



CONTROL OF COMMON WAREHOUSE INSECT PESTS

Insects infesting food products are responsible for serious losses to the people of Canada—losses amounting to many millions of dollars each year. The damage they do is a form of taxation without any exemptions. The thought of insects crawling over, and feeding on products designed for human consumption is by no means pleasant, and even though the infestation may not make the products injurious to humans, few people would eat them if they knew of their condition. The most serious losses, however, arise from the food which is rendered unsaleable by the actual presence of insects. Much of the loss suffered annually is preventable. Knowledge, care, and attention to certain details by those handling the products from the farm to the home, would bring about a considerable reduction in the losses caused by pests. Canada is at war and it is essential that all forms of waste be eliminated. The warehouseman, by controlling the insects in his warehouse, can make a large contribution toward eliminating this waste.

Principal Insects Infesting Cereal and Milled Foods in Storage in Canada

Flour Beetles.—The confused flour beetle, *Tribolium confusum* Duv.; and the rust red flour beetle, *Tribolium castaneum* Herbst.

Both flour beetles are reddish-brown in colour and about $\frac{1}{8}$ inch in length. They are frequently encountered in flour mills and other places where cereals are manufactured, as well as in buildings where such products are stored. Practically all cereal products are attacked. The adult female beetles lay eggs which hatch in about a week. The resulting grubs or larvae mature in approximately 3 weeks, and a further week is required for the pupal stage. Under favourable conditions one generation follows another quite rapidly resulting in serious infestations.

Control.—These insects may be controlled by heat, cold or fumigation, as outlined under the section dealing with control (page 5).

Spider Beetles.—The hairy spider beetle, *Ptinus villiger* Reit.; the white-marked spider beetle, *Ptinus fur* L.; the eastern spider beetle, *Ptinus raptor* Sturm.; *Ptinus ocellus* Brown (no common name), and the golden spider beetle, *Niptus hololeucus* Fald.

Spider beetles are responsible for serious losses in flour, cereal products, and seeds while in storage. The several species are rather similar in general appearance, life-history and habits. All are spider-like in form, reddish brown in colour, frequently with 4 irregular white patches, 2 on each wing cover. In size they vary from a little less to more than $\frac{1}{8}$ inch in length. The larvae are creamy white in colour, with a darker head, and the body is covered with long hairs to which particles of food adhere. The adult females lay eggs in spring; $3\frac{1}{2}$ months are required for the development of the larval stage. Most of the damage is done by the grubs. In addition to infesting cereal products, the containers are often damaged by the larvae in leaving the packages. One of the features which render the members of this group such serious pests is their ability to withstand low temperatures. In the colder areas of Canada many of the other stored product insect pests are killed by normal winter temperatures in unheated buildings.

Control.—The use of a contact spray is advised against these pests because of the wide range of conditions under which the control must be carried out.

Meal Worms.—The yellow meal worm, *Tenebrio molitor* L.; and the dark meal worm, *Tenebrio obscurus* Fab.

Two meal worms are found in Canada. Each requires a year to pass through its life cycle. The adult beetles appear in early summer, and lay eggs on coarse food material. The mature grubs of both species are about $1\frac{1}{8}$ inch in length and are found commonly in warehouses in places where the cleaning is not done thoroughly. This may occur only in a few places which are hard to get at; their presence, however, indicates that more attention should be paid to such places.

Control.—General cleanliness in the warehouse coupled with the use of a contact spray is usually sufficient to control these pests.

The Mediterranean Flour Moth

The Mediterranean flour moth, *Ephestia kuehniella* Zell., occurs frequently in flour mills, and at times causes considerable trouble. The adult is a greyish-coloured moth. The mature caterpillar or larva is about $\frac{3}{4}$ inch in length, varying from white to pinkish in colour. It spins silken threads and tunnels in the food. Under summer conditions, a generation requires approximately 2 months.

Control.—Heat, cold and fumigation (see page 5) have given satisfactory results in the control of this pest in mills. Contact sprays may also be used in a supplementary manner against the moths.

