

Khapra beetle, Warehouse beetle

(Genus: *Trogoderma*) (selected species)

<i>Trogoderma glabrum</i>	Glabrous carpet beetle
<i>Trogoderma granarium</i>	Khapra beetle
<i>Trogoderma inclusum</i>	Larger cabinet beetle, Mottled dermestid
<i>Trogoderma ornatum</i>	Ornate carpet beetle
<i>Trogoderma sternale</i>	
<i>Trogoderma variabile</i>	Warehouse beetle

Summary

Feeding strategies	primary pest, secondary pest
Commodities attacked	dried material of plant and animal origin
Distribution	worldwide, but individual species have restricted distributions
Economic importance	high
Eggs	laid amongst commodity
Larvae	eruciform, mobile, live amongst commodity
Adults	short lived, do not feed on commodity, some species can fly

Introduction

Member of the genus *Trogoderma* are associated with dried material of animal and sometimes plant origin. The number of species of this genus remains unknown as many species remain undescribed. Some six species are frequently associated with stored material of animal and plant origin. Of those, the khapra beetle, *T. granarium*, ranks among the most feared pests of stored products.

Identification

To identify *Trogoderma* from other Dermestids, see keys above or Kingsolver (1987), Haines (1991) or Peacock (1993). In addition to the species listed here, other *Trogoderma* are occasionally found in the storage environment and many others are recorded from natural habitats.

Adult *Trogoderma* are oval, light to dark brown beetles covered with fine hairs, 1.8 to 3 mm long (females are bigger than males) (Figures 93–102). The elytra are marked with irregular paler markings, which vary in intensity between species and specimens. Larvae are oval in shape and vary in colour from whitish yellow when young to reddish brown when mature and are clothed in transverse bands of hairs (Figure 103). Tufts of short barbed hairs known as hastisetae (Figure 104) are found on either sides of the final abdominal segments but do not overlap over the middle of the abdomen.

Correct identification of *Trogoderma* found in stored products is difficult. Identification of both adult and larvae to species requires skill and training, a microscope plus an appropriate identification key such as Banks (1994), Hinton (1945), Kingsolver (1987) and Peacock (1993). Adults of *T. granarium* can sometimes be distinguished from other important pest species by its light brown colour and general absence of markings on the elytra (Figure 94). The elytra of other species are usually obviously patterned. Any population of *Trogoderma* without elytral patterns doing damage to stored products should be especially closely examined, just in case they are *T. granarium*. Adults of *T. inclusum* are distinctive, having an obvious notch in the inner margin of the eye (Figure 98). *T. variabile* is also relatively distinct, as elytra of this species are marked with three wavy lines (Figure 101).

Life cycle

Eggs are laid amongst the foodstuff. Larvae hatch and initially feed on fragments and damaged grains, but as they get bigger they can attack whole grains. Larvae moult from 5 to 15 times (larger number when conditions are unfavourable). Cast skins remain entire and are a very obvious sign of the presence of these insects. Pupation occurs within the last larval skin. Adults are short lived and do not feed on the commodity. *T. granarium* cannot fly but other species fly well. Adult beetles do not feed on stored commodities but may visit flowers to feed on nectar and pollen.



