



- County of Los Angeles -



Department of Agricultural Commissioner/Weights and Measures



Field Guide to Target Insects in Pest Detection Programs

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Introduction

Pest detection is an important step in the pest prevention program. Accurate recognition of newly introduced, economically significant insects in the field enables the prompt implementation of steps to effectively and efficiently confine and eradicate new infestations to prevent establishment and subsequent spread of these pests to agricultural, urban and natural environments.

This field guide is prepared primarily as a reference manual for agricultural inspectors working in insect detection trapping and eradication programs. It may also be helpful for quarantine inspectors intercepting shipments of plant material entering California through various ports of entry.

Diagnostic characters used in this work are selected to help recognize target insects in the field with 16-20X magnification lens. All measurements are given in millimeters (mm). Please use the ruler provided below as a reference.

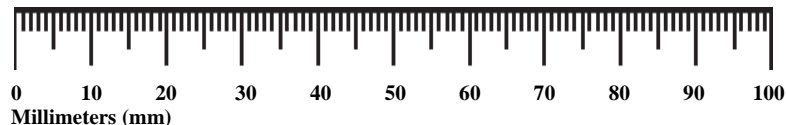
It is important to remember that this guide is solely for initial recognition of target pests in the field. All suspect specimens must be subsequently submitted to appropriate state/county entomology laboratories for final identification.

Not all insects placed on the detection program trapping target list were possible to include in this work. We were often limited by absence of fresh specimens, with well preserved colors and intact body parts, essential for obtaining realistic images comparable with wild specimens in the field. This guide will be periodically updated as mentioned specimens become available.

The supplemental part of this work, located at the end of the guide, was added to encompass some important exotic species that are not on the pest trapping list, but can possibly be encountered during detection work in the field.

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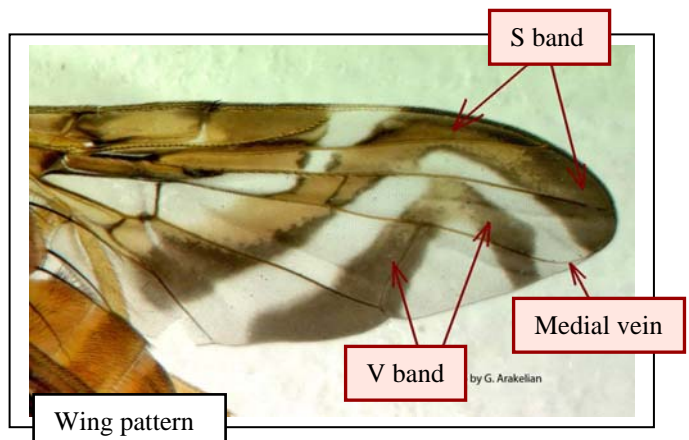
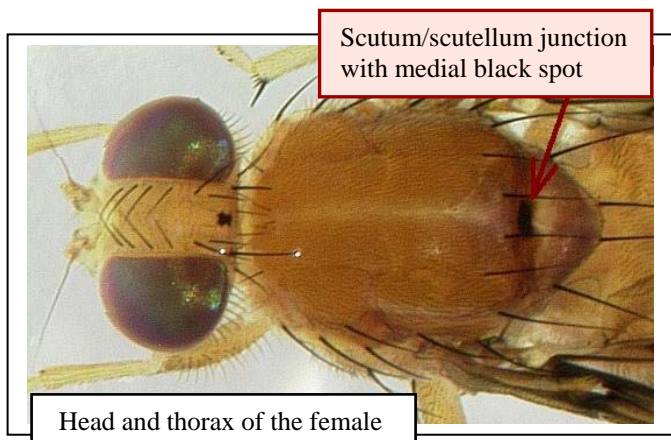
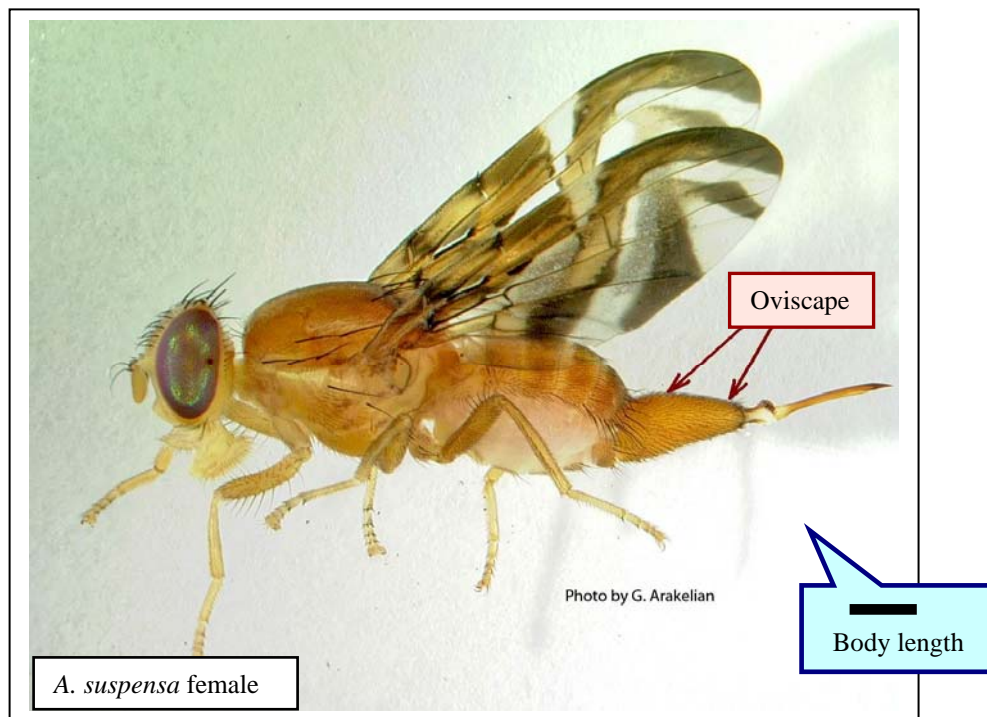
Caribbean fruit fly (*Anastrepha suspensa*)

Distribution: Bahamas, Cuba, Dominican Republic,, Haiti, Jamaica, and Puerto Rico. In the U.S.: Florida.

Hosts and Damage: Caribbean fruit fly has been recorded from many plant species, including avocado, citrus, guava, loquat, mango, nectarine, peach, pear, persimmon, pomegranate, and rose apple.

Trap/Attractant: McPhail trap with yeast pellets (general feeding response).

Field ID: Caribbean fruit fly is slightly larger than a housefly. It has yellowish-tan body and wings with brownish-yellow to brown bands. The junction of scutum and scutellum bears a distinct medial black spot. S band has a broad apical part touching medial vein. V band is usually narrowly joined to S band. Females with oviscape that is shorter than the thorax. Larvae (maggots) are legless, creamy white with cylindrical bodies narrowed at the anterior end. They develop inside the fruit and later move into the soil to pupate.