The Indian Meal Moth

In addition to infesting many cereal products and whole grain, the Indian meal moth, *Plodia interpunctella* Hbn., causes serious damage to nuts and dried fruits. In the case of whole grain, the caterpillar frequently destroys the germ end of the kernel. The adults usually emerge in early summer and immediately lay eggs in the food product. Seeds, particularly corn, are often badly damaged. The adult is about $\frac{5}{8}$ inch in wing spread, the outer portion

of the front wings being coppery brown, while the inner third is of a creamy colour. The caterpillar is about $\frac{3}{4}$ inch in length, varying in colour from pale cream to light pink. The entire life cycle requires from 5 to 6 weeks under the conditions usually encountered in heated buildings; 4 or more generations are possible annually under such circumstances.

Control.—Fumigation (page 6) supplemented by the use of contact sprays is the common method of control.

The Saw-toothed Grain Beetle

While termed the saw-toothed grain beetle, *Oryzaephilus surinamensis* L., this insect is also found in a variety of milled products. Due to its small size and active nature it can penetrate readily into many containers. The adults are reddish brown in colour, with little projections on the thorax which give that section a saw-like appearance. The grub is light in colour with darkened areas on each segment. Like the confused flour beetle, this insect breeds continuously, and in serious infestations enormous numbers may be present. The life cycle requires about 4 to 5 weeks under summer conditions.

Control.—Fumigation (page 6) supplemented by the use of contact sprays is recommended.

The Cadelle

The cadelle, *Tenebroides mauritanicus* L., is about $\frac{3}{8}$ inch in length, dark brown in colour, shiny, and somewhat flattened in appearance. The mature grub is about $\frac{3}{4}$ inch in length, whitish in colour with a reddish-brown head and with patches of the same colour back of the head and at the end of the body. There is only one generation annually. The beetles appear in early summer and deposit eggs on grain and coarse cereal products in which the grubs develop.

Control.—General cleanliness in the warehouse and the use of contact sprays against this pest are recommended.

Dermestid Beetles.—The black carpet beetle, *Attagenus piceus* Ol.; the larder beetle, *Dermestes lardarius* L.; and the hide or leather beetle, *Dermestes vulpinus* L.

The black carpet beetle in addition to being a serious household pest of woollens is a common pest in flour and seed warehouses. The adults are small, oval, black beetles about $\frac{3}{16}$ inch in length. The grub is reddish brown with tufts of long hairs at the end of the body. The adult females appear in early summer and lay eggs. The grubs develop in cracks and crevices in the warehouses and are often found around stock which has not been disturbed. They can mature on flour, other cereal products and seeds, but thrive best on materials of animal origin.

Both the larder beetle and the hide or leather beetle prefer products of an animal nature and are usually associated with materials of this type. They are often common around abattoirs where they may cause damage to wooden structures in seeking places for pupation.

Control.—General cleanliness in the warehouse and the use of contact sprays against these pests are recommended. In the case of particularly heavy infestations it may be necessary to use a fumigant (see page 6).

Principal Insects Infesting Stored Grain and Seeds in Canada

Grain Weevils.—The granary weevil, *Sitophilus granarius* L.; and the rice weevil, *Sitophilus oryzae* L.

These insects are rather similar in appearance, the latter being somewhat smaller in size. The adults are from $\frac{1}{8}$ to $\frac{1}{2}$ inch in length and are dark, shiny, mahogany brown in colour, the head being prolonged into a slender snout. The females drill fine holes in the kernels of grain and deposit their eggs within the cavity which is then sealed over. The legless grubs develop entirely within the kernel and under summer conditions the adult emerges about 5 weeks after the egg is laid. When heavily infested, the grain is reduced to a collection of shells and dust.

Control.—The use of a fumigant is advised (see page 6).

The Bean Weevil

The bean weevil, *Acanthoscelides obtectus* Say., is a small, oval, hard-shelled beetle of a greyish-brown colour and is often found in dried beans. The infestation usually starts in the field and in warm storage one generation follows another until the beans are reduced to dust.

Control.—The use of a fumigant is advised (see page 6).

The Flat Grain Beetle

The flat grain beetle, *Laemophloeus minutus* Ol., is a small brownish beetle with long antennae and is often found associated with granary weevils in grain. It also attacks flour and other cereal material, particularly if the stock is carrying a high amount of moisture.

Control.—The use of a fumigant is advised (see page 6).

