ECO CARE
LABORATORIES

STORED GRAIN PESTS AND THEIR ENTOMOLOGY

Overseas customers demand insect-free grain. For this reason, Indian Plant Quarantine has imposed nil tolerance of insects in export grain. Insect pests also increase costs to grain growers both directly through the expense of control on the farm, and indirectly through the costs incurred by grain handling authorities in controlling weevils in bulk storages.

It has been estimated that between one quarter and one third of the world grain crop is lost each year during storage. Much of this is due to insect attack. In addition, grain which is not lost is severely reduced in quality by insect damage. Many grain pests preferentially eat out grain embryos, thereby reducing the protein content of feed grain and lowering the percentage of seeds which germinate. Some important stored grain pests include the lesser grain borer, rice weevil and rust red flour beetle.

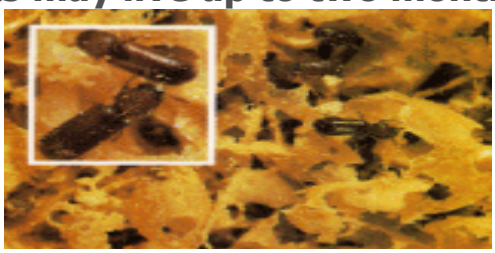
Grain insect pests may be divided into primary and secondary pests. Primary grain insects have the ability to attack whole, unbroken grains, while secondary pests attack only damaged grain, dust and milled products

ECO CARE LABORATORIES

PRIMARY GRAIN PESTS

Lesser grain borer (*Rhyzopertha dominica*);

The lesser grain borer is the most serious pest of stored grain. It is a dark brown cylindrical beetle about 3mm long. The head is hidden by the thorax when viewed from above. Females lay up to 500 eggs scattered loosely through the grain. The eggs hatch to produce curved white larvae with brown heads and three pairs of legs. The larvae burrow into slightly damaged grains and eat out the starchy interior. After pupating the adults emerge from the grain, leaving large irregular exit holes. The life cycle takes from three to six weeks depending on the temperature. Adults may live up to two months.



The adult lesser grain borers chews grain voraciously causing damage which may facilitate infestation by a secondary pest. It is a strong flyer and may rapidly migrate from infested grain to begin new infestations elsewhere.

Granary weevil (*Sitophilus granarius*);

When disturbed it sits very still for several minutes. An adult lays up to 450 eggs singly in holes chewed in cereal grains. Each egg hatches into a white, legless larva, which eats the grain from the inside. The larva pupates within the grain and the adult then chews its way out. The exit holes are characteristic signs of weevil damage. The life cycle takes about one month under summer conditions and adults may survive for a further eight months. The granary weevil is a small dark brown-black beetle about 4mm long with a characteristic

rostrum (snout) protruding from its head. It has biting mouth parts at the front of the rostrum and two club-like antennae.

Rice weevil (*Sitophilus oryzae*);

An adult lays up to 450 eggs singly in holes chewed in cereal grains. Each egg hatches into a white, legless larva, which eats the grain from the inside. The larva pupates within the grain and the adult then chews its way out. The exit holes are characteristic signs of weevil damage. The life cycle takes about one month under summer conditions and adults may survive for a further eight months. The rice weevil has four orange-brown areas on the wing cases, and is about 3mm long with a characteristic rostrum (snout) protruding from its head. It has biting mouth parts at the front of the rostrum and two club-like antennae. Unlike the granary weevil, the rice weevil is winged and may occasionally fly.

Angoumois grain moth (*Sitotroga cerealella*);

The Angoumois moth is yellow-brown with darker markings. Its wingspan is 12-20mm. Females lay up to 250 eggs on or near the surface of stored grain. The eggs hatch into a caterpillar which bores into grain kernels remaining inside until mature. It then eats its way out of the grain, leaving characteristic exit pin holes on the grain surface.
Unlike most other moth pests, no surface web is formed. The life cycle may be completed in as little as five weeks.

As well as reducing the weight of grains, Angoumois moth infestations impart an unpleasant smell and taste to the cereal.