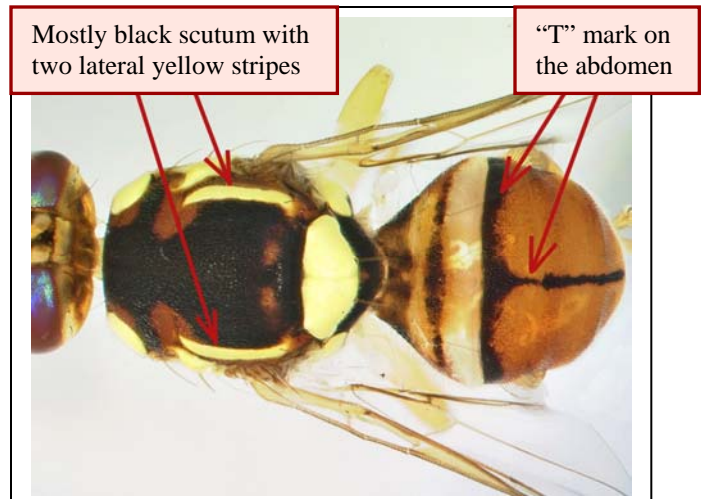
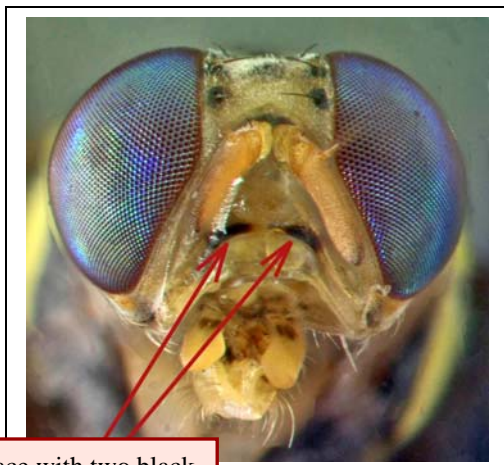
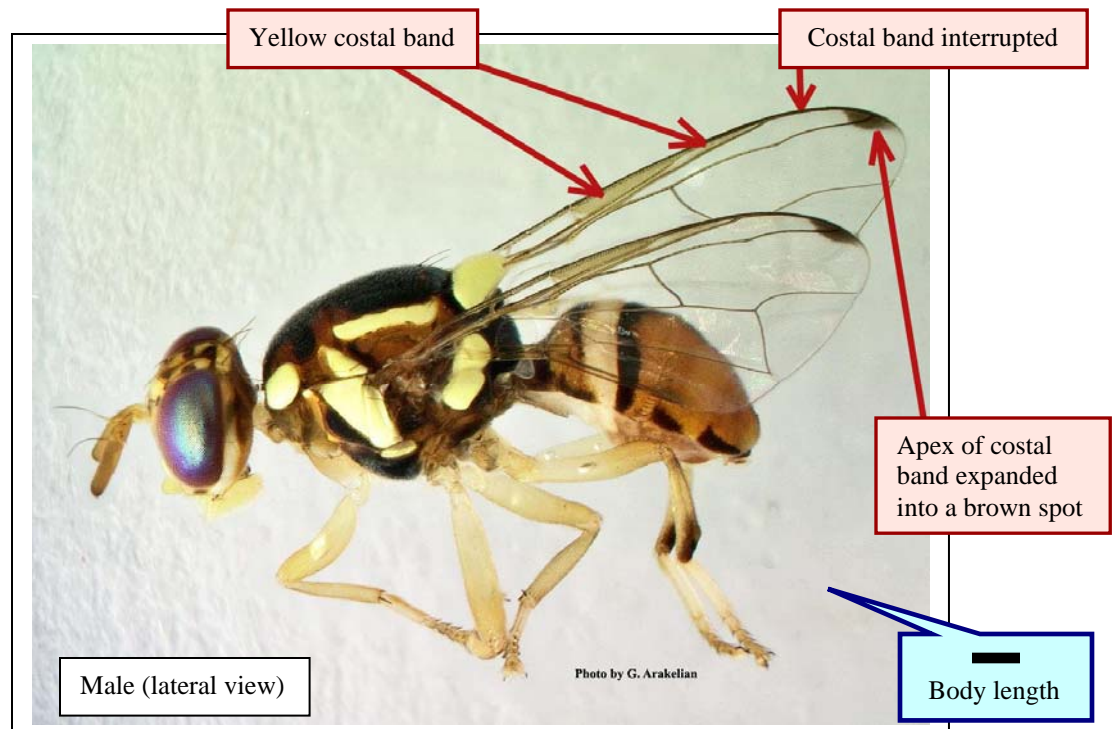
Guava fruit fly (*Bactrocera correcta*)

Distribution: Occurs in China, India, Myanmar, Nepal, Pakistan, Sri Lanka, and Thailand.

Hosts and Damage: Known to attack apple, citrus, fig, guava, jujube, mango, peach, roseapple, sapodilla, etc. Larvae (maggots) feed inside the fruit, making it unfit for consumption.

Trap/Attractant: Jackson trap with methyl eugenol (primarily as a male attractant) and McPhail trap with yeast pellets (general feeding response).

Field ID: Guava fruit fly is slightly larger than a housefly. It has two black transverse bands on its face and a predominately black scutum with two yellow lateral stripes. Yellow costal band on the wing is interrupted and expanded at apex into a brown spot. Abdomen yellow to orange-yellow with a black “T” mark on dorsal surface. Larvae (maggots) are white to creamy white, legless with cylindrical bodies narrowed at the anterior end. After developing inside the fruit they enter the soil to pupate.



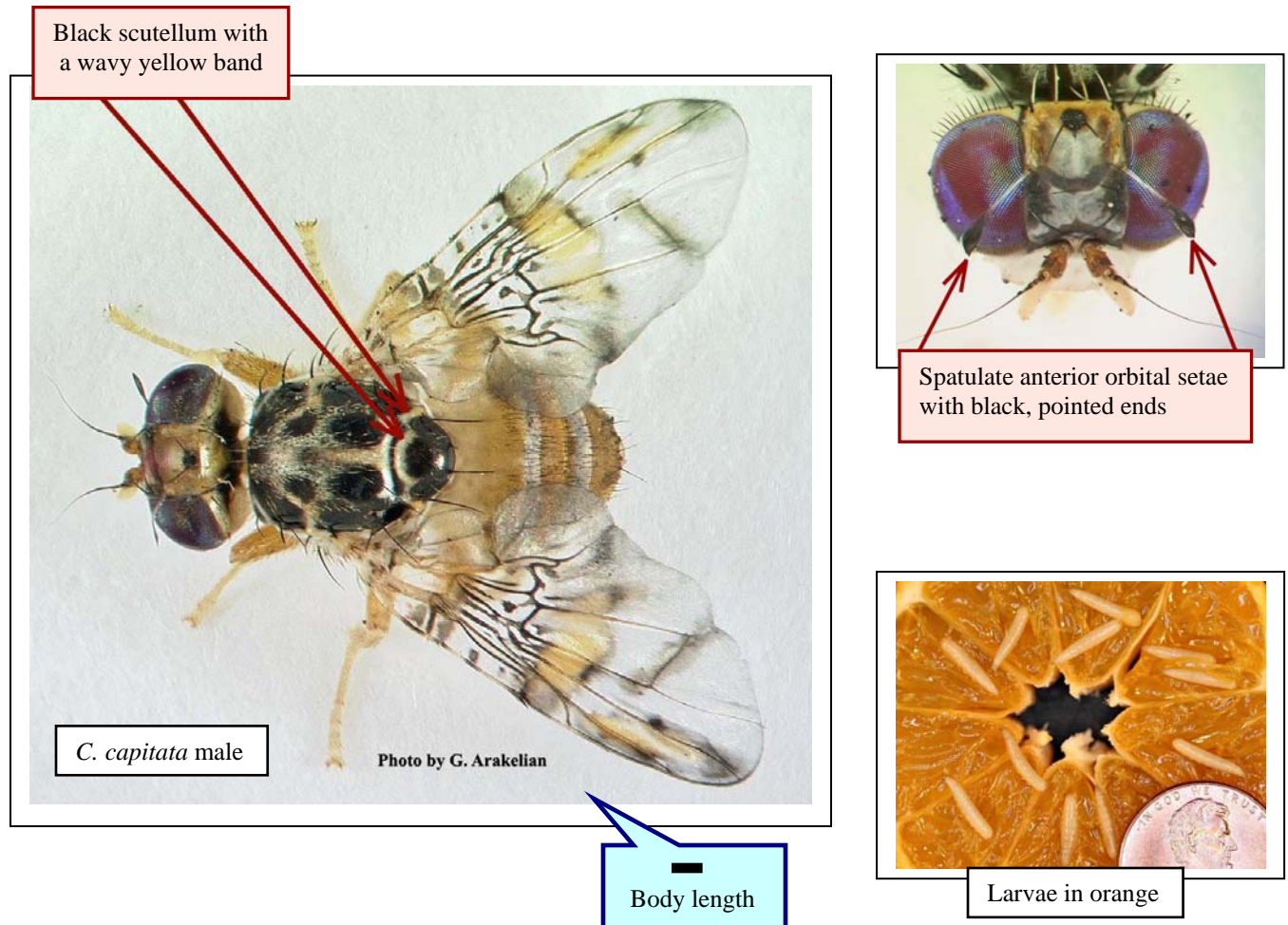
Mediterranean fruit fly (*Ceratitis capitata*)

Distribution: Known from Africa, southern Europe, Middle East, Australia, South and Central America. In the U.S.: Hawaii.

Hosts and Damage: Mediterranean fruit fly is a highly polyphagous species recorded from more than 300 plants, including apple, apricot, avocado, cherry, cherimoya, citrus, coffee, fig, guava, jujube, loquat, mango, nectarine, papaya, peach, pear, persimmon, sapote, tomato, walnut, etc. Larvae feed inside the fruit, making it unfit for consumption.

Trap/Attractant: Jackson trap with Trimedlure (primarily as a male attractant) and McPhail trap with yeast pellets (general feeding response).

Field ID: *C. capitata* is slightly smaller than a housefly. It has a black scutellum with a wavy yellow band near base. Males have spatulate anterior orbital setae with black, pointed ends. Adults may also be separated from other species by their characteristic pattern of wing bands. Larvae are legless, creamy white with cylindrical bodies narrowed at the anterior end. They develop inside the fruit and later enter the soil to pupate.



