Laodelphax striatellus

Scientific Name
Laodelphax striatellus (Fallén, 1826)

Synonyms
Delphax striata Fallén, 1806
Delphax striatella (Fallén, 1826)
Liburnia striatella (Sahlberg, 1842)
Delphax notula (Stal, 1854)
Liburnia akashiensis (Matsumura, 1900)
Liburnia devastans (Matsumura, 1900)
Liburnia gifuensis (Matsumura, 1900)
Liburnia maikoensis (Matsumura, 1900)
Liburnia minonensis (Matsumura, 1900)
Liburnia nipponica (Matsumura, 1900)
Delphacodes striatella (Fallén, 1917)
Liburnia marginata (Haupt, 1935)
Calligypona marginata (Fabricius 1946)

Figure 1. *Laodelphax striatellus* adult. James Lindsey at Ecology of Commanster, CC BY-SA 3.0.

Common Name(s)
Small brown planthopper, Smaller brown planthopper, Brown planthopper

Type of Pest
Planthopper

Taxonomic Position
Class: Insecta **Order:** Hemiptera **Family:** Delphacidae

Reason for Inclusion in Manual
2017 CAPS Pests of Economic and Environmental Concern List

Pest Description
Eggs: Eggs, which are white in color, are laid in masses of 60-260 in lower portions of the host plant, in the midrib or leaf sheath (Dale, 1994).

Nymphs (Fig. 2):
There are five nymphal instars, and nymphal color ranges from light to dark brown (Dale, 1994). The fifth instar has extended mesonatal wingpads which are distinct from other delphacids (Wilson and Claridge, 1991). The fifth and final instar has a head with a width of 0.50-0.54 mm (~$^{1}/_{64}$ in) and distinct dark-brown markings on the post clypeus (Wilson and Claridge, 1991).

Adults (Fig. 1, 2): Adults have macropterous (M, large-winged) and brachypterous (B, small-winged) wing forms, which vary based on environmental and genetic factors (Mori and Nakasuji, 1991). A study in China showed that the M wing form is more common (Wang et al., 2013). The wings are hyaline (Wilson and Claridge, 1991). The adult body, mesonotum and pterostigma are black to dark-brown, and the areas between the carinae of the frons are deep black (Wilson and Turner, 2010). These colors vary with general body coloration, and coloration varies with season (CABI, 2017). The distinctive deep black color of the areas between the carinae of the frons is the most stable and is diagnostic (Mori and Nakasuji, 1991; Wilson and Turner, 2010). Abdominal color ranges from milky-white to black (Mori and Nakasuji, 1991). Dark suffusion on the apical part of the fore wings, which occurs in certain delphacids, is absent. The aedeagus is curved ventrally (Wilson, 2005).

Additional high-resolution photographs of *L. striatellus* adults can be found in Wilson and Turner (2010), http://naturalhistory.museumwales.ac.uk/vectors/browsespecies.php?-recid=744#Tabs and Bartlett (2018), http://canr.udel.edu/planthoppers/north-america/north-american-delphacidae/genus-laodelphax-fennah-1963/.

Biology and Ecology

The average life span of *L. striatellus* adults at 20, 25 and 30ºC (68, 77, and 86ºF) is 30.2, 23.37 and 18.8 days, respectively (Chiu and Wu, 1994). During this lifespan, a female laid 146.04 eggs at 20ºC (68ºF), 186.17 eggs at 25ºC (77ºF), and 71.75 eggs at 30ºC (86ºF) (Chiu and Wu, 1994). The average duration for egg development at 20, 25 and 30ºC (68, 77, and 86ºF) was 14.02, 8.84 and 5.65 days respectively. The fecundity of Macropterous (M) and Brachypterous (B) adults is comparable (Chiu and Wu, 1994).

Figure 2. Left: *Laodelphax striatellus* Adult and nymphs. Center: A rice field with stunted plants infected with the Black Streak Dwarf Virus disease (center). Right: A field infected with rice stripe virus (right). Courtesy of www.ricehoppers.net, CC BY-SA 3.0

The nymph undergoes four molts, and the fifth instar has a longer development than other instars. The nymphal period is shorter with temperatures between 18–28°C (64.4–82.4°F), but significantly longer at 30°C and 32°C (86°F and 89.6°F) (Wang et al., 2013). Reproduction is sexual, and females attract males by emitting vibrating signals (Ichikawa, 1979). *Laodelphax striatellus* adults are capable of flying long distances (Denno and Roderick, 1990), and overseas migration from China to Japan has been documented (Otuka, 2013).

