Bulletin of Insectology **64** (Supplement): S147-S148, 2011
ISSN 1721-8861

Stolbur phytoplasma interaction with vector longevity in alternative plants

Jes Johannesen[1], Andreas Albert[1], Miriam Imo[1], Michael Maixner[2]
[1]*Zoological Institute, Department of Ecology, University of Mainz, Mainz, Germany*
[2]*JKI, Institute for Plant Protection in Fruit Crops and Viticulture, Bernkastel-Kues, Germany*

Abstract

The epidemiology of phytoplasma-induced plant diseases is significantly influenced by the interaction between phytoplasma and the vectoring insect. Infection with phytoplasma may increase or lower fitness, or change the behaviour of the vector. The cixiid *Hyalesthes obsoletus* vectors stolbur 16SrXII-A phytoplasma from bindweed and stinging nettle to grapevine, where it causes the yellows disease 'bois noir'. Here we present first experiments studying the effect of stolbur infection on longevity in *H. obsoletus*. Preliminary tests of female *H. obsoletus* sampled on bindweed and stinging nettle, respectively, showed that females survive significantly longer on the own plant, whereas no effect of stolbur infection was observed on other host plant.

Key words: *Hyalesthes obsoletus*, Cixiidae, 'bois noir', longevity, host plant attraction, host races.

Introduction

Despite the important role of vectors in the epidemiology of phytoplasma-induced plant diseases, few studies have addressed how phytoplasma affect the insect vector. Generally, negative effects (virulence) of symbiont infection may accrue if vectors acquire new "maladapted" strains, e.g. by feeding on new host plants, or by competition between different symbiont strains, whereas symbionts should become benign towards the vector when it is the more mobile species, free symbionts rarely disperse and strains do not compete (Elliot *et al*., 2003). Symbionts may also influence the behaviour of vectors, for example by manipulating them to find host plants (Mayer *et al*., 2008). Benefits of infection to the vector by phytoplasma include increased longevity (Beanland *et al*., 2000; Ebbert and Nault, 2001) and fecundity (Beanland *et al*., 2000), while studies showing negative effects include reduced life span (Garcia-Salazer *et al*., 1991) and lower fecundity and longevity (Bressan *et al*., 2005) of the vector.

Stolbur 16SrXII-A phytoplasma induces the grapevine yellows disease 'bois noir'. Stolbur is transmitted to grapevine from the natural host plants of both stolbur and its main vector, *Hyalesthes obsoletus* (Cixiidae). Grapevine itself is a dead end host and does not contribute to the epidemiology of bois noir.

In Germany, *H. obsoletus* has two host races associated with bindweed (*Convolvulus arvensis*) and stinging nettle (*Urtica dioica*), respectively. Bindweed harbours the stolbur tuf-type b strain, whereas the tuf-type a strain is associated with stinging nettle. Hence, there are two epidemiological cycles. The "nettle cycle" is younger than the "bindweed cycle" in Germany. In a newly arisen, non-adapted infectious pathway one might expect detrimental vector-symbiont interactions, whereas a co-adapted system should show neutral or positive interactions.

We are investigating how stolbur infection influences *H. obsoletus* life-history by studying longevity and host plant attraction of *H. obsoletus* to own and alternative host plants in relation to infection with 16SrXII-A phytoplasma. In this paper, we present preliminary results regarding longevity of females.

Materials and methods

H. obsoletus used for analyses were caught in June and July 2010 in the Mosel Valley, Germany. Individuals were studied for longevity on own and alternative host plants relative to infection with stolbur. Longevity was defined as the number of days surviving on plants in the laboratory. All individuals of one host race were caught on the same day to ensure equal mean survival estimates between treatments within each host race. Individuals were kept in large plastic cups with small plant twigs with 2-3 leaves. The plant twigs were immerged in vials that contained water and were sealed with foil to avoid evaporation. Survival was checked on a daily basis, and analysed for each cohort separately. Different rates of survival were tested with Kaplan-Meier survival analysis (Log-Rank-tests). All specimens were checked for stolbur infection using the *tuf* gene via nested PCR.

Results and discussion

Females of *H. obsoletus* host races lived significantly longer on the own host plant (figure 1A, D), as previously reported for *H. obsoletus* caught on stinging nettle in Switzerland (Kessler *et al*., 2011). Different survival times may be influenced by phenotypic conditioning of the larvae to the host plant rather than by an evolutionary adaptation. However, because *H. obsoletus* in the Mosel Valley has genetically divergent populations (M. Imo, unpublished data) we contend that the different survival rates are further evidence for specialisation of host races.

