Biological Control 67 (2013) 390–396

Contents lists available at ScienceDirect

Biological Control

journal homepage: www.elsevier.com/locate/ybcon

A potential spider natural enemy against virus vector leafhoppers in agricultural mosaic landscapes – Corroborating ecological and behavioral evidence

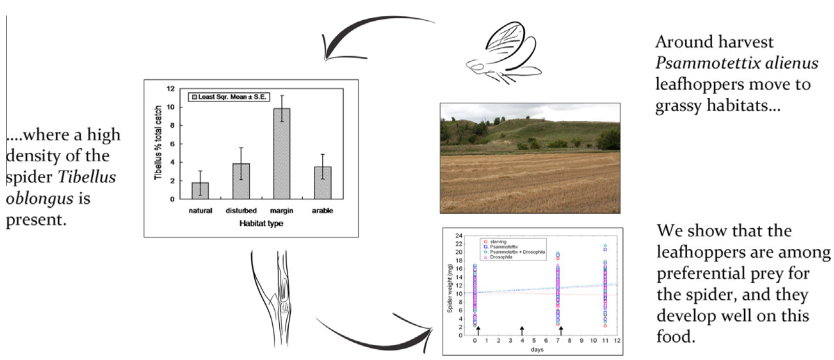
Ferenc Samu [a,*], Orsolya Beleznai [a,b], Gergely Tholt [a,c]

[a] *Plant Protection Institute, Centre for Agricultural Research, Hungarian Academy of Sciences, 15 Herman Ottó Str., Budapest, H-1022 Hungary*
[b] *Doctoral School of Animal- and Agricultural Environmental Sciences, University of Pannonia, Georgikon Faculty. 16 Deák Ferenc Srt., Keszthely, H-8360 Hungary*
[c] *Eötvös Loránd University, Faculty of Scinece, Institute of Biology, Department of Systematic Zoology and Ecology. 1/C Pázmány Péter sétány, Budapest, H-1117 Hungary*

HIGHLIGHTS

- Virus vector leafhopper moves from cereal fields to grassy habitats at harvest.
- A dominant hunting spider in grassy margins has peak population density at that time.
- In laboratory the leafhopper is among the favorable prey types for the spider.
- When fed on a pure leafhopper diet spiders maintained their growth.
- The spider is a potential natural enemy against the leafhopper.

GRAPHICAL ABSTRACT



ARTICLE INFO

Article history:
Received 5 March 2013
Accepted 29 August 2013
Available online 5 September 2013

Keywords:
Spider
Leafhopper
Virus vector
Natural enemy
Predation
Field margin
Prey preference

ABSTRACT

We intended to establish the potential for interaction between the wheat dwarf virus (WDV) vector leafhopper *Psammotettix alienus* – a dominant sap feeding pest in cereal fields, and the spider *Tibellus oblongus* – a dominant predator of grassy field margins. The relationship is important, because with the senescing and harvest of cereals *P. alienus* migrates to alternative host species, grasses. We analyzed the potential of *T. oblongus* to be an effective natural enemy of *P. alienus* by studying the probability of their co-occurrence seasonally and at the habitat and microhabitat scale. By gathering data from long term research (1994–2011) in six agricultural regions of Hungary, we assembled 96 one-year-long datasets obtained by suction sampling from the four key habitats of the agricultural landscape mosaic. The analysis showed that both in space and time the spider has the potential to prey on *P. alienus*. *T. oblongus* populations can reach considerable densities and represent high dominance among other spiders in the habitats of the leafhopper. Given this co-occurrence pattern, we devised laboratory experiments to study whether *P. alienus* is included among the preferred prey types of *T. oblongus* and to ascertain whether prolonged feeding has no adverse effects and provides the nutrients for growth. *P. alienus* proved to be both a preferred prey type and one that can be utilized for growth by the spider. This study collected the circumstantial ecological and direct laboratory feeding trial proofs that *T. oblongus* can be an important biological control agent against the leafhopper pest *P. alienus*.

1. Introduction

Recent field studies drew our attention to a leafhopper and a spider species, which are dominant herbivorous and predatory

* Corresponding author.
E-mail address: samu.ferenc@agrar.mta.hu (F. Samu).

1049-9644/$ - see front matter © 2013 Elsevier Inc. All rights reserved.
http://dx.doi.org/10.1016/j.biocontrol.2013.08.016

arthropods in their respective habitats, cereal fields and field margins. Leafhoppers have to seek alternative habitats around harvest and ploughing, among them grassy field margins. Therefore, we aimed to study the feasibility that the spider *Tibellus oblongus* (Walckenaer, 1802) (Araneae, Philodromidae) has the potential to act as a natural enemy against the leafhopper *Psammotettix alienus* (Dahlbom, 1850) (*Auchenorrhyncha*, *Cicadellidae*).

Predatory arthropods, like spiders, play an important role in regulating population dynamics of insects (Nyffeler and Sunderland, 2003; Riechert and Lockley, 1984; Rypstra and Marshall, 2005). For predation to take place predators and prey must occur together in space and time. Movements between different habitats in landscapes and the seasonality of the interacting species influences predation success. Agricultural fields have a typical spatial and temporal disturbance pattern. Regular management of crop fields, like harvest and ploughing, causes repeated changes in vegetation architecture, cover and biomass. The 'cyclic colonization in predictably ephemeral habitats' hypothesis (Wissinger, 1997) predicts that, on the one hand, successful natural enemies must be adapted to this cyclic nature of agricultural habitats (Welch et al., 2011). On the other hand, pest species face the same recurrences of disturbance, and are also likely to have evolved adaptive strategies to cope with cyclic disturbance. Ripening of seeds and senescing in crop plants negatively influences sap feeders (Huberty and Denno, 2004; Williams, 1995), and might be the driving force for host alteration (Sandstrom, 2000), which culminates in the major disturbance of harvest and subsequent ploughing that forces herbivorous insects to migrate to alternate or secondary habitats (Christian and Willis, 1993; Kindler et al., 1999).