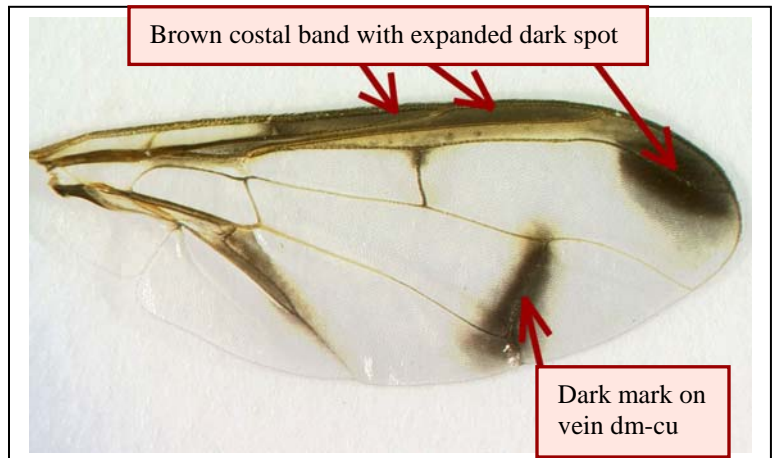
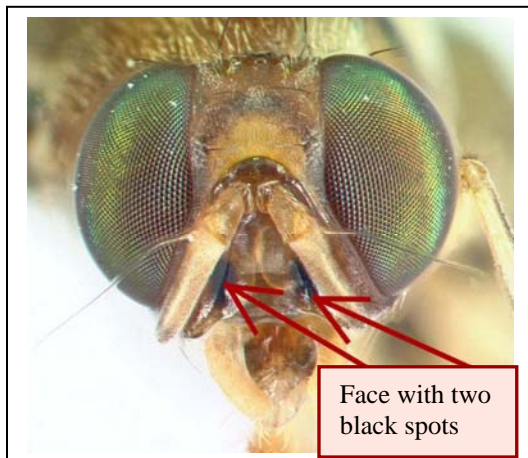
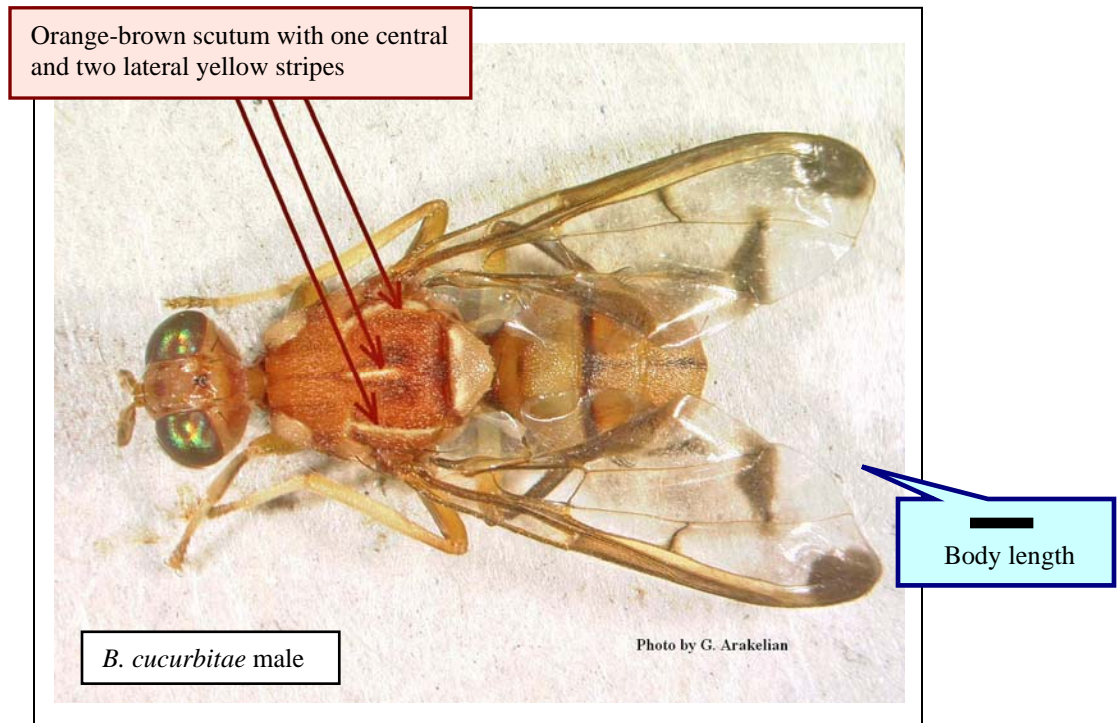
Melon fruit fly (*Bactrocera cucurbitae*)

Distribution: Widely distributed in the Oriental region and neighboring islands. Found also in East Africa, Mauritius, Reunion, Iran, and Hawaii.

Hosts and Damage: Melon fruit fly damage has been recorded on over 125 plant species. A serious pest of *Cucurbitaceae*, it may also attack avocado, fig, quince, mango, papaya, tomato, pepper, etc.

Trap/Attractant: Jackson trap with Cue-lure (male sexual attractant) and McPhail trap with yeast pellets (general feeding response).

Field ID: *B. cucurbitae* is slightly larger than a housefly. It has an orange-brown scutum with one central and two lateral yellow stripes. The face bears two black spots. Brown costal band is expanded near the apex of the wing into a prominent dark spot. Vein dm-cu with a dark mark covering it. Larvae (maggots) are creamy white, legless with cylindrical bodies narrowed at the anterior end. They develop inside the fruit, flowers, and stems of host plants and enter the soil to pupate.



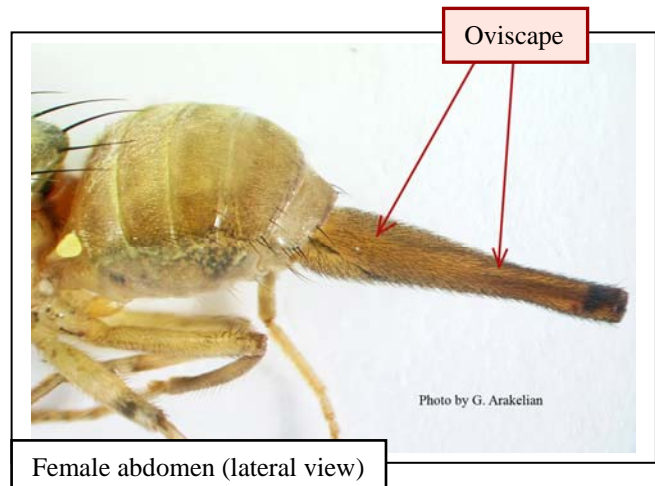
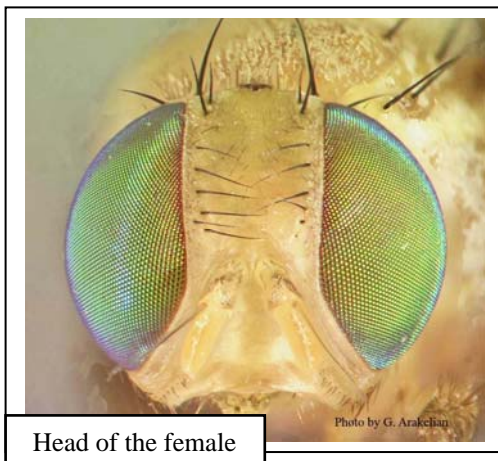
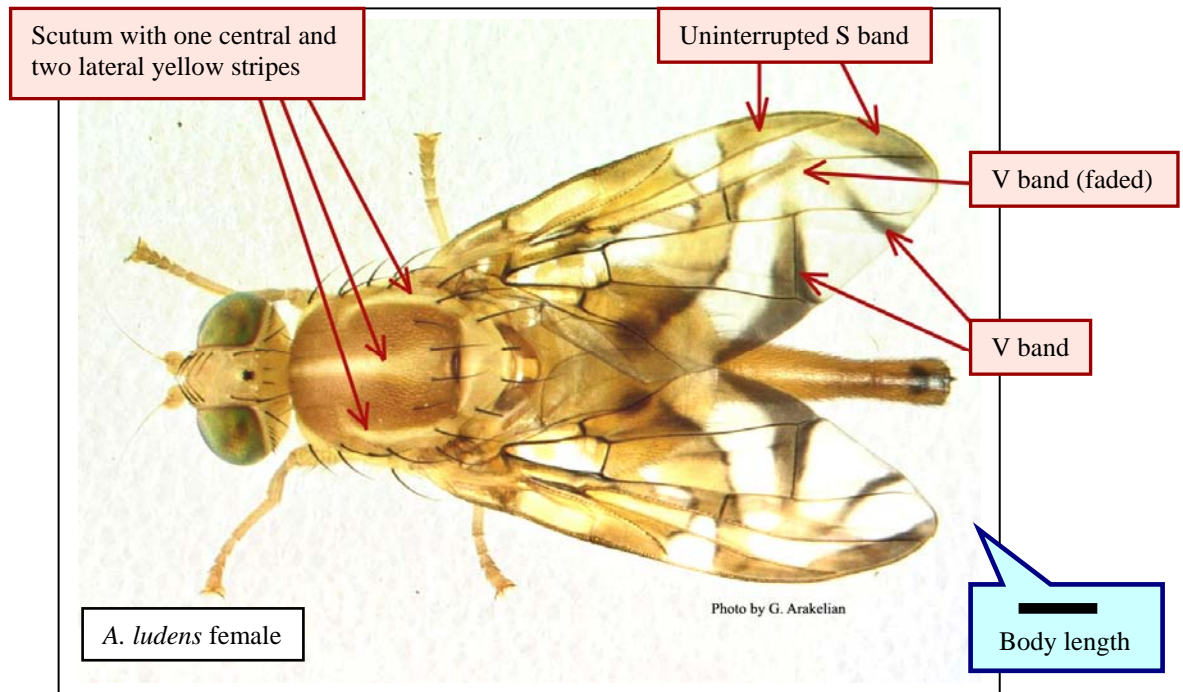
Mexican fruit fly (*Anastrepha ludens*)

Distribution: Widely distributed from Costa Rica to southern USA (Texas).

