The first population of the small brown planthopper *Laodelphax striatellus* (Homoptera: Delphacidae) in the Netherlands

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Area extension, invasive species, maize, minor pest, MRDV

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The small brown planthopper *Laodelphax striatellus* has always been considered a migrant species in the Netherlands, since no established populations were known. However, the first reproducing Dutch population was discovered in 2016. Climate change might have caused an area extension of *L. striatellus*. Future research has to show whether the area extension is permanent. Unfortunately, the habitat of the discovered population is destroyed. The small brown planthopper is of economic importance in southern Europe, mainly due to transmission of the maize rough dwarf virus (MRDV). In this respect, attention should be given to possible area extensions of this species.

Introduction

The small brown planthopper *Laodelphax striatellus* (Fallén, 1826) has a wide distribution in the Palearctic region, mainly in southern areas (Jach & Hoch 2013, Nast 1972). In eastern Asia (including Japan) it is one of the most serious pest insects of rice (Heinrichs 1994, Sanada-Morimura *et al*. 2011). *Laodelphax striatellus* damages rice plants directly by feeding on phloem sap, and indirectly by the transfer of viruses (rice stripe virus and rice black-streaked dwarf virus; Nault 1994). This planthopper is also known as a vector of various other diseases of cereal crops, mostly in warmer climates. Examples in Europe include maize rough dwarf virus (MRDV) in Central-Europe and the Mediterranean area, barley yellow striate mosaic virus (BYSMV) in Sweden, Italy and France, and wheat chlorotic streak virus in France (Adams & Antoniw 2016, Lindsten 1974, Nault 1994). In Spain, MRDV has emerged as a major constraint to maize crop production. *Laodelphax striatellus* was the sole planthopper species present in maize field trials and 52% of the captured planthoppers contained MRDV (Achon *et al*. 2014).

MRDV propagates in the small brown planthopper; therefore the planthopper functions as a source of the virus. Hibernating larvae carrying MRDV survive the winter, and after moulting into adults infest maize again (Häni *et al*. 1989).

The small brown planthopper is known as a successful long-distance migrant which is for example is regularly blown from the Asian mainland to Japan across the Japanese Sea (Otuka *et al*. 2012, Sanada-Morimura *et al*. 2011).

In the Netherlands, *L. striatellus* has only occasionally been recorded since 1907 (Bierman 1907). Such records could result from macropterous individuals that were blown to the Netherlands by air currents. I always assumed that these individuals would not found permanent populations, comparable to the situation in England (Stewart 2015) and northern Germany (Nickel 2003). Because of its pest status and capability to transfer viruses to agricultural crops, I have always watched this species carefully. In this article, I summarize the results of research of collection material and recent field notes.

Of the collection sites mentioned below the Dutch geographical coordinates (Amersfoortcoördinaten = AC) are given. Ma is used to indicate macropterous specimens, and Br to indicate brachypterous specimens. Unless otherwise stated the material was collected by the author and preserved in his collection.

Observations

Material Noord-Holland: Amsterdam, 27.vii.1956, 1♂ Ma leg. W.H. Gravestein, former collection Zoological Museum Amsterdam (ZMAN), now Naturalis collection, Leiden (RMNH). Groningen: Lauwersmeer (AC 213-596), no date, one specimen in a windowtrap (Schulz & Meijer 1978). Gelderland: Arnhem, 19.vii.1907, 1♀ Ma, leg. Bierman, collection RMNH. Limburg: Slavante near St Pietersberg (AC 176-315), 17.viii.1950, 1♂ Ma, RMNH. Noord-Brabant: Oisterwijk: nature reserve Kampina (AC 145-398) heath land, 7.ix.2003, 1♂ Ma; Bergen op Zoom: nature reserve De Duintjes in a ditch (AC 79.1-385.3), 1♂ Ma; Breda: rural estate Wolfslaar (AC 114.7-396.8) damp road side, 2.vi.2007, 1♂ Ma and 6.vi.2008, 1♀ Ma. Oosterhout, industrial area De Vijf Eiken (AC 120.7-404.1) (figure 1), 17.vii.2016 (4♂♂ Br, 9♂♂ Ma, 4♀♀ Br, 3♀♀ Ma, also first larval instars), 18.vii.2016 (1♂ Br, 12♂♂ Ma, 4♀♀ Br, 1♀ Ma), and 23.vii.2016 (1♂ Br, 8♂♂ Ma, 9 ♀♀ Br, 2♀♀ Ma) all collected on the grass species *Cynodon dactylon*. Some individuals of the last two catches have been used for acoustical recordings. Other planthopper species at the Oosterhout site included *Javesella pellucida* (Fabricius, 1794), *J. dubia* (Boheman, 1868), *Ribautodelphax collina* (Boheman, 1847), *R. vinealis* Den Bieman, 1987 and *Xanthodelphax stramineus* (Vilbaste, 1858).