The number of generations per year varies significantly depending on the length of the growing season. In Sweden, *L. striatellus* produces two generations per year, and eight generations per year are produced in Israel (Denno and Roderick, 1990). In Spain, two adult peak populations were observed, one in June and the other in September (Achon et al., 2013). Populations in colder climates overwinter as diapausing nymphs while southern populations reproduce continuously. Diapause is induced by cold temperatures and short photoperiods (Denno and Roderick, 1990).

When *L. striatellus* overwinters, nymphs enter diapause amongst withered plants in and around the summer habitats (Kisimoto, 1968). After overwintering, *L. striatellus* grows on early season hosts such as wheat, barley, or annual ryegrass before returning to their summer habitats (CABI, 2017). Summer habitats include paddy and upland rice fields and nearby weed vegetation (Dale, 1994). *Laodelphax striatellus* prefers the vegetation of sunny, upland, wet, or even watery conditions over shadowy or woody vegetation Dale, 1994; CABI, 2017). In cooler areas, it lives on summer host plants throughout the growing season. In the Philippines, it grows in paddy and upland rice fields in cool, mountainous areas. In the field conditions, *L. striatellus* tends to inhabit on the upper part of rice plants toward nightfall (CABI, 2017).

This planthopper is a vector of several viruses which are known to cause economic damage to important field crops, including rice, corn, and wheat (Conti, 1980; Izadpanah, 1991; Wilson and Turner, 2010). Each virus occurs in certain geographically restricted areas where the virus-vector-host plant complex is established. These viruses persist in *L. striatellus* throughout its lifespan (CABI, 2017). Virus diseases are transmitted during the first 30-40 days after germination or transplantation of cultivated host plants, when the plants are most susceptible (CABI, 2017).

Figure 3: Rice leaves displaying symptoms of infection with Rice stripe virus. William Brown Jr., Bugwood.org

Damage

In general, damage to host plants is caused by viruses transmitted by *L. striatellus* and not by the pest itself (Heong et al., 2014).

Pest damage

Nymph and adult *L. striatellus* suck the sap from the phloem of host plants. Yield loss has been reported in experimental rice plots exposed to a high density of virus-free planthoppers (Hachiya and Akiyama, 1989). Host symptoms of phloem feeding include 'hopperburn', or wilting and yellowing as a result of sap sucking by many insects (Denno and Roderick, 1990). "Sooty mold" symptoms may also appear on hosts after planthopper feeding (Zhu et al., 2009).

Virus symptoms

General symptoms of infection of viruses transmitted by *L. striatellus* include: Stem and/or leaf discoloration, wilting, stunted growth, and honeydew or sooty mold (Zhu et al., 2009; CABI, 2017).

Rice stripe virus (RSV) (Fig. 2, 3): In rice, this virus causes chlorotic stripes, chlorosis, moderate stunting and loss of vigor. In severe infections, leaves develop brown to grey necrotic streaks and die. Diseased plants produce few or no panicles, and panicles that do form are malformed and discolored (Toriyama, 2000).

Rice black-streaked dwarf virus (RBSDV) (Fig. 4): Infection causes stunted growth, darkened leaves, and "white waxy or black-streaked swellings" develop on veins throughout the plant, including the underside of leaves (Zhang et al., 2013).

Barley yellow striate mosaic virus (BYSMV): Infected plants exhibit severe stunting with leaf symptoms varying depending on plant species (Conti, 1980). Leaf symptoms may include striate mosaic, chlorotic stripes, apical yellowing, and/or narrowing of leaf blades (Conti, 1980).

Maize rough dwarf virus (MRDV): Corn plants infected by Maize rough dwarf virus (MRDV) exhibit small enations on the veins of the sides of their leaves, which are associated with mild to severe dwarfing of the plant. Significant reductions in yield may occur if plants are infected at early vegetative stages (Achon et al., 2013), and the virus can be rapidly spread in susceptible corn cultivars by a low population of *L. striatellus* (Achon et al., 2015). This virus also can infect wheat (Achon et al., 2015), but disease incidence is low. However, wheat may still serve as a reservoir host for MRDV and contribute to an increase in virus inoculum (Achon et al., 2015).

