

Flour beetles (Genus: *Tribolium*)

<i>Tribolium audax</i>	American black flour beetle
<i>Tribolium castaneum</i>	Rust red flour beetle, Red flour beetle
<i>Tribolium confusum</i>	Confused flour beetle
<i>Tribolium destructor</i>	False black flour beetle
<i>Tribolium madens</i>	Black flour beetle

Summary

Feeding strategy	secondary pest (primary pest?)
Commodities attacked	dried material of animal and plant origin, but especially cereal grain and products
Distribution	<i>T. confusum</i> and <i>T. castaneum</i> worldwide, others have restricted distributions
Economic importance	<i>T. confusum</i> and <i>T. castaneum</i> high, others variable
Eggs	laid amongst commodity
Larvae	elateriform, mobile, live amongst commodity
Adults	long lived, feed on commodity, some species fly

Introduction

The genus *Tribolium* consists of some 30 species. In nature they live under the bark of trees and in animal nests where they feed on other insects and detritus of animal and plant origin. A number of species are associated with stored products. Two of these, *T. castaneum* and *T. confusum*, are amongst the most important pests of stored produce worldwide.

Identification

Worldwide some five *Tribolium* species are frequently found associated with stored products (Figures 168–184). These can be identified by using the key below. By far the most frequently encountered are *T. castaneum* and *T. confusum*. In Europe, North America and parts of temperate



Figure 168 *Tribolium audax*, adult

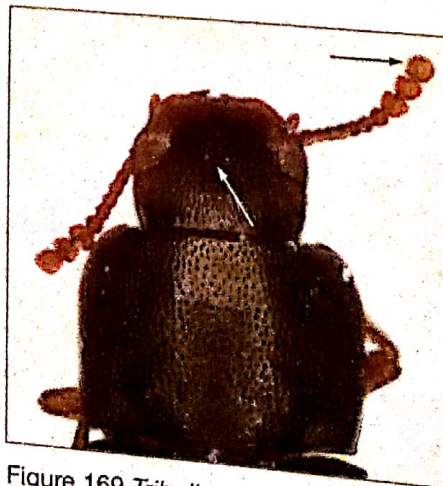


Figure 169 *Tribolium audax*, adult, head from above, pits on surface between eyes running together, terminal segment of antennae somewhat square

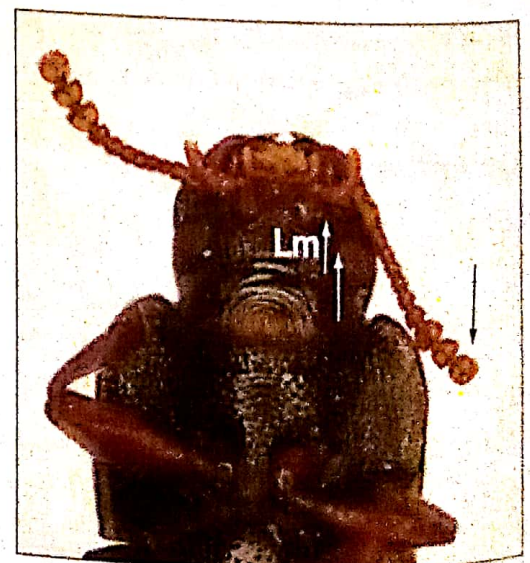


Figure 170 *Tribolium audax*, adult, underside head, eye does not extend as far as lateral margin of maxillary fossa (Lm)



Figure 171 *Tribolium castaneum*, adult, live



Figure 172 *Tribolium castaneum*, adult, head side view, showing division of eye, eye two facets wide at narrowest point



Figure 173 *Tribolium castaneum*, adult, head underside, gap between eyes relatively narrow, obvious three segmented antennal club, process between front legs shaped like axe head

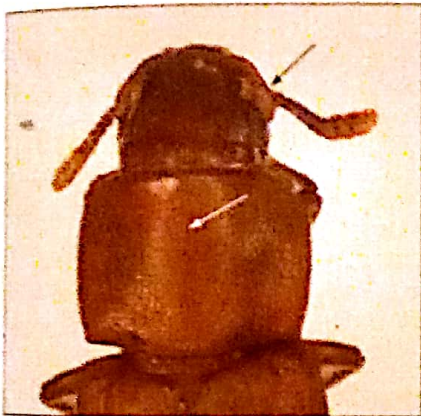


Figure 174 *Tribolium castaneum*, adult, head from above, obvious brow over eye, pits on surface in centre of thorax small



Figure 175 *Tribolium castaneum*, adult, infestation



Figure 176 *Tribolium castaneum*, larva



Figure 177 *Tribolium confusum*, adult, head underside, gap between eyes relatively wide, segments of antennae gradually get wider towards tip, process between front legs shaped like axe head



