

INSECTS OF STORED GRAIN

A POCKET REFERENCE

SECOND EDITION

DAVID REES



CSIRO
PUBLISHING

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National Library of Australia Cataloguing-in-Publication entry
Rees, David.
Insects of stored grain : a pocket reference.

2nd ed.
Includes index.
ISBN 9780643093850.

1. Arthropod pests – Identification. 2. Grain – Diseases and pests. 3. Grain – Storage. I. CSIRO. II. Stored Grain Research Laboratory (Australia). III. Title.

633.104965

Published by and available from
CSIRO PUBLISHING
150 Oxford Street (PO Box 1139)
Collingwood VIC 3066
Australia

Telephone: +61 3 9662 7666
Local call: 1300 788 000 (Australia only)
Fax: +61 3 9662 7555
Email: publishing.sales@csiro.au
Web site: www.publish.csiro.au

Front cover
Indian meal moth, *Plodia interpunctella*.
Photo by John Green

Set in 8.5/10 Optima
Cover and text design by James Kelly
Printed in Australia by BPA Print Group

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Introduction

Insects of Stored Grain: A Pocket Reference concisely illustrates and describes the most important pests associated with stored cereal grain. Other durable commodities of animal and plant origin, such as pulses and oilseeds, dried fish and meat, skins, hides and wool, are also featured.

Given the book's compact nature, insects associated with the built environment that are accidental in stored commodities – e.g. ants, cockroaches, silverfish, wood boring beetles and termites – are not covered.

This publication is designed to fit in a pocket or toolbox. It provides basic information on the appearance, biology, pest status and distribution of species most likely to be found in durable stored products worldwide. The book can be used in conjunction with *Insects of Stored Products* by DP Rees (CSIRO Publishing 2004), where additional information on each species is available.



How to use this book

Each species or closely related group of species is explained under the following headings.

Identification

Common and scientific names are provided, with family names appearing in brackets.

Major features used for identification are given; however, as a basic field guide, only those characters that are easily seen with a hand lens or basic binocular microscope are emphasised. Use of specialist keys may be needed in some situations to properly confirm a species' identity. Images are annotated with arrows that point to important characters useful in identification. Unless otherwise indicated, the scale bar represents 1 mm.

Identification of beetle larvae to species is difficult and often impossible, and is beyond the scope of this book. However, larvae differ between families, and the major forms are illustrated on pages 7 and 8.

Similar species

Similar species are listed, which should be compared to help confirm the identity of your specimen. The number in brackets corresponds to the species number in this book.

Pest type

Insects infesting stored grain feed and live in a number of ways, including:

Commodity feeders

These feed directly on commodities and can be conveniently divided into **primary pests**, those that attack intact commodities, and **secondary pests**, which require the

commodity to be damaged before they can attack it. In reality, each pest requires a different level of 'damage' before it can survive on a commodity. For some species this level is minimal, but for others it may be substantial. Commodities accumulate damage from harvesting, handling, pest attack and processing, which increases the risk of attack from secondary pests. Secondary pests dominate in milled products such as flour, and processed and manufactured food products (e.g. breakfast cereals, chocolate and compound animal foods).

Fungal feeders

Some species supplement their diet by feeding on mould and mould spores while others eat nothing but mould. Fungal feeders are often present on ripening grain and usually die out in storage but may persist in poorly stored grain or in grain heavily infested with other insects.

Predators

Many storage pests will prey on other insects present, including members of their own species. Obligate predators only feed on other insects.

Parasitoids

A number of parasitoid wasps attack beetles and moths. Larvae of these wasps develop in or on their host, eventually killing it. These are potential 'beneficial' insects as they can control pest populations.

Scavengers

Some scavenger species feed on bodies of insects and other dried material of animal origin. Many are important pests of stored products of animal origin such as wool, hides, skins and dried fish.

Commodities attacked

Details are given of commodities attacked. Secondary pests usually attack a wider range of commodities and many can feed on almost any dry material of animal or plant origin.

Economic importance

A rating of importance from high to low is given based on the potential capability of the species to inflict serious damage to a commodity. This rating does not take into account situations where the simple presence of an individual insect is in itself important. Such situations include where an individual insect is of quarantine interest or when it is found in a high value finished product such as a box of chocolates.

Distribution

Comments on geographical distribution are provided. Most species have a worldwide or a pan-tropical distribution. Many tropical species not established in temperate areas are often intercepted there on infested imports.

Life cycle

Data is shown where available. It has been collated from studies published in the scientific literature worldwide (see 'Additional information' below) and is presented as follows:

Optimum

Conditions of temperature and relative humidity (r.h.), along with number of days or months, at which eggs take the shortest time to develop into adults.

Range

Conditions under which eggs can complete development to adults. At the extremes, population growth is slow due to high mortality or low activity. As a rule of thumb, population growth under optimum conditions may be 10 or more times faster than at the extremes.

Maximum population growth rate per month

The rate at which the species in laboratory studies can multiply in a month under optimum conditions. In reality, rates of population growth observed in the field vary depending on the presentation and nutritional quality of the commodity infested. Nevertheless, pests capable of rapid population growth under laboratory conditions are usually significant pests in commodity storages.

Details are also given on the process of development from egg to adult with particular reference to the lifestyle of larvae/nymph and adult stages.

Additional information

Additional information on this pest is available in *Insects of Stored Products (ISP)* by DP Rees (CSIRO Publishing 2004), on the page listed. In addition, this book provides a detailed reference list to publications on the biology and identification of insect pests of stored products.

Photographic credits

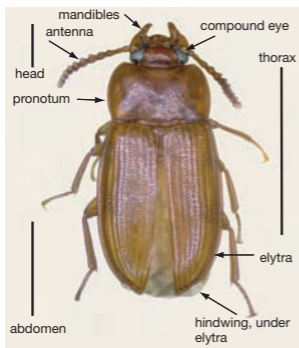
Photographs in this publication were taken by John Green, David McClenaghan, Vanna Rangsi, Roslyn Schumacher, Noel Starick and the author. Copyright of all images, with the exception of *Pyralis farinalis*, rests with CSIRO. Copyright of the image of *P. farinalis* rests with the author.

BETLES – COLEOPTERA

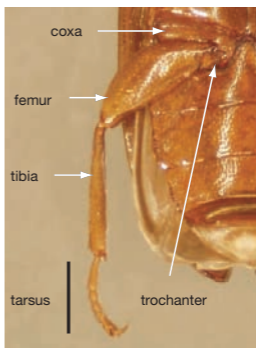
The structure of beetles

Adults

Knowledge of the basic structure of beetles is required for their identification. Terms illustrated below are used in the following species descriptions.



Major body components of an adult beetle



Structure of a beetle leg

Larvae

Larvae of beetles found in stored products have one of five distinct body forms, which are described and illustrated below.

Apodous – legless, immobile and lives internally within foodstuff.



Apodous



Scarabaeiform

Scarabaeiform – effectively immobile when mature, legs partly or fully developed. Lives internally within foodstuff for all or all but initial stage of life.

Campodeiform – elongate flattened body with well-developed legs, usually pale and translucent, head capsule and/or last abdominal segment may be pigmented. Active, lives freely within commodity.



Campodeiform

Elateriform – body is long and cylindrical, cuticle leathery, legs relatively short. Active, lives freely within commodity.



Elateriform



Eruciform

Eruciform – oval or elongate and hairy. Active, lives freely within commodity.

1 Cigarette beetle

Lasioderma serricorne (Anobiidae, Anobiinae)



L. serricorne

Identification: *Adults* – 3–4 mm, brown, globular. Antennae long, segments saw-like, elytra smooth with fine hairs. *Larvae* – scarabaeiform, legs fully developed

Similar species: *Stegobium* (2)

Pest type: primary pest, secondary pest

Commodities attacked: dried material of animal and vegetable origin, especially tobacco, nuts, herbs and spices, seeds, grain and grain products

Economic importance: high in artifacts and processed goods, minor in raw cereals. Important pest of herbaria and museums

Distribution: worldwide, sheltered environments in temperate areas

Life cycle: *Optimum* – 26 days at 30°C, 70% r.h. *Range* – 20–38°C, r.h. > 25%. *Maximum population growth rate per month* – 20. *Eggs* – laid in crevices in commodity. *Larvae* – internal feeders, immobile when mature. *Adults* – active, short-lived, do not feed on commodity, fly

Additional information: page 18, *ISP*

2 Drugstore beetle

Stegobium paniceum (Anobiidae, Anobiinae)



S. paniceum



Head – underside

Identification: *Adults* – 3–4 mm, brown, globular, last three segments of antennae form loose club, elytra with fine longitudinal ridges and fine hairs. *Larvae* – scarabaeiform, legs fully developed

Similar species: *Lasioderma* (1)

Pest type: primary pest, secondary pest

Commodities attacked: dried material of animal and vegetable origin, especially nuts, herbs and spices, seeds, grain and grain products

Economic importance: high in artifacts and processed goods, minor in raw cereals. Important pest of herbaria and museums

Distribution: worldwide, tolerant of temperate conditions

Life cycle: *Optimum* – 40 days at 30°C, 60–90% r.h. *Range* – 15–34°C, r.h. >35%. *Maximum population growth rate per month* – 8. *Eggs* – laid in crevices in commodity. *Larvae* – internal feeders, immobile when mature. *Adults* – active, short-lived, do not feed on commodity, fly

Additional information: page 18, *ISP*

3 Spider beetles (Anobiidae, Ptininae)



Gibbium psylliodes



Mezium americanum



Niptus hololeucus

Identification: Adults – 2–5 mm, long-legged, globular, resemble small spider. Some species hairy, others totally or partly shiny. Antennae long and hair-like. Larvae – scarabaeiform, legs fully developed

