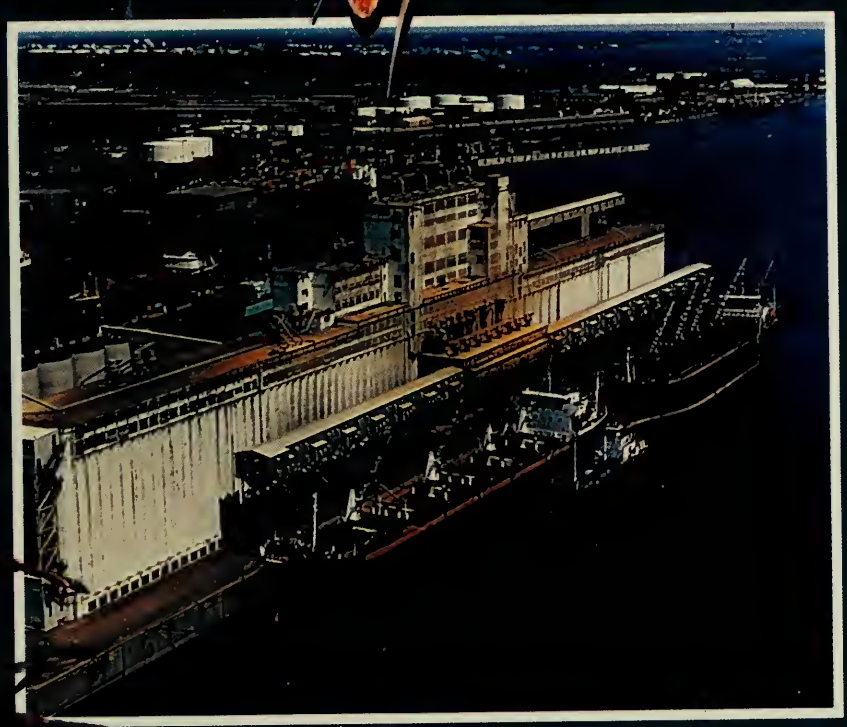
INSECT PESTS IN CARGO SHIPS



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CONTENTS

SHIP TRANSPORTATION AND INFESTATION

The transportation of food by ship is only one link in the chain between production and consumption. Precautions must be taken at many points to protect foodstuffs from insect attack. Grain is treated in farm storages, elevators and warehouses in the country of origin. Importing countries must also protect railroad cars and other carriers from residual insect populations so that clean foodstuffs do not become contaminated en route to their final destination.

Unwelcome passengers

The insects and mites that eat and contaminate foodstuffs in storage and in transit usually are not present in large enough numbers to be noticed by crews. However, when infested cargoes are unloaded, the few pests inevitably left behind will continue to breed and multiply in cargo residues unless eradicated. The combination of a residual pest population and food debris in uncleaned cracks and crevices in a ship's hold leads to the large numbers of pests that will attack and spoil subsequent cargoes. This publication deals with the problems presented by these residual populations.

Insect-free ships important

All efforts to control insects in a food shipment are wasted if, at any stage of the journey, infestation occurs.

Clearly then, care must be taken to ensure that vessels are insect-free, not only to maintain Canada's reputation for clean produce but also to reduce the possibility of infestation when the cargo is stored in the country of destination.

Infestation not new

Ships have been infested with insects and mites ever since the earliest days of maritime commerce. The granary weevil, one of the world's most common storage pests, is probably the "Curculio" mentioned by the Roman writer, Plautus, about 200 B.C. Slow-moving sailing vessels gave insects ample opportunity to multiply profusely. In one shipment of 130 t of American corn sent to England in 1868, well over 4 million weevils — almost 2 t of insects — were screened out. Even today, voyages in warm weather allow insects to spread from infested merchandise to clean material stowed nearby, while residual populations emerge from recesses in holds to breed in new cargoes.

The opening up of the St. Lawrence Seaway to international shipping, however, added a new dimension to the problem of protecting cargoes from infestation. Insect pests from all parts of the world may now be carried not only to ocean ports but also to inland ports close to important food-growing and storage areas in the heart of the North American continent.

Losses high

Each year, insects and rodents cause losses that vary from 5-10% of the value of the original crops. Some insects are particularly destructive, as they confine their attacks to those parts of the commodity richest in vitamins, often neglecting the bulk of the food. In this way, a few insects may seriously reduce the nutritive value of a large quantity of material. In addition to the food the insects actually eat, they may bring about considerable incidental losses. In stored grain, for example, even a small focus of infestation can trigger a complex heating process that spreads throughout the pile and causes losses more serious than those resulting from the insects themselves. Even lightly infested material often has to be discarded since modern standards of cleanliness demand that food products reaching the consumer be free of insect material, whether living, dead or in the form of excreta.

Sources of infestation

Infestation usually starts by loading contaminated material into one or more of the holds. Unless the holds are properly cleaned or treated after unloading, material left behind from an infested cargo may allow the insects to survive for several years. Very often, commodities free of insects at the time of loading become infested during transit, as a result of either residual populations in the holds or infested commodities being loaded into the same cargo space.

Dunnage is any material such as blocks, boards, paper and burlap used for the safe stowage of cargo. The term usually covers the collection of jute (burlap) bags ships sometimes carry for bagging or 'topping' part of a cargo of grain, as well as the jute separation cloths used to prevent grain seepage. In all this material, debris may persist for a long time, forming an ideal hiding and breeding place for insects.

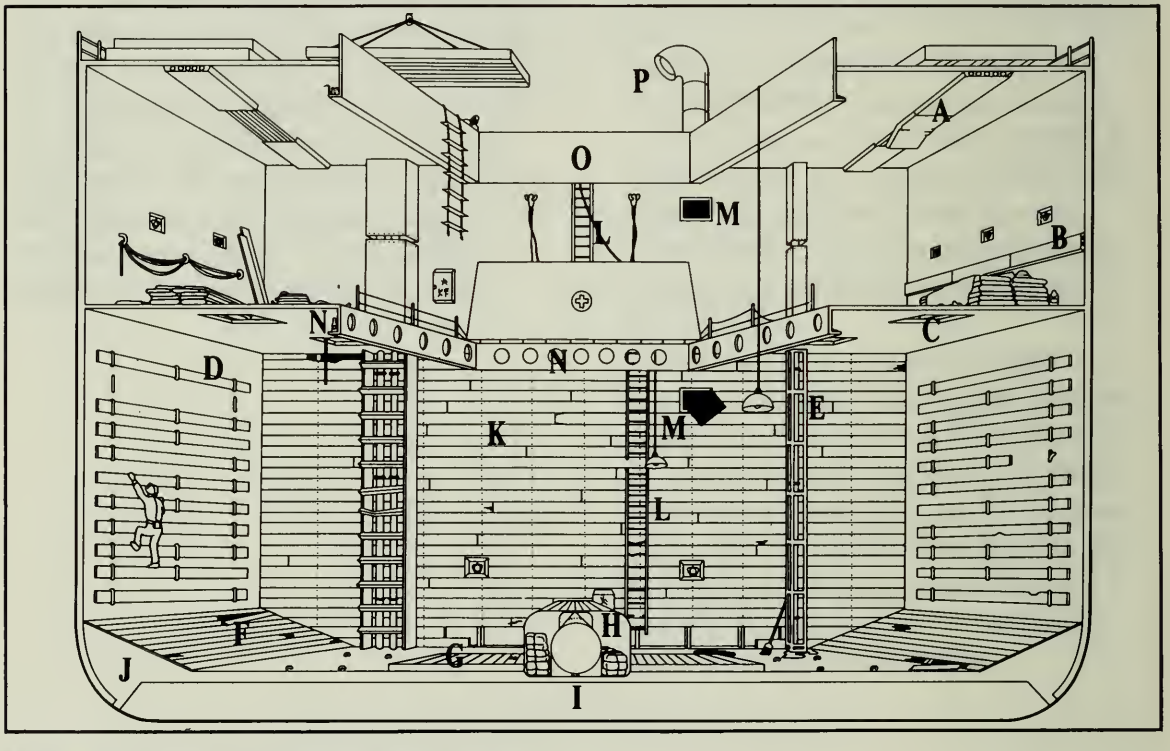
INSPECTION IN CANADA

At the beginning of World War II, Agriculture Canada, fully realizing the dangers of insect infestation during prolonged storage of foodstuffs, worked out an inspection system. All essential foodstuffs produced in Canada, whether for export or for home consumption, were checked for signs of infestation at various stages of storage and transportation. Early in 1940, the department began inspecting empty holds before they were loaded. This successful program is still in effect today, although enlarged in scope.