Figure 93 *Trogoderma glabrum*, adult

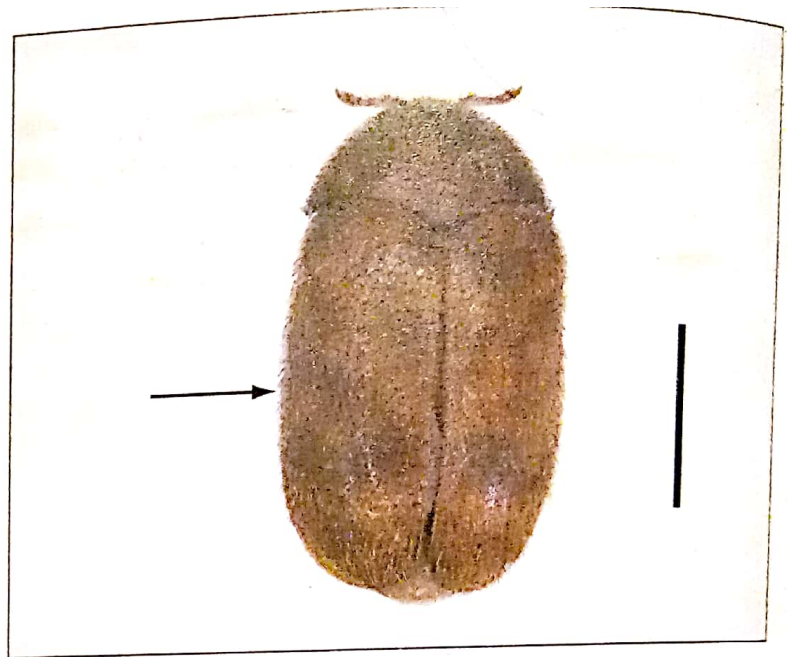


Figure 94 *Trogoderma granarium*, adult, note relative lack of patterning on elytra

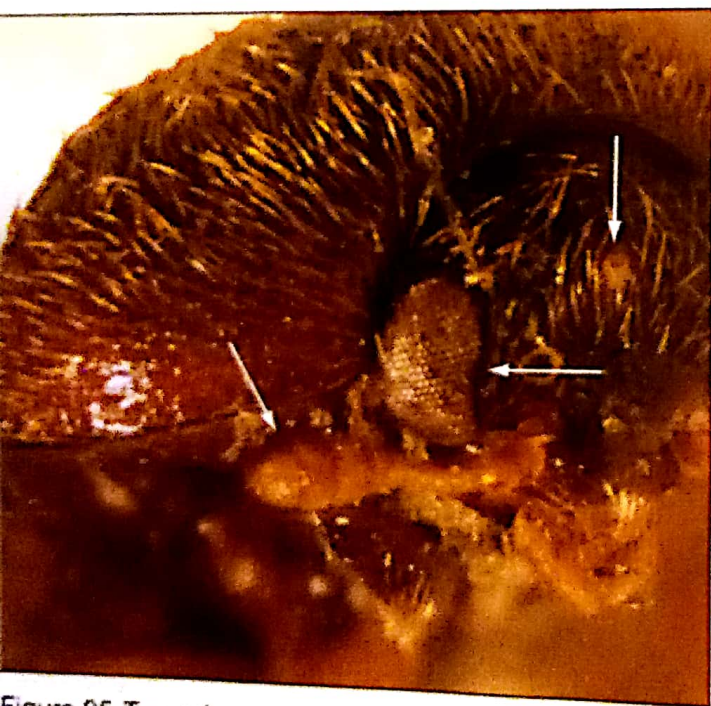


Figure 95 *Trogoderma granarium*, adult, head / antennae, showing median ocellus and antennal club with symmetrically jointed segments



Figure 96 *Trogoderma granarium*, adult, underside, showing antennal cavity



Figure 101 *Trogoderma variabile*, adult showing distinctive wavy bands on elytra



Figure 102 *Trogoderma variabile*, adult, head underside showing antennal cavity



Figure 103 *Trogoderma variabile*, larva, showing tufts of hairs including hastisetae on abdomen