Northern cereal mosaic virus (NCMV): Symptoms of NCMV infection include chlorotic spots that coalesce on the foliage and the stunting of the plant. In wheat, panicles may not form, or if they do they are small and disfigured with "low quality grain" (Toriyama, 1986).

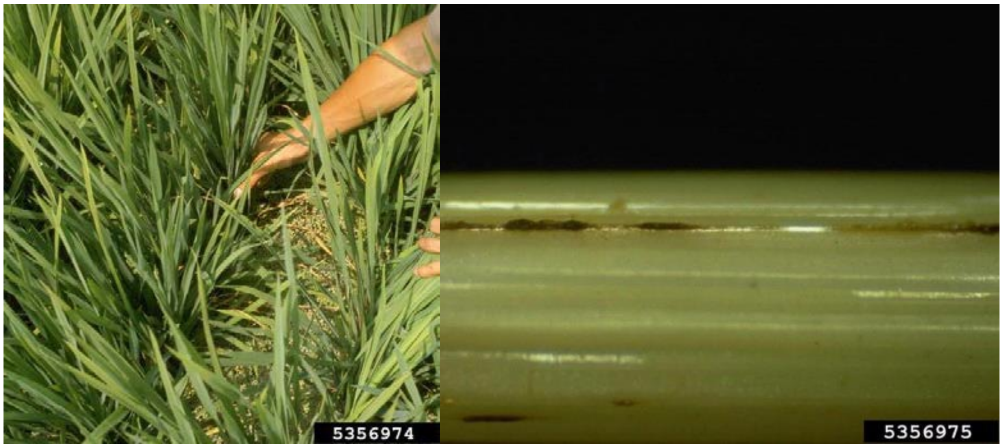

Figure 4. Left: Rice plants exhibiting symptoms of Rice Black Streaked Dwarf Virus (RBSDV) in South Korea - note the dark green coloration. Right: Close up of a rice stem infected with RBSDV. William Brown Jr., Bugwood.org

Pest Importance

Viruses transmitted by *L. striatellus* affect several crops which are widely grown in the United States. The 2017 value of U.S. production of the following vulnerable crops was: Corn for grain ($48.4 billion), wheat: ($8.1 billion), rice ($2.24 billion), barley: ($614.2 million), and oats: ($140 million) (USDA-NASS, 2018).

Rice stripe disease is still one of the most important viral diseases in Japan, and it also causes damage in other rice growing areas in Asia (Hibino, 1996). Yield loss of 14-89% due to Rice stripe virus (RSV) has been reported in Japan (Yasuo, 1969). Yield loss of 13-22% was reported in experimental rice plots infested with virus-free planthoppers (Chiu and Wu, 1994). Rice strips virus is transmitted at a high rate (>97%) to the next generation of *L. striatellus* through the ovaries (CABI, 2017). In some regions of China, Rice black-streaked dwarf virus (RBSDV) has cause yield loss above 50% with total loss of harvest in some fields during epidemic years (Zhang et al., 2013).

Maize rough dwarf virus (MRDV) can cause substantial yield loss in corn fields. In 1999, corn crops failed in most of the commercial fields in parts of northeast Spain due to this virus, and incidence of the virus has exceeded 80% in more recent growing seasons (Achon et al., 2013, 2015). Yield loss of over 70% has been reported in corn fields in Greece in 2002 (Dovas et al., 2004). In China, yield losses attributed to MRDV are estimated to be over 30% and even as high as 100% in severely infected fields (Shi et al., 2012).

Barley yellow striate mosaic virus (BYSMV) can cause economic damage to wheat and millet. In a survey in Iran, 30% of wheat plants and 50% of millet plants were infected by the virus in their respective fields. The average weight of infected wheat and millet heads was significantly lower than the weight of healthy heads in these fields (Izadpanah et al., 1991).

Northern cereal mosaic virus (NCMV) infects wheat and can reduce yield. Field-infected wheat plants may be only 20-50% as high as uninfected ones. In a wheat field in which more than 50% of the plants were diseased, the grain yield was decreased by 75% (Toriyama, 1986).

Laodelphax striatellus is listed as a harmful organism in Colombia, Honduras, Indonesia, Israel, and Timor-Leste (PExD, 2018). There may be trade implications with these countries if this pest becomes established in the United States.