Hosts and Damage: Mexican fruit fly has been recorded from more than 50 plant species, including apple, avocado, cherimoya, citrus, coffee, guava, mango, papaya, peach, pear, persimmon, pomegranate, quince, and sapote.

Trap/Attractant: McPhail trap with yeast pellets (general feeding response).

Field ID: *A. ludens* is slightly larger than a housefly. It has yellowish-orange scutum with one central and two lateral yellow stripes. Wings with yellow-brown bands which are often darker at their edges. S band is uninterrupted and V band is gradually faded in anterior section. Abdomen is yellow to orange. Females with relatively long oviscapae (longer than the thorax). Larvae (maggots) are legless, creamy white with cylindrical bodies narrowed at the anterior end. They develop inside the fruit and later move into the soil to pupate.



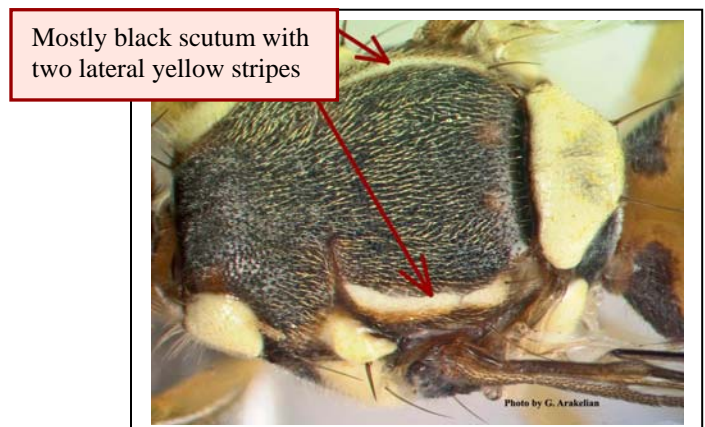
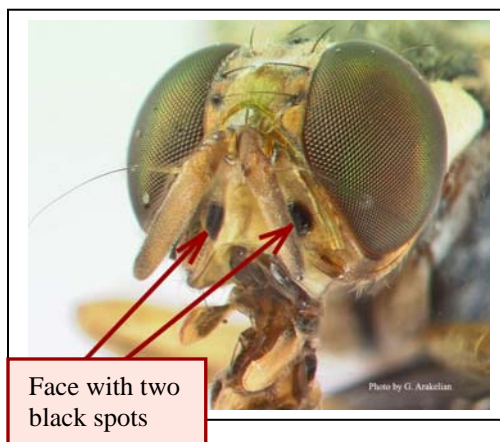
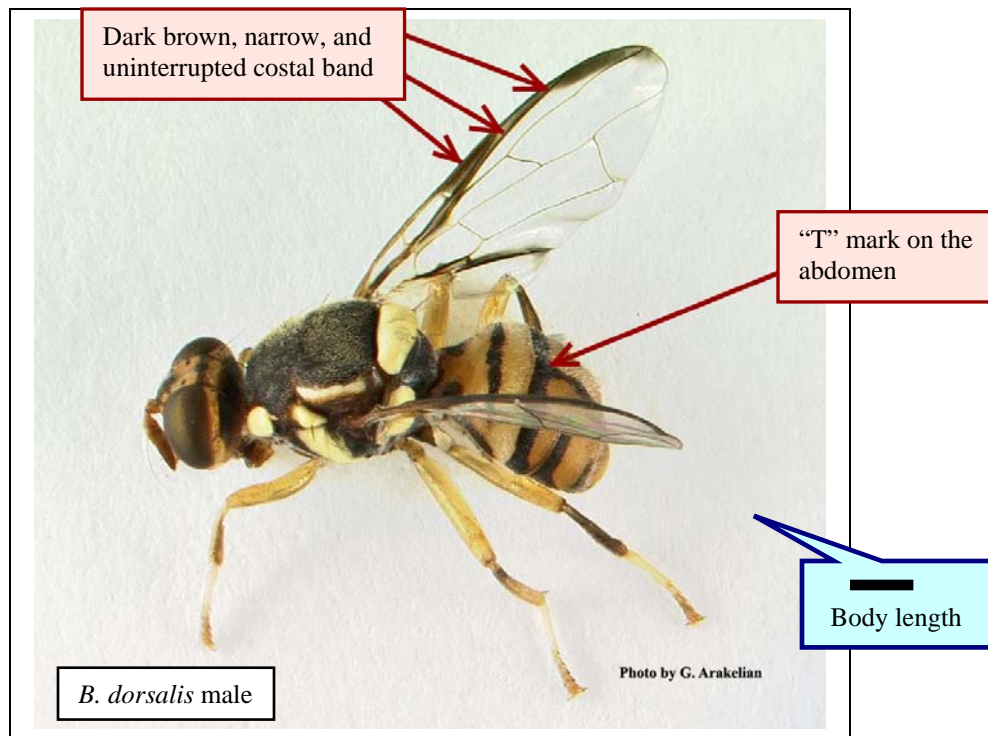
Oriental fruit fly (*Bactrocera dorsalis*)

Distribution: Widely distributed in the Oriental region. Found also in Hawaii and Micronesia.

Hosts and Damage: Oriental fruit fly has been recorded from more than 230 plant species, including almond, apple, apricot, avocado, banana, cherry, citrus, coffee, fig, guava, loquat, mango, papaya, peach, pear, pepper, persimmon, pineapple, squash and tomato.

Trap/Attractant: Jackson trap with methyl eugenol (primarily as a male attractant) and McPhail trap with yeast pellets (general feeding response).

Field ID: *B. dorsalis* is slightly larger than a housefly. It has a mostly black scutum with two yellow lateral stripes. The face bears two black spots. Dark brown costal band on the wing is narrow and uninterrupted. Abdomen yellow to orange with a black “T” mark on dorsal surface. Larvae (maggots) are legless, creamy white with cylindrical bodies narrowed at the anterior end. They develop inside the fruit and later move into the soil to pupate.