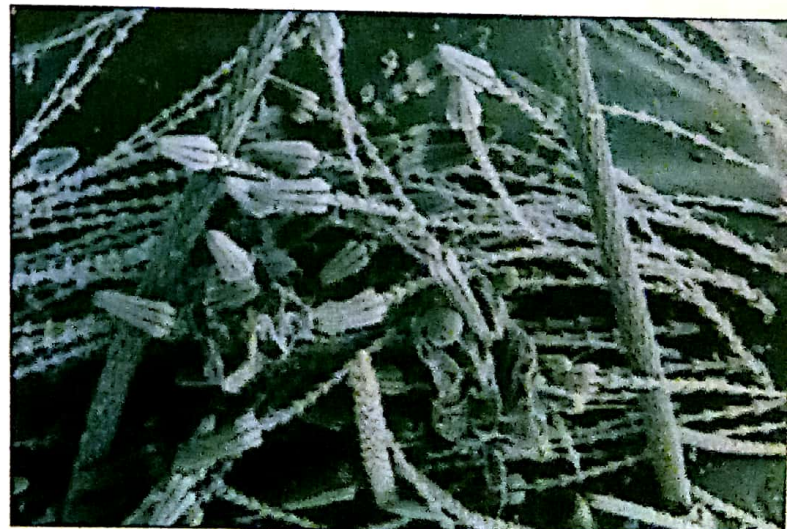


Figure 104 *Trogoderma variabile*, larva, hastisetae, showing their distinctive structure

Larvae of *Trogoderma* species are able to enter a state of type of suspended animation known as diapause. During this time, larvae hide away in cracks and do not feed, except for the occasional brief foraging excursion. In this state, larvae of *T. granarium* can live for up to eight years. This adaptation allows these insects to survive times when food is scarce or when environmental conditions are unfavourable. Diapause can be initiated by a number of things including lowered temperature, inadequate food and overcrowding.

Physical limits and optimum rate of multiplication

Species	Conditions within which breeding takes place	Shortest development period, with optimum conditions	Maximum monthly rate of increase
<i>Trogoderma glabrum</i>		30–36 days at 30°C, 65–70% r.h.	
<i>Trogoderma granarium</i>	20–40+°C, r.h. > 2%	25 days at 33–37°C, 45–75% r.h.	13
<i>Trogoderma inclusum</i>	20–40°C	60 days at 30°C.	
<i>Trogoderma variable</i>	17–37°C	30 days at 30°C	8

T. granarium in particular is very tolerant of hot and dry conditions. Development time can greatly extended due to the ability of larvae to diapause.

Economic importance

By far the most important species worldwide are *T. granarium* and *T. variable*. *T. granarium* is a feared pest of stored products and is especially serious on grain and oilseeds stored in bags in hot dry climates. Under such conditions, populations can cause total loss of infested commodities. Formerly it was a pest of maltings in Japan and northern Europe where it infested kilned grain or residues near the kilns. It also attacks a wide range of other plant-based materials, for example in retail packs of dried cucurbit seeds sold as snacks in the Middle East and south-west Asian region. Due to its ability to diapause, structural infestations of ships, rail cars and containers can persist for years after initial infestation, only to cross-infest other material at a later date. Used sacks can also be a source of infestation.

Next most important worldwide is *T. variable*, which is often a difficult-to-eradicate pest in silos, mills and processing plants where it usually attacks crop residues. While not usually a serious pest of bulk grain, it can become a damaging pest of bagged grain and processed and packaged foods. In Australia, *T. variable* has recently become a pest of bulk stored canola seed.

Larvae of *Trogoderma* spp. can penetrate most common packaging materials and commonly infest packaged foods of all kinds. They will infest rodent baits dispensed around store sites. They are also sometimes found attacking material of animal or plant origin in museums and private collections. As with other dermestids, bodies and cast skins of *Trogoderma* species are highly allergenic to humans.

Quarantine legislation exists in many countries to prevent the introduction of *Trogoderma* spp., especially *T. granarium*. Major exporters of agricultural commodities, such as the USA and Australia, take considerable effort to prevent the importation and establishment of this pest. A major reason for the widespread requirement to fumigate stored products in international trade is to prevent the spread of *T. granarium*.

Type of damage and symptoms

Trogoderma spp. are general feeders and as a result damage directly caused is not distinctive. However, if left unchecked, large quantities of cast larval skins can accumulate in and around infested materials.