Similar species: none

Pest type: secondary pest, scavenger

Commodities attacked: dried material of animal and vegetable origin. Usually infests aged residues

Economic importance: generally low except under cool temperate conditions

Distribution: worldwide, especially in temperate regions, tolerant of cold conditions

Life cycle (*Ptinus ocellus*) *Optimum* – 61 days at 27°C. *Range* – 10–28°C, >70% r.h. *Maximum population growth rate per month* – 4. *Eggs* – laid in crevices in commodity. *Larvae* – internal feeders, immobile when mature. *Adults* – long-lived, feed on commodity, some species can fly

Additional information: page 22, ISP

4 Cocoa weevil, Coffee-bean weevil

Araecerus fasciculatus (Anthribiidae)



A. fasciculatus

Identification: *Adults* – 3–5 mm, globular, long legs and antennae, elytra patterned with light and dark patches giving chequered appearance. Last three segments of antennae form loose club. *Larvae* – scarabaeiform, legs partly developed

Similar species: bruchids (9–14)

Pest type: primary pest

Commodities attacked: cocoa, coffee, dried cassava and yams, maize, groundnuts, Brazil nuts, nutmegs

Economic importance: high on high value crops, low elsewhere

Distribution: tropical

Life cycle: *Optimum* – 22–66 days at 28–32°C, >60% r.h. *Range* – >22°C, r.h. >60%. *Maximum population growth rate per month* – 40. *Eggs* – laid onto seed or root. *Larvae* – on hatching bore into commodity, development completed inside single seed. *Adults* – on emergence leave neat exit hole, short-lived, do not feed on commodity, fly

Additional information: page 27, ISP

5 Bamboo borers, Ghoon beetles

Dinoderus spp. (Bostrichidae)



Identification: *Adults* – 3 mm, dark brown, cylindrical in cross-section. Head bent downwards and concealed. Tip of abdomen with rounded corners. From side, end of elytra rounded. Often with two oval-shaped depressions on thorax. *Larvae* – scarabaeiform, legs fully developed

Similar species: *Prostephanus* (6), *Rhyzopertha* (7)

Pest type: primary pest

Commodities attacked: maize, dried root crops, bamboo, rattan

Economic importance: medium on high value articles and under tropical subsistence conditions, low elsewhere. Can infest crop prior to harvest

Distribution: tropical, accidental in temperate regions

Life cycle: *Optimum* – about 180 days at 35°C, 75% r.h. *Maximum population growth rate per month* – 4. *Eggs* – laid on commodity and in tunnels bored by adults. *Larvae* – internal feeders producing lots of flour, immobile when mature. *Adults* – long-lived, feed and bore into commodity, fly

Additional information: page 30, *ISP*

6 Larger grain borer

Prostephanus truncatus (Bostrichidae)



P. truncatus



Underside – square tip of elytra

Identification: *Adults* – 4 mm, black, cylindrical in cross-section. Head bent downwards, concealed. Tip of abdomen square, boundary between end and side of elytra marked with ridge. *Larvae* – scarabaeiform, legs fully developed

Similar species: *Dinoderus* (5), *Rhyzopertha* (7)

Pest type: primary pest

Economic importance: high, especially in bagged and traditionally stored produce under subsistence conditions. Pest of international quarantine concern

Commodities attacked: maize, especially on cob, and dried cassava. Often infests prior to harvest

Distribution: native to extreme south USA to northern South America, introduced to Africa in 1980s, becoming widespread

Life cycle: *Optimum* – 26 days at 30°C, 75% r.h. *Range* – 18–36°C, 40–90% r.h. *Maximum population growth rate per month* – 25. *Eggs* – laid on commodity or in tunnels bored by adults. *Larvae* – internal feeders producing lots of flour, immobile when mature. *Adults* – long-lived, feed and bore into commodity, fly

Additional information: page 30, *ISP*

7 Lesser grain borer

Rhyzopertha dominica (Bostrichidae)



R. dominica



Thorax and gradual slope of tip of elytra

Identification: *Adults* – 3 mm, dark reddish-brown, cylindrical in cross-section. Head bent downwards and concealed. Tip of abdomen tapered, end of elytra curved gradually. *Larvae* – scarabaeiform, legs fully developed

Similar species: *Dinoderus* (5), *Prostephanus* (6)

Pest type: primary pest

Commodities attacked: cereal grains, especially wheat, barley, rice and sorghum (milo)

Economic importance: high, even in modern bulk storage systems

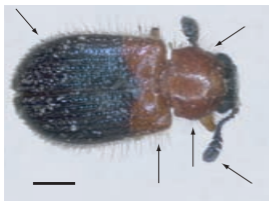
Distribution: worldwide, especially warm temperate to tropical regions

Life cycle: *Optimum* – 25 days at 34°C, 70% r.h. *Range* – 20–38°C, >30% r.h. *Maximum population growth rate per month* – 20. *Eggs* – laid on commodity or in tunnels bored by adults. *Larvae* – internal feeders producing lots of flour, immobile when mature. *Adults* – long-lived, feed and bore into commodity, fly

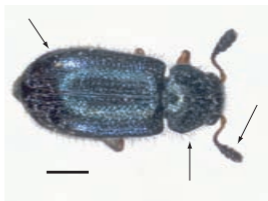
Additional information: page 30, *ISP*

8 Ham beetles

Necrobia spp. (Cleridae)



N. rufficollis



N. rufipes

Identification: *Adults* – 5 mm, all or part metallic blue-green, flattened parallel-sided, antennae with three-segmented club. Side of thorax with stiff, bristle-like hairs. *Larvae* – campodeiform

Similar species: none

Pest type: secondary pest, predator

Commodities attacked: copra, oilseeds, products of animal origin (e.g. dried fish)

Economic importance: medium under tropical conditions, minor elsewhere

Distribution: worldwide, especially tropics

Life cycle: (*N. rufipes*) *Optimum* – 30–34°C, high humidity. *Range* – 21–42°C. *Maximum population growth rate per month* – 25. *Eggs* – laid amongst commodity. *Larvae* – mobile, active external feeders. *Adults* – long-lived, feed on commodity and other insects, fly

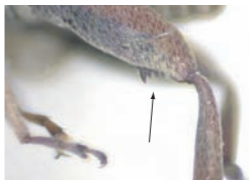
Additional information: page 36, *ISP*

9 Bean weevil

Acanthoscelides obtectus (Chrysomelidae, Bruchinae)



A. obtectus



Hind leg – spines on lower edge of hind femur

Identification: *Adults* – 3–4 mm, globular, long legs and antennae, elytra patterned and do not fully cover abdomen, lower edge of hind femur with three or four ‘teeth’. *Larvae* – scarabaeiform, legs partly developed

Similar species: other bruchids (10–14)

Pest type: primary pest

Commodities attacked: beans (*Phaseolus* spp.). Attacks commodity in storage and prior to harvest

Economic importance: high, especially in bagged and traditionally stored produce in warm temperate to tropical regions. Infestations often cause heating, leading to extensive mould growth

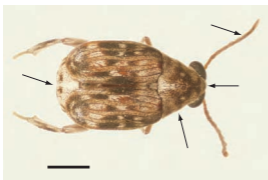
Distribution: worldwide, absent from parts of East and South-East Asia, tolerant of temperate conditions

Life cycle: *Optimum* – 27 days at 30°C, 80% r.h. *Range* – 15–33°C. *Maximum population growth rate per month* – 25. *Eggs* – laid loose on commodity. *Larvae* – bore directly into seed, develop concealed within seed. *Adults* – leave neat exit hole in seed, short-lived, do not feed on commodity, fly

Additional information: page 39, *ISP*

10 Bruchid beetles

Bruchidius spp. (Chysomelidae, Bruchinae)



Bruchidius spp.



Hind leg – spine on lower side of hind femur

Identification: *Adults* – 4–6 mm, globular with long legs and antennae, elytra patterned and do not fully cover abdomen. Inner ridge on lower side of hind femur with or without spine. *Larvae* – scarabaeiform, legs partly developed

Similar species: other bruchids (9, 11–14)

Pest type: primary pest

Commodities attacked: ripening lentils (*Lens* spp.), broad bean (*Vicia* spp.) and mung beans, grams and cowpeas (*Vigna* spp.). Emerges from dried seed in storage but incapable of reinfestation

Economic importance: high in crops destined for human consumption

Distribution: worldwide, especially in warm temperate and Mediterranean regions

Life cycle: linked to cropping cycle and availability of ripening seeds. *Eggs* – glued individually to pod. *Larvae* – on hatching bore directly into seed, develop concealed within seed. *Adults* – leave neat exit hole in seed, long-lived, survive between crops as adults, do not feed on commodity, fly

Additional information: page 39, *ISP*

11 Pea weevil

Bruchus pisorum (Chysomelidae, Bruchinae)



B. pisorum



Thorax – blunt spine on margin

Identification: *Adults* – 6–7 mm, globular with long legs and long antennae, elytra patterned and do not fully cover abdomen. Inner ridge on lower side of hind femur with single spine. Side of thorax with spine. *Larvae* – scarabaeiform, legs partly developed

Similar species: other bruchids (9–10, 12–14)

Pest type: primary pest

Commodities attacked: ripening peas (*Pisum* spp.). Emerges from dried seed in storage but incapable of reinfestation

