Spodoptera littoralis

Scientific Name
Spodoptera littoralis (Boisduval, 1833)

Synonyms:
Hadena littoralis Boisduval,
Noctua gossypii Fabricius,
Prodenia littoralis Boisduval,
Prodenia litura Fabricius,
Prodenia retina Freyer,
Spodoptera retina Freyer, and
Spodoptera testaceoides Guenée

The two Old World cotton leafworm species *S. littoralis* and *S. litura* are allopatric, their ranges covering Africa and Asia, respectively. Many authors have regarded them as the same species.

Common Name
Egyptian cottonworm, Egyptian cotton leafworm, cotton leafworm, Mediterranean climbing cutworm, tobacco caterpillar, tomato caterpillar, Mediterranean brocade moth, and Mediterranean climbing cutworm

Figure 1. Adult moths of *Spodoptera littoralis* (Top: Julieta Brambila, USDA-APHIS-PPQ, bottom: Bernard Fransen, www.invasive.org).

Type of Pest
Moth

Taxonomic Position
Class: Insecta, **Order:** Lepidoptera, **Family:** Noctuidae

Reason for Inclusion in Manual
CAPS Target: AHP Prioritized Pest List – 2003 through 2014

Pest Description
Eggs: Spherical, somewhat flattened, 0.6 mm (< $^{1}/_{32}$ in) in diameter, laid in clusters arranged in more or less regular rows in one to three

Figure 2. Eggs and neonates. Eggs are laid in batches covered with orange-brown hair scales (Department for Environment, Food, and Rural Affairs, U.K.).

layers, with hair scales derived from the tip of the abdomen of the female moth (Fig. 2). The hair scales give the eggs a "felt-like appearance." Usually whitish-yellow in color, changing to black just prior to hatching, due to the big head of the larva showing through the transparent shell (Pinhey, 1975).

Figure 3. Larva of *Spodoptera littoralis* (Biologische Bundesanstalt für Land-und Forstwirtschaft Archive, Biologische Bundesanstalt für Land-und Forstwirtschaft, www.bugwood.org).

Larvae: Upon hatching, larvae are 2 to 3 mm (approx. $^{1}/_{16}$ to $^{1}/_{8}$ in) long with white bodies and black heads and are very difficult to detect visually. Larvae grow to 40 to 45 mm (approx. 1 $^{9}/_{16}$ to 1 $^{3}/_{4}$ in) and are hairless, cylindrical, tapering towards the posterior and variable in color (blackish-gray to dark green, becoming reddish-brown or whitish-yellow) (Fig. 3). The sides of the body have dark and light longitudinal bands; dorsal side with two dark semilunar spots laterally on each segment, except for the prothorax; and spots on the first and eighth abdominal segments larger than the others, interrupting the lateral lines on the first segment. Larvae are nocturnal and during the day can be found at the base of the plants or under pots.

Figure 4. Pupae of *Spodoptera littoralis* (Esmat M. Hegazi, University of Alexandria, www.bugwood.org).

Pupae: When newly formed, pupae are green with a reddish color on the abdomen, turning dark reddish-brown after a few hours (Fig. 4). The general shape is cylindrical, 14 to 20 x 5 mm (approx. $^{9}/_{16}$ to $^{13}/_{16}$ x $^{3}/_{16}$ in), tapering towards the posterior segments of the abdomen. The last segment ends in two strong straight hooks (Pinhey, 1975).

Adults: The moth has a gray-brown body (Fig. 1), 15 to 20 mm (approx. $^{9}/_{16}$ to $^{13}/_{16}$ in) long; wingspan is 30 to 38 mm (approx. 1 $^{3}/_{16}$ to 1 $^{1}/_{2}$ in); forewings are gray to reddish brown with paler lines along the veins (in males, bluish areas occur on the wing base and tip). Hindwings are grayish white, iridescent with gray margins, and usually lack darker veins (EPPO, 1997).

Biology and Ecology

Spodoptera littoralis larvae damage many agricultural plants, particularly cotton (Venturini, 1975). Adults feed on nectar, and females oviposit on the leaves of crop plants.