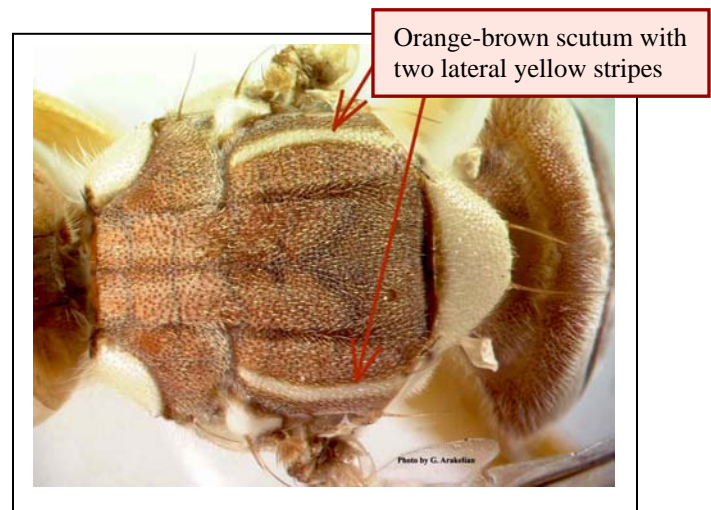
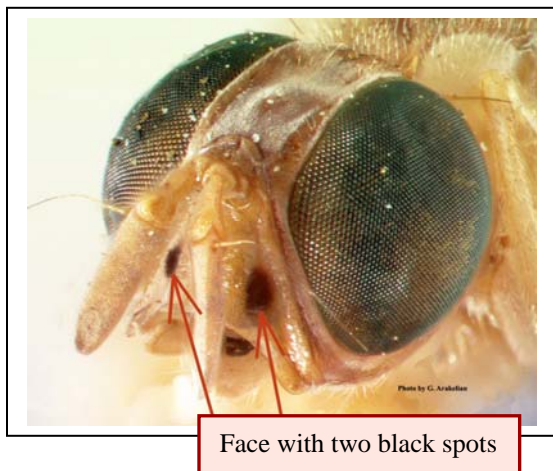
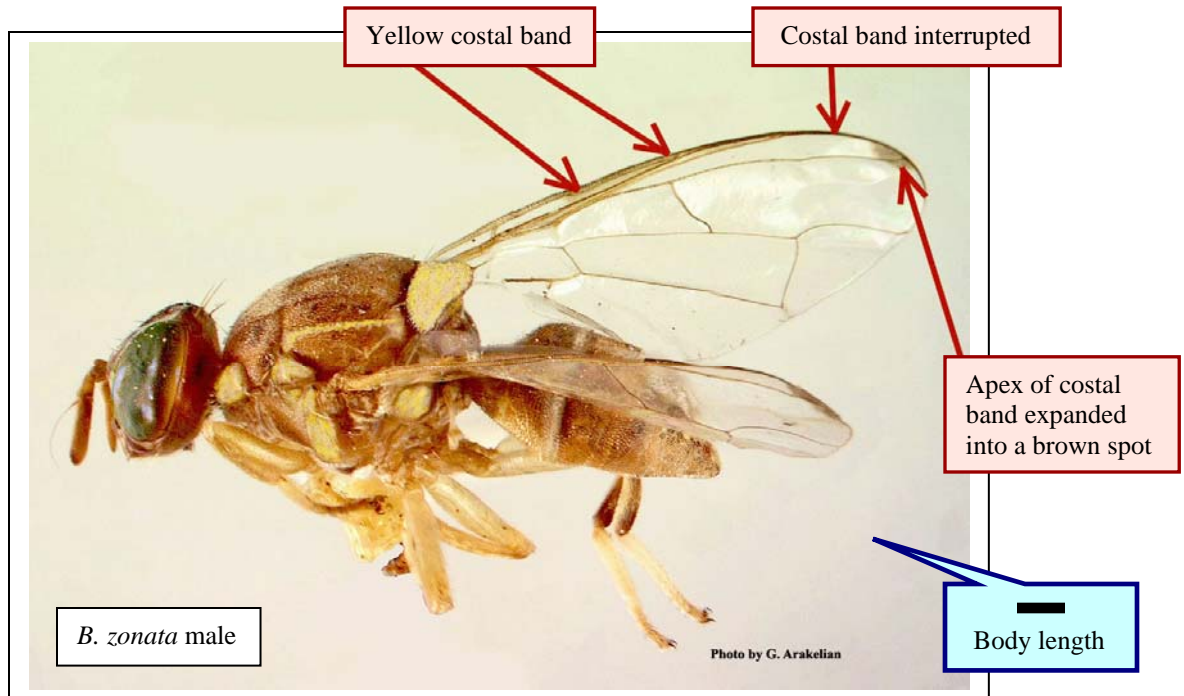
Peach fruit fly (*Bactrocera zonata*)

Distribution: Native to southern and southeastern Asia. Introduced to Near East, Egypt, Mauritius, and Reunion.

Hosts and Damage: Known to attack apple, apricot, citrus, fig, guava, mango, papaya, peach, pomegranate, quince, etc. Larvae (maggots) feed inside the fruit, making it unfit for consumption.

Trap/Attractant: Jackson trap with methyl eugenol (primarily as a male attractant) and McPhail trap with yeast pellets (general feeding response).

Field ID: Peach fruit fly is slightly larger than a housefly. It has two black spots on its face and orange-brown scutum with two yellow lateral stripes. Yellow costal band on the wing is interrupted and expanded at apex into a brown spot. Larvae (maggots) are white to creamy white, legless with cylindrical bodies narrowed at the anterior end. After developing inside the fruit they enter the soil to pupate.



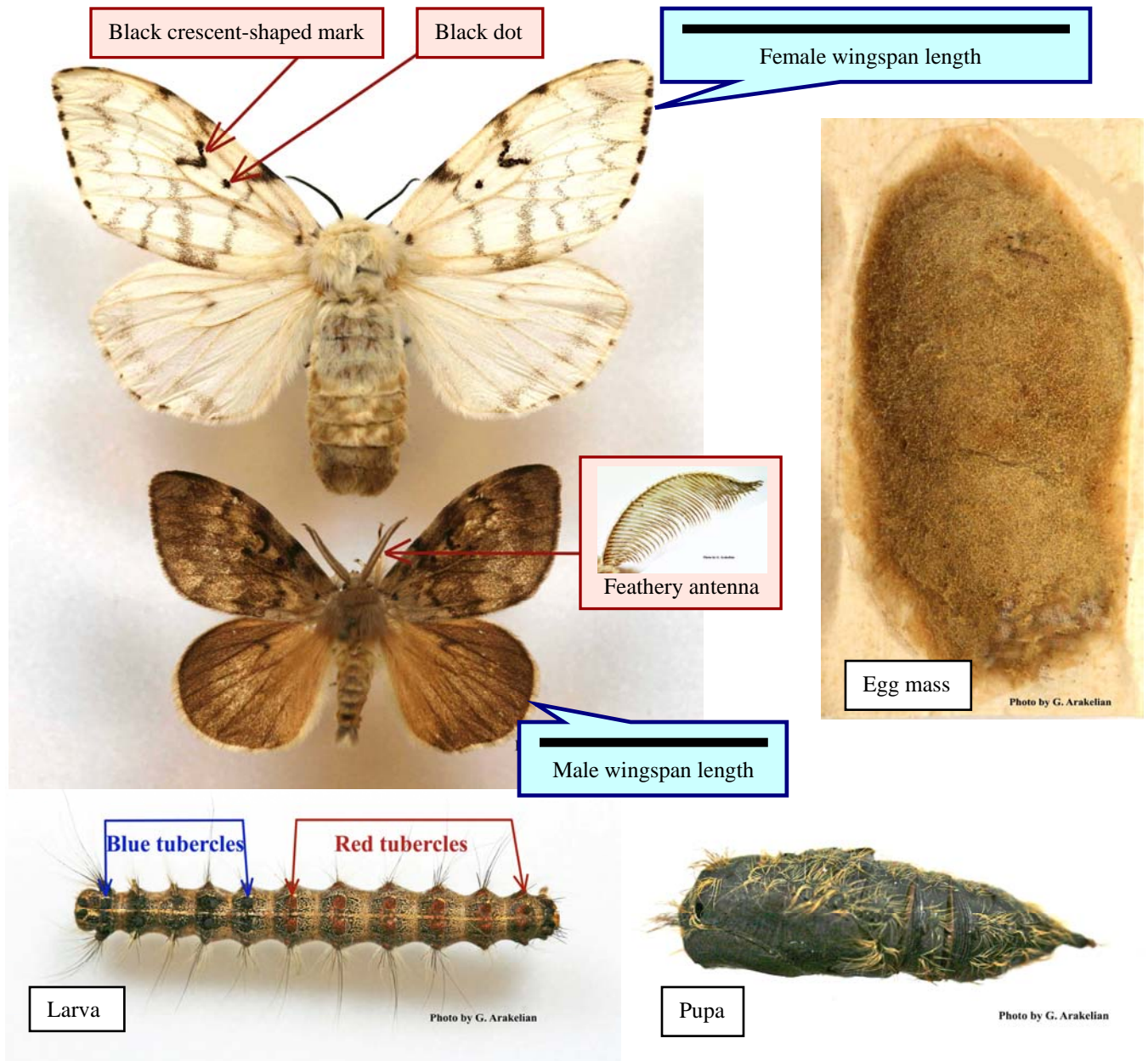
Gypsy moth (*Lymantria dispar*)

Distribution: Widely distributed in Eurasia. Found also in northern Africa and eastern Canada. In the U.S.: the entire Northeast and portions of the Southeast and Midwest.

Hosts and Damage: Recorded on over 500 plant species. A serious pest of many broadleaf trees and conifers in forests and urban areas. Larvae often defoliate and kill their host plants.

Trap/Attractant: Gypsy moth delta trap with Disparlure (sex pheromone to attract males).

Field ID: Adults are dimorphic. Females (wingspan 55-65 mm) are stout with mainly white coloration. Males (wingspan up to 40 mm) are slender and mostly brown. The forewing (both sexes) with a crescent shape discal mark and an isolated black dot. Adults have bipectinate antennae with longer branches in male (feathery appearance). Mature larvae with five pairs of blue dorsal tubercles on thoracic and first two abdominal segments followed by six pairs of red dorsal tubercles on abdominal segments three to eight. Pupae are dark reddish-brown. Ovoid egg masses (100-1,000 eggs) are covered with tan hairs.



