

Feeding strategies

Insects infesting stored products feed and live in a number of ways which include:

- Commodity feeders (primary and secondary pests)
- Fungal feeders
- Predators
- Parasitoids
- Scavengers
- Foragers and accidentals.

Commodity feeders

Insects that feed directly on a commodity, especially seeds and products made from them, are often divided into primary pests – insects that can attack intact seeds and secondary pests that require the commodity to be damaged before they attack. In reality the situation is more complex. Each pest species requires its own level of 'damage' before it is able to successfully breed on a commodity. At one extreme are insects which clearly fill the role of primary pests as they are able to attack undamaged seed. Examples include bruchids, bostrichids, weevils and the moth *Sitotroga cerealella*. In reality, grain never enters storage totally undamaged. Grain accumulates damage such as chipped seed coats as a result of harvesting, handling, transporting, cleaning and drying. Such damage increasingly allows attack by secondary pests such as *Tribolium* spp., *Oryzaephilus* spp., *Cryptolestes* spp. and psocids *Liposcelis* spp. Damage previously caused by pre-harvest pests and by primary storage pests will also assist secondary pests.

In milled products such as flour, secondary pests dominate. Flour is after all highly 'damaged' grain. Indeed the primary pests listed above are unable to attack milled products unless they are

highly compacted or are processed into a solid form such as pasta or milled rice. Secondary pests are often selective as to which parts of the commodity they attack – many preferentially feed on the germ of grains. Secondary pests form the bulk of the pests attacking complex processed and manufactured food products such as breakfast cereals, chocolate and compound animal foods. Many of these pests are highly flattened in form and are able to easily enter packaged goods.

Primary pests tend to have a more restricted host range than secondary pests. Many secondary pests, such as *Trogoderma* spp. (Coleoptera: Dermestidae) and *Tribolium* spp. attack a very wide range of materials of both animal and plant origin.

Some commodities, e.g. copra and dried fish, inherently provide opportunities for access by insects, as the processes used to make them always produces cracks and crevices. Here the classification into primary and secondary pests is not very meaningful.

Which of the primary or secondary pests species present is the most important depends on the situation. For subsistence maize producers in tropical Africa, primary pests such as *Sitophilus zeamais* (Coleoptera: Curculionidae) and *P. truncatus* are of greatest concern. For a manufacturer of chocolates a secondary pest *Plodia interpunctella* (Lepidoptera: Pyralidae) is likely to be the major problem.

Commodities vary in their susceptibility to attack. Commodities that contain toxins and antifeedant chemicals, tend to have fewer and more specific pests, like the bruchid beetles that have evolved to attack pulses. Even dried tobacco – a material which contains the insecticide nicotine, has a characteristic suite of pests – notably *Lasioderma serricorne* (Coleoptera: Anobiidae) and *Ephestia elutella* (Lepidoptera: Pyralidae). In comparison, cereal grains and their products are attacked by a wide range of pest species.

Fungal feeders

Many storage pests supplement their diet by feeding on mould and mould spores. This provides additional nutrients that are absent or unavailable directly from the commodity itself. Other species, for example beetles of the families Latridiidae and Mycetophagidae, are mostly obligatory mould feeders and cannot survive on clean dry grain. Fungal feeders are often present on ripening grain and usually die out in storage but may continue to breed in poorly stored grain or in grain heavily infested with other insects.

Predators

Many storage pests, for example beetles of the families Cleridae, Tenebrionidae and Trogossitidae, will also prey on other insects present including members of their own species. Hemiptera and members of the beetles of the family Histeridae are obligate predators. One histerid, *Teretrius nigrescens*, has been deliberately introduced in Africa as a bio-control agent to prey on the larger grain borer *Prostephanus truncatus*.

Parasitoids

Beetle and moth pests of stored products may be attacked by a number of parasitic wasps. These wasps lay their eggs on or in the eggs or larvae of their host. Wasp larvae then develop on host tissue, eventually killing their host as they emerge as mature larvae prior to pupation or as an adult wasp depending on species. Presence of large numbers of these wasps in a store usually indicates established pest infestations. There has been interest in using these wasps as bio-control agents, especially against structural infestations in premises that process organic grade produce.

Scavengers

A number of species feed on dead insects and other dried material of animal origin. These include members of the families Ptininae, Cleridae and Dermestidae. Many of these insects are also important pests of stored products of animal origin such as wool, hides, skins and dried fish.