Economic importance: high in crops destined for human consumption

Distribution: worldwide, especially in warm temperate and Mediterranean regions

Life cycle: linked to cropping cycle and availability of ripening seeds. *Eggs* – glued individually to outside of pod. *Larvae* – on hatching bore directly into seed, develop concealed within seed. *Adults* – leave neat exit hole in seed, long-lived, survive between crops as adults, do not feed on commodity, fly

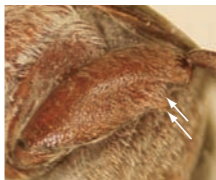
Additional information: page 39, *ISP*

12 Cowpea weevils

Callosobruchus spp. (Chysomelidae, Bruchinae)



C. maculatus



Hind leg – spines on lower side of hind femur

Identification: *Adults* – 3–4 mm, globular with long legs and antennae, elytra patterned and do not fully cover abdomen. Inner and outer ridge of lower side of hind femur each with spine. *Larvae* – scarabaeiform, legs partly developed

Similar species: other bruchids (9–11, 13–14)

Pest type: primary pest

Commodities attacked: most pulses except beans (*Phaseolus* spp.). Attacks commodity both in storage and prior to harvest

Economic importance: high, especially in bagged and traditionally stored produce in the tropics. Infestations often cause heating, leading to extensive mould growth

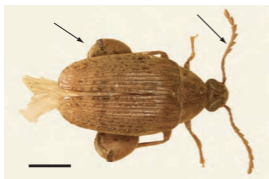
Distribution: worldwide, especially warm temperate to tropical regions

Life cycle: (*C. maculatus*) *Optimum* – 21 days at 32°C, 90% r.h. *Range* – 18–37°C, 20–90% r.h. *Maximum population growth rate per month* – 50. *Eggs* – glued individually to pod or seed. *Larvae* – on hatching bore directly into seed, develop concealed within seed. *Adults* – leave neat exit hole in seed, generally short-lived, do not feed on commodity, fly

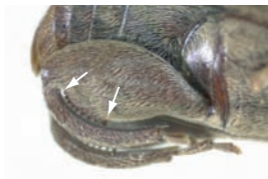
Additional information: page 39, *ISP*

13 Groundnut bruchid

Caryedon serratus (Chysomelidae, Bruchinae)



C. serratus



Hind leg – enlarged femur and row of small spines on lower edge

Identification: *Adults* – 7 mm, globular with long legs and antennae, elytra light brown and do not fully cover abdomen. Femur of hind leg enlarged, with one large tooth and 11–12 smaller ‘teeth’ on lower edge. *Larvae* – scarabaeiform, legs partly developed

Similar species: other bruchids (9–12, 14)

Pest type: primary pest

Commodities attacked: peanuts/groundnuts, dried tamarind

Economic importance: high, especially in bagged and traditionally stored produce in the tropics

Distribution: worldwide, subtropical to tropical

Life cycle: *Optimum*, 42 days at 30–33°C, 70–90% r.h.

Range – 23–35°C. *Eggs* – glued individually to pod or seed.

Larvae – on hatching bore directly into seed, develop completely within seed but may pupate in flimsy cocoon outside seed. *Adults* – leave neat exit hole in seed, short-lived, do not feed on commodity, fly

Additional information: page 39, *ISP*

14 Mexican bean weevil

Zabrotes subfasciatus (Chrysomelidae, Bruchinae)



Z. subfasciatus



Hind leg – spines at tip of tibia on hind leg

Identification: *Adults* – 3–4 mm, globular with long legs and antennae, elytra patterned and do not fully cover abdomen. Tibia of hind leg with two long movable spurs at tip. *Larvae* – scarabaeiform, legs partly developed

Similar species: other bruchids (9–13)

Pest type: primary pest

Commodities attacked: beans (*Phaseolus* spp.) in storage and prior to harvest. Some strains also attack cowpeas and mung beans (*Vigna* spp.)

Economic importance: high, especially in bagged and traditionally stored produce in the tropics. Infestations often cause heating, leading to extensive mould growth

Distribution: worldwide, especially tropics, absent in Australasia and parts of East Asia

Life cycle: *Optimum* – 24–27 days at 32°C, 70% r.h. *Range* – 20–38°C. *Eggs* – glued individually to pod or seed. *Larvae* – on hatching bore directly into seed, develop concealed within seed. *Adults* – leave neat exit hole in seed, short-lived, do not feed on commodity, fly

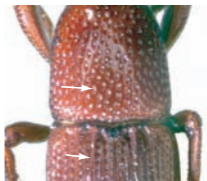
Additional information: page 39, *ISP*

15 Grain weevil

Sitophilus granarius (Curculionidae)



S. granarius



Thorax

Identification: *Adults* – 3–4 mm, dark brown, oval, long legs, front of head with long snout, elytra unmarked, flight wings (under elytra) absent, thorax with oval-shaped punctures.

Larvae – apodus

Similar species: *Sitophilus oryzae/zeamais* (16)

Pest type: primary pest

Commodities attacked: cereal grains

Economic importance: high, infestations can cause grain to heat, leading to extensive mould growth

Distribution: worldwide, especially temperate and other cool climates. Replaced by *S. oryzae/zeamais* in warm climates

Life cycle: *Optimum* – 25 days at 30°C, 70% r.h. *Range* – 11–34°C. *Maximum population growth rate per month* – 15. *Eggs* – laid singly in prepared hole in grain then covered with waxy plug. *Larvae* – immobile, develop concealed within single grain. *Adults* – on emergence leave ragged hole in grain, long-lived, feed, cannot fly

Additional information: page 46, *ISP*

16 Rice weevil, Maize weevil

Sitophilus oryzae, *Sitophilus zeamais* (Curculionidae)



S. oryzae



S. oryzae

Identification: *Adults* – 3–4 mm, dark brown to black, elytra each with two dull orange spots, flight wings (under elytra) present, thorax with circular-shaped punctures. These species are externally identical and can only be distinguished by examination of genitalia. *Larvae* – apodus

Similar species: *Sitophilus granarius* (15)

Pest type: primary pest

Commodities attacked: cereal grains and solid cereal products (e.g. pasta). *S. oryzae* also attack stored pulses. In tropics, *S. zeamais* often attacks commodity prior to harvest

Economic importance: high. Infestations can cause grain to heat, leading to extensive mould growth

Distribution: worldwide, *S. zeamais* most frequent in subtropics and tropics

Life cycle: *Optimum* – 25 days at 30°C, 70% r.h. *Range* – 15–34°C. *Maximum population growth rate per month* – 25. *Eggs* – as *S. granarius*. *Larvae* – as *S. granarius*. *Adults* – on emergence leave ragged hole in grain, long-lived, feed, fly

Additional information: page 46, ISP

17 Variegated carpet beetles, Museum beetles

Anthrenus spp. (Dermestidae)



A. verbasci



A. verbasci, larva

Identification: *Adults* – 2–3 mm, oval, covered in multi-coloured scales giving characteristic patterned appearance. *Larvae* – eruciform, oval, hairy, tufts of hairs at rear converge over tip of abdomen

Similar species: *Anthrenocerus* (18), *Trogoderma* (23–25)

Pest type: secondary pest, scavenger

Commodities attacked: dried organic material, especially of animal origin (particularly biological specimens, woolen goods, skins and hides, also residues and nests)

Economic importance: high in herbaria, museums and domestic situations, low elsewhere

Distribution: worldwide, common in houses in temperate areas

Life cycle: (*A. flavipes*) *Optimum* – 70–80 days at 35°C. *Eggs* – laid amongst commodity. *Larvae* – mobile, cast skins left throughout infested material. *Adults* – short-lived, do not feed on commodity, fly

Additional information: page 53, *ISP*

18 Australian carpet beetle

Anthrenocerus australis (Dermestidae)



A. australis



Head – antennae

Identification: *Adults* – 2.2–2.5 mm, oval, mid to dark brown. Thorax with patches of light-coloured hairs, elytra with three wavy bands of light-coloured hairs. Antennae with three-segmented club, segments joined asymmetrically.

Larvae – eruciform, oval, hairy, tufts of hairs at rear converge over tip of abdomen

Similar species: *Anthrenus* (17), *Trogoderma* (23–25)

Pest type: scavenger

Commodities attacked: dried organic material, especially of animal origin (particularly biological specimens, woolen goods, skins and hides)

Economic importance: medium in museums and domestic situations, low elsewhere

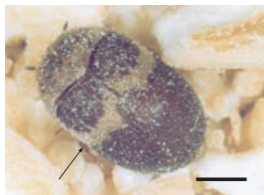
Distribution: Australia, New Zealand, Europe

Life cycle: *Optimum* – >100 days at 30–35°C. *Range* – 20–35°C. *Eggs* – laid amongst commodity. *Larvae* – mobile, cast skins left throughout infested material. *Adults* – short-lived, do not feed on commodity, fly

Additional information: page 56, *ISP*

19 Black carpet beetles, Fur beetles

Attagenus spp. (Dermestidae)



A. fasciatus



A. fasciatus,
larva



A. pellio

Identification: *Adults* – 3–5 mm, oval. *A. fasciatus* – distinctive pale band across elytra; *A. pellio* – black, elytra each with small white spot in centre; other species unmarked and dark brown to black. *Larvae* – eruciform, hairy, elongate

Similar species: *Dermestes* (20–22), *Alphitobius* (36)

Pest type: secondary pest, scavenger

Commodities attacked: dried organic material, especially of animal origin (particularly woolen goods, skins and hides)

Economic importance: medium in herbaria, museums and domestic situations, low elsewhere

Distribution: worldwide, common in houses in temperate areas

Life cycle: *Optimum* – four to eight months at 24°C, 70–80% r.h. *Range* – 15–30°C. *Eggs* – laid amongst commodity.