SECONDARY PEST OF STORED GRAIN

Rust-red flour beetle (*Tribolium castaneum*);

The rust-red flour beetle is frequently found on farms. It is a reddish brown beetle about 3mm long. The final three segments of its antennae are greatly enlarged to form a club shape. Young adults are pale brown in colour becoming darker with age. Females lay up to 1000 eggs loosely scattered throughout infested grain. Cream-coloured larvae with biting mouth parts and three pairs of legs hatch and remain free from the grain, feeding on cereal dust and damaged grains. A generation takes about one month to complete under summer conditions, but longer in cold weather. Adults may live up to a year. The adult is winged and may fly.

Confused flour beetle (*Tribolium confusum*);

The confused flour beetle closely resembles the rust-red flour beetle in appearance and life history except for the antenna segments which do not have a distinct three-segmented club at the end. It is more often found in flour mills than on farms, as it prefers more finely divided materials.

ECO CARE LABORATORIES

Saw-toothed grain beetle (*Oryzaephilus surinamensis*);

The saw-toothed grain beetle is common on farms. Adults are dark brown to black with six tooth-like projections on each side of the thorax. They lay up to 500 eggs loosely spread through the infested grain; eggs hatch to produce larvae which feed externally on grain dust and sometimes wheat embryos. The mature larvae pupate within a silken cocoon. A complete generation may take place in as little as three weeks but the adults may live up to nine months. They frequently hide in cracks and crevices of buildings and machinery.

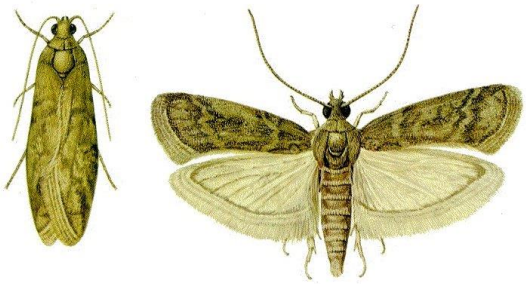
Flat grain beetle (*Cryptolestes* spp.):

Flat grain beetles are small reddish brown insects about 1.5mm long with long antennae and a flattened body. Eggs are laid throughout the stored grain and develop into tiny larvae with characteristic tail horns, biting mouth parts and three pairs of legs. They feed on damaged grain and wheat embryos. Pupation takes place in a cocoon. A complete life cycle takes from 4-5 weeks and adults may survive up to one year.

Warehouse moth (*Ephestia* spp.);

The warehouse moth is a drab grey moth with a 10-12mm wingspan. It usually only infests the surface of stored grain.

Moths live for only about two weeks, but during that time lay up to 200 eggs. These are distributed loosely on the grain surface. Larvae hatch out of the eggs and wander over the grain surface leaving a trail of silk which may form a thick mat covering the surface of the infested grain. Mature larvae pupate in a silk cocoon among the grain or on the walls of the building. The life cycle takes at least four weeks.



Indian meal moth (*Plodia interpunctella*)

The adult Indian meal moth is grey with distinctive brownish-red tips to the forewings. The female lays up to 200 eggs near the grain surface as it slowly passes from grain to grain spinning a silk thread. Severe infestations may form a surface web on the grain heap. Larvae attack the wheat germ, then pupate in a cocoon which may be found in cracks and crevices of buildings. The insects quickly emerge as adult moths. A generation takes as little as four weeks under warm conditions.

Warehouse beetle (*Trogoderma variable*);

The warehouse beetle is a pest of stored grain in its own right, but the greater threat is the impact on trade that it could have by masking an incursion of the world's worst pest of stored grain — the khapra beetle. Warehouse beetle and khapra beetle require microscopic examination to distinguish them. Khapra beetle does not occur anywhere in Australia and would

have a severe impact on international trade if it became established.

Eggs are usually laid in crevices and under the surface of loose food. They hatch in about a week. Only the larval stage damages grain. It is frequently found in seeds, groceries and used sacks. The larvae are conspicuously hairy. They usually live for about five weeks but may enter a dormant phase (diapause) for more than two years. Larvae may moult up to ten times.

