

Psocids, Booklice and Dustlice

(Order: Psocoptera)

The order Psocoptera contains over 4000 species. Psocids are small soft-bodied insects that live on plant material, under bark, in leaf litter and in nests and animal burrows. Unlike beetles, moths and wasps, psocids undergo an incomplete metamorphosis where eggs hatch into nymphs, which are similar in appearance to adults except that they are smaller, paler and wingless. At each moult nymphs become bigger and more like the adult. Wings, where present become functional only in the adult stage.

Psocids, Booklice and Dustlice

(Families: Lachesillidae, Liposcelididae, Psyllipsocidae and Trogiidae)

Family: Lachesillidae

Lachesilla pedicularia

Lachesilla quercus

Family: Liposcelididae

Liposcelis bostrychophila

Liposcelis brunnea

Liposcelis corrodens

Liposcelis decolor

Liposcelis entomophila

Liposcelis paeta

Liposcelis pubescens

Liposcelis rufa

Family: Psyllipsocidae

Psocathorpos laclani

Family: Trogiidae

Lepinotus reticulatus

Lepinotus inquilinus

Lepinotus patruelis

Trogium pulsatorium

Summary

Feeding strategies	secondary pest, mould feeder
Commodities attacked	dried material of animal and especially plant origin
Distribution	worldwide
Economic importance	low to high
Eggs	laid in amongst commodity
Nymphs	similar in appearance to adults but smaller, mobile, external feeders
Adults	some are long lived, feed on commodity, <i>Liposcelis</i> wingless, others winged

Introduction

Species that are associated with stored products mostly belong to four families: the Lachesiilidae, Liposcelididae, Psyllipsocidae and Trogidae (Figures 213–220). By far the most important of these is the Liposcelididae, which contains the wingless genus *Liposcelis*.

Identification

Genera of psocids associated with stored products can be identified as below. Identification of psocids to species is difficult and generally involves examination of cleared, prepared slide-mounted specimens at high magnification (see references below). Male specimens of *Liposcelis* spp. are mostly impossible to identify to species, except by association with females.

On account of their small size, wingless psocids can be confused with some larger predatory mites that occur in stored products. Mites have four pairs of legs, do not have antennae or wings and their bodies are not clearly divided into head, thorax and abdomen like insects. Predatory mites can be orange or red, colours never seen in psocids associated with stored products. *Liposcelis* species move with a characteristic rapid jerky motion, not seen in mite species.

Keys for the identification to species of psocids found in stored products can be found in Lienhard (1990, 1998) and Mockford (1987, 1993).

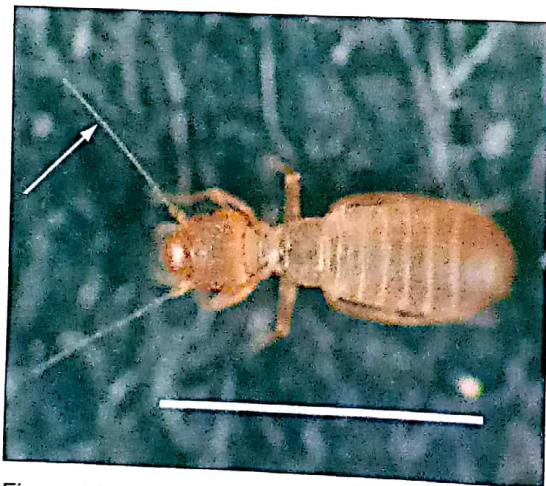


Figure 213 *Liposcelis bostrychophila*, adult showing long hair-like antennae and enlarged hind femur of hind leg typical of genus