Ships' holds are now inspected before loading wheat, oats, barley, rye, corn, buckwheat, whole grain and seeds or any of their milled products; oilseeds, peas and beans; vegetable pressings from oil production; brewers' grain and malt; and feed grains, screenings and pellets.

In 1964, it was recognized that extraneous material in ships' holds could alter the grade of a cereal after it was loaded. The department then accepted the added responsibility of inspecting holds to ensure their freedom from such matter as coal, ores, rust scale, glass, water, free oil, residue cereals and general debris, before signing clearance papers.

Many countries now require that a phytosanitary certificate be issued by the Plant Protection Division of Agriculture Canada stating that an exported commodity is practically free from injurious pests. Accordingly, the department regularly inspects both cargo ships and grain storages where satisfactory cleanliness standards must be met.



Midship section of a typical cargo vessel

A — Electrical casing B — Degaussing casing C — Trimming hatch D — Cargo battens E — Pipe casing F — Limber boards G — Wooden ceiling (on bearers) H — Propeller shaft tunnel (protected with wood) I — Fuel tank area J — Bilge area K — Wooden bulkhead L — Ladder M — Ventilator grill N — Longitudinal and transverse box beams O — Longitudinal box beam P — Ventilator

SHIP CONSTRUCTION AND INFESTATION

Many construction features of ships' holds favor the establishment and increase of insect pests. Inevitably, all kinds of food products become lodged in crevices during loading, especially when under pressure, or while in transit. The usual spillage and breakage of bagged and boxed commodities also add to the residue. This accumulation allows unseen insects to increase, even when the ships do not carry foodstuffs for many years.

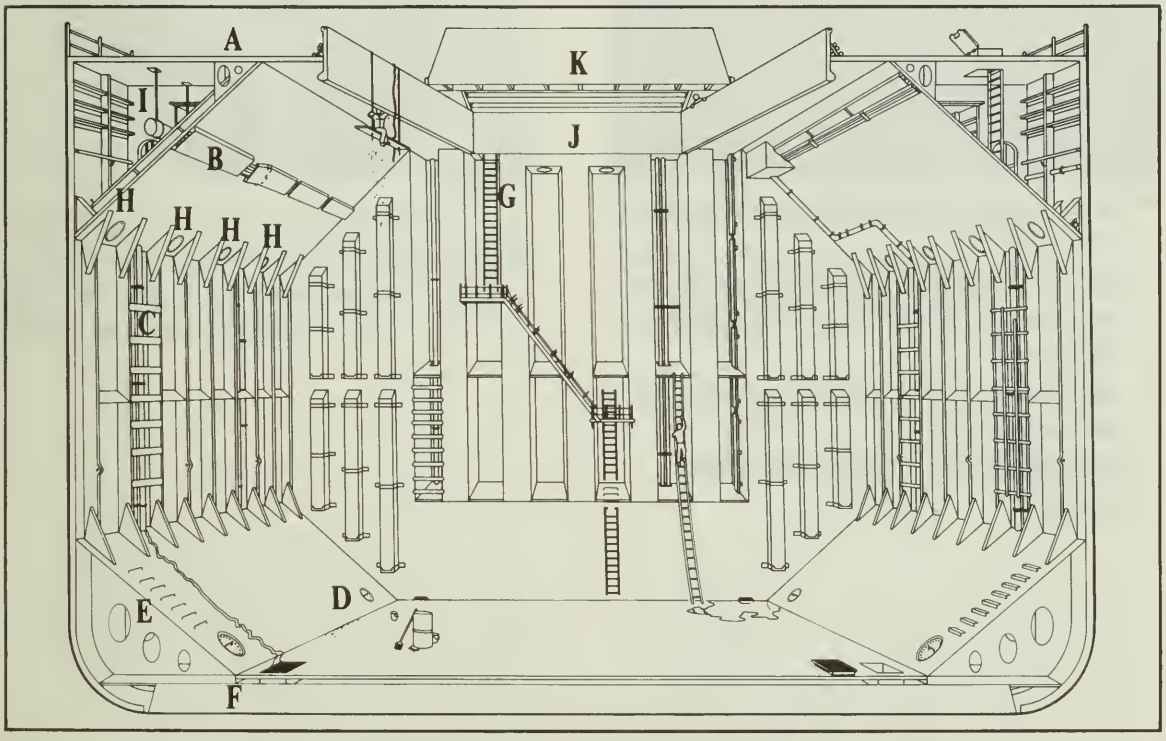
Main sites of infestation

WOODEN STRUCTURES

Wooden planking is often used to protect and insulate double-bottom tanks, deep tanks, water tanks and others. Planks may be laid directly on a steel surface but, more often, bearers are fastened to the steel plating over which planking is applied. Cargo residue and insects can accumulate in this underlying space where they may remain for years if left undisturbed. There should be hinged openings at the bottom of vertical sheathing on bulkheads and tanks to provide access for easy cleaning.

FRAMING MEMBERS

Transverse beams, longitudinal girders and brackets often have the typical web and flange construction. Cargo residues and insects may lodge on these flanges even if they are sloped. Such sites are often difficult to examine, especially in larger ships, and require special attention during cleaning.



Midship section of a typical bulk carrier

A — Deck B — Electrical casing C — Pipe guard D — Access hole covers E — Fuel tank F — Fuel tank area
G — Ladder H — Discharge holes I — Wing tank J — Coaming beam K — Macgregor hatch cover (open)

CARGO BATTENS

Used in ships fitted for general cargo, these longitudinal wooden planks hold the cargo away from the steel plates of the hull. Metal brackets, or sparring cleats, secure the planks to the main frames. The crevices where these structures join provide ideal places for material to lodge and insects to hide.

BILGES

The spaces between the rounded portion of the hull and the sides of the cargo holds are called bilges where insects and food debris often accumulate. In many newer ships, bilges have been replaced by bottom wing tanks.

ELECTRICAL CONDUIT CASINGS

When damaged, grain can fill these sheet-metal coverings situated between decks and become heavily infested. Damaged casings should be repaired immediately or replaced with more easily cleaned steel strapping.

OTHER PLACES

Insects can also breed and hide in other areas where material accumulates such as:

- pipe, cable and hydraulic casings;
- angled brackets at the tops and bases of vertical frames;
- under loose rust and paint scale in all locations including frames, beams and deckheads;
- false covers over access holes in tank tops and wing tanks;
- horizontal frame stiffeners and splash guards;
- special structures in car carriers such as car deck ledges, lifting tackle, supports and brackets, tackle boxes and fire extinguisher boxes;
- ventilators, especially horizontal trunkways;
- hollow beams and posts; and
- "Macgregor" and "Pontoon" hatch cover ledges.