Larvae – mobile, cast skins left throughout infested material.

Adults – short-lived, do not feed on commodity, fly

Additional information: page 58, *ISP*

20 Black larder beetle, Hide beetles

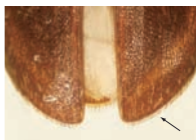
Dermestes ater, *Dermestes haemorrhoidalis*, *Dermestes peruvianus* (Dermestidae)



D. ater



D. haemorrhoidalis,
abdomen – underside



D. haemorrhoidalis,
tip of elytra

Identification: *Adults* – 5–10 mm, oval, dark brown to black with sparse light hairs. *D. ater* – underside brown with dark patches, others uniform light brown; *D. haemorrhoidalis* – outer edge of elytra with fringe of hairs, *D. peruvianus* without fringe. *Larvae* – eruciform, hairy, as *D. lardarius* (21).

Similar species: *Attagenus* (19), *Alphitobius* (36), other *Dermestes* (21–22)

Pest type: secondary pest, scavenger

Commodities attacked: dried fish, copra, oilseeds, hides and skins. Scavenger in stored grain, feeding on dead insects/animals; larvae damage wooden storage structures

Economic importance: high, especially in tropics

Distribution: *D. ater* mostly tropical, others tolerant of temperate conditions

Life cycle: (*D. haemorrhoidalis*) *Optimum* – 21 days at 30°C, 75% r.h. *Range* – 15–32.5°C, >40% r.h. *Eggs* – laid amongst commodity. *Larvae* – mobile, cast skins left throughout infested material. *Adults* – long-lived, feed on commodity, fly

Additional information: page 61, ISP

21 Larder beetle

Dermestes lardarius (Dermestidae)



D. lardarius



Dermestes spp. larva

Identification: *Adults* – 5–10 mm, oval, with pale band across top half of elytra, rest dark brown with sparse light hairs. *Larvae* – eruciform, hairy, pair of horn-like structures at tip of abdomen

Similar species: none

Pest type: secondary pest, scavenger

Commodities attacked: dried fish, copra, hides and skins. Scavenger in stored grain, feeding on dead insects/animals; larvae damage wooden storage structures

Economic importance: low–medium, minor pest in domestic situations

Distribution: mainly temperate regions

Life cycle: *Optimum* – 18–20°C, 80% r.h. *Range* – 15–30°C, >40% r.h. *Eggs* – laid amongst commodity. *Larvae* – mobile, cast skins left throughout infested material. *Adults* – long-lived, feed on commodity, fly

Additional information: page 61, *ISP*

22 Hide beetles

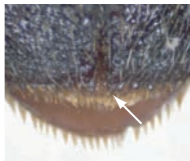
Dermestes carnivorus, *Dermestes frishii*, *Dermestes maculatus* (Dermestidae)



D. maculatus



D. maculatus,
abdomen – underside



D. maculatus, tip of
elytra

Identification: *Adults* – 5–10 mm, oval, dark brown to black. Underside of abdomen white, black patches at tip and sides (*D. maculatus/frishii*), black patches sides only (*D. carnivorus*). Tip of elytra of *D. maculatus* with spine, others without. *Larvae* – eruciform, hairy, as *D. lardarius* (21)

Similar species: *Attagenus* (19), *Alphitobius* (36), other *Dermestes* (20–21)

Pest type: secondary pest, scavenger

Commodities attacked: dried fish, copra, oilseeds, hides and skins. Scavenger in stored grain, feeding on dead insects/animals; larvae damage wooden storage structures

Economic importance: high, especially in tropics

Distribution: worldwide, *D. frishii* more tolerant of temperate conditions

Life cycle: (*D. maculatus*) *Optimum* – 21 days at 30°C, 75% r.h. *Range* – 20–40°C, >30% r.h. *Maximum population growth rate per month* – 30. *Eggs* – laid amongst commodity. *Larvae* – mobile, cast skins left throughout infested material. *Adults* – long-lived, feed on commodity, fly

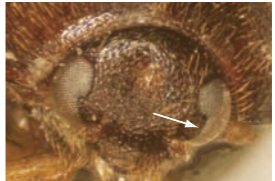
Additional information: page 61, *ISP*

23 Larger cabinet beetle, Mottled dermestid

Trogoderma inclusum (Dermestidae)



T. inclusum



Head – 'notch' in inner margin of eye

Identification: *Adults* – 2–3.5 mm, oval, hairy, elytra mottled. Eyes with notch in the inner margin. Antennal club three to eight segments; segments joined symmetrically. *Larvae* – eruciform, oval, with bands of hairs. Tufts at rear do not converge over tip of abdomen

Similar species: *Anthrenus* (17), *Anthrenocerus* (18), other *Trogoderma* (24–25) – identification only reliable by examination of genitalia and internal structures

Pest type: primary pest, secondary pest

Commodities attacked: dried animal and plant material, e.g. oilseeds, processed foods, grain and grain products

Economic importance: medium, persistent in storage structures and transportation

Distribution: North America, Europe and northern and central Asia

Life cycle: *Optimum* – 60 days at 30°C. *Range* – 20–40°C. Eggs – laid amongst commodity. *Larvae* – mobile, cast skins left in infested material, survive without food for years. *Adults* – short-lived, do not feed on commodity, fly

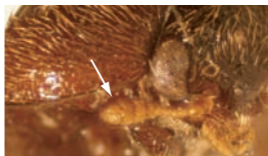
Additional information: page 66, *ISP*

24 Khapra beetle

Trogoderma granarium (Dermestidae)



T. granarium



Head – antennae

Identification: *Adults* – 2–3 mm, oval, hairy, elytra unmarked or light markings. Antennal club three to eight segments; segments joined symmetrically. *Larvae* – eruciform, oval, with bands of hairs as *T. variabile* (25)

Similar species: *Anthrenus* (17), *Anthrenocerus* (18), other *Trogoderma* (23, 25) – identification only reliable by examination of genitalia and internal structures

Pest type: primary pest, secondary pest

Commodities attacked: dried animal and plant material, e.g. oilseeds, processed foods, grain and grain products

Economic importance: high, especially in bagged produce in hot dry climates, persistent in storage structures and transportation. Pest of international quarantine concern

Distribution: North and West Africa to Burma and central Asia. Occasional or absent in Europe; North, North-East and South-East Asia; southern Africa; absent in Australasia and Americas

Life cycle: *Optimum* – 25 days at 33–37°C, 45–75% r.h. *Range* – 20–40+°C, r.h. >2%. *Max. pop. growth rate per month* – 13. *Eggs* – laid amongst commodity. *Larvae* – mobile, cast skins left in infested material, survive without food for years. *Adults* – short-lived, do not feed on commodity, do not fly

Additional information: page 66, *ISP*

25 Warehouse beetle

Trogoderma variabile (Dermestidae)



T. variabile



Larva

Identification: *Adults* – 2–3.5 mm, oval, hairy, elytra with three transverse wavy pale brown lines. Antennal club three to eight segments; segments joined symmetrically. *Larvae* – eruciform, oval, with bands of hairs. Tufts at rear do not converge over tip of abdomen

Similar species: *Anthrenus* (17), *Anthrenocerus* (18), other *Trogoderma* (23–24) – identification only reliable by examination of genitalia and internal structures

Pest type: primary pest, secondary pest

Commodities attacked: dried animal and plant material, e.g. oilseeds, processed foods, grain and grain products

Economic importance: high, especially in processed/packaged produce, persistent in storage structures/transportation

Distribution: worldwide, especially warm temperate and Mediterranean regions

Life cycle: *Optimum* – 30 days at 30°C. *Range* – 17–37°C. *Maximum population growth rate per month* – 8. *Eggs* – laid amongst commodity. *Larvae* – mobile, cast skins left in infested material, survive without food for years. *Adults* – short-lived, do not feed on commodity, fly

Additional information: page 66, *ISP*

26 Histerid beetles

(Histeridae)



Carcinops spp.



Teretrius nigrescens

Identification: *Adults* – 3–7 mm, oval, seed-like, shiny black or dark metallic, elytra short leaving two or three segments of abdomen exposed. Antennae with spherical three-segmented club. *Larvae* – campodeiform, elongate with large forward-pointing sickle-shaped mandibles

Similar species: *Carpophilus* (32)

Pest type: predator

Economic importance: beneficial insect

Distribution: worldwide, especially tropics. *Teretrius nigrescens* – specific predator of larger grain borer *Prostephanus truncatus* (6) – native to Mexico and northern South America, introduced into Africa as biological control agent

Life cycle: (*T. nigrescens*) *Optimum* – two months at 27°C, 70% r.h. *Maximum population growth rate per month* – 3.5. *Eggs* – laid amongst commodity. *Larvae* – active mobile hunters. *Adults* – long-lived, feed on prey and damaged commodity, fly

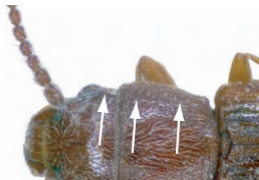
Additional information: page 72, ISP

27 Flat grain beetles

Cryptolestes spp. (Laemophloeidae)



C. ferrugineus



C. ferrugineus, head/thorax – ridge running from behind eye and across thorax

Identification: *Adults* – 1.5–2 mm, reddish-brown, highly flattened, parallel-sided. Hair-like antennae, up to length of body. A ridge runs from above each eye down each side of thorax. Species difficult to distinguish except by examination of genitalia. *Larvae* – campodeiform

Similar species: *Ahasverus* (33), *Cathartus* (34)

Pest type: secondary pest

Commodities attacked: cereal grain and products, other dried material of plant origin, packaged and processed goods

Economic importance: high, especially in milled, processed and packaged produce

Distribution: *C. ferrugineus* and *C. pusillus* worldwide, others more restricted. Some species cold tolerant

Life cycle: (*C. ferrugineus*) *Optimum* – 21 days at 35°C, 90% r.h. *Range* – 20–42.5°C, 40–90% r.h. *Maximum population growth rate per month* – 60. *Eggs* – laid amongst commodity. *Larvae* – mobile, external feeders. *Adults* – long-lived, walk with characteristic sway, feed on commodity, fly

Additional information: page 75, *ISP*

28 Minute mould beetles

Cryptophagus spp. (Cryptophagidae)



Cryptophagus spp.

