Australian Museum, 2019). Earwigs are mostly omnivorous and eat a wide variety of live and decaying plant and animal material. The forceps are used for defence, catching, and carrying prey. They have chewing mouthparts and are most active at night.

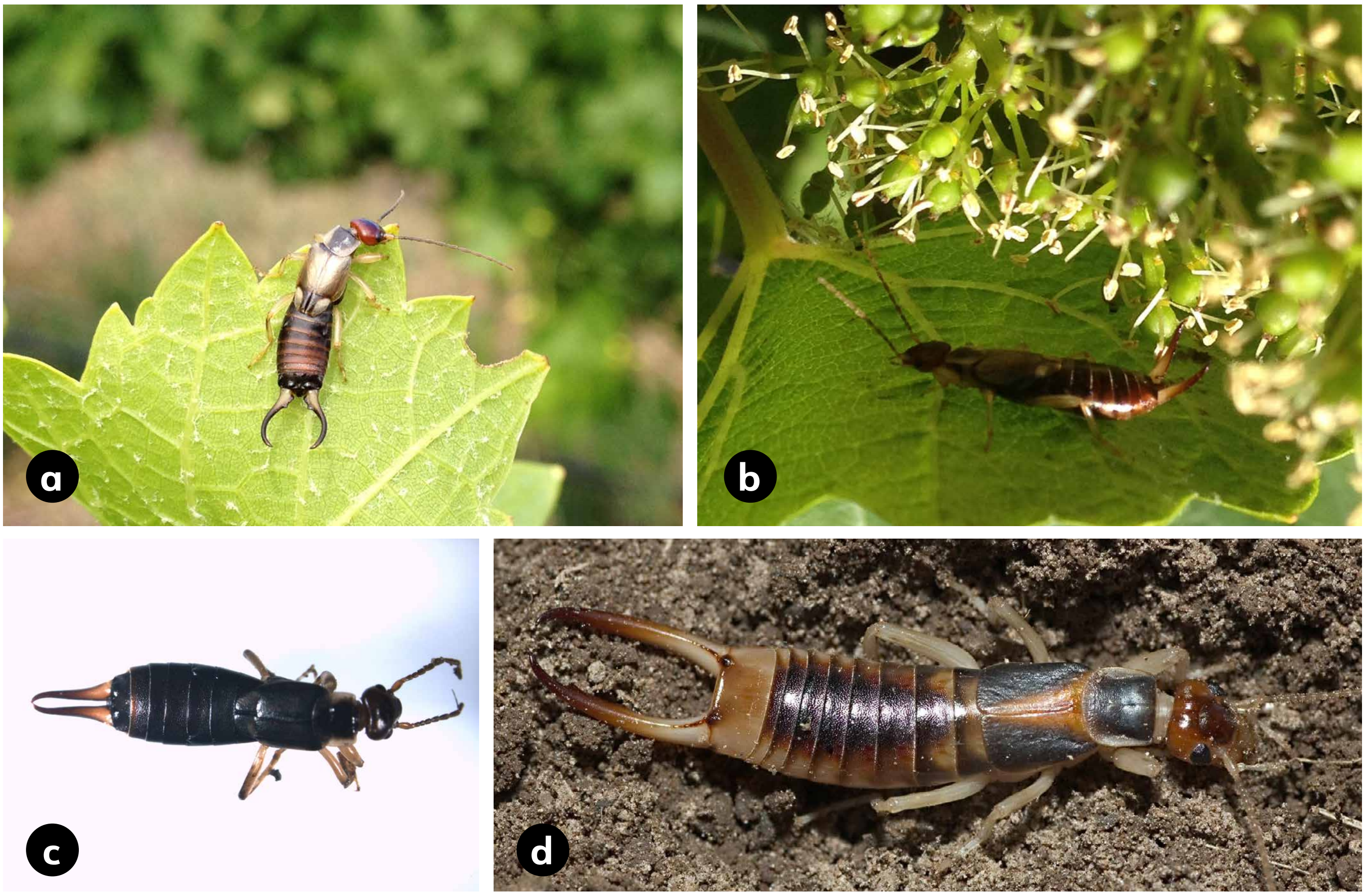

Figure 16. (a) *Forficula Auricularia*, male European earwig, (b) European earwig during flowering, (c) female European earwig [Photos: Mary Retallack], and (d) *Labidura truncata*, native, common brown earwig [Photo: Michael Nash].

BREEDING CYCLE: There are two generations per year. One breeding cycle occurs in late winter/early spring and a second in summer.

WHEN TO MONITOR: From budburst onwards. Earwigs can be trapped with corrugated cardboard bands around the upper portion of grapevine trunks, or layers of hessian or newspaper placed at the base of vines. Earwigs will use these traps for shelter during the day.

SUGGESTED ACTION THRESHOLDS: None established. The potential value of the European earwig as a predator of vineyard pests should be considered before any decision is taken to control this species.

Biocontrol options

Poultry are major predators of earwigs as a source of protein and energy. In vineyards where birds, such as guinea fowl, chickens, bantams, or ducks, are encouraged, some reduction in earwig numbers can be expected.

PREDATORY ARTHROPODS: *Labidura truncata*, common brown earwig is known to eat the European earwig (Crawford, 2015), as well as spiders, assassin bugs, and centipedes.

FURTHER READING

For more information on natural enemies, please see natural predators of vineyards insect pests booklet and associated articles and fact sheets on the EcoVineyards knowledge hub.

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EcoVineyards proudly acknowledges the Aboriginal and Torres Strait Islander Peoples, and their ongoing cultural and spiritual connection to this ancient land on which we work and live.

As the Traditional Custodians of this land, we recognise their wealth of ecological knowledge and the importance of caring for Country.

We pay our respects to elders past and present and extend this respect to all Aboriginal and Torres Strait Islander Peoples.

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