Identification

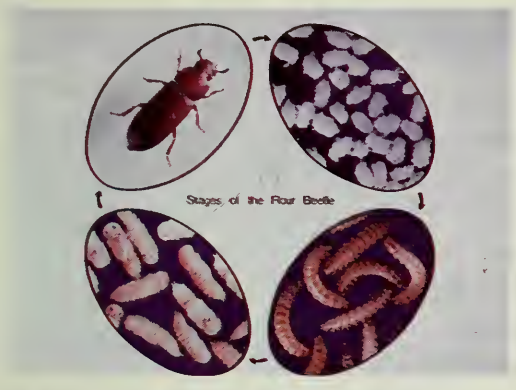
Inspectors collect insects and mites from empty holds. Because of their small size and inconspicuous appearance and habits, a hand lens or binocular microscope is usually needed to correctly identify insects. A trained entomologist should identify immature insects, such as the larvae of moths and beetles, and less common adults.

COMMON INSECTS AND MITES IN CARGO SHIPS

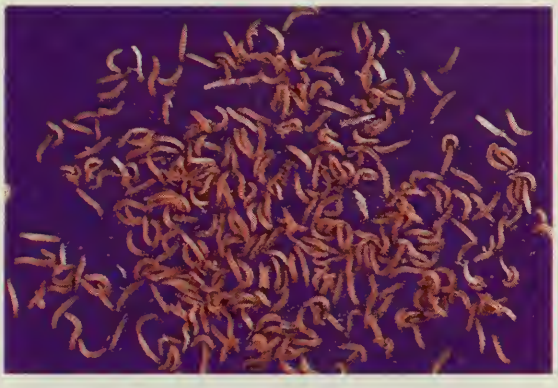
Insects (class Insecta) and mites (order Acarina) are invertebrate animals falling under the broad classification of the arthropods (phylum Arthropoda), animals with jointed appendages and six legs. Mites are closely related to the true spiders and are grouped with them in the class Arachnida.

Of the 33 orders within the class Insecta, only two — beetles (Coleoptera) and moths (Lepidoptera) — cause concern in ships. Insect parasites, belonging mainly to the order Hymenoptera, and predators, belonging mainly to the order Hemiptera, sometimes appear in large numbers in cargo ships but rarely control harmful pests.

The moths and beetles that infest stored-products have two significant biological characteristics: a fairly short life cycle and a high breeding potential. In summer or a warm storage, these insects can grow from an egg to a mature adult in 4-6 weeks, and a female may lay 300-400 eggs in her remaining life span of a few weeks to several months. During a normal season of activity of 150 days, one mated female flour beetle (*Tribolium confusum* Duv.) can give rise to 38 880 adult and 1 049 600 immature insects.



The life cycle of the red flour beetle,* Tribolium castaneum *(Hbst.), illustrating the four stages of development — egg, larva, pupa and adult.



Potential increase of the red flour beetle,* Tribolium castaneum. *These 360 offspring developed within 3-4 months.

Beetles (order Coleoptera)

RICE WEEVIL, *Sitophilus oryzae* (L.)

This insect's name is misleading because the rice weevil is a serious pest of *all* grains. The adult is small, 2.5-4.0 mm long, with an elongated snout. It is darkish brown, with four lighter, reddish areas on the wing covers that can sometimes be seen clearly with the naked eye. It can develop in hard cereal products such as macaroni, or in flour or meal that has caked, but cannot establish itself in loose material such as flour.

In addition to attacking stored products, in warm countries adult females may fly into fields to lay eggs in ripening grain. Using mandibles located at the end of her snout, the female beetle bores a small hole through the outer coat of the grain, turns around and inserts an egg through this hole into the starchy portion of the kernel, and seals the opening with a small amount of fluid that hardens. The immature stages — egg, larva and pupa — are passed inside the kernel, and at 20-27°C a fully developed adult beetle emerges 4 weeks after the laying of the egg. Under favorable conditions, adult weevils may live for several months, the female continuing her laying for most of this time.

Sitophilus oryzae *(L.), 2.5-4.0 mm*

The rice weevil is a major pest in warm, humid lands and does not thrive in countries that have cold winters. An outbreak of this insect can render stored rice unfit for human consumption within 8 months. Authorities regard this insect as the most widely destructive insect attacking grains.

GRANARY WEEVIL, *Sitophilus granarius* (L.)

Although similar in general appearance to the rice weevil, the granary weevil is usually slightly larger, 2.5-4.7 mm long, and has no light areas on the wing covers. It is unable to fly because the wings, though present under the wing covers, are weak

Sitophilus granarius *(L.), 2.5-4.7 mm*

and functionless. The granary weevil develops within a kernel of grain as does the rice weevil, though somewhat slower. This beetle thrives in north and south temperate regions, such as the northern United States, Canada and southern Australia, since it is able to develop over longer periods in the spring and fall.

RED FLOUR BEETLE, *Tribolium castaneum* (Hbst.) and
CONFUSED FLOUR BEETLE, *Tribolium confusum* Duv.

These two species are very similar in appearance and habits and often referred to as "bran bugs". The adult beetles are reddish brown and about 3.6 mm long. The larvae are yellowish worms, 6.5 mm long when fully grown. Both the larvae and the adults feed voraciously on foodstuffs, mainly flour and other milled products. They are frequently found in both the cargo holds and spaces and constitute 84% of the insect population of flour mills in the southwestern milling area of the United States.

Unable to feed on unbroken grain kernels, these beetles rapidly establish themselves in grain that has been physically damaged by other insects. An established population adds greatly to the heating and destruction started by other insects. An interesting feature of both beetles is their scent glands which eject a vile-smelling fluid when the insect is disturbed; heavily infested food may have an unwholesome, pungent odor.

The red flour beetle is more common in ships. The adult can be distinguished from that of the confused flour beetle by its antennae (feelers), the three outer segments of which form a distinct club. Also, in warm weather, the red flour beetle may fly.

The red flour beetle is more generally distributed throughout the world; though it thrives best in warm climates it is also well established in temperate regions. It often appears in large numbers in imported tropical products such as peanuts.

The confused flour beetle, so called because of the original difficulty of distinguishing it from the red flour beetle, is mainly a pest of flour and milled products in cooler countries such as Canada. It has never been observed to fly. This insect can become a major pest in flour mills in temperate countries, and is the main cause of the difficulties in obtaining flour that is absolutely free of insects. Three other species of *Tribolium* are also found in ships, but less often. They are *T. destructor*, *T. madens* and *T. audax*.

Tribolium confusum ***Duv., 2.6-5.0 mm***

Tribolium destructor, ***4.5-5.7 mm***

Tribolium madens, ***3.9-5.1 mm***

Tribolium castaneum ***(Hbst.), 2.3-4.5 mm***

Tribolium audax

LONG-HEADED FLOUR BEETLE, *Latheticus oryzae* (Waterh.)

This insect is closely related to the *Tribolium* beetles but has the five segmented clubs on the antennae and a longer head. The adult is 2.5-3.0 mm long and is an important pest of grains and cereals in tropical and subtropical countries.

Latheticus oryzae *(Waterh.), 2.5-3.0 mm*

SAW-TOOTHED GRAIN BEETLE, *Oryzaephilus surinamensis* (L.)

This active brown beetle is 2.5-3.0 mm long and is named "saw-toothed" because of the six teeth-like projections on either side of the thorax. Common throughout the world as a pest of all kinds of foodstuffs, it often attacks dried fruits and packaged foods. This beetle is unable to attack whole, dry kernels, but infests grain damaged by other insects. *Oryzaephilus mercator* (Fauv.), the merchant grain beetle, is a close relative and is similar in appearance and habits.

Oryzaephilus surinamensis *(L.), 2.5-3.0 mm*

Oryzaephilus mercator *(Fauv.), 2.5-3.0 mm*

LESSER GRAIN BORER, *Rhyzopertha dominica* (F.)

In many parts of the world this insect is a major grain pest. It gained prominence during World War I when it bred in large numbers in shipments of Australian wheat delayed by submarine warfare. At that time, when it was introduced into the southern United States via California, it was known as the Australian wheat weevil.