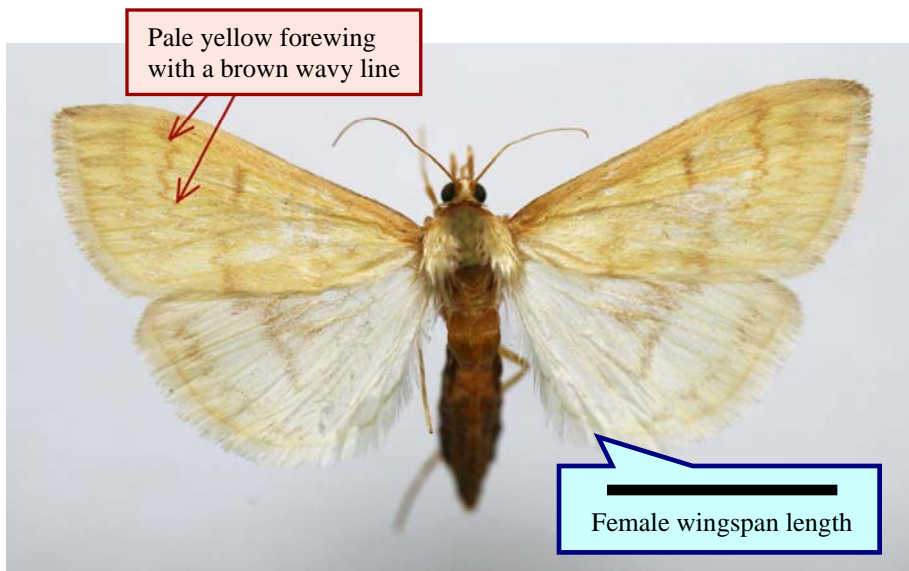
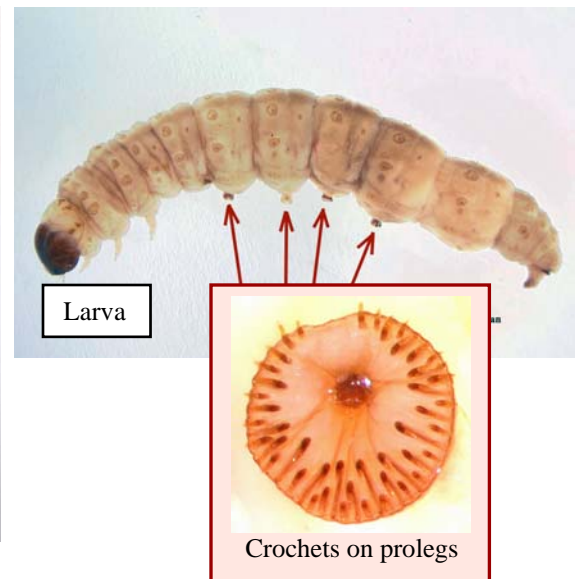
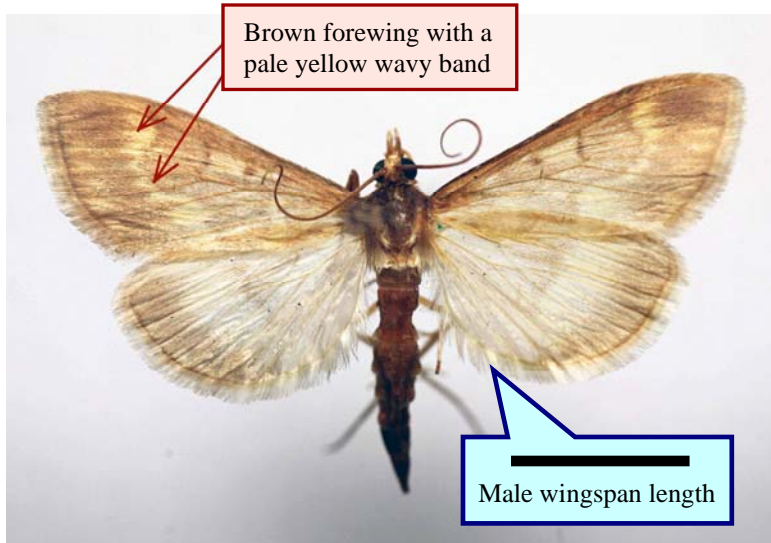
European corn borer (*Ostrinia nubilalis*)

Distribution: Occurs in Europe, western and central Asia, northern Africa, and Canada. In the U.S.: widely distributed from Atlantic coast westward to the Rocky Mountains.

Hosts and Damage: Serious pest of maize (corn). Feeding is recorded on over 200 plant species, including barley, bean, celery, dahlia, cotton, millet, oat, pepper, potato, sorghum, and others.

Trap/Attractant: Pherocone 1C trap with a synthetic sex pheromone to attract males.

Field ID: Adults are dimorphic. Females (wingspan 25-34 mm) are larger than males and have pale yellow forewings crossed by brown wavy lines. Males (wingspan 20-26 mm) with pale yellow wavy bands across their predominately brown forewings. Mature larvae (about 25 mm long) have pale brown to pinkish-brown bodies and reddish-brown to dark brown heads. Caterpillars found on maize can be easily separated from commonly occurring Corn earworm (*Helicoverpa zea*) by crochets positioned in an incomplete triordinal ellipse (instead of a single transverse band). Pupae (14-17 mm long) have yellowish-brown to dark brown color. Oval, flattened eggs are laid in clusters overlapping each other.



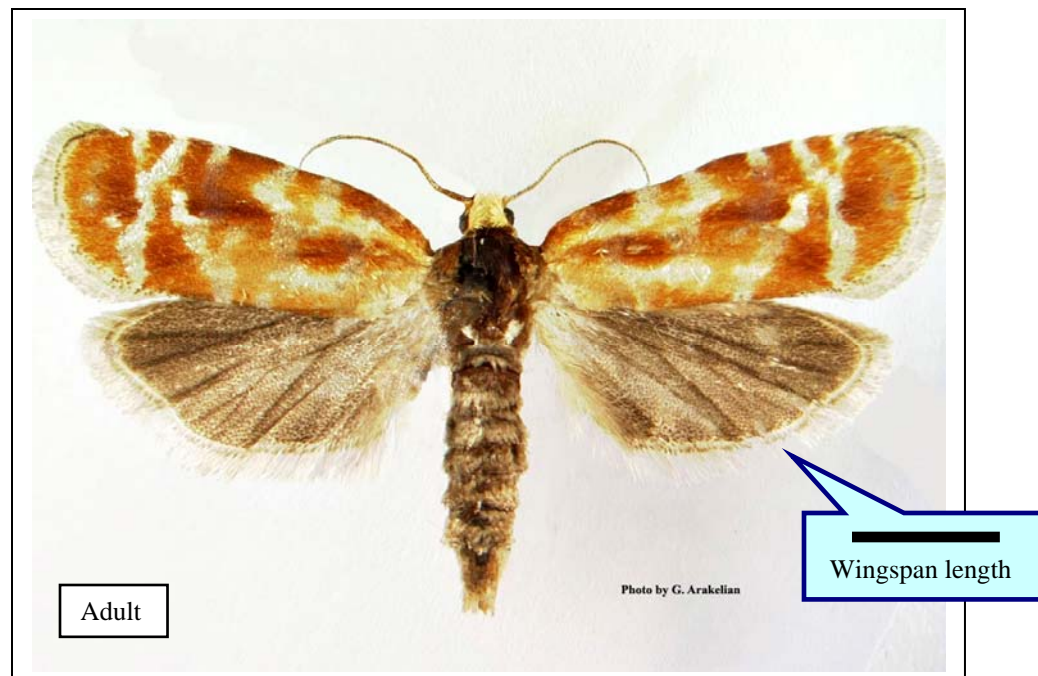
European pine shoot moth (*Rhyacionia buoliana*)

Distribution: Native to Europe. Introduced to southern Canada, northeastern United States, and Pacific Northwest (Oregon, Washington).

Hosts and Damage: Attacks various species of pines (*Pinus spp.*) including Austrian black pine, Eastern white pine, Japanese red pine, Lodgepole pine, Mugho pine, Ponderosa pine, Scotch pine, and others. Larvae tunnel in buds and shoots of host trees, distorting them and reducing their economic and aesthetic value.

Trap/Attractant: Pherocone II trap with synthetic sex pheromone to attract males.

Field ID: European pine shoot moth has distinctive orange-red forewings marked with irregular silvery cross lines and grayish-brown hindwings. Wingspan is about 16-23 mm. Mature larva (up to 21 mm long) has yellowish-brown body and black head.