Identification: *Adults* – 1.5 mm, oval, hairy flat beetles. Thorax with distinctive ‘tooth’ midway along side. *Larvae* – campodeiform

Similar species: Lathridiidae (29)

Pest type: mould feeder, scavenger

Commodities attacked: dried material of plant origin, including grain, straw and hay. Often found in newly harvested grain but does not persist unless it remains damp

Economic importance: low, indicator of damp produce

Distribution: worldwide, frequently encountered in temperate regions, cold tolerant

Life cycle: *Optimum* – 30–50 days at 15–18°C. *Eggs* – laid amongst commodity. *Larvae* – mobile, external feeders. *Adults* – long-lived, feed on commodity, fly

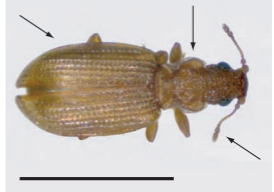
Additional information: page 79, *ISP*

29 Minute mould beetles, Plaster beetles

(Lathridiidae)



Corticaria spp.



Lathridius spp.

Identification: *Adults* – 1.3–2 mm, flattened, head and thorax small relative to bulbous abdomen. Antennae with two or three-segmented club. Some species hairy. Elytra of hairless species with ridges and rows of pits in between, some with constriction about halfway along thorax. *Larvae* – campodeiform

Similar species: Cryptophagidae (28)

Pest type: mould feeder, scavenger

Commodities attacked: dried material of plant origin, including grain, straw and hay. Often found in newly harvested grain but does not persist unless it remains damp

Economic importance: low, indicator of damp produce

Distribution: worldwide, especially temperate regions, many species cold tolerant

Life cycle: (*Corticaria fulva*) *Optimum* – 40 days at 18°C, high humidity. *Eggs* – laid amongst commodity. *Larvae* – mobile, external feeders. *Adults* – long-lived, feed on commodity, fly

Additional information: page 79, ISP

30 Siamese grain beetle

Lophocateres pusillus (Lophocateridae)



L. pusillus



Underside – flattened margins of thorax and elytra

Identification: *Adults* – 3 mm, highly flattened, parallel-sided, brown to dark grey. Elytra with longitudinal ridges. Sides of thorax and elytra distinctively flattened to form ‘flange’.

Larvae – campodeiform

Similar species: *Typhaea* (31), *Sitophagus* (43)

Pest type: mould feeder, scavenger

Commodities attacked: dried material of plant origin, especially if damp (e.g. rice, beans, dried cassava)

Economic importance: low, indicator of poor storage conditions

Distribution: worldwide, tropics

Life cycle: *Optimum* – 42 days at 30°C, >10% r.h. *Range* – 20–35°C at 75% r.h. *Eggs* – laid amongst commodity. *Larvae* – mobile, external feeders. *Adults* – long-lived, feed on commodity, fly

Additional information: page 81, *ISP*

31 Hairy fungus beetle

Typhaea stercorea (Mycetophagidae)



T. stercorea

Identification: *Adults* – 3 mm, oval, brown, flattened, hairy, elytra with parallel lines of fine hairs. *Larvae* – campodeiform

Similar species: *Lophocateres* (30), *Gnatocerus* (39–40), *Palorus* (42), *Tribolium* (45–48)

Pest type: mould feeder, scavenger

Commodities attacked: dried material of plant origin, including grain and its products, straw and hay, especially if damp and/or newly harvested

Economic importance: low, indicator of damp produce

Distribution: worldwide

Life cycle: *Optimum* – 21–33 days at 25°C, 80–90% r.h. *Eggs* – laid amongst commodity. *Larvae* – mobile, external feeders. *Adults* – long-lived, feed on commodity, fly

Additional information: page 83, *ISP*

32 Dried fruit beetles, Corn sap beetles, Sap beetles

Carpophilus spp. (Nitidulidae)



C. hemipterus



C. marginellus

Identification: *Adults* – 2–4 mm, oval, flattened, light brown to black. Elytra short leaving two to three segments of abdomen exposed. Elytra often with one to two yellow, reddish or brown spots. Antennae with three-segmented globular club. *C. hemipterus* is distinctive, having a large triangular yellow spot on each elytra. *Larvae* – campodeiform

Similar species: Histeridae (26)

Pest type: secondary pest, mould feeder

Commodities attacked: dried and ripening fruit, newly harvested and damp grain, grain residues, compost heaps

Economic importance: high on dried fruit, low elsewhere

Distribution: worldwide, varies

Life cycle: (*C. hemipterus*) *Optimum* – 12 days at 32°C, high humidity. *Range* – 19–42°C, r.h. >50%. *Maximum population growth rate per month* – 50. *Eggs* – laid amongst commodity. *Larvae* – mobile, external feeders. *Adults* – long-lived, feed on commodity, fly

Additional information: page 85, ISP

33 Foreign grain beetle

Ahasverus advena (Silvanidae)



A. advena



Antennae and teeth-like structures at corners of thorax

Identification: *Adults* – 2.5 mm, flattened, light brown. Thorax with obvious tooth-like structure at each corner.

Larvae – campodeiform

Similar species: *Typhaea* (31), *Cathartus* (34), *Oryzaephilus* (35), *Latheticus* (41), *Palorus* (42)

Pest type: secondary pest, mould feeder

Commodities attacked: cereal grain, hay, straw and other dried material of plant origin, especially if slightly damp

Economic importance: low, usually only present in numbers on damp or newly harvested commodities

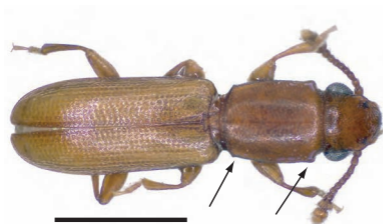
Distribution: worldwide

Life cycle: *Optimum* – 23 days at 27°C, 75% r.h. *Range* – >18°C, >65% r.h. *Eggs* – laid amongst commodity. *Larvae* – mobile, external feeders. *Adults* – long-lived, very active, feed on commodity, fly

Additional information: page 89, *ISP*

34 Square-necked flour beetle

Cathartus quadricollis (Silvanidae)



C. quadricollis

Identification: *Adults* – 3 mm, highly flattened, elongate, shiny reddish-brown. Thorax parallel-sided, corners square, sides of abdomen straight and parallel-sided. *Larvae* – campodeiform

Similar species: *Typhaea* (31), *Ahasverus* (33), *Oryzaephilus* (35), *Latheticus* (41), *Palorus* (42)

Pest type: secondary pest, mould feeder

Commodities attacked: cereals, especially maize, infestation often begins prior to harvest

Economic importance: high under conditions of tropical subsistence agriculture, low elsewhere

Distribution: tropics – Americas, Africa, Asia, absent from Australia

Life cycle: *Optimum* – 20 days at 27–29°C, 80–85% r.h. *Range* – 20–30°C, r.h. >65%. *Eggs* – laid amongst commodity. *Larvae* – mobile, external feeders. *Adults* – long-lived, very active, feed on commodity, fly

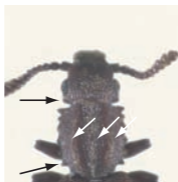
Additional information: page 89, *ISP*

35 Saw-toothed grain beetle, Merchant grain beetle

Oryzaephilus surinamensis, *Oryzaephilus mercator*
(Silvanidae)



O. surinamensis



O. surinamensis



O. mercator

Identification: *Adults* – 3 mm, dark brown to dark grey, highly flattened, parallel-sided. Thorax with three longitudinal ridges. Side of thorax with six tooth-like projections. Length of head behind the eye – long in *O. surinamensis*, short in *O. mercator*. *Larvae* – campodeiform

Similar species: *Ahasverus* (33), *Cathartus* (34)

Pest type: secondary pest

Commodities attacked: *O. surinamensis* – cereals and cereal products; *O. mercator* – dried fruit and oilseeds

Economic importance: high, even in temperate areas, major pests of processed and packaged goods

Distribution: worldwide, *O. surinamensis* cold tolerant

Life cycle: (*O. surinamensis*) *Optimum* – 20 days at 30–33°C, 70–90% r.h. *Range* – 20–38°C, r.h. >10%. *Maximum population growth rate per month* – 50. *Eggs* – laid amongst commodity. *Larvae* – mobile, external feeders. *Adults* – long-lived, very active, walk long distances, feed on commodity, fly

Additional information: page 89, *ISP*

36 Lesser mealworms

Alphitobius spp. (Tenebrionidae)



A. diaperinus



A. diaperinus – eye three or four facets wide at narrowest part



A. laevigatus – eye one facet wide at narrowest part

Identification: *Adults* – 5.5–7 mm, oval, flattened, reddish-brown to black, head widest before eyes. Eye divided, minimum number of eye facets at narrowest point: *A. diaperinus* – 3–4; *A. laevigatus* – 1. *Larvae* – elateriform

Similar species: *Lophocateres* (30), *Cynaenus* (38), *Sitophagus* (43)

Pest type: secondary pest, mould feeder, scavenger

Commodities attacked: dried material of animal or plant origin, e.g. store residues. Common inhabitant of chicken houses where they feed on droppings, etc.