Rhyzopertha dominica *(F.), 2.5-3.5 mm*

The adult is brownish black, 2.5-3.5 mm long, with the head deflexed and concealed by the thorax in a manner peculiar to the family of wood-boring beetles, Anobiidae, to which this species belongs. The larvae can feed both inside the grain and on grain dust produced by the boring of the adults. Since this insect attacks whole, dry grain in storage, it must be regarded as a primary pest.

CADELLE, *Tenebroides mauritanicus* (L.)

The cadelle is a shining black beetle, 6.5-11 mm long; the larva, dirty white with a black head, is 19 mm long. The cadelle causes losses much greater than the amount of grain it consumes, partly because of its habit of eating the germ and leaving the rest of the kernel untouched, but mostly because of its incidental activities. The larvae bore

Tenebroides mauritanicus *(L.), 6.5-11 mm*

into the woodwork of storage bins, box cars, elevator boots and ship hatch floorings or shifting boards, and hide there to emerge later and infest new shipments. As well as collecting spillage from packages and bags cut by the insects, these burrows provide hiding and breeding places for other insects.

The adult sometimes feeds on other stored-product pests but does not control them. The cadelle is usually considered injurious rather than beneficial. The larva takes considerably longer to develop than all the other species discussed in this publication. The egg can develop into an adult in 70 days, but usually takes much longer. The beetles may live for 18 months or more, the female laying up to 3000 eggs.

RED-LEGGED HAM BEETLE, *Necrobia rufipes* (De G.)

The red-legged ham beetle, often called the copra beetle, is 6.4 mm long, blue or violet, and in some light takes on a greenish luster. The legs are conspicuously reddish-brown, hence its name.

Necrobia rufipes *(De G.), 6.4 mm*

The beetle is often found in ships carrying copra (dried coconut meat, *Cocos nucifera*), with which it is associated. In North America, the insect is mainly a pest of old cheese and smoked pork, particularly ham and bacon.

The beetles spread to all parts of a ship and, during loading or unloading, invade nearby cargo sheds and structures.

FLAT GRAIN BEETLE, *Cryptolestes pusillus* (Schönh.) and
RUSTY GRAIN BEETLE, *C. ferrugineus* (Steph.)

These very minute, brown, flat beetles, with antennae sometimes as long as the body, often accumulate in cargo spaces. These two and other related species are very similar in appearance and are difficult to distinguish.

Cryptolestes pusillus *(Schönh.), 2 mm*

Although *Cryptolestes* beetles heavily infest grain, at one time it was thought that they caused little destruction. It was believed that they were unable to feed on sound grain, but only on that already damaged by other insects. During World War II, however, when large populations of the beetles developed in wheat stored a long time at high humidity or high temperature (or both), it was discovered that the larvae devoured the wheat germ and thus caused serious losses.

YELLOW MEALWORM, *Tenebrio molitor* L. and DARK MEALWORM, *T. obscurus* F.

The larvae of both mealworms are about 25 mm long when fully grown. Sometimes found in large numbers in material that is

Tenebrio molitor *L., 14-18 mm*

spoiling due to poor storage, they thrive in damp, dark places and often tend to migrate into sound material. The adults — dark brown or black beetles, about 12.5 mm long — are reared for fish bait or as food for birds and small mammals. As pests on ships, these two species are of secondary importance.

Tenebrio obscurus *F., 14-18 mm*

LESSER MEALWORM, *Alphitobius diaperinus* (Panz.)

The lesser mealworm sometimes appears in holds of ships in great numbers, but it is rated as a secondary pest in both adult and larval forms. The adult is a black beetle, 6-7 mm long, and the larva looks like a smaller version of one of the yellow or dark mealworms.

Alphitobius diaperinus *(Panz.), 6-7 mm*

The lesser mealworm does not attack sound grain, but thrives on the damp, spoiled and generally broken-down material commonly found in the recesses of holds. Its presence indicates lack of cleanliness favoring the establishment and development of more harmful pests.

Another species, *Alphitobius laevigatus* (F.) (= *A. piceus* (Oliv.)), closely related to the lesser mealworm, is known as the black fungus beetle. It is found in similar conditions on ships.

Alphitobius laevigatus *(F.), 6-7 mm*

CIGARETTE BEETLE, *Lasioderma serricorne* (F.)

The adult is a small, robust, oval, reddish yellow beetle, about 2.5 mm long. The cigarette beetle is primarily a pest of stored tobacco, but often attacks stored foods, especially spices. It is a major pest of cocoa beans in tropical Africa.

Lasioderma serricorne *(F.), 2.5 mm*

FOREIGN GRAIN BEETLE, *Ahasverus advena* (Waltl)

This small, inconspicuous beetle feeds mainly on damp, moldy grains in cargo spaces. It is reddish brown and 2-3 mm long. It is not regarded as a pest of sound grain.

Ahasverus advena *(Waltl), 2-3 mm*

HAIRY FUNGUS BEETLE, *Typhaea stercorea* (L.)

The hairy fungus beetle may sometimes appear in large numbers in holds. The adult is a small brown beetle, 2.5 mm long, covered with fine hairs. It is not a primary pest because it does not attack sound grain.

Typhaea stercorea *(L.), 2.5 mm*

KHAPRA BEETLE, *Trogoderma granarium* Everts

The khapra beetle is rarely found in ships arriving at Canadian ports; however, if detected, fumigation of the infested parts of the vessel is mandatory. The United States authorities have taken stringent measures to eradicate the insect from some of the western states where it was accidentally introduced, and to prevent its reentry anywhere in that country.

The khapra beetle, a major pest of stored grains, is related to the well-known carpet beetles and is similar in appearance. The adult is a small, oval, brownish black beetle. The female measures 3.2 mm in length and is slightly larger than the male. The mature larva, which is similar to that of the carpet beetle, is about 6.4 mm long, reddish brown on the top and cream colored below; its body is covered with brown hairs.

This species dies in cold weather. It is not known to be established in Canada, but it may be able to survive the winter in heated storages.

Detection of the khapra beetle is sometimes difficult. It hides in cracks and crevices in a ship, in both agricultural and non-agricultural commodities, and can survive for years without food. Used burlap (jute cloth) is a common source of infestation; other unlikely cargoes in which it has been found include steel wire, steel, crude rubber and kegs of nails. Infestations in grain, on the other hand, are often easy to detect because cast larval skins lay on the surface of the grain.

Trogoderma granarium *Everts, 3-3.2 mm*

The khapra beetle is more difficult to kill with fumigants than most other insects found in ships, and higher doses are needed to control it.

Moths (order Lepidoptera)

ANGOUMOIS GRAIN MOTH, *Sitotroga cerealella* (Oliv.)

This moth is a primary pest that breeds in all kinds of stored grain. It is especially active in warm, humid regions, such as the southern United States and Queensland, Australia, where the female flies to fields to lay eggs on ears of grain.

Sitotroga cerealella *(Oliv.), 12.7 mm*

The moth is small, with a 12.7 mm wingspread, buff in color, and in flight resembles the common clothes moth. When a young caterpillar hatches out, it eats its way inside a kernel where it stays for the remainder of the larval and all the pupal life. A single kernel provides sufficient nourishment for one insect to develop in 4-5 weeks. The moths are often present in holds, but are too fragile to force their way into the bulk of the grain.

MEAL MOTH, *Pyralis farinalis* (L.)

The meal moth is primarily a pest of coarsely ground cereals, but on occasion the larvae may damage wheat by matting the surface kernels together. It is a common inhabitant of holds, the larvae sometimes being collected in great numbers.

Pyralis farinalis *(L.), 25 mm*

The moths, with wings of various hues of brown crossed with white, wavy lines, have a wingspread of almost 25 mm and are among the largest and most attractive of the insects found in ships. A fully grown larva is 25 mm long with a brown head and a fleshy white body, except for the first body segment which is black.