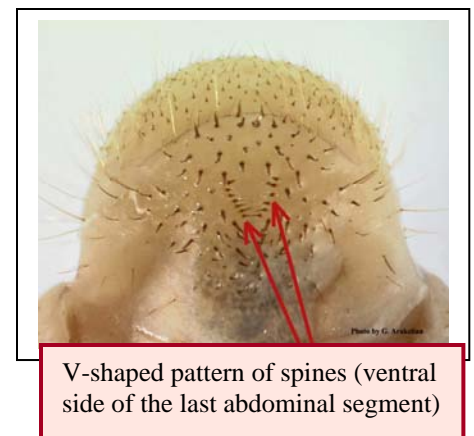
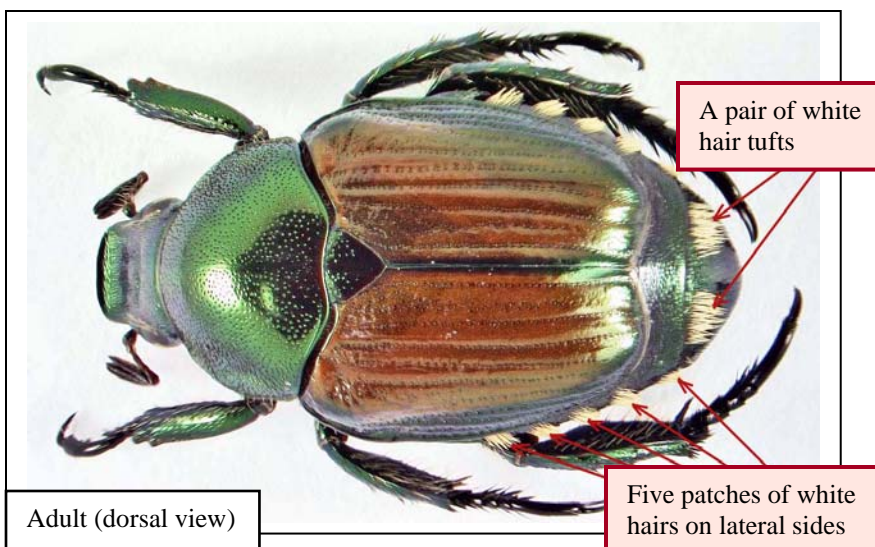
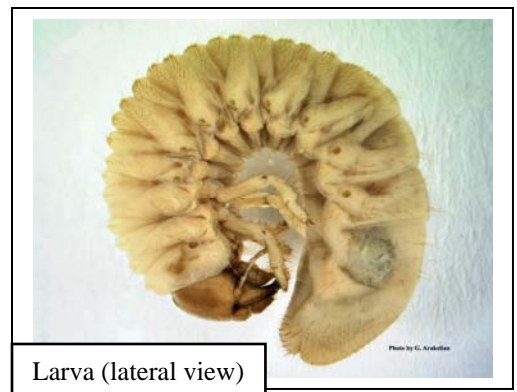
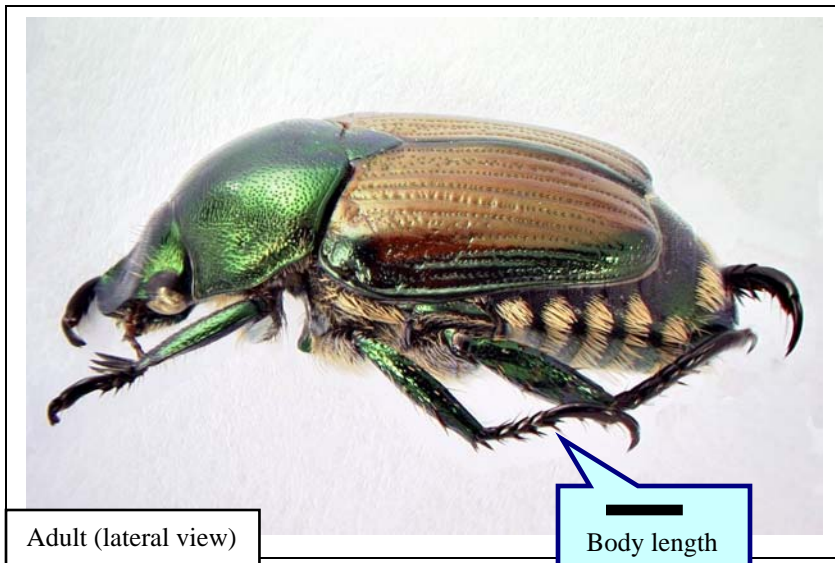
Japanese beetle (*Popillia japonica*)

Distribution: Native to Japan. Found also in China, Canada, Portugal, and Russia. Introduced and widespread in eastern and southeastern U.S.

Hosts and Damage: Polyphagous (feeds on nearly 300 species of plants). Adults attack foliage, flowers and fruit of plants. Larvae (grubs) feed on roots and often cause significant damage, especially to turfgrasses and seedlings of ornamental and commercial plants.

Trap/Attractant: Japanese beetle trap with three attracting components: 1. Japonilure pheromone (male sexual attractant), 2. Lure dispenser with phenethyl propionate, eugenol and geraniol (feeding response), and 3. The green color of the trap (visual attractant).

Field ID: Adults (about 8-11 mm long) have oval, mainly metallic green bodies. Coppery-brown forewings (elytra) do not cover abdomen entirely and expose five patches of white hairs on each lateral side and a pair of white hair tufts on the last abdominal segment. Females are slightly larger than males. Larva can reach a length of about 25-30 mm and has creamy-white, C-shaped body with three pairs of legs and light brown head. The ventral side of the last abdominal segment with two rows of short spines in a characteristic V shape.



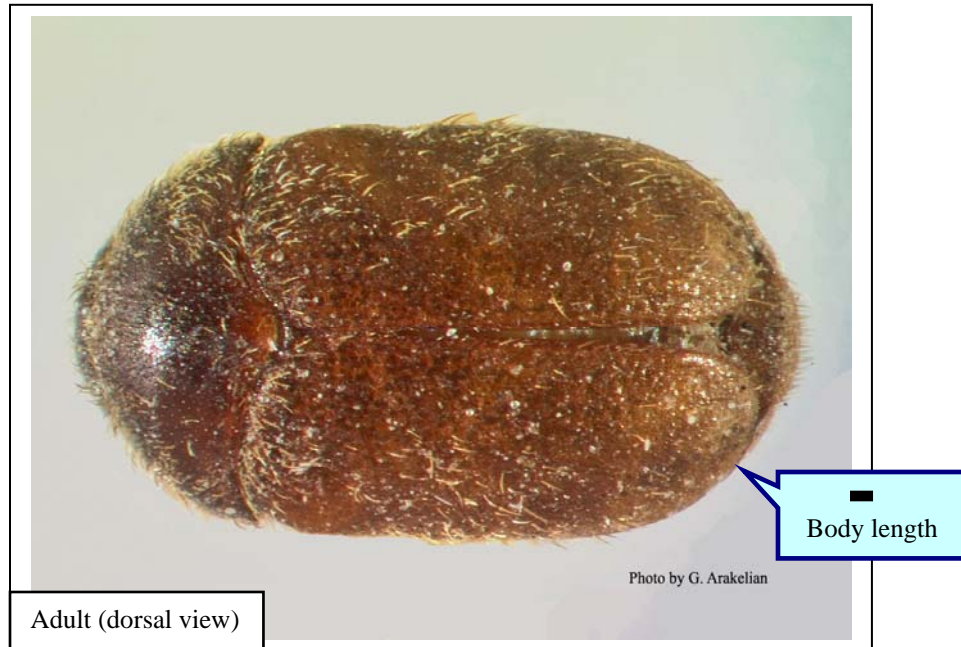
Khapra beetle (*Trogoderma granarium*)

Distribution: Originated in India. Currently established in several countries in Europe, Africa, and Asia.

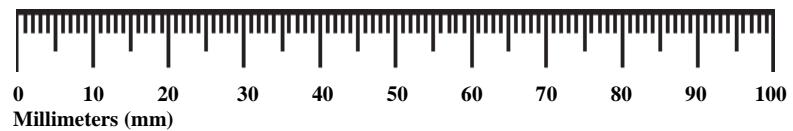
Hosts and Damage: One of the world's most destructive pests of stored products. It was recorded feeding on barley, beans, cereal products, corn, dried milk, dried fruits, fishmeal, nuts, oats, peas, rice, wheat, and others.

Trap/Attractant: Trogotrap with a food paste made of powdered milk, ground-up insect bodies, and wheat germ.

Field ID: Adults (about 1.6-3.4 mm long) have hairy, oval, brown to black bodies. Forewings with indistinct reddish-brown markings. Females are noticeably larger than males. Mature larva can reach a length of about 4.0-6.0 mm and has yellowish-brown body covered with relatively long reddish-brown hairs.