After pupation adults emerge. They are less obvious than the larvae and do no damage to grain. They live for up to five weeks during which females lay up to 80 eggs. Warehouse beetles cannot fly and are spread only in infested commodities and old sacks.

A characteristic of warehouse beetle infestations is the accumulation of cast larval skins. Hairs shed by larvae may cause asthma, skin or gastric problems.

It is impossible to distinguish between *T. variabile* and several harmless native species without the aid of a microscope. Any hairy larvae found in grain stores should be sent at once to the Department of Agriculture and Food, Western Australia for positive identification.

<u>Khapra beetle (Trogoderma granarium);</u>

<u>Type of pest:</u> Primary pest, secondary pest.

<u>Distribution:</u> 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 Australia and the Americas. The khapra beetle is thought to have originated in India.

ECO CARE
LABORATORIES

Identification: ***Adults are 2 – 3.5 mm, oval, hairy, with elytra unmarked or light markings. The antennal club has three to eight segments, joined symmetrically. Larvae:*** **eruciform*, oval, with bands of hairs as Trogoderma variabile.***

Life cycle: ***The life cycle is complete in 26 to 220 days depending on temperatures. Khapra beetle populations can increase rapidly under optimal conditions (hot and dry). Optimal conditions are 25 days at 33-37 ºC, 45-75% r.h. In adverse conditions this insect can enter larval*** **diapause and**

survive in this state with limited food for several years. Eggs are laid amongst the commodity. Larvae are mobile, cast skins left in infested material, surviving without food for years. Adults are short-lived, do not feed on the commodity and do not fly.

Commodities infested: The Khapra beetle will feed on most dried plant or animal matter. However they prefer grain and cereal products, particularly wheat, barley, oats, rye, maize, rice, flour, malt, and noodles. They can feed on products with as little as 2% moisture content and can develop on animal matter such as dead mice, dried blood, and dried insects. Damage by this insect is mostly caused when the larvae feed. Signs of infestation are cast larval skins in and around infested foodstuffs and dust-like debris. If the beetle is left undisturbed in stored grain it can cause significant weight loss, and in the case of seeds, it may lead to significant reduction in seed viability. Infestations are difficult to control because of the insect's ability to survive without food for long periods. Severe

infestation may cause unfavorable changes in chemical composition.

This beetle has never been observed to fly; therefore its spread is probably dependent on movement of infested goods or in containers where it may be transported while in diapause. The Khapra beetle is a quarantine pest in many countries and is more resistant to fumigants than most stored product pests.

ECO CARE
LABORATORIES

Caryedon serratus **Olivier.-Groundnut Beettle;**

Significance;

Caryedon serratus **is a serious pest of stored groundnuts, particularly when these are still in their shells. The damage caused is particularly significant when the nuts are destined for confectionery purposes.**

Symptoms;

The translucent milky-white eggs are attached to the pod wall. After hatching, the larva burrows straight through the egg shell and the pod wall, and starts eating the seed. The first sign of attack is the appearance of 'windows' cut into the pod wall by the larva to allow the adult to leave the pod after emerging from the pupal cacoon. Fully grown larva sometimes come out through the exit holes made by the previous generations. They often live in the storage sacks and pupate in large numbers at the bottom of the pile of sacks. By this stage, the groundnut seeds are severely damaged for human consumption or oil expulsion (Wightman and Ranga Rao 1993)

ECO CARE
LABORATORIES

Host;

Arachis hypogaea **(groundnut), stored products (dried stored products),** ***Elaeis guineensis*** **(African oil palm),** ***Gossypium*** **(cotton),** ***Phaseolus*** **(beans),** ***Theobroma cacao*** **(cocoa) and** ***Tamarindus indica*** **(Indian tamarind).**

Geographical distribution;

Caryedon serratus **is of Asian origin, but is distributed to many tropical and subtropical regions of the world (Southgate 1979). Although it is especially prevalent in the warm and hot parts of Asia, North-eastern and West Africa, the West Indies, Hawaii, and parts of South and Central America as far north as Mexico, it is a serious pest of stored groundnuts only in West Africa.**

Biology and transmission;