The Meal Moth

The meal moth, *Pyralis farinalis* L., is about 1 inch in width with wings expanded and of varying shades of brown with 2 irregular white lines crossing all wings. The caterpillar, about $\frac{1}{2}$ inch long when mature, is greyish-white in colour with a brownish head. Most of the feeding occurs in material damaged by moisture, and largely in grain or coarse cereal products.

Control.—The use of contact sprays or if necessary a fumigant (see page 6) is advised.

Stored grain and seeds are also damaged by the following species which have been described under the section dealing with insects infesting cereals and milled foods. The Indian meal moth, *Plodia interpunctella* Hbn., the saw-toothed grain beetle, *Oryzaephilus surinamensis* L., the cadelle, *Tenebroides mauritanicus* L., and the black carpet beetle, *Attagenus piceus* Ol.

Grain Mites (Tyroglyphidae)

There are several species of mites associated with grain. They are all minute, barely visible to the naked eye, and in case of heavy infestations are present in enormous numbers. Usually their feeding is confined largely to the debris associated with grain. They can, however, bring about changes in the moisture content of the material, and if present long enough the grain is likely to heat and spoil.

Control.—The best treatment is to clean the grain and burn the debris. Where cleaning equipment is not available, transferring the grain from one bin to another in the elevator is often successful. Under farm conditions the use of a fanning mill is recommended.

Warehouse Methods Which Aid in Combating Insect Pests

1. Warehouses should be kept clean at all times. This greatly reduces the possible breeding places of pests. Where material is found to be infested it should be removed at once to other premises; all materials and empty bags returned to customers should be stored and examined in locations other than the warehouse. All sweepings from the warehouse and screenings from infested bags should be burned.

2. All incoming material should be carefully examined. If insects are found the shipper should be advised immediately and the stock in question should not be taken into the warehouse until it is free from insects. If the warehouse is free from insect pests, careful work in this respect will aid greatly in keeping them out.

3. Where possible the stock should be piled on racks. The erection of a false wall 6 or 8 inches out from the main wall is also advisable. This allows for easy access in spraying operations and cats are allowed more freedom of movement in keeping down rats and mice. When a rack is emptied, the rack and space beneath it should be carefully cleaned before piling in new stock.

4. Care should be exercised when ordering stocks. Small, fresh stocks which remain in the warehouse for only a short period of time are much less likely to become infested with insects. For the same reason, poor-selling lines should not be stocked, for they may be carried for a long time and constitute a threat to new clean material. Products with a seasonal sale should be ordered with care to avoid carry-over from one season to the next.

5. Stocks of different ages **should not be mixed**. Old stock in an otherwise fresh lot is always dangerous. Care should be taken to dispose of the older stock first before it becomes infested and unsaleable.

Control Methods

Regardless of the treatment, it is essential that the insects to be killed be brought into intimate contact with the agent being used, be it heat, cold, fumigant, or contact spray. A protecting layer of flour, debris, etc., reduces very materially the effect secured.

Various methods of control are used against stored product insect pests. The most common are: heat, cold, fumigation, and contact sprays. The choice of control measures will be governed largely by local conditions, such as the availability of equipment for superheating, the geographical location which will render low temperature treatment feasible, the tightness of the structure in order to render fumigation effective, suitable temperatures, etc. These methods of control may be used against any of the pests mentioned, other than mites, save in cases where specified remedies are recommended for the control of particular insects.

Heat.—If the insects are subjected to a temperature of 130° F. to 135° F. for a period of 24 hours or more, satisfactory control will be secured. This method has been used in mills and other places with good results. To attain the required conditions it is necessary to have a considerable amount of radiation surface to bring the premises to the temperature desired. The air in the building must be circulated by fans, etc., to prevent stratification.

Cold.—Because in certain parts of Canada the temperatures in winter drop very low it is possible to kill many kinds of insects which infest food products by exposing the product to outside temperatures. Most of these insects live normally at ordinary room temperature and are unable to survive

exposure for a few days to severe winter weather. This method has been used in flour mills and other food processing plants with good results. Unfortunately, in many regions the winter temperatures are not low enough to bring about satisfactory control.

To secure good results, a period of weather should be selected when the maximum temperature during an exposure period of 48 hours does not rise above zero. The weather bureau can often forecast probable dates, and, if the premises and equipment have been thoroughly cleaned in anticipation of the low temperatures, very satisfactory control can be secured. Before such exposure it is necessary to drain all water systems such as radiators, water supply, and sprinkler systems in order to avoid damage. It is also wise to thoroughly warm the entire plant after the "freeze-out" before attempting operation, in order that machines, bearings, lubricants, etc., may be in normal condition.