ALMOND MOTH, *Cadra cautella* (Wlk.)

Species of moths belonging to the genus *Cadra* (formerly *Ephesta*) are destructive pests of cereals throughout the world. However, only one species, *C. cautella* (Wlk.), variously known as the almond, fig or date moth, is frequently found in empty

Cadra cautella, *(Wlk.), 19 mm*

ships. This insect is a more common pest of dried fruits and nuts than of grains and cereals. The moth has a 19 mm wingspread and is rather inconspicuous; the fore wing is dull gray, crossed near the base by a dark, straight band which is paler on its inner edge. The larvae are whitish caterpillars, 12.7 mm long when fully grown.

MEDITERRANEAN FLOUR MOTH, *Anagasta kuehniella* (Zell.)

A close relative of the almond moth, the Mediterranean flour moth is a major pest in flour mills and is rarely found in cargo spaces. The larvae are difficult to distinguish

Anagasta kuehniella *(Zell.)*

from those of the almond moth without a microscopic examination. The moths are similar, but the fore wings of this insect are more uniformly greyish than those of the almond moth and the cross bands are less conspicuous.

EUROPEAN GRAIN MOTH (WOLF MOTH), *Nemapogon granella* (L.)

The wolf moth is often found in cargo spaces of ships docking at Canadian ports, especially in British Columbia. Despite its common occurrence, it is not considered an important grain-infesting insect. It resembles the Angoumois grain moth, but is creamy white, mottled with brown, and has a wingspread of 9-14 mm.

Nemapogon granella *(L.), 9-14 mm*

This insect is related to the clothes moths, which are primarily pests of fur, wool and feathers. However, some species are capable of subsisting on stored products and are sometimes found in ships. The large pale clothes moth, *Acedes* (Tinea) *pallescentella* (Staint.), is commonly found in holds. It is not a pest of sound grain.

INDIAN MEAL MOTH, *Plodia interpunctella* (Hbn.)

Another species not often found in ships is the Indian meal moth, which is a major pest of packaged foods and a great nuisance in grain stores. The webbing activities of the larvae, if not checked, result in the formation of a thick carpet of silk across the entire surface of the grain. The fully grown larvae

Plodia interpunctella *(Hbn.), 13-18 mm*

are pale, creamy caterpillars, 12.7 mm long. The adult moths have a wingspread of 13-18 mm with a distinctive pattern, the outer two-thirds of each fore wing being reddish brown and the base practically white. When the moth rests, it appears to be marked with a thick white band.

BROWN HOUSE MOTH, *Hofmannophila pseudospretella* (Staint.)

This moth, sometimes called the seed moth, has brown fore wings with black specks. It has a wingspread of approximately 19 mm. It is a major pest of seeds and causes much damage in herbaria.

Hofmannophila pseudospretella *(Staint.), 19 mm*

WHITE-SHOULDERED HOUSE MOTH, *Endrosis sarcitrella* (L.)

The head and the front of the thorax of this small but distinctive moth are conspicuously white; its wingspread is approximately 12 mm. This insect feeds on seeds, causing much damage unless checked.

Endrosis sarcitrella *(L.), 12 mm*

Psocids or book lice (order Psocoptera)

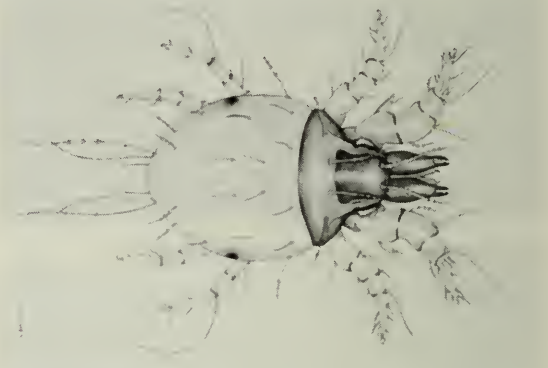
Psocids are slender, pale, usually wingless insects, less than 2 mm long, that move actively among debris in the holds. The name "book lice" is based on their frequent occurrence in old, undisturbed books. Their

Liposcelis subfucus

feeding habits are not completely understood, but they are believed to feed mainly on the dust, debris and molds associated with plants and plant products.

Mites (class Arachnida, order Acarina)

Adult mites generally have eight legs and are, therefore, not insects but arachnids which are closely related to spiders. Some are common inhabitants of foodstuffs, the species most familiar to the average person being the cheese, grain and mold mites. Mites lay eggs, and the newly hatched are very similar to the adults except that they have six legs instead of eight.



Acarus siro

Individual mites are almost invisible to the naked eye, but when present in large numbers they can be detected by the mass of little animals. The presence of many mites in grain or flour is a sure indication that the moisture content is too high for safe storage; they do not develop to any extent in grain unless the moisture content is 12% or higher.

Several species of mites are major pests of foodstuffs, even though some of them feed on molds, not foods. Damage occurs when the mites carry spores into foodstuffs they infest. Unless mites are present in very great numbers in holds, special control measures are not necessary. Cleaning and drying the cargo space is usually sufficient to eliminate large populations.

Miscellaneous insects

The following insects are not major pests, but are often found in cargo spaces:

SILVERFISH

Primitive, wingless insects, silverfish are about 13 mm long and are covered with scales. They have long antennae and three long, tail-like appendages at the end of the body. The species most commonly found on

Thermobia domestica *(Pack.), 13 mm*

ships is the firebrat, *Thermobia domestica* (Pack.). This insect has a number of dusky scales, which give it a mottled appearance. Sometimes they are present in holds, and since they prefer warm places, are often detected near the engine rooms. Silverfish feed on starchy materials but are essentially scavengers.

SPIDER BEETLES

These small beetles, about 3.5 mm long, are principally warehouse pests, where they can cause considerable damage; they are seldom found in cargo spaces. As the name implies, they resemble small spiders, having very long legs and roundish bodies. The small cocoon-like structures associated with these insects are often thought to be eggs but are, in fact, cells constructed by the grubs from material on which they have been feeding. *Ptinus ocellus* Brown (= *P. tecus* auct.) is a common species.

Ptinus ocellus *Brown, 3.5 mm*

COCKROACHES

Often called "steamflies" by seafarers, cockroaches are familiar insects on ships. They are extremely numerous in the galley and the crew's quarters and are sometimes found in the holds. Crews welcomed cockroaches on sailing ships because they believed the insect eradicated bed bugs. In fact, cockroaches *are* predators of bed bugs; they also eat stored foods. Cockroaches prefer hot, humid environments such as the

Periplaneta americana *(L.), 40 mm*

casing around steam pipes. A common species found in ships is the American cockroach, *Periplaneta americana* (L.), which grows to about 40 mm long.

Insect parasites and predators

Insect parasites and predators are sometimes found in large numbers where infestations occur.

An *insect parasite* develops in or on one host insect and eventually destroys it. Beneficial insects found with stored-food pests belong mainly to the order Hymenoptera, which also includes ants, bees and wasps. The adult parasites of stored-product insects are minute wasps that are often seen flying toward light and windows. A good example is the parasite of the rice and granary weevils, *Anisopteromalus calandrae* (How.).

Anisopteromalus calandrae *(How.)*

The female wasp detects a weevil grub inside a grain kernel and paralyzes it with her ovipositor. She lays an egg on the grub and the larva that hatches feeds on the paralyzed host and slowly destroys it. Unfortunately, these parasites are seldom present in sufficient numbers to greatly reduce the weevil population.

An *insect predator*, on the other hand, actively seeks out and devours another insect, often destroying it in one meal. It spends very little time with each victim. Most of the predators of insects on cargo ships belong to the order Hemoptera, which are true bugs.