Depending on the climate of the region, *S. littoralis* can have from two to seven generations per year and does not undergo diapause (Salem and Salama, 1985). Female moths lay most of their egg masses (20 to 1,000 eggs) on the lower leaf surface of younger leaves or upper parts of the plant. Anderson and Alborn (1999) showed that *S. littoralis* preferred to oviposit on small plants (with three to four leaves) that had been fed upon by third or fourth instars over non-damaged control plants. When using larger plants (with eight to ten true leaves), however, the preference was reversed with only 30% of eggs deposited on induced (previously fed upon) plants. Eggs begin to hatch after 28.6 degree days (DD) at a base temperature of 14.8°C (59°F). The optimal temperature range for egg hatch is 28 to 30°C (82 to 86°F).

As the insect develops, it completes six instars. Early instars remain on the underside of leaves and feed throughout the day. On cotton, the first three instars feed mainly on the lower surface of the leaves, whereas later instars feed on both surfaces. Third and fourth instars remain on a plant but do not feed during the daylight. Later instars migrate off the plant and rest in the soil during the day and return to the plant at night.

Upon pupation, the fully grown larva pushes downward on the loose surface of the soil until it reaches more solid ground 3 to 5 cm (approx. 1 $^{3}/_{16}$ to 2 in) deep. It then creates a clay 'cell' or cocoon in which it usually pupates within five to six hours. Emergence of moths occurs at night, and they have a life span of five to ten days. Adults fly at night, mostly between the hours of 8 pm and midnight (Salama and Shoukry, 1972). About half of females will lay their eggs before sunrise the same night of mating (Hassan et al., 1960).

The lower threshold temperatures for eggs, larvae, pupae and pre-oviposition periods were 12, 8, 12 and 11°C (53, 46, 54, and 51°F), respectively (Dahi, 2005). The upper temperature threshold for complete development of *S. littoralis* is 37°C (99°F) (El-Malki, 2000). At temperatures of 18°C (64°F) and 36°C (97°F), eggs hatched within two and nine days, the larval stage lasted 10 and 35 days, and the pupal stage took 8 and 27 days, respectively (Ocete Rubio, 1984).

For a more detailed description of the biology of *S. littoralis*, see Ellis (2003).

Damage

On most crops, damage arises from extensive feeding by larvae, leading to complete stripping of the plants. Larvae prefer to feed on young, tender leaves. They may also feed on growing points, young shoots, stalks, bolls, buds, and fruits. The larvae often gnaw into boles which allow disease to enter the host. Damage of *S. littoralis* consists of feeding scars and skeletonizing caused by feeding on the undersides of the leaves. On newly infested hosts, young larvae feed at numerous small feeding points that

eventually spread over the entire leaf. Older instars chew large holes or wholly consume leaves, or mine their way into young shoots or bare sections on young stalks, bolls, and buds.

Corn: Corn stems are often mined by *S. littoralis,* and young grains in the ear may also be damaged.

Cotton: On cotton, the pest may cause considerable damage by feeding on the leaves, fruiting points, flower buds, and occasionally the bolls. Damage starts with numerous small feeding points and finally spreads over the entire leaf. Later, holes and bare sections are found on leaves, young stalks, bolls, and buds resulting from larval feeding. In some cases, the shoot tips above a feeding hole turn yellow, wilt, and eventually die.

Deciduous Orchards: In deciduous orchards, larvae may cause severe damage to trees by feeding on leaves and terminal growing points. Young orchards suffer great damage. Larvae can completely defoliate ornamental plants and fruit trees in nurseries. If food supply is in short supply, large numbers of larvae may migrate en masse to new cropland.

Grape: On grape, larvae gnaw holes in the leaves until sometimes only the veins remain. The damage caused by larvae to grapevines is not merely temporary; vines may suffer so severely from exposure to intense sunlight during the summer that their development in the following year will be retarded. Larvae also gnaw at grape bunch stalks, which then dry up; the larvae also feed on the grape berries (USDA, 1982).

Solanaceous: This species may destroy fruit such as tomatoes and peppers. If larvae feed on a young plant heavily, the plant's development is retarded and it may only produce small or late fruit.

Pest Importance

Spodoptera littoralis is one of the most destructive agricultural lepidopterous pests within its subtropical and tropical range. The pest causes a variety of damage as a leaf feeder and sometimes as a cutworm on seedlings. It can attack numerous economically important crops throughout the year (EPPO, 1997).

On cotton, the pest can cause considerable damage by feeding on the leaves, fruiting points, flower buds, and occasionally on bolls. When peanuts are infested, larvae first select young folded leaves for feeding, but in severe attacks, leaves of any age are stripped off. Sometimes, even the ripening kernels in the pods in the soil may be attacked. Pods of cowpeas and the seeds they contain are also often badly damaged. In tomatoes, larvae bore into the fruit, rendering them unsuitable for consumption. Numerous other crops are attacked, mainly on their leaves.

