Insect Identification

The most common insects found during microanalysis are: pomace or fruit fly (Drosophila), dried fruit beetle (Carpophilus hemipterus), raisin moth (Cadra figuliella) Indian meal moth (Plodia interpunctella), and sawtooth grain beetle (Orzaephilus surinamensis). Also encountered may be springtails (Order: Collembola), psocids or bark lice (Order: Corrodentia), leaf-hoppers and sharpshooters (Order: Homoptera), and mites (Class: Acaria). Parasitic wasps (Order: Hymenoptera) and thrips (Order: Thysanoptera) occur rarely, as do aphids (Order: Homoptera, Family Aphididae).

Of the above insects, drosophila flies, moths, beetles, and wasps exhibit complete metamorphosis. This means that the egg hatches into a larva (plural larvae) which eventually enters the pupa or resting stage, from which the adult emerges. The other insects listed (and the mites, which are not insects) hatch from eggs and develop into nymphs which more or less resemble the adults. The nymphs increase in size and development and shed their skins until they are adults. This is known as incomplete metamorphosis, as the insect does not go through the four states (egg, larva, pupa, and adult) of complete metamorphosis.

The adult insects usually have three main body regions: head, thorax, and abdomen. The head bears the eyes, antennae, and mouth parts. Typically, insects have three main pairs of legs and two pairs of wings, all carried on the thorax. The thorax may be divided into three segments with a pair of legs on each. When present, the wings are attached to the middle (mesothorax) and last (metathorax) segments. The abdomen of an adult insect usually does not have appendages and resembles a segmented sack.

A. Drosophila

Drosophila flies are known by several common names, including pomace, fruit and vinegar flies. They are common in and around fermenting fruit and are pests of raisin plants.

An egg is laid on fermenting fruit. It hatches in 24 hours, producing a slender white maggot (larva) which feeds on yeasts in the fermenting fruit. After four days, the maggots form pupae from which the adults emerge after another four days. A generation is completed in only nine days.

The eggs are minute and oblong, with two appendages as long as the egg.

Drosophila larvae are whitish, and measure up to 7 mm (¼ inch) long. They are identified by their typical maggot appearance and the presence of mouth hooks - dark H-shaped structures seen beneath the skin at the anterior end of the larva.

The pupae are somewhat shorter and bigger around than the full grown larvae, and have two characteristic horn-like respiratory tubes. The color is yellow to brown and often the red eyes of the developing adult may be seen within the pupa.

The adult is a yellowish fly about 3 mm long, and is easily identified by its red eyes.

B. Raisin and Indian-meal Moths

The raisin moth and Indian-meal moth are treated as similar for the purposes of microanalysis of raisins. Both moths infest dried fruit and can greatly damage the raisins. The eggs are oval to nearly spherical, and may be yellowish (raisin moth), or pearly white and look like a golf ball (Indian-meal moth).

Larvae of the moths appear as typical caterpillars. They may be brown, white, yellow, pink, or lavender in color, with a head. Since the pupae are seen only occasionally, it is sufficient to be able to identify the typical hard, brown pupa case of a moth. Adults may be observed flying about the lab and are rarely found in the samples. They are about $^{3}/_{8}$ inch long, and the wings are folded around the body when at rest. The wings of the Indian-meal moth are dark brown and cream-colored; those of the raisin moth are drab gray.

C. Dried Fruit Beetles

The dried fruit beetle, a sap beetle, is widely distributed throughout the world and attacks ripe and overripe vegetation, especially fruits. In California, the dried fruit beetle breeds in stone fruits, figs, melons, citrus and grapes, then migrates from crop to crop as the fruits ripen. Its population increases through the season, and it is especially attracted to grapes with bunch rot.

Adults are dark brown with lighter brown or amber spots on their wing covers. They are about 3 mm ($^{1}/_{8}$ inch) long, oval-shaped and robust.

The wing covers are short, leaving the tip of the abdomen exposed. The antennae are knobbed at the tips. Legs and antennae are reddish or amber.

The newly hatched larva is yellowish and translucent, but soon becomes creamy white with brownish ends. It has a pair of pointed tubercles on the end of the abdomen. Fully grown, it is sparsely haired and about 6 mm (¼ inch) long. The pupa is pale yellow until nearly mature; then it darkens and is somewhat spiny. No cocoon is formed.

D. Saw-toothed Grain Beetles

The sawtoothed grain beetle is a very common pest that feeds on practically any stored dried food. Fairly dry foods are preferred. Both larvae and adults attack the commodities. The sawtoothed grain beetle infests all cereals (rice, wheat, maize, barley, and pastas such as macaroni), bread, flour, nuts, copra, starch, drugs, tobacco and dried fruit. Raisins are a favorite. In raisins stored for a year or more, this insect can become a real problem. It crawls rapidly, even on vertical surfaces, but it has not been observed to fly. Newly hatched larvae can enter extremely narrow crevices in search of food.