Known Hosts

The complete host range of *L. striatellus* is unclear. This planthopper feeds on many different plant species and does not complete its lifecycle on every feeding host (CABI, 2017). The 'major hosts' listed below are hosts which are subject to economic damage (typically caused by transmitted viruses) due to the presence of *L. striatellus*.

Major hosts: *Oryza sativa* (rice), *Triticum aestivum* (wheat), *Triticum durum* (Durum wheat), *Triticum* spp. (wheat), and *Zea mays* (maize) (Izadpanah et al., 1991) (Lijun et al., 2003; Achon et al., 2013).

Minor hosts: *Avena sativa* (oats), *Hordeum vulgare* (barley), and *Setaria* spp. (Millet) (Izadpanah et al., 1991; EPPO, 2015; CABI, 2017).

Wild hosts: *Agrostis capillaris* (bent grass), *Allium sativum* (garlic), *Alopecurus aequalis* (orange foxtail), *Amaranthus retroflexus* (American pigweed), *Beckmannia syzigachne* (American slough grass), *Beta* spp. (beet), *Capsella bursa-pastoris* (shepherd's purse), *Cynodon dactylon* (Bermuda grass), *Dactylis glomerata* (orchardgrass), *Digitaria ciliaris* (southern crabgrass), *Echinochloa* spp. (barnyardgrass), *Eragrostis curvula* (African love grass), *Eleocharis ovate* (ovate spikebrush), *Juncus spp.* (rush), *Lolium* spp. (ryegrasses), and *Panicium* spp. (panicgrass), *Poa annua* (annual meadowgrass), Polypogon fugax (Asia Minor bluegrass), and Saccharum spp. (sugarcane) (Yasuo et al., 1969; Izadpanah et al., 1991; Novotný, 1994; Qiao et al., 2009; CABI, 2017; EPPO, 2017; den Bieman, 2017; USDA-APHIS-PPQ, 2018).

Experimental hosts: *Agropyron repens (couch grass)*, *Briza* spp. (quaking grasses), *Bromus arvensis* (field brome), and *Lagurus ovatus* (bunnytail) (CABI, 2017).

Pathogens or Associated Organisms Vectored

Barley yellow striate mosaic virus (BYSMV)
Maize rough dwarf virus (MRDV)
Northern cereal mosaic virus (NCMV)
Rice black-streaked dwarf virus (RBSDV)
Rice stripe virus (RSV)

(Conti, 1980; Achon et al., 2013; CABI, 2017; Bartlett, 2018)

Known Distribution

Africa: Morocco, Tunisia; **Asia:** Armenia, China, India, Indonesia, Iran, Israel, Japan, Kyrgyzstan, Philippines, South Korea, Taiwan, Thailand, Uzbekistan, Turkmenistan, Vietnam; **Europe:** Austria, Belgium, Bulgaria, Czech Republic, Finland, France, Germany, Greece, Hungary, Italy, Latvia, Lithuania, Madeira, Netherlands, Poland, Romania, Russia, Slovakia, Spain, Sweden, Switzerland, Turkey; **Oceania:** Papua New Guinea.

(Vilbaste, 1974; Conti, 1980; Safaryan et al., 1988; Izadpanah et al., 1991; Gueclue, S. 1996; Nickel and Remane, 2002; Novikov et al., 2006; Wang et al., 2008; Söderman et al., 2009; Achon et al., 2013; Otuka, 2013; Bellis et al., 2014; den Bieman, 2017; EPPO, 2017; Tancik and Seljak, 2017).

Pathway

The most likely pathway of entry is through movement of contaminated plant material or by movement of *L. striatellus* specimens in cargo. *Laodelphax striatellus* has been intercepted three times at U.S. ports of entry on general cargo between 1986-2015 (AQAS, 2018).

Host material has been intercepted in cargo, mail, and baggage (AQAS, 2018). Since 2008, *Oryza sativa* (rice) has been intercepted at least 9,245 times from countries where *L. striatellus* is known to be present. Nearly all of these interceptions were intended for consumption (AQAS, 2018). *Oryza sativa* plant material intended for propagation has been intercepted 56 times at U.S. ports of entry since 20087 (AQAS, 2018). These interceptions came from China (3), France (1), India (13), Indonesia (5), Japan (4), Philippines (6), Spain (6), Thailand (10), and Vietnam (8) (AQAS, 2018). Since 2008, there have also been 108 interceptions of *Triticum aestivum* (wheat) plant material from 26 different countries throughout Asia and Europe where *L. striatellus* is present (AQAS, 2018).