In Europe, damage caused by *S. littoralis* was minimal until about 1937. In 1949, there was a catastrophic population explosion in southern Spain, which affected alfalfa, potatoes, and other vegetable crops. At present, this noctuid pest is of great economic

importance in Cyprus, Israel, Malta, Morocco, and Spain (except the north). In Italy, it is especially important on protected crops of ornamentals and vegetables (Inserra and Calabretta, 1985; Nucifora, 1985). In Greece, *S. littoralis* causes slight damage in Crete on alfalfa and clover only. In North Africa, *Capsicum* spp., corn, cotton, tomato, and other vegetables are affected. In Egypt, it is one of the most serious cotton pests.

Many populations of *S. littoralis* are extremely resistant to pesticides, and if they become well established, can be exceptionally difficult to control (USDA, 1982).

The economic consequences of establishment by *S. littoralis* would not be limited to its direct effects on production agriculture; *S. littoralis* could also adversely affect access to foreign markets. The European and Mediterranean Plant Protection Organization (EPPO) considers *S. littoralis* an A2 quarantine pest; the pest also has quarantine status with the Caribbean Plant Protection Commission (CPPC), the Organismo Internacional Regional de Sanidad Agropecuaria (OIRSA), the North American Plant Protection Organization (NAPPO), Belarus, Russia, Ukraine, and Turkey (EPPO, 1999).

Known Hosts

The host range of *S. littoralis* covers over 40 families, containing at least 87 species of economic importance (Salama et al., 1970). Economically important hosts are identified below.

Major Hosts

Abelmoschus esculentus (okra), *Allium* spp. (onion), *Amaranthus* spp. (pigweed, amaranthus), *Apios* spp. (groundnut), *Arachis hypogaea* (peanut), *Beta vulgaris* (beet), *Brassica oleracea* (cabbage, broccoli), *Brassica rapa* (turnip), *Brassica* spp. (mustards), *Camellia sinensis* (tea), *Capsicum annuum* (pepper), *Chrysanthemum* spp., *Citrullus lanatus* (watermelon), *Citrus* spp., *Coffea arabica* (coffee), *Colocasia esculenta* (taro), *Corchorus* spp. (jute), *Cucumis* spp. (squash, pumpkin), *Cynara cardunculus* (artichoke), *Daucus carota* (carrot), *Dianthus caryophyllus* (carnation), *Ficus* spp. (fig), *Glycine max* (soybean), *Gossypium* spp. (cotton), *Helianthus annuus* (sunflower), *Ipomoea batatas* (sweet potato), *Lactuca sativa* (lettuce), *Linum* spp. (flax), *Medicago sativa* (alfalfa), *Morus* spp. (mulberry), *Musa* spp. (banana, plantain), *Nicotiana tabacum* (tobacco), *Oryza sativa* (rice), *Pennisetum glaucum* (pearl millet), *Persea americana* (avocado), *Phaseolus* spp. (bean), *Pisum sativum* (pea), *Prunus domestica* (plum), *Psidium guajava* (guava), *Punica granatum* (pomegranate), *Raphanus sativus* (radish), *Rosa* spp. (rose), *Saccharum officinarum* (sugarcane), *Solanum lycopersicum* (tomato), *Solanum melongena* (eggplant), *Solanum tuberosum* (potato), *Sorghum bicolor* (sorghum), *Spinacia* spp. (spinach), *Theobroma cacao* (cacao), *Trifolium* spp. (clover), *Triticum aestivum* (wheat), *Vicia faba* (broad bean), *Vigna* spp. (cowpea, black-eyed pea), *Vitis vinifera* (grape), and *Zea mays* (corn).

Minor Hosts

Acacia spp. (wattles), *Actinidia arguta* (tara vine), *Alcea rosea* (hollyhock), *Anacardium occidentale* (cashew), *Anemone* spp. (anemone), *Antirrhinum* spp., *Apium graveolens* (celery), *Asparagus officinalis* (asparagus), *Caladium* spp. (caladium), *Canna* spp.

(canna), *Casuarina equisetifolia* (she-oak), *Convolvulus* spp. (morning glory, bindweeds), *Cryptomeria* spp. (Japanese cedar), *Cupressus* spp. (cypress), *Datura* spp. (jimsonweed), *Eichhornia* spp. (waterhyacinth), *Eucalyptus* spp. (eucalyptus), *Geranium* spp. (geranium), *Gladiolus* spp. (gladiolus), *Malus domestica* (apple), *Mentha* spp. (mint), *Phoenix dactylifera* (date palm), *Pinus* spp. (pine), and *Zinnia* spp. (zinnia).