The eggs of ***C. serratus*** **are translucent, white, oval, approximately 1 mm long and 0.5 mm wide (Davey, 1958). The larvae are scaribeiform and sparsely hairy. They usually leave the pods of their host before pupation. Pupae are creamy white, glabrous, about 5 mm long (Cox, 1996). It is a large robust bruchid which, in commerce, is almost always associated with groundnuts or tamarinds. It has a reddish-brown cuticle, densely clothed with grey-brown setae, but with dark, irregular markings on the elytra. The pygidium in the female is fully visible from above. Body length is 3.5-7.4 mm. Almost entirely covered dorsally by golden scale-like setae. Antennae are 5 to 10 serrate with 2-4 segments impressed basally. Head is with prominent and median carina. Pronotum is subconical, evenly convex dorsally, reddish-fuscous to testaceous, irregularly punctured, with fine bead around all margins, except for anterior angles. Elytra is one-and-a-half times as long as broad, puctate-striate, testaceous to dark reddish-fuscous usually with darker maculatron. Metafemora strongly thickened, with ventral, comb-like row of one large, sub median tooth followed by 8-12 small teeth. Metatibiae strongly curved, but simple, without either ventral, sub basal tubercle or two small, unequal, ventroapical calceriae (Prevett 1967). The optimum**

conditions for development are 30-33°C and 70-90% RH, under which conditions the development period is 41-42 days. Breeding can take place between 23 and 35°C (Davey 1958).

***Corcyra cephalonica* The Rice Moth**

Host: A pest of stored rice, millets and other cereals. Prefers broken grains and flour.

Damage: Caterpillars cause the damage by webbing together grains and forming lump and feed from inside it. Larvae before pupation wander about and leave a lot of webbing in the grains, causing excessive lumping, which reduces marketing quality of the grains.

Life cycle: **Adults light greyish-brown in colour, 12 mm long and with a wing span of about 15 mm, without any markings on the wings but veins are slightly darkened. Head bears a projected tuft of scales. Moths are short lived but realise a fecundity of 150—200 eggs per female within a few days after emergence. Eggs are laid anywhere, on the grains, among grains, on the containers or on any surface near the grains, either singly or in clusters. Eggs are whitish, oval in shape, 0.5 mm long and having an incubation period of 4-5 days. Tiny larva after hatching is creamy-white, with a prominent head. It moves about actively and feeds on broken grains for sometime and then starts spinning web to join grains. Full grown larva is pale whitish in colour, 15 mm long with short scattered hairs and no markings on body. Larval period is 25-35 days in summer and may be extended in winter. Pupation takes place inside an extremely tough, opaque whitish cocoon that is surrounded by webbed grains. Pupal period is about 10 days but may extend to 40-50 days to tide over winter moths. Moths commence mating and egg laying immediately after emergence.**

Sesame seed bug, elasmolomus sordidus :

ECO CARE
LABORATORIES

Abstract:

Sesame seed bug, Elasmolomus sordidus (Fabricius), is one of the most important post-harvest insect pests of oilseed crops in western Sudan. This study was conducted in El Nahud locality at West Kordofan State during 2003 and 2004 seasons to investigate the insect life history and damage caused by sesame seed bug on groundnut. Duration of each of the developmental stages of the pest was determined in laboratory. The results indicated that egg incubation period was 4.5 ± 0.17

days, while the respective nymphal duration from the 1st , to the 6th instar were 1.85 ± 0.13,6.3 ± 0.20, 4.95 ± 0.16, 5.0 ± 0.27, 5.3 ± 0.28 and 4.2 ± 0.15 days, respectively. The developmental period from egg to adult stage was 32.1 ± 0.52 days. The lifespan of adult female and male was 19.2 ± 0.38 and 9.85 ± 0.39 days, respectively. The lifespan from egg to adult death was 51.2 and 41.9 days for female and male, respectively. The male to female sex ratio was 1:1.2. Oviposition period was 4.9 ± 0.07days and the peak laying period was on the second day. The results showed that the insect caused losses in seed weight from 2 to 36%, reduction in oil content from 4 to 43%, increase in free fatty acids from 0.44 to 1.51 % and increase in the shriveled seeds to 40% in comparison with the control.