Xylocaris galactinus

These bugs have sucking beaks, by which they extract the body fluids from the hosts and thus kill them. Although this order includes the common bed bug, the predators of stored-food pests do not usually annoy people.

Frequency of occurrence of the principal species

In Canada, the collection and identification of samples of all insects found is a routine feature of ship inspection. The following table shows, in descending order, the number of times each of the more important species was collected during the 1982-83 and 1983-84 inspection seasons:

Common name	Scientific name	No. of times recorded 1982-83	1983-84	1984-85
Red flour beetle	*Tribolium castaneum*	42	61	28
Almond moth	*Cadra cautella*	28	35	10
Rice weevil	*Sitophilus oryzae*	22	32	12
Rusty grain beetle	*Cryptolestes ferrugineus*	20	30	25
Cigarette beetle	*Lasioderma serricorne*	15	33	16
Indian meal moth	*Plodia interpunctella*	16	25	8
Lesser grain borer	*Rhyzopertha dominica*	11	20	16
Large pale clothes moth	*Acedes pallescentella*	9	16	8
Lesser mealworm	*Alphitobius diaperinus*	5	17	7
Granary weevil	*Sitophilus granarius*	9	12	2
Foreign grain beetle	*Ahasverus advena*	6	12	6
Cadelle	*Tenebroides mauritanicus*	4	13	1
Meal moth	*Pyralis farinalis*	5	8	5
Mediterranean flour moth	*Anagasta kuehniella*	6	4	3
Flat grain beetle	*Cryptolestes pusillus*	5	4	15
Butterflies, moths, skippers	*Lepidoptera*	3	5	2
Yellow mealworm	*Tenebrio molitor*	5	3	2
Dried fruit beetle	*Carpophilus hemipterus*	5	2	4
	Cryptolestes spp.	4	3	4
Angoumois grain moth	*Sitotroga cerealella*	1	6	1
Confused flour beetle	*Tribolium confusum*	1	6	7
Red-legged ham beetle	*Necrobia rufipes*	1	5	1
Hairy fungus beetle	*Typhaea stercorea*	4	2	3
Miscellaneous		45	50	16

Over 60 species of insects and mites were collected and identified in 1983. Data are based on the examination of cargo spaces in ships inspected at Halifax, Saint John, Baie-Comeau, Port Cartier, Quebec, Sorel, Trois-Rivières, Montreal, Toronto, Thunder Bay, Churchill, Vancouver, Prince Rupert and Victoria, during 1982-83. In 1982-83, 1270 ships were examined, in 1983-84, 1386 ships, and in 1984-85 only 916.

PREVENTION AND CONTROL OF INSECT PESTS

Detailed recommendations for controlling insects are not provided here. However, everyone connected with cargo ships, including designers, builders and operators, should know something about the problems and methods of control to better understand the measures stipulated by inspectors.

Preventive measures

SHIP CONSTRUCTION

Ships are designed and constructed to operate as economically as possible for an intended use. Since one of the main uses of cargo ships is to convey bulk shipments of foodstuffs, designers and builders should modify features to discourage infestation. For example, it might be feasible to:

- eliminate all unnecessary wooden structures such as bulkheads, pipe casings and spar ceilings. Those that are necessary should have enough open space behind them to allow bulk materials to escape at the bottom. The lowest plank of a bulkhead or spar ceiling should be hinged (or left off) to allow continuous cleaning and washing;
- avoid using wood over the tank top ceiling. If protection is needed here, a thick layer of asphaltic material (mastic) can be used;
- use round "bulb-type" longitudinal and crosswise beams, rather than flat ones, in the lower holds and between decks. This eliminates the L-shaped beam structure in these inaccessible areas where residues accumulate;
- place ventilation trunks perpendicularly, rather than horizontally. Horizontal trunks along deckheads in lower holds and tween decks often have improperly sealed vents which allow residues to collect and insects to breed;
- use angle-iron strapping rather than wooden casings to protect cables of electrical conduits. On bulk carriers, electrical cables are inserted in large pipes placed on deck or inside top wing tanks;
- design the frame of a bulk carrier for self-cleaning, eliminating large angle brackets wherever possible.

Cleaning ledges and beams of a bulk grain carrier to remove cargo residues and potential insect infestation sites.

MAINTENANCE AND SANITATION

Obviously, ship holds, tank top ceilings and other parts of a ship must be kept in a good state of repair to avoid infestations. Many ports around the world have rules and by-laws dealing specifically with the maintenance of ships carrying grain; for example, boards and ceilings must be completely grain tight.

Since insects establish themselves and multiply in debris, their increase can be prevented by simple, thorough cleaning. Box beams and stiffeners, for example, become filled with debris during unloading of cargo and, unless kept clean, can become a source of heavy infestation. It is important to remove all cargo residues from deckhead frames and beams when unloading, preferably when the cargo height is low enough for proper cleaning.

Use a powerful vacuum cleaner to extract dust and particles of grain from cracks in such places as the shifting and limber boards that cannot be reached by ordinary methods. Using proper equipment, though initially expensive, reduces labor costs.

Immediately burn, or treat with an insecticide, material collected during cleaning so that the insects cannot escape and spread to other parts of the ship. If any part of the ship is being fumigated, spread the material on the tank top and expose it to the fumigant. Heap debris already on the upper deck so it can be soaked thoroughly and effectively with an insecticidal solution or emulsion. Thorough washing of the holds is recommended as a good preventive measure against infestation.

Chemical control

Once insects are firmly established in the hold of a ship, a chemical toxicant is needed to kill them. The choice of agent and method of application largely depend on the extent and location of the infestation, the importance and habits of the insects found, and climate. Recommended treatments are altered from time to time to keep pace with new developments.

The success of chemical treatment depends on the effectiveness of the insecticides used and the quality of application. Crew members can carry out small-scale or "spot" treatments, if they adhere to the manufacturers' instructions and take care to cover the whole area of infestation. More extensive treatments should be handled by professionals.

INSECTICIDAL SPRAYS

Spraying with an insecticide that does not require evacuation of the ship is the safest way to control insects but is laborious. Small, local infestations can be treated adequately if the spray can reach the insects. Insecticides with a residual toxicity will also kill insects that crawl across sprayed surfaces.

Every ship can be equipped with a portable electrical power sprayer. A sprayer for a larger bulk carrier should have a nozzle pressure of 1380 kPa and a tank capacity of 135-180 L.

The main disadvantage of spraying is that the spray does not reach insects hidden in inaccessible parts of cargo spaces. Another drawback is that insecticidal sprays applied in oil solutions or water emulsions take time to dry and are hazardous to people moving about the ship. Furthermore, some of this liquid may come into contact with the cargo.

Some organic insecticides that exhibit residual action may create a problem in their cumulative effect on people and animals if they are used too extensively. For this reason, insecticidal sprays used where they may contact food materials must be as harmless as possible to people, yet still possess adequate toxicity to the insects. Pyrethrum is such a material. This general name covers a closely related group of compounds extracted from the pyrethrum plant, a relative of the common chrysanthemum. Spray concentrates containing pyrethrum, alone or in combination with other comparatively harmless ingredients such as piperonyl butoxide, may be mixed with either water or a suitable oil carrier and are safe to use anywhere in the holds of ships. Obtain further information on spray treatments from Agriculture Canada's Plant Protection Division.

Some insecticides are not authorized for use in Canada and, to avoid accidental application, should not be carried by ships. These include lindane, dieldrin, aldrin, chlordane, heptachlor, endrin, DDT, parathion and others that are harmful to commodities or have limited tolerance in food. In addition, sprays containing perfumes or other odorous materials or oils must not be used. Inspection of a ship on arrival in Canada can be refused if any of these materials have been used.