Pathogens or Associated Organisms Vectored

Spodoptera littoralis is not a known vector and does not have any associated organisms.

Known Distribution

The northerly distribution limit of *S. littoralis* in Europe corresponds to the climatic zone in which winter frosts are infrequent. It occurs throughout Africa and extends eastwards into Turkey and north into eastern Spain, southern France and northern Italy. However, this boundary is probably the extent of migrant activity only; although the pest overwinters in southern Spain, it does not do so in northern Italy or France. In southern Greece, pupae have been observed in the soil after November and the species overwinters in this stage in Crete. Low winter temperatures are, therefore, an important limiting factor affecting the northerly distribution, especially in a species with no known diapause (Miller, 1976; Sidibe and Lauge, 1977).

Africa: Algeria, Angola, Ascension Island, Benin, Botswana, Burkina Faso, Burundi, Cameroon, Cape Verde, Central African Republic, Chad, Comoros, Congo, Democratic Republic of the Congo, Cote d'Ivoire, Egypt, Equatorial Guinea (including Bioko), Eritrea, Ethiopia, Gabon, Gambia, Ghana, Guinea, Kenya, Liberia, Libya, Madagascar, Malawi, Mali, Mauritania, Mauritius (including Rodrigues), Morocco, Mozambique, Namibia, Niger, Nigeria, Reunion, Rwanda, Saint Helena, Sao Tome and Principe, Senegal, Seychelles, Sierra Leone, Somalia, South Africa, Sudan, Swaziland, Tanzania, Togo, Tunisia, Uganda, Zaire, Zambia, and Zimbabwe; **Asia:** Afghanistan, Bahrain, Bangladesh, Brunei, Cyprus, Iran, Iraq, Israel, Jordan, Lebanon, Oman, Saudi Arabia, Syria, Turkey, United Arab Emirates, and Yemen; **Europe:** Albania, Greece (including Crete and Dodecanese), Italy (including Sardinia and Sicily), Malta, Portugal (including Azores and Madeira), and Spain (including Balearic Islands and Canary Islands); **Oceania:** American Samoa and Fiji (CIE, 1964; Evenhuis, 2010; Fibiger and Skule, 2011; EPPO, 2012).

Pathway

Both the eggs and larvae can move in international trade on planting material, cut flowers, or vegetables. This species has been trapped outside of its normal range in Europe, likely as a result of movement on imported commodities (EPPO, 1997).

This species has been intercepted over 170 times at U.S. ports of entry. Interceptions have occurred in permit cargo (164), baggage (5), stores (5), and general cargo (1). Most interceptions originated from Israel (121), the Netherlands (22), Spain (6) and Kenya (5). This species is mostly intercepted on plant material, including *Eustoma* sp. (18), *Anemone* sp. (16), *Gerbera* sp. (15), *Origanum* sp. (12), and *Thymus* sp. (9)

(AQAS, 2012; queried August 6, 2012). The pest has been intercepted at U.S. ports on plant parts, leaves, and flowers.

Potential Distribution within the United States

USDA (1982) states that the potential range for this species may be limited to the west coast and the lower southwestern and southeastern United States; however, migratory moths may be capable of periodic spread into northern states and even Canada by late summer or early fall.

Survey

CAPS-Approved Method*:

The CAPS-approved method is a trap and lure. A plastic bucket trap [unitrap] with dry kill strip is the approved trap. The lure is effective for 84 days (12 weeks).

IPHIS Survey Supply Ordering System Product Names:

1) *Spodoptera littoralis* Lure
2) Plastic Bucket Trap

The plastic bucket trap (also known as the Universal moth trap or unitrap) should have a green canopy, yellow funnel, and white bucket and should be used with dry kill strip. For instructions on using the bucket trap, see: http://caps.ceris.purdue.edu/dmm/398.

Though the lures for *Spodoptera litura* and *S. littoralis* are composed of the same two compounds (Z,E,9,11-14:AC and Z,E,9,12-14:AC), the compounds are loaded into the lure dispensers in different amounts depending on the target species. Therefore, it is necessary to use the specific lure for each of the two targets and separate the traps by at least 20 meters (65 feet).