Potential Distribution within the United States

Based on its presence in numerous countries with a wide variety of climate zones, such as Sweden, Russia, Greece, and Israel (CABI, 2017), *L. striatellus* would likely be able to establish in much of the contiguous Unites States based on climate suitability. In addition, host availability is not a constraint for distribution in the United States. Corn is commercially grown in every state in the contiguous United States, and wheat is grown commercially in 42 states (USDA-NASS, 2018). Rice is also commercially grown in several states. The top rice producing states in 2017 were: Arkansas, Louisiana, Missouri, Mississippi, and Texas (USDA-NASS, 2018).

Survey

CAPS-Approved Method*:

The approved survey method is a yellow sticky card (Fig. 5). Currently, there is no lure available for this planthopper.

Figure 5. A yellow sticky card trap. Courtesy of John Crowe, USDA-APHIS-PPQ.

IPHIS Survey Supply Ordering System Product Names:
1) Sticky Card, Yellow

Survey site selection

Where possible, place traps within the host crop approximately 1 m (approx. 3.28 ft) in from the edge of the field. If placement within the crop is not possible, place traps around the perimeter of a host crop with the yellow surface of the trap facing outward toward the crop.

Trap servicing

Traps should be inspected weekly, if possible, but at least every two weeks. Yellow sticky cards capture many kinds of non-target insects; therefore, the traps need to be inspected and cleaned regularly, particularly in windy or dusty areas. If traps become covered in dust, the traps will not be as effective.

*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:

Matsukura et al. (2011) demonstrated that yellow sticky traps worked better than two previously developed survey methods (suction and light traps) in showing seasonal occurrences of *L. striatellus*, indicating that sticky traps are effective for monitoring in forage maize fields. No height preference was observed, and yellow sticky traps worked better than blue sticky traps. In a survey by Achon et al. (2013), more adults were also captured with sticky traps (25cm x 30cm, 1.7m off the ground) than with the D-Vac suction sampler.

Several other trap types have also been used in surveys for *L. striatellus*. Otuka et al. (2010) used a tow net trap with a 1m ring mounted at the top of a pole 10m above ground. They also used a Johnson and Taylor suction trap installed on the roof of a three story building. Both of these traps were installed during a mass migration. Kisimoto (1968) used pan water traps in several different colors, which were set at the crop level. Yellow pan water traps attracted the most *L. striatellus* adults. Syobu et al. (2011) used net traps and light traps in a survey.

Key Identification

CAPS-Approved Method*:

Morphological. *Laodelphax striatellus* can be distinguished from other delphacids present in the United States using a combination of three key characters found on the adult male (Wilson and Claridge, 1991):

- pterostigma on the forewing is present and distinct,
- the mesonotum is black and shiny, and
- the aedeagus and the parameres of the genitalia.

Dissection of male genitalia is required for identification. Any suspect positive samples must be confirmed by a taxonomic expert for definitive identification.

For additional guidance, see the keys and images in Wilson and Claridge (1991) and the images on the *Laodelphax* page on the Planthoppers of North America website (Bartlett, 2018): http://canr.udel.edu/planthoppers/north-america/north-american-delphacidae/genus-laodelphax-fennah-1963/.

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Easily Confused Species

Other delphacids in the United States that infest rice include *Tagosodes orizicolus* and *Metadelphax propinquus* (Cherry et al., 1986). *Tagosodes orizicolus* also transmits Rice hoja blanca virus (Morales and Niessen, 1985). On corn, the planthopper *Peregrinus maidis* is found in the U.S. and transmits Maize mosaic virus (MMV) (Manandhar and Wright, 2016). *Sogatella kolophon* is also found on barley and corn (Wilson, 2005; Bartlett, 2018). *Javesella pellucida*, another delphacid that is present in the U.S., is found in wheat, barley, and corn (Bartlett, 2018). *Javesella pellucida* is also a vector of Oat sterile dwarf virus (OSDV), European wheat striate mosaic virus (EWSMV), and Maize rough dwarf virus (MRDV) (Bartlett, 2018).

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