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An introduction to Auchenorrhyncha phytoplasma vectors

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Abstract

An introduction to the taxonomy of Auchenorrhyncha vectors of phytoplasmas is given. The majority of phytoplasma vectors are found within the Membracoidea: Cicadellidae (leafhoppers) and especially within the subfamily Deltocephalinae.

Key words: Hemiptera, Auchenorrhyncha, Cicadellidae, leafhoppers, planthopper vectors.

Introduction

The Hemiptera (= Rhynchota) are a large and diverse order of exopterygote insects, which occur throughout the world. There are more than 60,000 species in around 100 families. The Hemiptera is now divided into 3 suborders: Heteroptera (true bugs), Sternorrhyncha (scale insects, aphids, whiteflies, psyllids) and Auchenorrhyncha (leafhoppers, planthoppers, cicadas, treehoppers and spittlebugs). It is worth pointing out that many textbooks still divide the group into two orders: Heteroptera (= Hemiptera) and Homoptera, which includes the Sternorrhyncha and Auchenorrhyncha. The single most successful order of insect phytoplasma vectors is the Hemiptera.

Weintraub and Beanland (2006) have reviewed the vectors of phytoplasmas. They point out that this group collectively possesses several characteristics that make its members efficient vectors of phytoplasmas: (a) they are hemimetabolous; thus, nymphs and adults feed similarly and are in the same physical location and often both immatures and adults can transmit phytoplasmas; (b) they feed specifically and selectively on certain plant tissues, which makes them efficient vectors of pathogens residing in those tissues; (c) they have a propagative and persistent relationship with phytoplasmas; (d) they have obligate symbiotic prokaryotes that are passed to the offspring by transovarial transmission, the same mechanisms that allow the transovarial transmission of phytoplasmas.

Feeding strategies

Most Auchenorrhyncha feed from phloem tissue but two superfamilies (Cicadoidea; cicadas, Cercopoidea; spittlebugs) and a subfamily of the Cicadellidae: Cicadellinae (sharpshooters) feed from xylem tissue. In addition the majority of the leafhopper subfamily Typhlocybinae feed by removing the cell contents from mesophyll cells, some species however, feed is the phloem as well. Since Phytoplasmas are phloem-limited; therefore, only phloem-feeding insects can potentially acquire and transmit the pathogen.

Where are the vectors of phytoplasmas distributed taxonomically?

Within the groups of phloem-feeding insects only a small number, primarily in three taxonomic groups, have been confirmed as vectors of phytoplasmas. Weintraub and Beanland (2006) provide a supplemental Table 1, which may be found by following the Supplemental Material link from the Annual Reviews home page at http://www.annualreviews.org.

The superfamily containing the largest number of vector species is the Membracoidea, within which all known vectors to date are confined to the Cicadellidae. Around 20,000 leafhopper species have been described by estimates suggest that 100,000 species may exist (Dietrich, 2005).

Morphological and molecular evidence indicates that the Membracoidea are a monophyletic superfamily (Dietrich *et al.,* 2001). However, the phylogenetic status and relationships of the families, subfamilies, and tribes remain poorly understood.

More than 75% of all confirmed phytoplasma vector species are found in the subfamily Deltocephalinae. The feeding habits of species within the Deltocephalinae range from monophagous to polyphagous, and members of this group can transmit one or more different phytoplasma taxa. It is perhaps not surprising that the majority of vectors are found within this subfamily. Species in this group are very common in grassland habitats of all kinds. Many phytoplasma (and virus) diseases are known from crops that are Poaceae, which are the hosts of this subfamily and because the crops are of economic importance both the diseases and insect vectors have been studied. The Deltocephalinae is subdivided into a number of relatively well-defined tribes. Some of these also seem to contain a disproportionate number of recognized vector genera, but perhaps for the same reason as given above for the subfamily. Weintraub and Beanland (2006) did not indicate into which tribes each vector species is placed. Further analysis will be presented on the distribution of vector species later (Wilson and Weintraub, in preparation).

The subfamily containing the second largest number of confirmed vector species is the Macropsinae. Vector members of the Macropsinae can be monophagous or

oligophagous, but most feed primarily on woody plants.

The morphologically distinct Membracidae (treehoppers) are part of the Cicadellidae but to date, no membracids have been confirmed as or are suspected of transmitting phytoplasmas. Although membracids are relatively poor transmitters of viruses compared with leafhoppers, it is unknown whether researchers have not considered membracids for use in phytoplasma vector studies because they appear to be a group distinct from the leafhoppers (which are known vectors) or because membracids actually do not transmit phytoplasmas. Because membracids tend to feed on woody hosts, it would not be surprising to find that they transmit phytoplasmas, found primarily in woody plants, such as those members of groups 16SrIII (Western-X, WX), and 16SrX (apple proliferation) like pear decline (PD), apple proliferation (AP), or European stone fruit yellows (ESFY).

Vector species are found in four planthopper families (Fulgoromorpha): Cixiidae, Delphacidae, Derbidae, and one species in the Flatidae. The first three families all have at least one species that transmits a phytoplasma in the coconut lethal yellows group (16SrIV). Several species in these families also transmit phytoplasmas from the stolbur (16SrXII) group. The one flatid vector, *Metcalfa pruinosa* (Say), transmits aster yellows (AY) (group 16SrI) (Lee *et al*., 1998). The majority of phytoplasma vector species occur in the Delphacidae, which are predominantly found on Poaceae.

At present two genera of psyllids include vectors and just two heteropteran families, the Pentatomidae and Tingidae, have confirmed vector species.

Future work

There are currently many more phytoplasma diseases known then vectors identified. As more vector species are confirmed and as more phytoplasma diseases are characterised the relationships between vector, disease and host plant will become better defined and understood.

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