In Central European cereal fields one of the most common species of leafhoppers is *P. alienus*. This leafhopper species is an important pest not for the direct damage it causes by sucking, rather because it is the only known vector of the wheat dwarf virus (WDV) (Manurung et al., 2004; Praslicka, 1997). *P. alienus* is an oligophagous species. Its host plants are restricted to the *Poaceae* family (Lindblad and Areno, 2002; Manurung et al., 2005; Nickel and Remane, 2002), similarly to the host range of WDV (Mehner et al., 2003). Manurung et al. (2005) studied *P. alienus* population dynamics in winter barley fields in Germany. They found that first generation leafhoppers occurred in May/June developing on maturing barley. Adults of the second generation first occurred in August, but the abundance of *P. alienus* did not peak until mid-September on self-sown winter barley and stubble. They concluded that self-sown barley fields are important in maintaining populations of *P. alienus*. Other field studies on the spread of *P. alienus* and WDV in Sweden showed that catches of adults peaked at end of June during the occurrence of first generation, however, abundance of the second generation was lower, which could be a result of lower monthly mean temperatures (Lindblad and Areno, 2002). The *Psammotettix* genus has 20 species in Hungary, out of which only *P. alienus* can be found in agricultural fields (Győrffy et al., 2009; Kiss et al., 2008). In Hungary *P. alienus* has two or three generations in a year; the leafhopper can be found from May until the end of November (Sáringer, 1989). In a previous study on *P. alienus* host range we tested host plant quality of 18 grass species and found that most of the acceptable species are common in field margins in Hungary (Tholt and Kiss, 2011). These studies show that fallows, pastures and other grassy areas act as important reservoirs for the leafhopper and the virus (Lindblad and Areno, 2002; Mehner et al., 2003), and therefore any controlling factor that act in these habitats are important both for the populations of *P. alienus* and for the virus it spreads.

Preliminary field studies showed that one potential predatory species, that is likely to meet the criteria of co-occurring with *P. alienus* in space and time is the spider *Tibellus oblongus* (Walckenaer, 1802) (Araneae, Philodromidae). Apart from generally knowing that this is a fairly common species in agricultural habitat mosaics (Buchar and Růžička, 2002; Samu and Szinetár, 2002), we have had very little specific knowledge about the species. Spiders in the Philodromidae family are known to hunt without web and to occur mainly above ground surface, in grass, on foliage and on bark; *T. oblongus* in particular "among grass" (Nentwig et al., 2013). Considering the prey of *T. oblongus* there are two studies that report that the species might be important predator against Miridae bugs (Wegener, 1998) and thrips (Zrubecz et al., 2004).

Spiders are traditionally regarded as generalist predators, that feed on any prey that is suitable in size (Enders, 1975). However, field studies revealed that spiders, depending on taxon and foraging strategy, have very variable prey preferences (Nyffeler, 1999; Nyffeler et al., 1994). Toft and co-workers in a series of laboratory experiments proved that many common prey, such as aphids and certain springtails, can be noxious to a number of agrobiont predatory arthropod species (Bilde and Toft, 1997; Toft, 1999). Proof of consumption and suitability may come from laboratory feeding experiments (Mayntz and Toft, 2001).

In the present study aimed to establish whether *T. oblongus* fulfills the main criteria of co-occurring with its potential prey in space and time and feeding and developing on it. In particular we intended to clarify the (i) spatial and (ii) temporal occurrence of *T. oblongus* and the main factors that determine it; further wanted to know (iii) whether *P. alienus* is acceptable prey for the spider, and if yes, (iv) whether feeding on it is nutritionally adequate for growth and development.

2. Materials and methods

2.1. Field datasets

In studying the ecological characteristics of *T. oblongus* we selected datasets from the long term database of our group's arachnological research (Samu, 2000; Samu et al., 2008). Datasets, dated between 1994 and 2011, represented 1 year of collecting with suction sampler in a habitat patch representative of the Hungarian agricultural landscape mosaic. The habitat types were comprised of (i) arable fields (cereals or alfalfa), (ii) grassy field margins, (iii) disturbed, secondary grasslands and (iv) natural grassland patches (loess steppe remnants). We selected 96 datasets from 62 habitat patches (some patches with 2 or 3 years of data), that represented 6 geographical regions scattered about the non-montane agricultural areas of Hungary. To assess collecting method efficiency, further 24 datasets were considered from the same habitat patches where collecting was done using pitfall traps. The datasets collectively contained data about 103,411 spider individuals (415 spider taxa), out of which 3528 belonged to the genus *Tibellus*. The *Tibellus* genus has three species in Hungary, of which by far the most dominant is *T. oblongus*. *Tibellus macellus* Simon, 1875 is a faunistical rarity; *Tibellus maritimus* (Menge, 1875) is also uncommon, preferring wetter habitats. At the 62 habitat patches considered not a single adult individual other than *T. oblongus* was caught from the genus, thus all juvenile *Tibellus* specimens could be safely regarded as *T. oblongus*.

2.2. Collecting methods

All suction sample data were collected by hand-held motorized suction sampler (Samu and Sárospataki, 1995), with a nozzle diameter of approx. 0.01 m^2. 10 applications of the suction sampler in a transect consisted one sample (taken from an area of 0.1 m^2). The additional method was pitfall trapping, which was carried out with plastic cups of 7 cm diameter at the opening, containing 40% ethylene glycol as preservative mixed with a little amount of detergent to decrease surface tension.