1. Collecting site of *Laodelphax striatellus* at industrial area De Vijf Eiken in Oosterhout, province of Noord-Brabant, the Netherlands. Photo: C.F.M. den Bieman
1. Vindplaats van *Laodelphax striatellus* op het industrieterrein De Vijf Eiken in Oosterhout, Noord-Brabant.

Identification and biology

Laodelphax striatellus is characterized by its dark frons with white keels and its light pronotum in combination with a dark streak along the claval commissure just proximally of the clavus apex, both in macropterous and brachypterous specimens (figure 2). The male genitalia are very characteristic (Biedermann & Niedringhaus 2004, Ossiannilsson 1978).

This species lives in a broad variety of habitats, from dry to moist, and often in anthropogenic sites: fallow land, fertilized meadows, damp grassland, vineyards, swamps and road verges (Kirby 1992, Nickel 2003, personal observations in France and the Iberian Peninsula). The species obviously adapts well to disturbed habitats and is a pioneer inhabiting open and poorly vegetated sites (Söderman 2007). It is a polyphagous species feeding on a variety of grass species (Gramineae) including the cereal crops: barley, maize, rice and wheat. In Europe, *Agropyron* sp. (Drosopoulos 1982), *Agrostis capillaris* (Söderman 2007) and *Cynodon dactylon* (Drosopoulos 1982 and personal observations), were mentioned as hostplants. In Japan, 36 other grass species were recorded as hostplants (Mochida & Okada 1971). Perhaps this species also lives on rushes (Juncaceae) and sedges (Cyperaceae) (Nickel 2003), eggs have been found in a *Carex* species (Mochida & Okada 1971).

The first Dutch population was found on the grass *C. dactylon* at a dry and sandy grassland in 2016 (figure 1). This grassland was mown once a year and it was heavily grazed by rabbits. Moreover, the grassland was occasionally used as a motor cycle circuit. *Cynodon dactylon* was the dominant grass in and along the motor cycle tracks. *Laodelphax striatellus* from this site was also reared on this hostplant in a greenhouse.

Cynodon dactylon originates from the tropics and was introduced into the Netherlands more than a century ago (Floron 2016). It appears in coastal and river dunes, sandy dikes, road verges, railroad yards, harbours and industrial areas. It has a preference for sunny areas on sandy soils. This broad variety of habitats matches the habitat preference of the small brown planthopper in Germany (Nickel 2003). In Europe, *C. dactylon* reaches its northern limit in the Netherlands. It mainly occurs in the central and southern parts of the Netherlands (Floron 2016).

Until 2016, the small brown planthopper was considered a rare migrant in the Netherlands and only a few macropterous specimens had been collected. The discovery of a population with both macropterous and brachypterous individuals as well as larvae was unexpected. Whether this population existed for some years already could not be determined, although it was not found at the same location in 2010. Unfortunately, in the winter of 2016 the location was destroyed, because a factory was build at this spot.

Recent observations on the distribution of the small brown planthopper in England suggest that it may never form permanent populations, and that individuals found in Britain have probably been blown there by air currents (Stewart 2015). Older data, mainly from the nineteenth century, suggest that it was formerly widespread in South-east England (Kirby 1992). It was suggested that climate change was the main cause of the population decline. It seems that thus far only macropterous migrant specimens have been collected in Belgium as well (Baugnée 2016, personal communication). In Germany, reproducing populations are largely confined to rather warm lowlands in the southern half of the country. Single individuals collected in the North German Plain were always macropterous (Nickel 2003). *Laodelphax striatellus* is not known from Denmark, was collected only once in Norway, is scarce in Sweden but, perhaps surprisingly, rather common in southern Finland (Ossiannilsson 1978, Söderman *et al.* 2009). The records north of the boreal region in Finland all concern macropterous individuals, possibly on dispersal flight. This species has apparently expanded its Finnish range northwards in this century (Söderman 2007).