Economic importance: low to medium, indicator of poor hygiene

Distribution: worldwide, *A. diaperinus* more cold tolerant than *A. laevigatus*

Life cycle: (*A. diaperinus*) *Optimum* – 46 days at 32°C, 95% r.h. *Eggs* – laid amongst commodity. *Larvae* – mobile, external feeders. *Adults* – long-lived, feed on commodity, fly

Additional information: page 94, *ISP*

37 Churchyard beetles, Egyptian beetles

Blaps spp. (Tenebrionidae)



Blaps spp.

Identification: *Adults* – 20–35 mm, black, globular, long spider-like legs. *Larvae* – elateriform

Similar species: none

Pest type: scavenger

Commodities attacked: damp and mouldy plant material, animal droppings

Economic importance: low, indicator of poor hygiene

Distribution: North America, Europe, Mediterranean, South-West Asia, introduced elsewhere (e.g. Australia)

Life cycle: development slow, cold tolerant. *Eggs* – laid amongst commodity. *Larvae* – mobile, external feeders. *Adults* – long-lived, feed on commodity, cannot fly

Additional information: page 97, *ISP*

38 Larger black flour beetle

Cynaesus angustus (Tenebrionidae)



C. angustus



Head widest at eyes



Margin of elytra obviously flattened

Identification: *Adults* – 5–6 mm, oval, flattened, reddish-brown to black. Head widest at eyes. Outside edge of elytra flattened as ‘flange’ that gradually narrows towards tip. *Larvae* – elateriform

Similar species: *Lophocateres* (30), *Alphitobius* (36), *Sitophagus* (43)

Pest type: primary pest, secondary pest, scavenger

Commodities attacked: cereal grain and products, especially maize. Inhabitant of chicken houses

Economic importance: medium

Distribution: Mexico, USA, Canada, Europe (Sweden), has potential to spread further

Life cycle: *Optimum* – 30–40 days at 30°C. *Eggs* – laid amongst commodity. *Larvae* – mobile, external feeders. *Adults* – long-lived, feed on commodity, fly

Additional information: page 99, *ISP*

39 Broad-horned flour beetle

Gnatocerus cornutus (Tenebrionidae)



G. cornutus – male



Female



Male, underside of head

Identification: *Adults* – 3–4 mm, flattened, parallel-sided, reddish-brown. Mandibles of males highly enlarged and horn-like, sides of head with flange-like processes. Structure between base of front legs parallel-sided and pointed at tip. *Larvae* – elateriform, as *G. maxillosis* (40)

Similar species: *Gnatocerus maxillosis* (40), *Latheticus* (41), *Palorus* (42), *Tribolium* (45–48)

Pest type: secondary pest, scavenger

Commodities attacked: dried material of animal and plant origin, especially cereal grain and products

Economic importance: low–medium, presence indicates long-term pest problem

Distribution: worldwide, tolerant of temperate conditions

Life cycle: *Optimum* – 57 days at 24–30°C, 66–92% r.h. *Range* – 16–32°C, r.h. >5%. *Maximum population growth rate per month* – 15. *Eggs* – laid amongst commodity. *Larvae* – mobile, external feeder. *Adults* – long-lived, feed on commodity, fly

Additional information: page 101, *ISP*

40 Slender-horned flour beetle

Gnatocerus maxillosis (Tenebrionidae)



G. maxillosis



Gnatocerus spp. larvae

Identification: *Adults* – 3–4 mm, flattened, parallel-sided, reddish-brown. Mandibles of males enlarged, sides of head without flange-like processes. Structure between base of front legs parallel-sided and pointed at tip. *Larvae* – elateriform

Similar species: *Gnatocerus cornutus* (39), *Latheticus* (41), *Palorus* (42), *Tribolium* (45–48)

Pest type: secondary pest, scavenger

Commodities attacked: dried material of animal and plant origin, especially cereal grain and products

Economic importance: low–medium, presence indicates long-term pest problem

Distribution: mostly tropical

Life cycle: *Optimum* – 30–40 days at 30°C. *Range* – 17.5–35°C, r.h. >7%. *Eggs* – laid amongst commodity. *Larvae* – mobile, external feeder. *Adults* – long-lived, feed on commodity, fly

Additional information: page 101, *ISP*

41 Long-headed flour beetle

Latheticus oryzae (Tenebrionidae)



L. oryzae



Last segment of antennae narrower than preceding one

Identification: *Adults* – 3 mm, parallel-sided, slender, flattened, yellowish-brown. Eyes crescent-shaped from side. Antennae with distinctive five-segmented club, final segment narrower than preceding one. *Larvae* – elateriform

Similar species: *Gnaticerus* (39–40), *Palorus* (42), *Tribolium* (45–48)

Pest type: secondary pest

Commodities attacked: dried material of animal and plant origin, especially cereal grain and products

Economic importance: low to medium, presence often indicates heating grain

Distribution: worldwide, especially under hot conditions or in heating grain

Life cycle: *Optimum* – 22 days at 35°C, 85% r.h. *Range* – 25–40°C, r.h. > 30%. *Maximum population growth rate per month* – 10. *Eggs* – laid amongst commodity. *Larvae* – mobile, external feeders. *Adults* – long-lived, feed on commodity, fly

Additional information: page 103, *ISP*

42 Small-eyed flour beetles

Palorus spp. (Tenebrionidae)



P. subdepressus



Eye round and undivided

Identification: *Adults* – 2.5–3 mm, reddish-brown, parallel-sided, like miniature *Tribolium*. Eyes undivided and round from side. *Larvae* – elateriform

Similar species: *Gnatocerus* (39–40), *Latheticus* (41), *Tribolium* (45–48)

Pest type: secondary pest

Commodities attacked: dried material of animal and plant origin, especially cereal grain and products

Economic importance: low

Distribution: worldwide, especially the tropics

Life cycle: *Optimum* – 36 days at 33°C. *Range* – 20–35°C, r.h. >50%. Eggs – laid amongst commodity. *Larvae* – mobile, external feeders. *Adults* – long-lived, feed on commodity, fly

Additional information: page 107, *ISP*

43 *Sitophagus hololeptoides*

(Tenebrionidae)



S. hololeptoides



Flange at margin of elytra abruptly narrows before tip of abdomen

Identification: *Adults* – 5–6 mm, yellowish-brown, highly flattened, mandibles enlarged. From below, outer edge of elytra abruptly narrows before tip of abdomen. *Larvae* – elateriform

Similar species: *Lophocateres* (30), *Alphitobius* (36), *Cynaenus* (38)

Pest type: secondary pest, mould feeder

Commodities attacked: cereal grain, especially maize, under conditions of subsistence agriculture

Economic importance: low

Distribution: Mexico, Central America, South America, West Africa

Life cycle: *Eggs* – laid amongst commodity. *Larvae* – mobile, external feeders. *Adults* – long-lived, feed on commodity, fly

Additional information: page 110, *ISP*

44 Mealworms

Tenebrio spp. (Tenebrionidae)



T. molitor



T. obscurus

Identification: *Adults* – 12–18 mm, reddish-brown to black, parallel-sided. Appearance of *T. molitor* glossy, *T. obscurus* matt. *Larvae* – elateriform

Similar species: *Dermestes* (20–22), *Lophocateres* (30), *Alphitobius* (36), *Cynaenus* (38)

Pest type: secondary pest, scavenger

Commodities attacked: cereal grain and products, usually associated with aged residues

Economic importance: low, indicator of poor hygiene

Distribution: worldwide, especially temperate regions

Life cycle: (*T. molitor*) *Optimum* – 120 days at 25–27°C. *Range* – 14–30°C, r.h. >30%. *Eggs* – laid amongst commodity. *Larvae* – mobile, external feeders. *Adults* – long-lived, feed on commodity, fly

Additional information: page 112, *ISP*

45 Rust red flour beetle

Tribolium castaneum (Tenebrionidae)



T. castaneum



Side of head



Underside of head

Identification: *Adults* – 3–4.5 mm, flattened, parallel-sided, reddish-brown. Gap between eyes – 33% of head width. Last three segments of antennae as distinct club. Structure between base of front legs widest at tip (like ‘axe head’). Eye divided, number of facets at narrowest point – 2. *Larvae* – elateriform, see *T. confusum* (46)

Similar species: *Gnaticerus* (39–40), *Latheticus* (41), other *Tribolium* (46–48)

Pest type: primary pest, secondary pest

Commodities attacked: dried material of animal and plant origin, especially cereal grain and products, oilseeds

Economic importance: high, especially in mills and processing plants and in grain stored in warm to hot climates

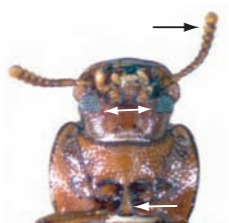
Distribution: worldwide

Life cycle: *Optimum* – 20 days at 35–38°C >70% r.h. *Range* – 22–40°C, r.h. >1%. *Maximum population growth rate per month* – 70. *Eggs* – laid amongst commodity. *Larvae* – mobile, external feeder. *Adults* – long-lived, feed on commodity, fly

Additional information: page 114, *ISP*

46 Confused flour beetle

Tribolium confusum (Tenebrionidae)