AEROSOLS

"Aerosol" is a convenient name used to signify the state of suspension, in air, of liquid or solid material dispersed in numerous, very fine particles. The popular insecticide "bombs", used to kill flies, mosquitoes, and greenhouse pests, are aerosols. Although sometimes propelled by gas, they are not gases and eventually will settle out of suspension as liquids or solids. Aerosols are intermediate in action and effect between sprays and fumigants.

Aerosols can be produced by a number of devices using different principles for use in cargo spaces. The so-called "fog generators" operate on the principle of thermal generation. An insecticide in the form of a liquid or coarse spray is brought into the path of a hot vapor, such as steam, under high pressure; the steam vaporizes the insecticide which, on reaching the air, condenses into the very small particles of an aerosol. Some machines use centrifugal force to break insecticides up into fine dispersions. In other types, insecticidal smokes are evolved from generators of various sizes simply by igniting the material with a match.

Tests in Canada have shown that these insecticidal smokes or aerosols can be very effective against stored-product insects moving freely in the open and in spaces such as holds. However, no appreciable penetration and control of insects can be obtained between or under floor boards, or under caked debris where infestation commonly occurs.

FUMIGANTS

Fumigants are gases and because they diffuse and penetrate materials, they can control pests in situations where other types of insecticides are not suitable. Fumigants have been used very effectively in empty cargo ships in Canada for about 50 years. The treatment is normally carried out while the ship is secured to a berth and all of the crew on shore. In some cases, cargo may be left in the hold to be treated.

The procedure, called "in-port fumigation", requires that all of the treatment, including complete removal of fumigant after treatment (aeration) is completed while the ship is tied up at the wharf. When fumigants are used in cargo spaces during an in-port fumigation, the Canadian Coast Guard requires that "a Fumigator-in-charge

(Fumigator) shall be retained throughout the fumigation period and until such time as the ship is certified to be gas free", and that "prior to application of the fumigant to the cargo spaces the crew shall be landed and remain ashore until the ship is certified 'gas free' by the Fumigator or a Marine Chemist. During this period a watchman shall be posted to prevent unauthorized boarding and warning notices shall be prominently displayed at the gangway and accommodation entrances."

In recent years, a new procedure known as "in-transit ship fumigation" has been carried out in some countries. Here the fumigant is applied to the cargo during or after loading and then the ship proceeds on its voyage while under fumigation. This procedure is not recommended by Canadian authorities and is not permitted on Canadian flag vessels. Non-Canadian ships may be treated by the in-transit procedure if prior written approval of the procedure by the flag administration of the ship is given to Canadian Coast Guard Headquarters in Ottawa. Minimum safety requirements are detailed in *Ship Safety Bulletin* 16/83 of the Canadian Coast Guard and the procedures are monitored by the port warden.

When a ship is fumigated, all ventilators, hatch covers and other openings must be made gas-tight to ensure a full and effective concentration of the fumigant in the space under treatment. Nylon fabric, impregnated with plastic, is recommended to cover openings; ordinary canvas is not completely satisfactory because it is pervious to fumigant gas.

The fumigant commonly used on ships is methyl bromide (CH_3Br). Phosphine (PH_3) and a formulation of carbon tetrachloride–carbon disulphide also have been approved for use in some countries. Hydrogen cyanide (HCN) is sometimes used to control rats on ships but it is almost completely ineffective in controlling insects at the concentrations required for rats.

Methyl bromide

Although it is toxic to human beings, methyl bromide was originally used as a fire-extinguishing agent. It is a colorless liquid that boils at 3.6°C and readily forms a gas at ordinary temperatures. The gas is odorless at concentrations toxic to human beings. Liquid methyl bromide is supplied in cylinders of various sizes suitable for ship fumigation. The chemical is also supplied in specially designed small cans from which it may be removed with an applicator.

Sealing

Since the penetration of methyl bromide is outstanding, all openings must be well sealed. Ships' officers, with their knowledge of the construction of the vessel, may assist in identifying possible sources of leaks, checking the ventilation system and openings between bulkheads on older ships and ensuring that hatch covers are properly secured. Ventilator openings may be closed with their normal canvas covers or with polyethylene sheets. If ventilators are common to two holds, seal them from the inside. Professional fumigators use specially developed products such as tapes, adhesives and aerosol foams for sealing cracks, openings around pipes and other potential leaks.

Most modern ships are equipped with Macgregor or similar self-sealing hatch covers. Unless excessively warped, these will seal effectively by their own weight without being fully secured. Seal wooden or steel pontoon covers with gasproof sheets. New polyethylene sheeting may be laid over the hatch covers and then secured with a canvas tarpaulin.

Dosages

The amount of fumigant used is based on the cubic capacities of the holds. At least 16 g of the methyl bromide per cubic metre of air space, for 10 hours, is required for satisfactory control of insects at temperatures above 15°C. This fumigant is also effective at temperatures as low as 0°C if the dosage is increased and the exposure period extended to 12 hours. Below 0°C, the dosage must be increased at least fourfold for each 5°C drop in temperature; for best results, heat the holds (with steam radiator heaters) to above 0°C. Since methyl bromide is more than three times as heavy as air and tends to stratify in the bottom of the hold when first introduced, use circulating fans to improve distribution. These fans should have a capacity of 70 m^3/min to give a complete air cycle in 30 minutes; they should be operating for 30-60 minutes from the beginning of the exposure. Once the gas has been well distributed, the fumigant will not settle again. The recommended dosages of methyl bromide for fumigation of most holds are:

Temperature in air space of hold[1] **(°C)**	**Methyl bromide (g/m^3)**	**Exposure period (h)**
15 and above	16	10
10-14	16	12
5-9	24	12
0-4	32	12

[1] *Circulating fans must be used at temperatures below 15°C.*

The khapra beetle requires considerably more fumigant to control than most species of stored-product insects. Obtain information on dosages required for this insect from the Plant Protection Officer of Agriculture Canada.

Measuring gas concentration

The introduction of a certain quantity of gas does not, in itself, result in the death of an insect. The gas must be maintained at a sufficient concentration for a specified time. The product of concentration multiplied by time, usually referred to as the c × t product, is obtained by analyzing the gas at suitable intervals. This analysis is best done with an instrument called the thermal conductivity gas analyzer.

Thermal conductivity gas analyzer

With proper placement of gas sampling tubes in the hold, the analyzer operator can detect such problems as miscalculation of dosage or excessive loss of gas through leakage or sorption and, if necessary, can add fumigant to assure a successful treatment. Use of a thermal conductivity instrument is now compulsory in fumigation treatments ordered by Canadian inspectors. Information on suitable instruments can be obtained from any of Agriculture Canada's Plant Protection offices.

Following fumigation, the fumigator must provide the Plant Protection Inspector with a paper showing: cubic capacity of the space treated; amount of gas used; concentrations recorded at specified locations and stated intervals; length of exposure period; and minimum and maximum temperatures during the exposure period.

Safety precautions

During the entire fumigation operation, the safety recommendations published by the Canadian Coast Guard in *Ship Safety Bulletin* No. 16/83 (or subsequent updates) must be carefully followed. Entry into spaces under treatment should be prohibited. If entry becomes imperative, it should be effected by the fumigator and at least one other person, each wearing full protective equipment suitable for the fumigant in use and equipped with a safety harness and life-line tended by a person outside the space who is similarly equipped.

Remember that during fumigation, gas could leak into other parts of the vessel, such as engine rooms, crew's living or sleeping quarters, galley and store rooms. Accidents have occurred in the past from such leaks and from failure to test for presence of fumigant in these areas.

At the end of the fumigation period, the fumigator must ensure complete dispersion of the fumigant. Crew members may assist in this process if provided with adequate respiratory protection and if they adhere strictly to the fumigator's instructions. Such work should be restricted to the opening of hatches and the starting and operating of generating and ventilating machinery.