Figure 178 *Tribolium destructor*, adult



Figure 179 *Tribolium destructor*, adult, underside, showing somewhat pointed end of final antennal segment

3. When viewed from underneath gap between eye is relatively narrow – about 33% of head width. Last three segments of antennae form distinctive club (Figure 173) *T. castaneum* (Figures 171, 175)
 When viewed from underneath gap between eye is relatively wide – about 50% of head width. Last three segments of antennae get gradually wider and do not form distinctive club *T. confusum* (Figure 177)
4. From above, many punctures meet and run into each other between eyes (Figure 169). When viewed from underneath, eye does not extend as far as lateral angle of maxillary fossa (Figure 170), length 2.8–4.5 mm *T. audax* (Figure 168)
 From above, punctures do not meet or run into each other between eyes (Figure 184). When viewed from underneath, eye extends as far as lateral angle of maxillary fossa (Figure 182), body length 3.9–5.1 mm *T. madens* (Figure 181)

Life cycle

Data provided is for *T. castaneum*. Eggs are laid at random amongst the commodity. They are sticky and soon become coated with flour or other particles. Females may lay up to 1000 eggs over most of their lifetime. Larvae are elateriform and are active and move through the food (Figure 176). They feed on the commodity and on other insects that are small enough to subdue. Cannibalism amongst larvae and adults is common. Full grown larvae of *T. castaneum* are about 10 mm long. Pupae are naked and are also found amongst the food. Egg and pupal stages are relatively brief and more than 60% of development time is spent as larvae. Adults are long lived, up to two to three years under temperate conditions.

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>Tribolium castaneum</i>	22–40°C, r.h. > 1%	20 days at 35–37.5°C, > 70% r.h.	70
<i>Tribolium confusum</i>	19–37.5°C, r.h. > 1%	25 days at 32.5°C, 70% r.h.	60
<i>Tribolium destructor</i>	Max 30°C, r.h. > 10%	44 days at 28°C, 75% r.h.	
<i>Tribolium madens</i>	20–35°C, r.h. > 10%	35 days at 35°C, 70% r.h.	

Under optimal conditions, growth of *T. castaneum* and *T. confusum* populations are among the most rapid achieved by insect pests of stored products. *T. confusum* is able to breed under slightly cooler conditions than *T. castaneum*, which may explain why *T. confusum* is more common in temperate regions. Both species are, however, remarkably tolerant of low humidity. Development periods for other species are longer. *T. destructor* appears intolerant of temperatures higher than 30°C which may account for this species being limited to areas with a cool climate.

Economic importance

Worldwide *T. castaneum* and *T. confusum* are major and frequently encountered pests of stored products. They attack virtually any dried material of animal or plant origin but are especially

important as pests of cereals and cereal products and are major pests of mills. *T. castaneum* occurs in both grain stores and mills, however, *T. confusum* is more often found in mills. *T. audax*, *T. destructor* and *T. madens* are also pests of cereal grain and grain products and can be locally important in regions where they are found. For example in southern Canada, *T. destructor* can be as important a pest as *T. castaneum* and *T. confusum*.

Type of damage and symptoms

Larvae and adult *Tribolium* spp. are general feeders and damage is not readily identifiable as being specifically caused by this insect. Infestation can lead to persistent disagreeable odours in the commodity due to secretion of benzoquinones from abdominal glands.

Ecology

Tribolium spp. have been long associated with stored products, as evidenced by the remains of *T. confusum* found in a sealed jar in an Egyptian tomb of circa 2500 BC. Their size, wide food range, long lifespan and ability to cope with very low humidities make *Tribolium* spp. highly successful pests of stored produce.

Especially under tropical conditions, *T. castaneum* is a coloniser species which is frequently the first pest to infest a stored commodity. It is also a ubiquitous pest of grain handling and transportation systems and is frequently found by quarantine officials infesting residues in empty shipping containers used in international trade.

Competition between *T. confusum* and *T. castaneum* is complex and not fully understood. Mixed populations only appear to exist at low density and as competition increases one or other species tends to dominate. One major difference between these species is their ability to disperse. *T. castaneum* flies readily under warm conditions. In contrast, *T. confusum* does not appear to fly so is much more reliant upon movement by human intervention. *T. confusum* may therefore persist better in places such as mills, where long-term populations can develop in machinery and residues whereas *T. castaneum* is a better coloniser species. *Tribolium* spp. also readily prey on other insects. When present in large numbers they may have a significant effect on other pests and potential competitors.

Different *Tribolium* species are at different stages of development as storage pests. At one extreme are *T. confusum* and *T. castaneum* and at the other extreme are species still only found in natural habitats. In between are species that are either locally distributed storage species such as *T. audax*, *T. destructor* and *T. madens*, or species which are only occasionally associated with stored products such as *Tribolium brevicorne* and *Tribolium freemanii*. It is possible that over time some of these additional species may become new or more serious storage pests.