Underside of head



Larvae

Identification: *Adults* – 3–4.5 mm, flattened, parallel-sided, reddish-brown, as *T. castaneum* (45). Gap between eyes – 50% of head width. Segments of antennae gradually wider towards tip. Structure between front legs as *T. castaneum*. Eye divided, number of facets at narrowest point – 2 as *T. castaneum* (45). *Larvae* – elateriform

Similar species: *Gnatocerus* (39–40), *Latheticus* (41), other *Tribolium* (45, 47–48)

Pest type: primary pest, secondary pest

Commodities attacked: cereal grain and products

Economic importance: high, especially in mills and processing plants in temperate climates

Distribution: worldwide, especially in temperate regions

Life cycle: *Optimum* – 25 days at 32.5°C >70% r.h. *Range* – 19–37.5°C, r.h. >1%. *Maximum population growth rate per month* – 60. *Eggs* – laid amongst commodity. *Larvae* – mobile, external feeder. *Adults* – long-lived, feed on commodity, do not fly

Additional information: page 114, *ISP*

47 False black flour beetle

Tribolium destructor (Tenebrionidae)



T. destructor

Identification: *Adults* – 4.5–5.7 mm, flattened, parallel-sided, dark brown to black. Structure between base of front legs as *T. castaneum*. Eye divided, two eye facets at narrowest point. *Larvae* – elateriform

Similar species: *Gnatocerus* (39–40), *Latheticus* (41), other *Tribolium* (45–46, 48)

Pest type: secondary pest

Commodities attacked: dried material of animal and plant origin, especially cereal grain and products

Economic importance: high, especially in temperate regions

Distribution: Americas, Europe and temperate Asia, Mediterranean

Life cycle: *Optimum* – 44 days at 28°C, r.h. >75%. *Range* – maximum 30°C, r.h. >10%. *Eggs* – laid amongst commodity. *Larvae* – mobile, external feeders. *Adults* – long-lived, feed on commodity, fly

Additional information: page 114, *ISP*

48 American black flour beetle, Black flour beetle

Tribolium audax, *Tribolium madens* (Tenebrionidae)



T. audax



T. madens



T. madens, side of head

Identification: *Adults* – (*T. audax*) 2.8–4.5 mm; (*T. madens*) 3.9–5.1 mm; flattened, parallel-sided, dark brown to black. Structure between base of front legs as per *T. castaneum*. Eye divided, four or more eye facets at narrowest point. *Larvae* – elateriform

Similar species: *Gnatocerus* (39–40), *Latheticus* (41), other *Tribolium* (45–47)

Pest type: secondary pest

Commodities attacked: dried material of animal and plant origin, especially cereal grain and products

Economic importance: medium in temperate regions

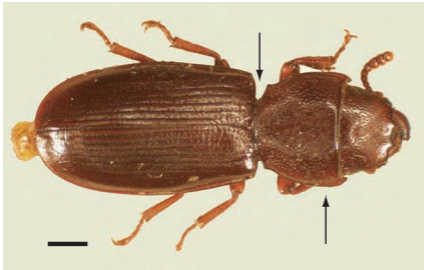
Distribution: *T. audax* – North America. *T. madens* – Americas, Europe and temperate Asia

Life cycle: (*T. madens*) *Optimum* – 35 days at 35°C, 70% r.h. *Range* – 20–35°C, r.h. >10%. *Eggs* – laid amongst commodity. *Larvae* – mobile, external feeders. *Adults* – long-lived, feed on commodity, fly

Additional information: page 114, *ISP*

49 Cadelle

Tenebroides mauritanicus (Trogossitidae)



T. mauritanicus

Identification: *Adults* – 6–11 mm, glossy black, flattened, parallel-sided, head and prothorax large, prothorax and elytra separated by distinct ‘waist’. *Larvae* – campodeiform

Similar species: *Dermestes* (20–22), *Alphitobius* (36), *Cynaesus* (38)

Pest type: secondary pest, scavenger

Commodities attacked: dried material of plant origin, especially cereal grain and products, usually associated with aged residues

Economic importance: low, indicator of poor hygiene

Distribution: worldwide

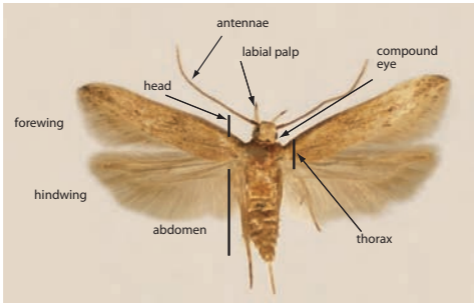
Life cycle: cold tolerant. *Eggs* – laid amongst commodity. *Larvae* – mobile, external feeders. *Adults* – long-lived, feed on commodity, fly

Additional information: page 119, *ISP*

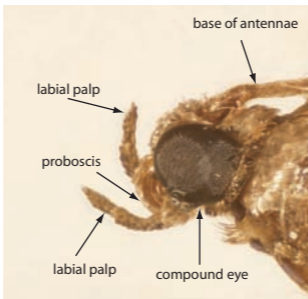
MOTHS – LEPIDOPTERA

The structure of moths

Knowledge of the basic structure of adult moths is required for their identification. Terms illustrated below are used in the following species descriptions.



Major body components of an adult moth



Structure of a moth head

50 White-shouldered house moth

Endrosia sarcitrella (Oecophoridae)



E. sarcitrella

Identification: *Adults* – labial palps long and strongly curved upwards. Head and thorax with white scales, forewing (6–10 mm) cream, heavily speckled with dark brown scales

Similar species: none

Pest type: scavenger

Commodities attacked: dried material of plant origin, usually associated with aged residues, bird nests

Economic importance: low except when attacking high value items, indicator of poor hygiene

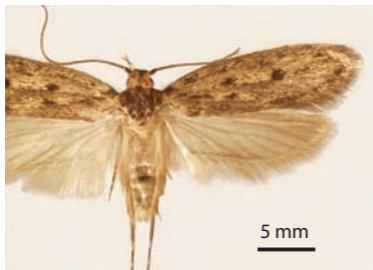
Distribution: worldwide, mainly temperate regions

Life cycle: *Optimum* – 62 days at 29°C, 90% r.h. Up to four generations a year. *Range* – 10–29°C r.h. >70%. *Eggs* – laid in crevices in commodity. *Larvae* – external feeders, produce silk webbing as they feed and pupate. Irregular holes may be bitten into attacked material. *Adults* – short-lived, do not feed on commodity, fly

Additional information: page 123, *ISP*

51 Brown house moth

Hofmannophila pseudospretella (Oecophoridae)



H. pseudospretella

Identification: *Adults* – labial palps long and strongly curved upwards. Head and thorax brown, forewing (6–12 mm) mottled brown

Similar species: *Cadra* (53), *Ephestia* (54), *Corcyra* (55)

Pest type: secondary pest, scavenger

Commodities attacked: aged residues, bird nests, woollen articles, wine corks

Economic importance: low except when attacking high value items, indicator of poor hygiene

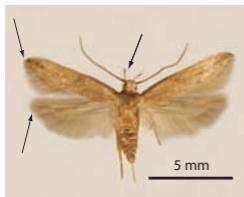
Distribution: worldwide, mainly temperate regions

Life cycle: *Optimum* – one generation a year. *Range* – 10–29°C, r.h. >80%. *Eggs* – laid in crevices in commodity. *Larvae* – external feeders, produce silk webbing as they feed and pupate. Irregular holes may be bitten into attacked material. *Adults* – short-lived, do not feed on commodity, fly

Additional information: page 123, *ISP*

52 Angoumois grain moth

Sitotroga cerealella (Gelechiidae)



S. cerealella



Labial palps



Larvae

Identification: *Adults* – labial palps long and strongly curved upwards. Forewing (5–6 mm) pale greyish-brown with single small black spot in centre, two-thirds from base. Wings heavily fringed with fine hairs, forewing tapered to apex, rear wing with finger-like projection

Similar species: none

Pest type: primary pest

Commodities attacked: cereal grain

Economic importance: high, especially in bagged or traditionally stored produce, can attack commodity prior to harvest

Distribution: worldwide, warm temperate to tropical regions

Life cycle: *Optimum* – 30 days at 30°C, 75% r.h. *Range* – 16–35°C, r.h. >30%. *Maximum population growth rate per month* – 50. *Eggs* – laid on commodity. *Larvae* – excavate cavity in grain, remain concealed there, make neat hole (covered with silk) in grain surface prior to pupation. *Adults* – exit through hole often leaving silken ‘door’ still attached to grain, short-lived, do not feed, fly

Additional information: page 125, *ISP*

53 Almond moth

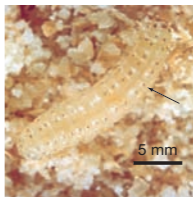
Cadra cautella (Pyralidae)



C. cautella



Labial palps



Larva

Identification: *Adults* – labial palps short and curved upwards. Forewing (7–9 mm) grey with darker markings. *Larvae* – 15–20 mm, white to pink with black spots (base of hairs), rim of abdominal spiracles evenly thickened

Similar species: *Hofmannophila* (51), *Corcyra* (55), *Plodia* (56), distinction from *Ephestia* spp. (54) only reliable by examination of genitalia

Pest type: secondary pest

Commodities attacked: dried material of plant origin, especially cereal products, oilseeds, cocoa, chocolate, spices, nuts, dried fruit, processed foods

Economic importance: high, especially in processed goods, mills and food factories, also in grain stores in warm climates

Distribution: worldwide, warm temperate to tropical

Life cycle: *Optimum* – 26 days at 30°C, 75% r.h. *Range* – 17–37°C, r.h. >20%. *Max. pop. growth rate per month* – 60. *Eggs* – laid loose in commodity. *Larvae* – external feeders, produce silk webbing. *Adults* – short-lived, do not feed on commodity, fly