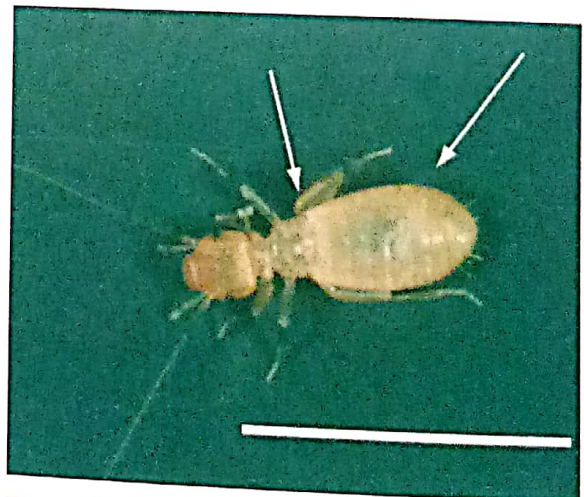


Figure 214 *Liposcelis decolor*, adult, showing plain unmarked abdomen

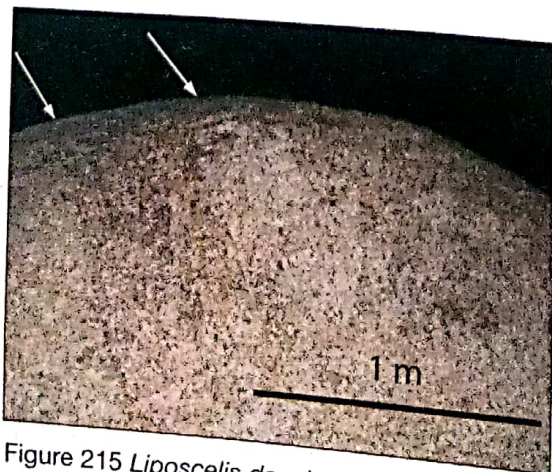


Figure 215 *Liposcelis decolor*, infestation on surface of bulk stored barley

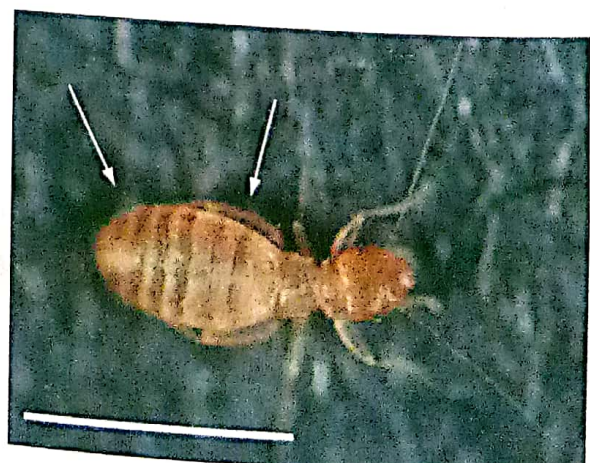


Figure 216 *Liposcelis entomophila*, adult, showing striped abdomen



Figure 217 *Lachesilla quercus*, adult, long wings which stretch well beyond end of abdomen

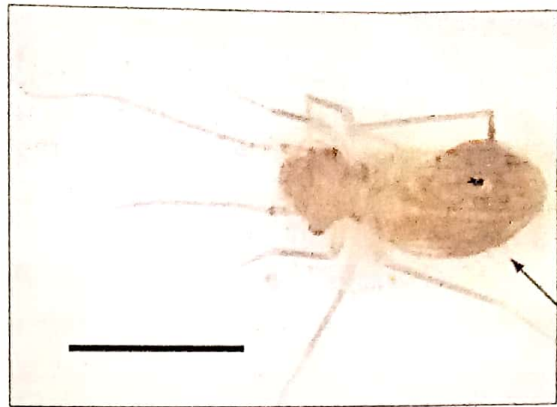


Figure 218 *Psocathorpos laclani*, adult, short wings which stretch to end of abdomen



Figure 219 *Lepinotus reticulatus*, adult, showing distinctive black colour and tiny scale-like wings

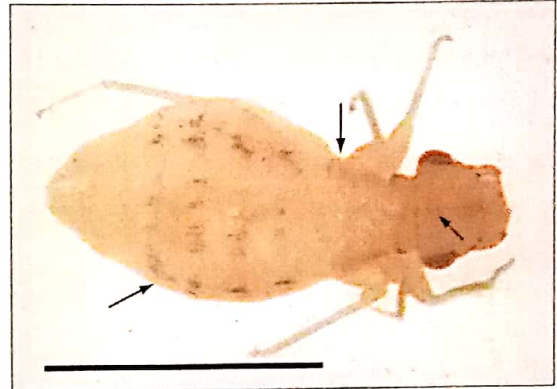


Figure 220 *Trogium pulsatorium*, adult, patterning on abdomen, dark line between eyes, tiny scale-like wings

Key to adults of major genera of Psocoptera associated with stored products

- 1 Body form highly flattened, adults wingless, length of adult – 0.7–1 mm, femur of hind leg much wider and flatter than other legs (Figure 214). Colour ranges from translucent to dark brown, (abdomen of adult *L. entomophila* characteristically striped – Figure 216) *Liposcelis* (Figures 213–216)
- Body form globular – not flattened, adults winged which range from small scale like structures to full size wings with complete venation (Figures 217–220) 2
- 2 Wings as tiny scale like structures, fore wings only present (Figures 219– 220) 3
- Wings larger, with venation, fore and hind wings present (Figures 217–218) 4
- 3 Colour of adult – frons (area of forehead between eyes) marked with a dark longitudinal line. Abdomen – light brown, with darker spots which form weak bands across abdomen; length of adult – 1.5–2.0 mm; adults can produce ‘ticking’ sound audible to humans *Trogium* (Figure 220)
- Colour – adults black (nymphs pale grey, which get darker as they mature); length of adult – 1.2–1.5 mm *Lepinotus* (Figure 219)
- 4 Partly winged (brachypterous) – at rest tip of wings does not reach end of abdomen, length of adult 1.2–1.4 mm *Psocathorpos* (Figure 218)
- Fully winged at rest tip of wings well beyond end of abdomen, flies readily; colour light brown, abdomen striped, venation of wings black, length of adult 2.0–2.7 mm *Lachesilla* (Figure 217)

Life cycle

The following data are for *Liposcelis* spp. Eggs are laid at random amongst the infested material. At 30°C, females lay about one egg per day which hatches in about a week. Metamorphosis is incomplete in Psocoptera and nymphs are similar in appearance to adults except they are smaller and paler. At 30°C development to adulthood takes about 21–28 days. Both adults and nymphs feed. Adults are long lived – several months at 30°C, six months or more at 20°C. Reproduction is sexual in all storage species, with the exception of *L. bostrychophila* which is parthenogenetic and consists only of females which lay fertile eggs without the intervention of males.