Trap Spacing: When trapping for more than one species of moth, separate traps for different moth species by at least 20 meters (65 feet).

IMPORTANT: Do not include lures for other target species in the trap when trapping for this target.

*For the most up-to-date methods for survey and identification, see Approved Methods on the CAPS Resource and Collaboration Site, at http://caps.ceris.purdue.edu/.

Literature-Based Methods: (From Venette et al., 2003; CABI, 2007)

Trapping: Pheromone traps can be used to monitor the incidence of *S. littoralis* (Rizk et al., 1990). The synthetic sex pheromone (*Z*,*E*)-(9,11)-tetradecadienyl acetate has proven highly effective at trapping male moths of *S. littoralis* (Salem and Salama, 1985). Kehat and Dunkelblum (1993) found that the minor sex pheromone component, (9*Z*,12*Z*)-9,12-tetradecadienyl acetate in addition to the major component (9*Z*,11*Z*)-9,11-tetradecadienyl acetate was required to attract males.

Sex-pheromone baited delta traps remained attractive for approximately twoweeks, but effectiveness declined after three to four weeks of use (Ahmad, 1988). To monitor male flight activity in vegetable production areas, delta traps were placed 1.7 m (5.6 ft) above the ground at a rate of two traps/ha (approximately one trap/acre) (Ahmad, 1988). Pheromone lures impregnated with 2 mg of the pheromone blend (blend not specified) were replaced after four weeks of use (Ahmad, 1988). Traps are deployed at a similar height (1.5 m (4.9 ft)) to monitor male flight in cotton (Salem and Salama, 1985). Catches in pheromone traps did not correlate as well with densities of egg-masses in cotton fields as did catches in a black-light trap (Rizk et al., 1990). The attractiveness of traps baited with (*Z*,*E*)-(9,11)-tetradecadienyl acetate is governed primarily by minimum air temperature, relative humidity, adult abundance, and wind velocity. Densities of female *S. littoralis* also affect the number of males that are captured at different times of the year (Rizk et al., 1990). Lures for *S. littoralis* may also attract *Erastria* spp. (established in the United States) (PPQ, 1993).

Survey Site Selection:
The host range of *S. littoralis* covers over 40 families, containing at least 87 species of economic importance (Salama et al., 1970). Areas where surveys may occur include host crops (both in outside and greenhouse settings), nurseries, and other areas where host plant material is prevalent.

Trap placement:
To monitor male flight activity in vegetable production areas, delta traps were placed 1.7 m (5.6 ft) above the ground at a rate of 2 traps/ha (approximately 1 trap/acre) (Ahmad, 1988). Traps are deployed at a similar height (1.5 m, 4.9 ft) to monitor male flight in cotton (Salem and Salama, 1985).

Time of year to survey:
Depending on the climate of the region, *S. littoralis* can have from two to seven generations per year and does not undergo diapause (Salem and Salama, 1985).

Not recommended: Light traps using a 125 W mercury-vapor bulb have been used to nondiscriminately capture multiple *Spodoptera* spp. (Blair, 1974) and most assuredly other insects as well. A modified light trap using six 20-W fluorescent lights also proved effective for monitoring flight activity of *S. littoralis* (El-Mezayyen et al., 1997).

For CAPS surveys, light traps are not an approved method for this species as they are not species-specific.

Visual survey: Visual surveys for this pest can take place any time during the growing season while plants are actively growing (usually spring through fall in temperate areas). Early instars (<third) are likely to be on lower leaf surfaces during the day, skeletonizing the leaves.

Sweep net sampling may be effective at dawn or dusk. First through third instars may be detected by sweep net sampling; nearly all instars can be detected by visual

inspection of plants; and, later instars (4th through 6th) and pupae may be found by sieving soil samples (Abul-Nasr and Naguib, 1968; Abul-Nasr et al., 1971).

For CAPS surveys, visual survey, sweep net sampling, and sieving soil samples are not approved methods for this species.

For additional survey information see: http://www.aphis.usda.gov/import_export/plants/manuals/emergency/downloads/nprg_spodoptera.pdf.

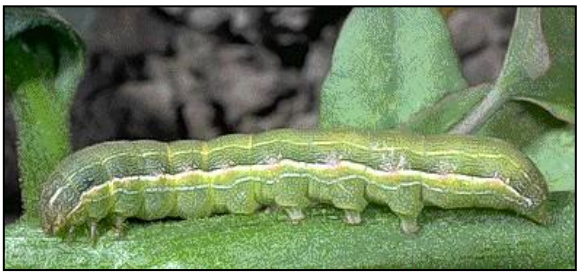

Figure 5. Larva of *S. exigua*. Photo courtesy of Oklahoma State University.