The eggs are laid individually in small clusters in the crevices of the skin of raisins. The eggs are white, shiny and elongated-oval in shape. They measure less than .25 mm ($^1/_{20}$ inch) in length. Except for the color, they resemble dried fruit beetle eggs. The larva is pale yellow with a dark band on each segment and a yellowish-brown head. It has six legs and its body is covered with numerous long hairs. The abdomen tapers to a blunt tip and lacks the four posterior tubercles of the dried fruit beetle.

Both the pupae and the adults show the characteristic "saw teeth" on the thorax. The adult is a slender brown beetle, about 3 mm long.

E. Sap Beetles

Different species of sap beetles are found in raisins and other fruit: the pineapple sap beetle, the Freeman sap beetle, the confused sap beetle and the yellow-brown sap beetle.

The yellow-brown sap beetle may be prevalent in raisin products and lay hundreds of eggs which hatch in 2-5 days. The eggs are whitish in color, oval and slightly curved. It takes 5-11 days before the larva mature and develop into pupae. The larva of the beetle has nearly parallel rows of prominent dorsal tubercles on each segment, and the color is whitish-brown. The adult is a uniform yellow-brown color and is oval, flattened and long (2-2½ mm) in shape. The complete life cycle is 21 days.

F. Springtails

Springtails are very small insects, many of which have a forked furcular or "spring" folded beneath the abdominal segment. These insects are characterized by a fused abdomen of not more than six segments and antennae with four to eight joints. The young are usually white or colorless and they assume a bluish-gray appearance when reaching maturity. Before failing any lot account Springtails, consult your supervisor.

G. Leafhoppers and Sharpshooters

Both leafhoppers and sharpshooters belong to the same order of insects and are very similar in appearance. Adult grape leafhoppers are small slender insects 3 mm or less in length. They are usually pale yellow with reddish and dark brown markings. Coloration and markings vary with each species. The outstanding characteristics of this group of insects is the triangular head and slender, tapering body.

H. Mites

Mites are not insects but are closely related to ticks, which they resemble. They are exceedingly small and clear-bodied. The coloration varies greatly according to species. They can be distinguished from insects by the presence of eight legs.

I. Parasitic Wasps

Parasitic wasps probably occur in raisin samples because of their relationship with the insects upon which they prey. Only adults will be found in the raisin samples. They are very tiny and most of them are dark brown to black. They have the characteristic "wasp waist" between the abdominal and thoracic sections.

J. Thrips

Thrips occur only occasionally in raisins, and most of these will be nymphs. Nymphs are lighter in color than the adults and lack the characteristic fringed wings and red eyes.

K. Psocids

Psocids are an easily identified insect, usually pale grey or yellow in color. They are approximately 1 mm long with the head making up a third of the length. The antennae is segmented. The insect has a short thorax and large oval-shaped abdomen. The abdomen is segmented and the digestive track may sometimes be seen in it.

Other Defects

Other defects refer to insect parts and other contaminants such as feather barbules and barbs and striated hairs.

A. Insect Heads

"Insect Heads" do not include empty head capsules which are left behind when the skin is shed. Insect heads include those coming from insects that were obviously living but killed by processing or treatment for microanalysis. Such heads will appear to contain "flesh." Score these in the "Insect Head" section of the worksheet.

B. Insect Fragments

Some of the most common fragments found in raisin samples are: empty egg cases, empty pupae cases, pieces of eggs, insect legs, wings, antennae and segments of skin. Moth scales may also be found. These are extremely small, flat objects of a long, triangular shape.

"Insect Fragments" also includes broken-off portions of insects.

However, if one of the following is found it is not scored as a fragment, but as a whole insect*:*

- two thirds of an insect,
- head and thorax of an insect,
- more than one-third of a larva or pupa which includes the head, or
- more than one-half of an adult insect which includes the head. Care should be taken not to score an "Insect Head" and then a whole insect of which the head was a portion.

C. Insect Eggs

Only full egg cases are counted as eggs. Broken or empty insect egg cases are classified as "Insect Fragments." Drosophila eggs are only counted under the "Dros. Eggs" heading. All others are recorded as "Other Eggs."

D. Mouth Hooks

"Mouth Hooks" refers to the H-shaped mouth parts of the Drosophila larvae or pupae, separated from the insect body. Although it is tallied in a separate category, it is totaled with other fragments. Thus there is no total for mouth hooks alone.

E. Feather Barbules and Barbs

"Feather barbules" and "feather barbs" refer to portions of bird feathers. Barbs are branches from the shaft of a feather and bear many barbules. A barbule has several nodes which appear as swellings, much like bamboo. Nodes may appear as blank portions in the colorations.

F. Striated Hairs

Hairs from cats, rodents, and other animals may be striated. "Striated Hairs" are hairs with striations of narrow bands around them. Under the microscope, the hair between striations may be clear and almost invisible so that often only the striations can be seen. This gives the striated hair an appearance of "cross-ties of a railroad track." The analyst must learn to distinguish between feather barbules **with nodes** and hair **with striations**.