Physical limits and optimum conditions

Species	Conditions within which breeding takes place	Optimum conditions
<i>Lachesilla quercus</i>	16–30°C, r.h. > 70%	22–26°C, 70–80% r.h.
<i>Liposcelis bostrychophila</i>	20–36°C, r.h. > 60%	30°C, 80% r.h.
<i>Liposcelis decolor</i>	18–36°C, r.h. > 60%	32°C, 80% r.h.
<i>Liposcelis entomophila</i>	18–36°C, r.h. > 60%	30°C, 80% r.h.
<i>Liposcelis paeta</i>	24–42°C, r.h. > 60%	33°C, 70% r.h.

Liposcelis species breed most rapidly under warm humid conditions. *L. paeta* is exceptional by the standards of storage insects in general in its tolerance to temperatures above 40°C. Psocids are generally sensitive to low humidity. *Liposcelis*, for example, are unable to survive long term in locations where the mean relative humidity is below about 60% r.h. Temperatures required by *L. quercus* to breed are lower than for *Liposcelis* species – which reflects its temperate rather than tropical origin.

Economic importance

Liposcelis species are omnivorous and will eat almost any stored product of animal or plant origin. They also feed on moulds and on glues made from animal by-products.

Liposcelis are traditionally thought to be only minor pests of stored grain and grain products. Recent experience suggests this is not always so. Four species, *L. bostrychophila*, *L. decolor*, *L. entomophila*, and *L. paeta*, are by far the most important species as pests of stored products. Enormous populations have been reported, infesting grain stored in warm temperate and tropical regions. These cause at the very least severe contamination and possible rejection of the infested commodity. Worldwide, such outbreaks appear to be becoming more frequent. For example, during the 1990s in some parts of Australia, severe infestations of *Liposcelis* became much more frequent in bulk grain storage facilities.

Liposcelis spp., in particular *L. bostrychophila*, are also important pests in museums, libraries, food processing plants, retail and domestic premises. Newly constructed buildings can often become infested by a range of psocid species as they dry out. Infestations of psocids, especially *Liposcelis* spp., are increasingly being implicated as an important source of inhalation allergens. These may produce a range of respiratory problems in sensitised people.

Other genera listed are usually associated with damp material or locations and are generally minor pests, but may cause concern on account of their mere presence. Recently in Australia, *L. quercus* has become a significant nuisance pest in coastal grain handling facilities where large populations build up from time to time, causing distress and inconvenience to workers and contamination of storage structures.

Type of damage and symptoms

Liposcelis are secondary pests that are able to excavate the soft endosperm from damaged and broken grain. They feed preferentially on grain germ and are capable of completely eating out the germ by first gaining access to it via damage to the seed coat caused by harvesting and handling. Psocids will also eat mould spores and fungal hyphae. The small size and flattened form of *Liposcelis* spp. allows them easy access into all but the most well-sealed package. Psocids are a problem in food packing plants; in addition to attacking the product directly, they often become trapped under shrink wrapping used to secure boxes onto pallets. Their presence often leads to the rejection of the contaminated goods.

In museums and libraries psocids may attack books, paper and fabrics, especially if these items are slightly damp. They will feed on glues made from animal or plant material, especially if such material is hygroscopic.

In silos with severe infestations, accumulations of dead and dying *Liposcelis* may be found at the top of the cells (Figure 215) and in the chutes leading from the cell outlet. Similar accumulations also occur on nearby walkways where they can affect worker safety by making it very slippery underfoot.

Infestations of *Lachesilla* spp. produce quantities of silken webbing, which gets covered in dust etc.

Ecology

Psocids associated with grain storage can also be found in natural habitats, such as in leaf litter, bird nests, compost, under the bark of trees and in clumps of dry grass. Such populations provide a continuous source of reinfestation.

There appears to be a link between the incidence of heavy infestations of *Liposcelis* in grain stores and poor and inappropriate fumigation practice. Survival of the psocid may have been due to insufficient gas being used or rapid re-invasion after fumigation from the surrounding structure. Resulting populations of *Liposcelis* can be present in grain in the absence of other pests and predators. Populations feed from competition and predation may explode given suitable environmental conditions.

Liposcelis species are sensitive to mean relative humidities below 60%, roughly equivalent to a grain moisture content of about 13–14%. However, in Australia, heavy infestations of *Liposcelis* spp. are commonly encountered in dry grain of less than 11% moisture content. In buildings, psocid infestations are usually associated with dampness and poor ventilation.

Monitoring

Psocids are easy to trap. Pitfall traps inserted into grain bulks are effective. Corrugated cardboard makes a highly attractive crevice trap especially for *Liposcelis* species. Pieces of cardboard can be left on grain surfaces or on storage structures. Psocids which accumulate inside can simply be shaken out.