Insecticide resistance

Insect populations of many species have evolved resistance to insecticides as a result of the widespread use of these chemicals in control. In some cases, insects which have only been exposed to one insecticide develop resistance to other, related compounds.

It takes many years and millions of dollars to develop and test new compounds. Therefore it is important that insecticide resistance is prevented from spreading. This may be achieved by appropriate use of pesticides and by farm hygiene. This consists of careful cleaning of all machinery and buildings used for storing and transporting grain right from the header to the port terminal.

ECO CARE
LABORATORIES

CONTROL MEASURES

Groundnuts are semi-perishable and are subject to quality losses during storage through

- **insect and rodent infestation,**
- **fungal development,**
- **flavor changes,**
- **rancidity,**
- **viability loss,**
- **physical changes like shrinkage, weight loss, etc.**

BEST STORAGE PRACTICES:

- **Drying the pods to less than 10% moisture before storing.**
- **No live insect pests are present in the produce or in the storage areas.**
- **Spraying the bags with pods with DDVP (Nuvan) at 2 ml/ liter of water or dusting with 5% Malathion.**
- **Fumigation of pods with Aluminum phosphide (Celphos) at 3 g tablets per bag of groundnut (40 kg) and covering the sacks with polythene sheet for 5 days can effectively control bruchids without affecting the seed viability.**
- **Fumigation should be done only in well aerated places outside the residential areas or in seed godowns only.**

- **Maintenance of optimum moisture content is always critical in preventing the development of storage pests.**
- **For protection against these 2 storage pests (Caryeden cerratus and sesame seed bug)groundnuts should be stored unshelled.**
- **If groundnuts are stored as seed, care should be taken to avoid breakage. Broken seeds should not be stored for long periods.**
- **Dusting with an inert substance such as clay dust can help to minimize storage insect problems. Fumigation of pods**

with Aluminum phosphide (Celphos) at 3 g tablets per bag of groundnut (40 kg) and covering the sacks with polythene sheet for 5 days can effectively control bruchids without affecting the seed viability.

- Fumigation should be done only in well aerated places outside the residential areas or in seed godowns only, under the supervision of plant protection specialist.
- This learning resources are still to be edited and likely to be modified according to new recommendations & area specific climate.
- High moisture and temperature regulates the rate of deterioration of kernels in storage.
- During shelling serious losses in milling quality may result, if groundnut kernels are dried below 7% moisture content (on weight basis) or stored at a temperature less then 7°C.
- Best storage conditions for normal dry bulk storage of unshelled groundnuts is about 7.5% kernel moisture content at 10°C and 65% relative humidity i.e. moisture in the surrounding air.
- If such storage conditions are maintained, unshelled groundnuts can be stored without significant loss in quality for about 10 months.
- Some groundnut varieties have been noted to have poor storability

For example, in Gujarat cultivar GG 2 loses its viability rapidly than any other cultivar.
The methods of cultivation, harvesting, curing, and post-harvest handling of the groundnuts may affect their storability.

Factors known to accelerate the ageing process during storage are:

- High soil moisture content during pod development, and harvest stage;
- High temperatures (>40° C) during curing of pods,
- High relative humidity (>80%) during storage.

Conditions for good storage of groundnut are:

Groundnuts always should be stored as pods rather than as kernels.

Pods should be well dried to have not more than 5% moisture.

- **If storage is done as kernels, pods should be decorticated carefully to avoid splits and broken kernels. The period of storage should be reduced to the minimum possible.**

  Smallholder farmers store groundnut as pods, in earthen pots, mud bins, bamboo baskets or in other types of receptacles. Such containers are often plastered with mud and cow dung with little or no use of pesticides.

  For long-term storage the containers are sealed with mud after the addition of ashes, ground pepper, dried neem leaves or other local herbs to control storage pests.The summer crop of groundnut is harvested in the month of May to June. When this produce is stored, the relative humidity increases up to 80 to 90% with the onset of monsoon in the month of June to July. Consequently the pod moisture also increases to 10 to 15%. Pod moisture percent over10% will affect seed viability and quality.