Key Diagnostics/Identification

CAPS-Approved Method*:

Confirmation of *S. littoralis* is by morphological identification. The forewing color pattern of male *Spodoptera littoralis* is similar to the pattern of male *Spodoptera ornithogalli* and nearly indistinguishable from that of *Spodoptera litura* (Brambila, 2008). It is necessary to dissect and examine adult male internal structures for final identification (Brambila, 2008). When dissecting *Spodoptera littoralis*, the aedeagus does not need to be everted (J. Brambila, personal communication, 2014). It is the simple examination of various characters in the valvae that is used to confirm the identification.

For field level screening, use:
Brambila, J. 2008. *Spodoptera littoralis* - Egyptian Cottonworm, Field Diagnostics

Brambila, J. 2008. *Spodoptera littoralis* - Egyptian Cottonworm, Wing Diagnostics

To distinguish the two exotic species, *Spodoptera litura* and *S. littoralis*, from native species, use:
Brambila, J. 2013. Identification notes for *Spodoptera litura* and *Spodoptera littoralis* (Lepidoptera: Noctuidae) and some native *Spodoptera* moths

For instructions on performing dissections, images of genitalia, and important identifying characters, use:
Brambila, J. 2009. Steps for the dissection of male *Spodoptera* moths (Lepidoptera: Noctuidae) and notes on distinguishing *S. litura* and *S. littoralis* from native *Spodoptera* species.

For images of genitalia of the native moth, *Leucania adjuta* see:
Brambila, J. 2010. Images of *Leucania adjuta* genitalia.

*For the most up-to-date methods for survey and identification, see Approved Methods on the CAPS Resource and Collaboration Site, at http://caps.ceris.purdue.edu/.

Easily Confused Species

Spodoptera littoralis is often confused with *S. litura,* which is not established in the continental United States but has been reported in Hawaii. Examination of adult genitalia is the only certain method to separate the two species. In the United States, *Spodoptera litura* is similar in appearance to *S. dolichos, S. latifascia, S. ornithogalli,* and *S. pulchella*. See Brambila (2009) for additional information and images to differentiate between these similar species.

For more information on morphological discrimination between *Spodoptera littoralis* and *S. litura,* refer to Schmutterer (1969), Mochida (1973), and Brown and Dewhurst (1975).

Although markings on larvae are variable, a bright-yellow stripe along the length of the dorsal surface is characteristic of *S. litura*. Larvae of *S. littoralis* can be confused with *S. exigua* (beet armyworm) (established in the United States) (Fig. 5). However, *S. littoralis* larvae are light or dark brown, while *S. exigua* are brown or green. *S. littoralis* is also larger than *S. exigua* (Venette et al., 2003).

Commonly Encountered Non-targets

Traps for *Spodoptera littoralis* in the United States usually capture few non-target species (J. Brambila, personal communication, 2014). However, various native *Spodoptera* species occasionally enter *S. littoralis* traps. The most common non-target is *Spodoptera frugiperda*. Compared to *S. littoralis*, *Spodoptera frugiperda* does not have banded wings, is much smaller, and is grey in coloration instead of dark brown with creamy bands on the wings (J. Brambila, personal communication, 2014). Cccasionally, *Leucania adjuta* moths are also captured (Fig. 6). *Leucania adjuta* does not closely resemble *S. littoralis*, but it is somewhat similar in body size and shape (J. Brambila, personal communication, 2014).

Figure 6. *Leucania adjuta*. Photo courtesy of Mark J. Dreiling.

For additional images of *Leucania adjuta*, see:

http://www.nearctica.com/leucania/sysfly/Ladjuta.htm

http://mothphotographersgroup.msstate.edu/species.php?hodges=10456

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Revisions

March 2014

1) Revised the **Key Diagnostics/Identification** section. Added:

- Brambila, J. 2013. Identification notes for *Spodoptera litura* and *Spodoptera littoralis* (Lepidoptera: Noctuidae) and some native *Spodoptera* moths and
- Brambila, J. 2010. Images of *Leucania adjuta* genitalia.

Last update: March 15, 2014

2) Revised the **Easily Confused Species** section.
3) Added the **Commonly Encountered Non-targets** section.

July 2016
1) NAPPFAST maps removed.
2) Screening aids links updated.