German and Italian data indicate that this species hibernates in the larval state and has two generations each year (Häni *et al.* 1989, Nickel 2003). Acoustical communication is an important element in sexual behaviour of planthoppers. Sound records of males collected from the Dutch population are available at the website Insect Drummers (www.insectdrummers.com).

Economic importance

European reports on virus transfer by *L. striatellus* in oats and barley are known from Sweden (Lindsten 1974). However, its importance as a virus vector is limited by the rarity and low abundance in Sweden (Ossiannilsson 1978).

Laodelphax striatellus is the only known vector of maize rough dwarf virus (MRDV). In Europe this virus occurs in France, Switzerland, former Czechoslovakia, Italy, Spain, former Yugoslavia (Lovisolo 1971) and Greece (Dovas *et al.* 2003). In the Netherlands, MRDV has not yet been observed (M. Verbeek & R. van der Vlugt, personal communication).

2. *Laodelphax striatellus* (a) male brachypterous, (b) female brachypterous, (c) male macropterous and (d) female macropterous; industrial area De Vijf Eiken, Oosterhout, province of Noord-Brabant, the Netherlands, 17.vii.2016. Photos: Theodoor Heijerman
2. *Laodelphax striatellus* (a) mannetje brachypteer, (b) vrouwtje brachypteer, (c) mannetje macropteer and (d) vrouwtje macropteer; industrieterrein De Vijf Eiken, Oosterhout, Noord-Brabant, 17.vii.2016.

Maize plants infected with MRDV exhibit small enations along the veins on the underside of the leaves, associated with mild to severe dwarfing of the plant and accompanied by drastic reductions in yield when plants are infected at early vegetative stages. Harvest loss was as high as 70% or more in Greece, while hardly any loss was observed the following year (Dovas *et al.* 2003). In Spain, MRDV was already reported in the 1960's. From 1999 onwards, severe maize crop losses were reported in north-east Spain (Achon *et al.* 2014). In Tessin (Switzerland), more than 50% of the maize plants was infected (Häni *et al.* 1989).

The only known natural hosts of MRDV are maize, *Digitaria sanguinalis*, *Echinochloa cruz-galli, C. dactylon* (Achon *et al.* 2014, Lovisolo 1971) and *Lolium perenne* (Achon *et al.* 2015). The latter four are common in and along maize fields. Also cultivated wheat is a host of MRDV (Achon *et al.* 2015).

Many factors affect the level of infection of maize crops. One factor is that *L. striatellus* does not breed on maize, it only feeds on this plant occasionally (Häni *et al.* 1989, Lovisola 2016). The amount and vicinity of true hostplants of *L. striatellus* near a maize field probably will determine the moment of invasion and the number of invading *L. striatellus*.

Conclusion

The small brown planthopper reaches its northwestern limit in England, the Netherlands and Central-Germany. Small climatic changes may influence its distribution. Whether the first Dutch population of *L. striatellus* is an indication of a range extension needs to be investigated in the coming years. As the small brown planthopper is of economic importance in southern Europe, this could also become an issue in the Netherlands.

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Samenvatting

De eerste populatie van de spoorcicade *Laodelphax striatellus* (Homoptera: Delphacidae) in Nederland

De spoorcicade *Laodelphax striatellus* was tot voor kort uit Nederland alleen bekend van enkele langvleugelige exemplaren. Hij werd daarom beschouw als een zeldzame migrant uit het zuiden zonder permanente populaties in ons land. In 2016 is er echter een populatie in Oosterhout, Noord-Brabant, ontdekt met zowel larven als kort- en langvleugelige adulten op handjesgras (*Cynodon dactylon*). De biologie wordt besproken, mede in relatie tot de verspreiding van handjesgras in ons land. *Laodelphax striatellus* brengt virussen over op onder andere haver, maïs, rijst en tarwe. In Europa is alleen de overdracht van *maize rough dwarf virus* (MRDV) van economisch belang. Dit virus kan grote schade aanrichten in maïsvelden in Zuid-Zwitserland, Griekenland en Noordoost-Spanje. Gelet op deze schadelijkheid, is het van belang om de vestiging en eventuele verdere uitbreiding van *L. striatellus* in ons land te volgen.

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