Supplement



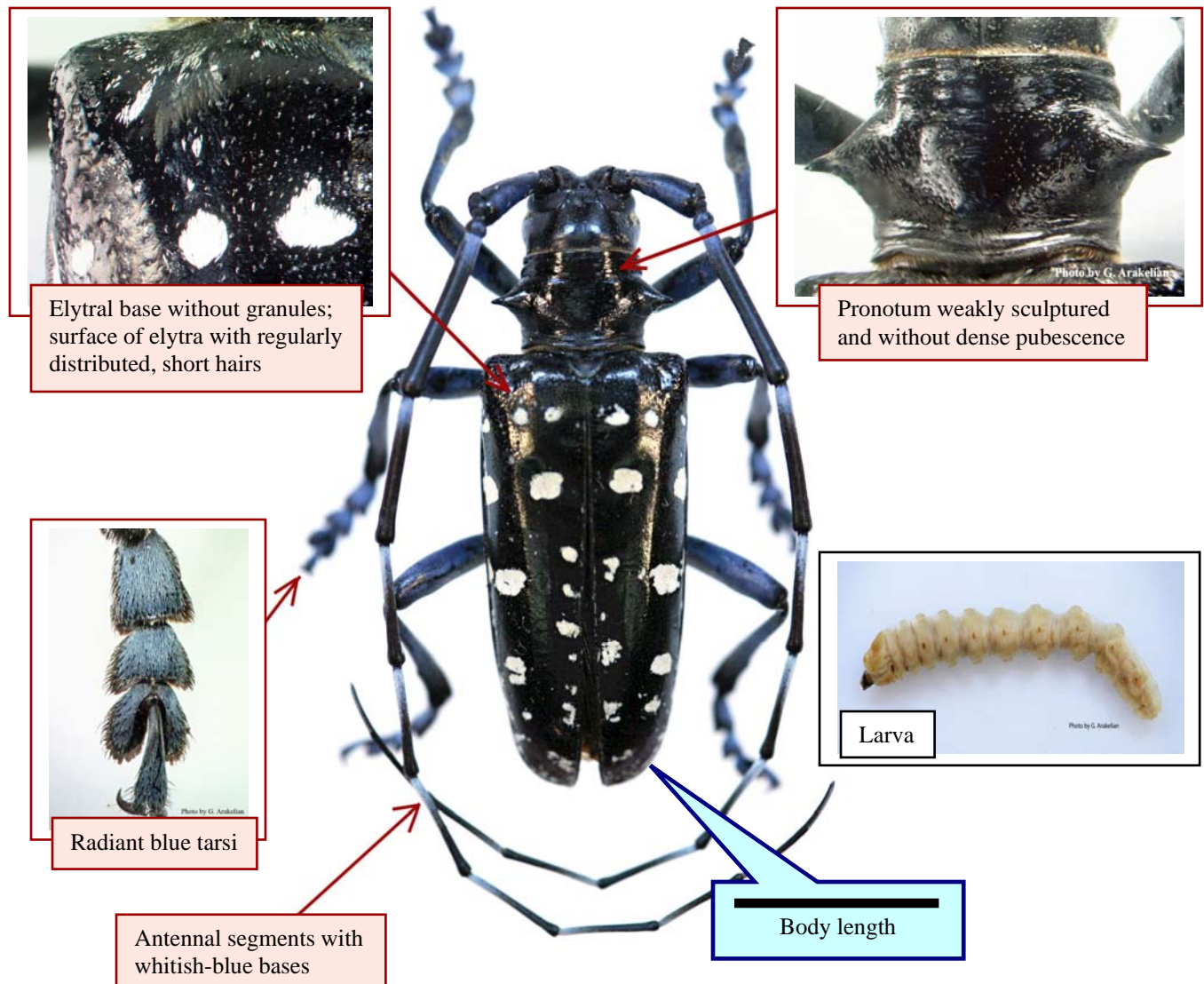
Asian longhorned beetle (*Anoplophora glabripennis*)

Distribution: Occurs in China, Japan, North and South Korea, and Taiwan. Accidentally introduced to the U.S. and currently present in Illinois, Massachusetts, New Jersey, and New York.

Hosts and Damage: Attacks many broadleaf trees, including ash, birch, elm, maple, mulberry, poplar, willow and others. Larvae feed in cambium and later enter woody tissues. Pupation occurs in the heartwood and emerging adults make large (about 10 mm in diameter), round exit holes in the tree. Both weakened and healthy trees can be attacked. Severe damage may lead to death of the host tree.

Trap/Attractant: Not developed.

Field ID: Adults are about 20-35 mm long with glossy black bodies and about 20 irregular white spots on the elytra. Females are larger than males. Antennal segments with whitish-blue bases. Pronotum is black, weakly sculptured, and without dense pubescence. Elytral base is relatively smooth without granules. Surface of elytra with regularly distributed, short hairs. Tarsi (dorsal view) radiant blue. Larva (about 50 mm long when fully grown) is legless creamy-white with brown pattern on prothorax. Eggs are elongate white about 5-7 mm long.



Emerald ash borer (*Agrilus planipennis*)

Distribution: Known from China, Japan, North and South Korea, Mongolia, Russia, and Taiwan. Accidentally introduced to the U.S. (IL, IN, KY, MD, MI, MN, MO, NY, OH, PA, VA, WV, WI), and Canada (Quebec and Ontario).

Hosts and Damage: Attacks ash (*Fraxinus*), and some species of elm (*Ulmus*), walnut (*Juglans*), and wingnut (*Pterocarya*). Adults feed on foliage. Larvae tunnel under outer bark reaching xylem and making long serpentine galleries filled with sawdust and frass. Pupation occurs near the surface and emerging adults make D-shaped (3-4 mm wide) exit holes in the tree. Both stressed and healthy trees can be attacked. Extensive damage often leads to death of the host tree.

Trap/Attractant: Purple (color attractant) Emerald ash borer panel trap with Manuka tree oil (lure).

Field ID: Adults (about 8.5-14.0 mm long) with slender, elongate bodies that have metallic emerald-green to golden-green color in general. Abdominal segments are purplish-copper in dorsal and emerald green in ventral view. Pygidium with emarginate spine. Females are larger than males. Larva (about 26-30 mm long when mature) is flattened, legless, creamy-white with bell-shaped abdominal segments. Terminal segment bears a pair of brown, pincer-like appendages.



Adult (dorsal view)

Photo by G. Arakelian

Body length

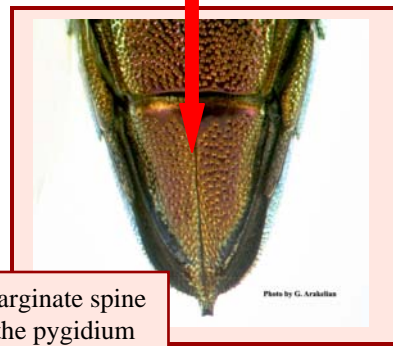


Abdominal segments (dorsal view)



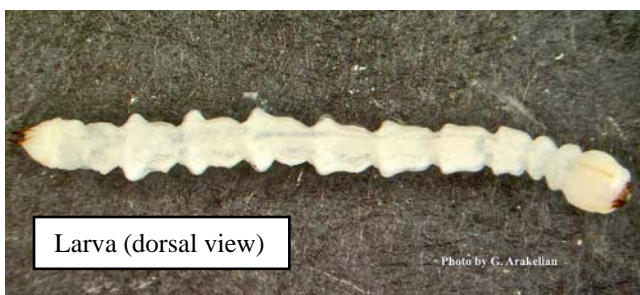
Adult (lateral view)

Photo by G. Arakelian



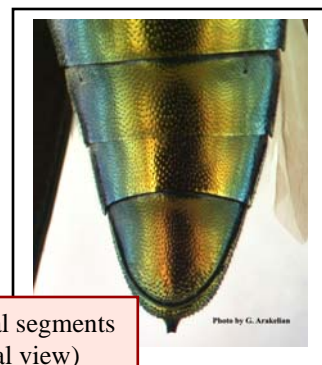
Emarginate spine on the pygidium

Photo by G. Arakelian



Larva (dorsal view)

Photo by G. Arakelian



Abdominal segments (ventral view)

Photo by G. Arakelian

References

- Ferguson, D.C. 1978. *Noctuoidea: Limantriidae*. In Dominick, R.B. et al. The Moths of America North of Mexico, Fascicle 22.2, 110 pp.
- Foote, R.H., Blanc, F.L. 1963. The fruit flies or *Tephritidae* of California, University of California Press, 117 pp.
- Foote, R.H., Blanc, F.L., Norrbom, A.L. 1993. Handbook of the fruit flies (*Diptera: Tephritidae*) of America North of Mexico, Comstock Publishing Associates, 571 pp.
- Gilbert, A.J., Bingham, R.R., Nicolas, M.A., Clark, R.A. 2010. Insect trapping guide, CDFA, 12th edition, 177 pp.
- Lingafelter, S.W., Hoebeke, E.R. 2002. Revision of the Genus *Anoplophora* (*Coleoptera: Cerambycidae*), The Entomological Society of Washington, 236 pp.
- Munroe, E. 1976. *Pyraloidea: Pyralidae* (part). In Dominick, R.B. et al. The Moths of America North of Mexico, Fascicle 13.2, 78 pp.
- White, I.M., Elson-Harris, M.M. 1992. Fruit flies of economic significance: their identification and bionomics, CAB International, 601 pp.
- Stone, A., 1942. The fruit flies of the genus *Anastrepha*, USDA miscellaneous publication No. 439, 112 pp.