Additional information: page 128, *ISP*

54 Tobacco moth, Mediterranean flour moth

Ephestia elutella, *Ephestia kuehniella* (Pyralidae)



E. elutella



E. kuehniella

Identification: *Adult* – labial palps short and curved upwards. Forewing (7–14 mm) grey with darker markings. *E. kuehniella* larger and more clearly marked. *Larvae* – as per *Cadra* (53)

Similar species: *Hofmannophila* (51), *Corcyra* (55), distinction from *Cadra* (53) only reliable by examination of genitalia

Pest type: secondary pest

Commodities attacked: dried material of plant origin, e.g. cereal products, oilseeds, cocoa, chocolate, spices, nuts, dried fruit, processed foods. *E. elutella* a major pest of tobacco

Economic importance: high, especially in processed foods, tobacco, mills and food factories

Distribution: worldwide, intolerant of hot conditions

Life cycle: (*E. kuehniella*) *Optimum* – 40 days at 25°C, 75% r.h. *Range* – 12–30°C, r.h. >0%. *Maximum population growth rate per month* – 50. *Eggs* – laid loose in commodity. *Larvae* – external feeders, produce silk webbing. *Adults* – short-lived, do not feed on commodity, fly

Additional information: page 128, *ISP*

55 Rice moth

Corcyra cephalonica (Pyralidae)



C. cephalonica



Female – labial
palps



Male

Identification: *Adults* – labial palps: male – short, hidden by scales; female – long, curved downwards. Forewing (8–13 mm) grey with no markings, males much smaller than females. *Larvae* – 15–20 mm, white, rim of abdominal spiracles thickened on one (rear) side

Similar species: *Hofmannophila* (51), *Cadra* (53), *Ephestia* (54)

Pest type: secondary pest

Commodities attacked: cereal grain and products

Economic importance: medium, especially in bagged and traditionally stored produce

Distribution: worldwide, subtropics to tropics

Life cycle: *Optimum* – 27 days at 30°C, 75% r.h. *Range* – 17–35°C, r.h. >20%. *Maximum population growth rate per month* – 10. *Eggs* – laid loose in crevices in commodity.

Larvae – external feeders, produce lots of silk webbing, irregular holes bitten into attacked material. *Adults* – short-lived, do not feed on commodity, fly

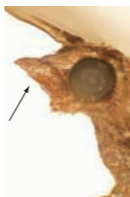
Additional information: page 128, *ISP*

56 Indian meal moth

Plodia interpunctella (Pyralidae)



P. interpunctella



Labial palps



Larva

Identification: *Adults* – labial palps point forwards. Forewing (7–9 mm) bi-coloured cream and reddish-brown. *Larvae* – 15 mm, unmarked creamy white, rim of abdominal spiracles evenly thickened

Similar species: *Cadra* (53), *Ephestia* (54); *Corcyra* (55), however, fresh specimens are distinctive

Pest type: secondary pest

Commodities attacked: dried material of plant origin, especially cereal products, oilseeds, cocoa, chocolate, spices, nuts, dried fruit, processed foods

Economic importance: high, especially in processed goods, domestic situations, mills and food factories

Distribution: worldwide, especially warm temperate to tropical regions

Life cycle: *Optimum* – 30 days at 30°C, 75% r.h. *Range* – 15–35°C, 25–90% r.h. *Maximum population growth rate per month* – 60. *Eggs* – stuck to commodity. *Larvae* – external feeders, produce silk webbing. *Adults* – short-lived, do not feed on commodity, fly

Additional information: page 128, *ISP*

57 Meal moth

Pyralis farinalis (Pyralidae)



P. farinalis

Identification: *Adults* – wings broad and richly patterned purplish-brown and brown regions (forewing 10–14 mm)

Similar species: none

Pest type: scavenger

Commodities attacked: dried material of plant origin, usually associated with aged residues and compost heaps

Economic importance: low, indicator of poor hygiene

Distribution: worldwide, especially in temperate regions

Life cycle: *Eggs* – laid loose in crevices in commodity. *Larvae* – external feeders, produce silk webbing, irregular holes bitten into attacked material. *Adults* – short-lived, do not feed on commodity, fly

Additional information: page 128, *ISP*

58 European grain moth

Nemapogon granella (Tineidae)



N. granella



Head covered in rough hairs

Identification: *Adults* – labial palps short and not curved upwards. Forewing (7 mm) with dark brown/black blotches on lighter background. Head covered in rough erect scales that give a hairy appearance

Similar species: case-bearing clothes moth and clothes moth (59)

Pest type: secondary pest, scavenger

Commodities attacked: dried material of plant origin, usually associated with aged residues, bird nests

Economic importance: low

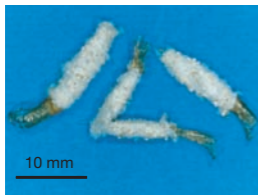
Distribution: worldwide, temperate regions

Life cycle: One to four generations a year. *Eggs* – laid loose in crevices in commodity. *Larvae* – external feeders, produce lots of silk webbing, irregular holes bitten into attacked material. *Adults* – short-lived, do not feed on commodity, fly

Additional information: page 134, *ISP*

59 Case-bearing clothes moths, Clothes moths

Tinea spp., *Tineola bisselliella* (Tineidae)



Tinea spp. – silken case produced by larvae



Tineola pellionella

Identification: *Adults* – head covered in rough erect scales to give hairy appearance. Forewing (5–8 mm) mottled grey. Adult moths are rarely seen. *Larvae* – *Tinea* spp. larvae live in distinctive silken tube-like case, *Tineola* infestations produce lots of webbing

Similar species: *Nemapogon* (58)

Pest type: secondary pest, scavenger

Commodities attacked: wool and woollen goods, feathers, nests, residues

Economic importance: high on valuable woollen goods, low on stored products

Distribution: worldwide, especially in temperate and Mediterranean areas

Life cycle: (*T. bisselliella*) *Optimum* – 39 days at 25°C. *Range* – 10–33°C. *Eggs* – laid in crevices. *Larvae* – external feeders, irregular holes bitten into attacked material. *Adults* – short-lived, do not feed on commodity, fly

Additional information: page 134, *ISP*

PSOCIDS, BOOKLICE – PSOCOPTERA

60 Psocids, booklice

Liposcelis spp. (Liposcelididae)



L. decolor



L. entomophila

Identification: *Adults* – 0.7–1 mm, highly flattened, wingless, femur of hind leg enlarged. Translucent to dark brown, some striped (e.g. *L. entomophila*)

Similar species: other psocids (61), mites

Pest type: secondary pest, mould feeder, scavenger

Commodities attacked: any dried material of plant and animal origin, especially if slightly damp. A common pest of crop residues

Economic importance: medium to high in museums, herbaria, domestic situations and sometimes in bulk and bagged grain

Distribution: worldwide

Life cycle: (*L. entomophila*) *Optimum* – 30°C, 80% r.h. *Range* – 18–36°C, r.h. >60%. *Eggs* – laid amongst commodity. *Nymphs/adults* – feed on commodity, long-lived, move with characteristic jerky motion

Additional information: page 137, *ISP*

61 Psocids, booklice (winged species)



Lachesilla quercus



Trogium pulsatorium

Identification: *Adults* – 1–2 mm, globular, colour variable, wings range from tiny knobs to membranous and fully functional

Similar species: *Liposcelis* (60), mites

Pest type: secondary pest, mould feeder, scavenger

Commodities attacked: any dried material of plant and animal origin, especially if slightly damp. Common pests of residues in structures

Economic importance: generally low, large populations indicate poor storage conditions

Distribution: worldwide, many tolerant of temperate conditions

Life cycle: (*Lachesilla quercus*) *Optimum* – 22–26°C, 70–80% r.h. *Range* 18–36°C, r.h. >70%. *Eggs* – laid on surface of commodity. *Nymphs/adults* – feed on commodity, produce silken webbing, some short-lived, some can fly

Additional information: page 137, *ISP*

BUGS – HEMIPTERA

62 Predatory bugs



Xylocoris spp.



Peregrinator biannulipes

Identification: *Adults* – 3–7 mm, brown, flattened diamond or triangular in shape, antennae and legs long, membranous tips of forewings overlap to form white ‘diamond’ over abdomen. Long needle-like mouthparts held at rest between front legs. *Nymphs* of *Xylocoris* spp. yellow or pink

Similar species: none in storage environment

Pest type: predator

Economic importance: beneficial insects, presence of large numbers typically indicates infestations of pest species

Distribution: worldwide

Life cycle: *Eggs* – laid at random in vicinity of suitable food supply. *Nymphs/adults* – size of prey they tackle gets bigger as they approach adulthood

Additional information: page 143, *ISP*

WASPS – HYMENOPTERA

63 Parasitoid wasps



Anisopteromalus calandrae



Habrobracon (Bracon) spp.

Identification: *Adults* – 0.5 to >5 mm, like small wasp, winged, some species wingless, many with needle-like ovipositor at tip of abdomen. Body of many species dark metallic in colour

Similar species: none in storage environment

Pest type: parasitoid, attacks eggs and larvae of moths and beetles

Economic importance: beneficial insect, presence of large numbers typically indicates infestations of pest species

Distribution: worldwide

Life cycle: *Eggs* – laid on or in the eggs or larvae of host. *Larvae* – develop on or inside host, which is killed when development is completed. *Adults* – short-lived, do not feed, fully winged species can fly

Additional information: page 147, *ISP*

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