There was no significant effect of stolbur infection on longevity in either host race on either plant (figures 1B, C, E, F). Lack of significant effects of infection might be influenced by low infection rates that led to low statistical power: 15% *H. obsoletus* caught on stinging nettle and 28% on bindweed were infected. A higher sample size will shed more light on this result. Lack of negative stolbur-effects on longevity suggests that the vector-phytoplasma interaction has not evolved recently but is part of a co-evolved system. However, future investigations will include analyses of longevity in males, which might differ from females. We found no mixed infections of tuf-type a and b, and the tuf type of all infected vectors corresponded to that of the field host plant. Homogeneous infection patterns are predicted to cause evolution of benevolence towards the vector. If one assumes that the stinging nettle host race in Germany is only recently evolved (M. Imo, unpublished results) our results imply that *H. obsoletus* is adapted to stolbur in general rather than to specific strains.

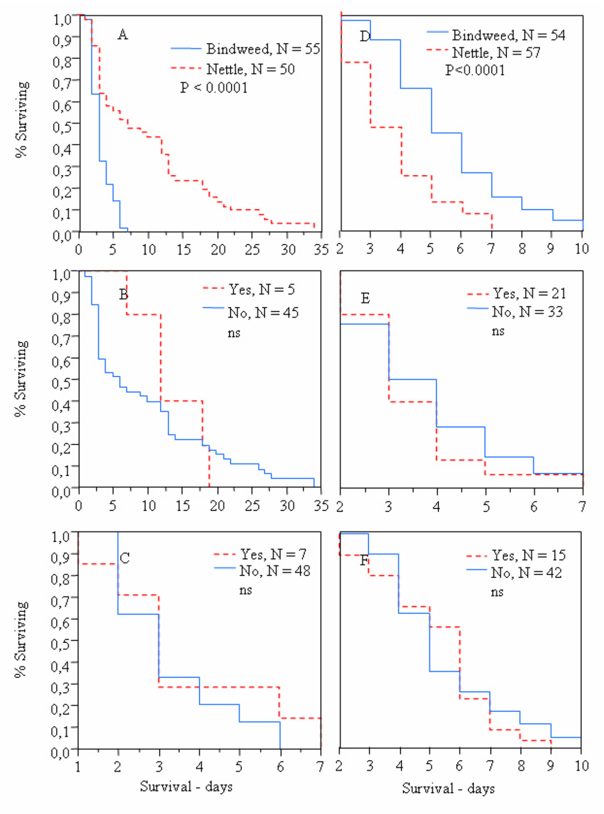

Figure 1. Survival of female *H. obsoletus*. 1) Survival of stinging nettle females; on stinging nettle or bindweed (A), infected and non-infected females on stinging nettle (B), infected and non-infected females on bindweed (C). 2) Survival of bindweed females; on stinging nettle or bindweed (D), infected and non-infected females on bindweed (E), infected and non-infected females on stinging nettle (F). Yes = infected; No = not infected; N = sample size; ns = not significant.
(In colour at www.bulletinofinsectology.org)

Acknowledgements

We thank the "Stiftung Rheinland-Pfalz für Innovation" (grant 0861) for financial support.

References

BEANLAND L., HOY C. W., MILLER S. A., NAULT L. R., 2000.- Influence of aster yellows phytoplasma on the fitness of aster leafhopper (Homoptera: Cicadellidae).- *Annals of the Entomological Society of America*, 93: 271-276.

BRESSAN A., CLAIR D., SEMETEY O., BOUDON-PADIEU E., 2005.- Effect of two strains of Flavescence dorée phytoplasma on the survival and fecundity of the experimental leafhopper vector *Euscelidius variegatus* Kirschbaum.- *Journal of Invertebrate Pathology*, 89: 144-149.

EBBERT M. A., NAULT L. R., 2001.- Survival in *Dalbulus* leafhopper vectors improves after exposure to maize stunting pathogens.- *Entomologica Experimentalis et Applicata*, 100: 311-324.

ELLIOT S. L., ADLER F. R., SABELIS W., 2003.- How virulent should a parasite be to its vector?- *Ecology*, 84: 2568-2574.

GARCIA-SALAZER C., WHALON M. E., RAHARDA U., 1991.- Temperatur-dependent pathogenicity of X-disease mycoplasma-like organism to its vector: *Paraphlepsius irroratus* (Homoptera: Cicadellidae).- *Environmental Entomology*, 20: 179-184.

KESSLER S., SCHAERER S., DELABAYS N., TURLINGS T. C. J., TRIVELLONE V, KEHRLI P., 2011.- Host plant preferences of *Hyalesthes obsoletus*, the vector of the grapevine yellows disease 'bois noir', in Switzerland.- *Entomologia Experimentalis et Applicata*, 139: 60-67.

MAYER C. J., VILCINSKAS A., GROSS J. 2008.- Pathogen-induced release of plant allomone manipulates vector insect behavior.- *Journal of Chemical Ecology*, 34: 1518-1522.

Corresponding author: Jes JOHANNESEN (e-mail: jesjo@uni-mainz.de), Zoological Institute, Department of Ecology, University of Mainz, Mainz, Germany.