Fumigation.—Fumigation is the name applied to the treatment of a commodity or space with a gaseous material in order to kill the insects present in it. In order to secure satisfactory results certain conditions must be provided: (1) The space must be tight enough to confine the gas for a long enough period to kill the insects; (2) enough of the toxic agent must be used to bring this about; (3) the temperature at which the treatment is carried out must be sufficiently high to completely vaporize the fumigant if applied as a liquid, and at the same time to keep the insects in an active condition.

Fumigation is the usual treatment for bulk grain in storage because the space in which it is normally stored is reasonably gas-tight. In the treatment of infested grain the temperature of the grain is the important consideration rather than the air temperature. When stored in bins the grain temperature changes slowly and is often very different from the air temperature.

In a few cases it is also possible to fumigate warehouses, but, in the vast majority of cases, the premises in which sacked grain, flour and feed are maintained are by no means tight, and the cost of rendering them so would usually be prohibitive. In general, where warehouses or other similar premises are to be fumigated, results will be secured more readily when the temperature is at least 70° F. At temperatures below 60° F. the insects are much less active, and increased dosages of the fumigant are necessary.

Carbon disulphide-carbon tetrachloride-sulphur dioxide mixture.—This material is in general use as a grain fumigant and is employed at the rate of 1 to 1½ gallons per 1,000 bushels of grain in large lots, and at somewhat higher dosages where small lots are to be treated. The material is very effective at temperatures of from 60° F. to 70° F., though satisfactory control has been secured at somewhat lower temperatures.

Ethylene dichloride-carbon tetrachloride mixture.—This fumigant is also used in the treatment of grain as well as for space fumigation. In the latter case it is applied at the rate of 14 pounds per 1,000 cubic feet, while 50 to 55 pounds per 1,000 bushels of grain will give satisfactory control in bins. To promote rapid vaporization the temperature should be at least 70° F. and best results in space fumigation are secured at 80° F. to 85° F.

When either material is being purchased, care should be exercised to buy only materials which are approved by the fire underwriters in order to comply with insurance regulations. For this reason carbon disulphide alone should **never** be used. The approved mixtures with carbon tetrachloride are sufficiently free from fire and explosion hazard that the underwriters are willing to permit their use.

Contact Sprays.—The use of contact sprays for the control of insect pests of stored products has increased greatly in recent years. Their use is really two-fold:—

- (1) as a supplementary measure in premises which are regularly fumigated;
- (2) as the principal method of control against spider beetles and certain other insects when these occur in warehouses which cannot be fumigated effectively.

One of the most useful sprays consists of extract of pyrethrum in a high grade oil carrier. Only a **water-white highly refined** grade should be used. Such a spray may be used safely around bags of flour and other cereal products, and as long as the liquid is not allowed to drip on to the bags there is little possibility of the product becoming tainted.

Because of the cost of extract of pyrethrum, attempts have been made to find suitable substitutes. Among the more widely used of the new materials are the aliphatic thiocyanates. These are essentially as toxic as pyrethrum and make very satisfactory sprays.

Recently various new materials have appeared on the market under the name of "activators" which increase the toxicity of the standard pyrethrum or aliphatic thiocyanate spray, when added to it.

Spraying.—In spraying it is necessary to make actual contact with the insects in order to kill them. A fine misty type of spray is far more effective than a coarse one and for this reason a suitable sprayer should be selected. There is practically no possibility of the product becoming tainted if only the mist comes into contact with the product. *Drops of liquid spray should not be allowed to drip on the stock.*

If the stock is arranged to permit spraying of the walls, etc., much better results will be secured. After spraying the walls, floors, stock, etc., it is advisable to direct some of the spray toward the ceiling in order to produce a "fog" effect. The building should then be closed in order to reduce air currents and allow the particles to settle as slowly as possible.

If large premises are to be sprayed the use of an electric sprayer is advised. The better types not only produce a fine misty spray but throw the spray much farther than hand-operated sprayers. Where piles of stock are high it is almost impossible to do the work adequately without one.

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