Methyl bromide can be removed by ventilation fairly rapidly if hatch covers are opened completely and ventilators are turned toward the wind. However, it is recommended that blowers be used, aided by fans placed in the holds earlier, to circulate the gas. For effective operation, blowers should have a capacity of at least 100 m^3 of air per minute. They are usually driven by gasoline motors, and may be set up in almost any place for operation at very short notice. A canvas duct can be let down from the blower toward the bottom of the hold. The air pressure inflates this duct, and it can be rotated in various directions by cords operated from the top deck.

When crew members assist in aeration, the fumigator must regularly monitor the spaces to which crew have been admitted and if the threshold limit value (TLV) of the fumigant is exceeded, evacuate crew from the affected areas until measurements show the area to be safe for reoccupation.

No unauthorized persons should be permitted aboard the ship until it is declared gas-free and the warning signs removed.

Gas-free clearance certificates should only be issued when tests with approved equipment show that all residual fumigants have dispersed and any residual materials removed. Particular attention must be paid to the slow release (desorption) of fumigants from fine-grained and dense materials, especially when cargo temperatures do not exceed 10°C.

After fumigation and aeration, cargo is unloaded by remotely controlled equipment, the operator of which should, if on the ship, be located to windward of the hatchway in a position well clear of any ventilators. Entry into the hold to service the equipment should only be permitted under continuous monitoring to ensure the safety of personnel. Should gas concentrations in excess of 50% TLV of the fumigant used be detected, all personnel should be evacuated from the hold(s) or provided with adequate respiratory protection.

Treatment of used bags

Used burlap (jute) bags, which form part of a ship's dunnage, are a common source of infestation. None of the mechanical devices used to reclean bags eliminate living insects of all stages, and fumigation in a suitable vault or airtight enclosure is required. These enclosures should be well ventilated following fumigation. Fumigation at normal atmospheric pressure with methyl bromide is satisfactory for loosely piled bags. To completely eliminate all insect stages in bales of pressed bags, fumigation in a vacuum chamber is advisable.

CANADIAN REGULATIONS AND PROCEDURES

In Canada, the Plant Protection Division of Agriculture Canada is responsible for inspection and treatment of vessels before loading cargoes of grain and cereal products. *Plant Quarantine Regulation 13(1)* states that "any Canadian cereal or cereal product that is to be conveyed from Canada by means of a ship that is likely to be infested be conveyed only if, prior to the loading of the grain, the ship is inspected and approved for conveyance by the inspector", and *Plant Quarantine Regulation 23(1)* states that "where a ship is inspected pursuant to subsection 13(1), the owner or agent, as the case may be, shall, for each inspection pay the fee set out in Schedule IV of the Regulations".

Plant Protection Inspectors are authorized to:

- enter any premises, nursery, lands, train, ship, aircraft, vehicle or other carrier when there are plants or plant products that prevent the successful control of a pest or disease;
- hold for examination any imported plants or any carrier of them or any ship or other carrier of cereal exports;
- have any carrier that is infested or suspected of being infested or any infested imported plants, treated as the inspector deems necessary. When any of the above action is necessary, the owner or his agent must be notified. Any expense or risk associated with treatment or other measures is the responsibility of the owner.

Note: The procedure of "in-transit" fumigation is not recommended in Canada; masters of non-Canadian ships intending to fumigate "in-transit" should study the requirements of the Canadian Coast Guard *Ship Safety Bulletin* No. 16/83, or any subsequent updates. No phytosanitary certificate can be issued for this treatment.

INSPECTION PROCEDURES AT CANADIAN PORTS

Ocean vessels

When a vessel is due at a Canadian port to take on a cargo of grain or cereal products, the ship's agent must notify Agriculture Canada's Plant Protection Division of the time the vessel will be ready for inspection (inspection offices at Canadian ports are listed in the next section). Being ready for inspection means the holds are thoroughly clean and ready to receive cargo. An inspector reports to the ship's officer and obtains a list of the holds to be loaded, information on the quantity, type and destination of the commodity to be loaded, and a record of the previous cargo, particularly the last grain or cereal product carried.

The inspector then visits the areas to be examined, along with an officer of the ship. Not only is it safer when two people visit the holds together but, at the same time, any infestations found can be pointed out to the ship's officer. The inspector also makes notes on cleaning for extraneous matter and on structural alterations that would help eliminate pockets of infestation. In addition, the ship's officer can have boards and planks removed for better examination.

If the cargo space requires further cleaning, spraying or fumigation, the inspector issues a certificate "not approved for loading" outlining the work to be done before the hold will be re-examined for clearing. When the hold can be cleared, a certificate "approved for loading" is issued.

The crew, stevedoring company or pest-control operator may clean and spray small localized infestations, at the discretion of the ship's captain or agent, using materials authorized by the inspector. Large-scale jobs or fumigations must be assigned to a qualified pest-control operator.

Examining the base of a pipe casing, where grain may accumulate and insect infestations may occur.

Lakers

Lakers are considered an essential part of Canada's export grain trade and are inspected in a similar way to ocean vessels. However, due to the number of vessels involved, the rapid turnaround and frequent return voyages for grain it is not practical to inspect before loading in each Canadian port. Plant Protection offices on the Great Lakes and St. Lawrence exchange inspection records on each laker as the shipping season progresses. These records identify vessels that are prone to contamination and infestation problems and therefore warrant more frequent inspection.

In lakers, most insect infestations and residues from previous cargoes have been found on overhead beams, hatch coamings and frame stiffeners. These areas are relatively inaccessible, both for cleaning and inspection, and hence inspection is often done when sufficient grain has been loaded in the holds to permit close examination of the overhead structures.

When excessive residues are present, or when insects are detected, the Plant Protection inspector issues a "Notice of Detention" prescribing the treatment necessary for the ship and the cargo. The Plant Protection office at the discharge port is notified of the infestation, and fumigation of the cargo or other treatment may be required at this point. Re-inspection may be carried out at the unloading port, or at another Canadian port when the vessel arrives to load grain. The detention notice remains in effect until the remedial action has proven to be effective and must be cancelled by an inspector before the vessel may reload Canadian cereal products for export.

Examining out-of-the-way ledges where residues of previous cargoes often provide breeding sites for insects.

AGRICULTURE CANADA PLANT PROTECTION INSPECTION PORTS

St. John's, Newfoundland	Sir Humphrey Gilbert Bldg. Room 719, P.O. Box E 5609 Tel: (709) 772-5030
Halifax, Nova Scotia	5614 Fenwick St. Tel: (902) 426-3874
St. John, New Brunswick	Custom Bldg., Room 240 P.O. Box 6219, Station "A" Tel. (506) 648-4568
Baie Comeau, Quebec	168A Lasalle Blvd. P.O. Box 364 Tel: (418) 296-3173
Montreal, Quebec	150 St. Paul St. W. Tel: (514) 283-5686
Quebec, Quebec (Port Cartier)	Gare Maritimes Champlain Room 391 Tel: (418) 694-7373
St. Hyacinthe (Sorel/ Trois Rivières)	3100 Laframboise Blvd. Room 206 Tel: (514) 773-6639
Hamilton, Ontario	1053 Main St. W., Room 211 Tel: (416) 523-2201
London, Ontario	457 Richmond St., Room 402 Tel: (519) 679-4021
Niagara Falls, Ontario	4551 Zimmerman Ave. P.O. Box 35 Tel: (416) 357-5981
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Thunder Bay, Ontario	430 Waterloo St. S. Tel: (807) 623-6122
Toronto, Ontario	150 Bridgeland Ave., Room 104 Tel: (416) 781-6186
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Winnipeg, Manitoba (Churchill)	624-269 Main St. Tel: (204) 949-3775
Prince Rupert, British Columbia	Federal Building 417-2nd Ave. W. Tel: (604) 627-8818
Vancouver, British Columbia	215 Commercial Dr. Tel: (604) 666-3837
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