



## The community ecology of *Ribautodelphax imitans* (RIBAUT, 1953) (Hemiptera: Delphacidae), a rare UK planthopper in a distinct grassland habitat

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**Abstract:** *Ribautodelphax imitans* (RIBAUT, 1953) (Hemiptera: Delphacidae) is a rare planthopper throughout its recorded range, and in the UK where it is afforded conservation priority status. Following the discovery of this species on a site in Cambridgeshire, UK in 2010 a study was designed to understand the population status of *R. imitans* and its place in the Auchenorrhyncha community structure. The species was found not to be rare within the community – in fact it was one of the most abundant delphacids on the site. However, the community was dominated by *Javesella pellucida* (FABRICIUS, 1794). Although the reason for the general rarity of *R. imitans* on a national scale is still unclear, evidence from the community structure suggests that strong interspecies interactions between other species that it is phenologically synchronous with may be a factor.

**Key words:** Auchenorrhyncha, insect conservation, rarity, interspecific interactions, phenology

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### Introduction

Auchenorrhyncha (Insecta: Hemiptera) are an abundant grassland insect group, although little consideration is afforded them with research often focused on more charismatic insects such as butterflies and moths (Lepidoptera) (PAWAR 2003). In spite of this, leafhoppers and planthoppers have key roles in ecosystem function. For example, they form a valuable part of passerine birds diet (BUCHANAN et al. 2006). More recently, they have been recognised as important indicator species, particularly in grassland and forest systems (HOLLIER et al. 2005, MOIR & BRENNAN 2007), as they respond quickly to changes in environmental factors (SEDLACEK et al. 1988, DITTRICH & HELDEN 2012, HELDEN et al. 2010).

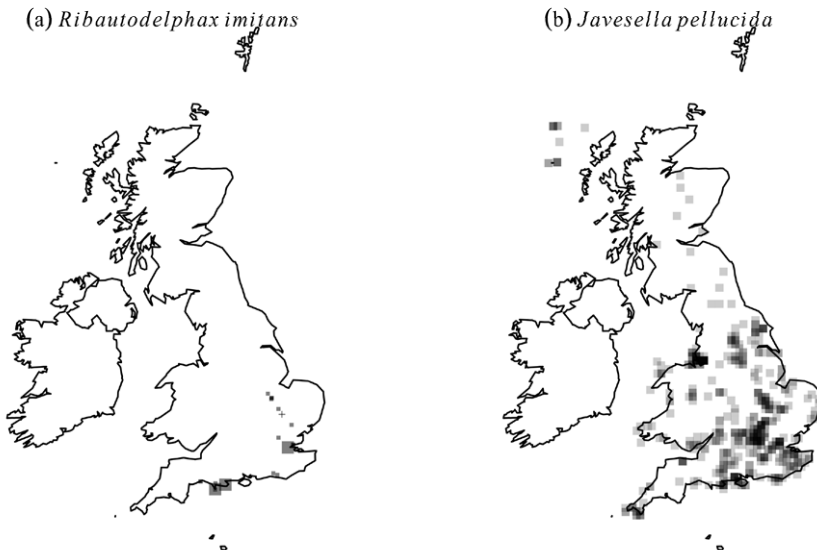
In the UK, the Auchenorrhyncha fauna is mainly composed of leafhoppers (Cicadellidae) (296 species) and planthoppers (Delphacidae) (75 species). Although there are representatives from the Cixidae (12 species), Aphrophoridae (9 species), Membracidae (2 species), Issidae (2 species), Cercopidae (1 species), Cicadidae (1 species), and Tettigometridae (1 species) (STEWART & BANTOCK 2015). The numbers of species on the UK list however



**Fig. 1:** A female of *Ribautodelphax imitans*.

is quite dynamic, with many new additions in recent years. Since 2007 seven species have had been added to the UK fauna. These include *Delphax crassicornis* (PANZER, 1796), *Psammotettix helvolus* (KIRSCHBAUM, 1868), *Oncopsis appendiculata* WAGNER, 1944, *Zygina nivea* (MULSANT & REY, 1855), *Macropsis megerlei* (FIEBER, 1868), *Dryodurgades antoniae* (MELICHAR, 1907) and *Pithytettix abietinus* (FALLÉN, 1806) (SKIDMORE 2008, MACZEY & MASTERS 2009, RAMSAY 2010, BANTOCK et al. 2010, BANTOCK 2011, BANTOCK 2012, DENTON 2012).

Historically Auchenorrhyncha have not been recognised the same level of protection as higher vertebrates (MYERS et al. 2000, BIEDERMANN et al. 2005) and other more charismatic insects such as the greater stag beetle *Lucanus cervus* (Coleoptera), and many butterflies (Lepidoptera). However there are a small number of Auchenorrhyncha considered conservation priorities, based on the now defunct Biodiversity Action Plan (BAP), which has now been replaced within a Joint Nature Conservation Committee JNCC framework. These species are: *Cicadetta montana* (SCOPOLI, 1772) the UK's only true cicada (Hemiptera: Cicadidae), restricted to the New Forest and now believed to be extinct, *Erotettix cyane* (BOHEMAN, 1845) the pondweed leafhopper, restricted to just three sites in the UK, *Doratura impudica* HORVATH, 1897, *Euscelis venosus* (KIRSCHBAUM, 1868), *Eurysanoides douglasi* (SCOTT, 1870), *Chlorita viridula* (FALLÉN, 1806) and *Ribautodelphax imitans* (RIBAUT, 1953) (Fig. 1), the target species in this study.



**Fig. 2:** The UK distribution of (a) *Ribautodelphax imitans* and (b) *Javesella pellucida*.

Historically *R. imitans* was only recorded from Dorset and Devon (1959 and 1969). The species was then rediscovered in Dorset in 1997 and then again in 2000, there was also a single report from East Sussex in 1998. Following these discoveries there were some scattered observations of the species in Middlesex (2000), Essex (2006–2013), Northampton (2013), Lincolnshire (2013), Peterborough (2013) and most recently three sites in Cambridgeshire which include Coe Fen, Needingworth Quarry and Devils Dyke (2011–2015) (Fig. 2a). However, records do need to be taken with some caution, as insect records are often patchy and suffer from under-recording (DUNN 2005) without the resolution of higher taxa such as mammals (CEBALLOS & EHRlich 2006). This aside, predictions of insect distributions can be made (HASSALL 2012). Arguably the most common planthopper in the UK is *Javesella pellucida* (FABRICIUS, 1794) and even though its dominance in surveys illustrates this commonness, there is still a large proportion of the UK not covered by *J. pellucida* records (Fig. 2b). In many areas this is likely to be due to lack of recording and reporting, – rather than it actually being absent. Therefore estimates on *R. imitans* distributions need to be considered with caution. However, notwithstanding under-recording, the species is considered rare in other parts of its range (NICKEL & REMANE 2002).

In 2010 *R. imitans* was found on Coe Fen Cambridgeshire (N 52°11'58.39", E 0°00'06.58.77°), a meadow covering approximately 6.6 hectares of cattle grazed land on the banks of River Cam, close to the historic city centre of Cambridge. A field study was designed for 2011 to understand more about its community ecology, and ecological position. Here we describe a field study in 2011 and present detail regarding its ecological position within the Auchenorrhyncha community.

## Material and methods

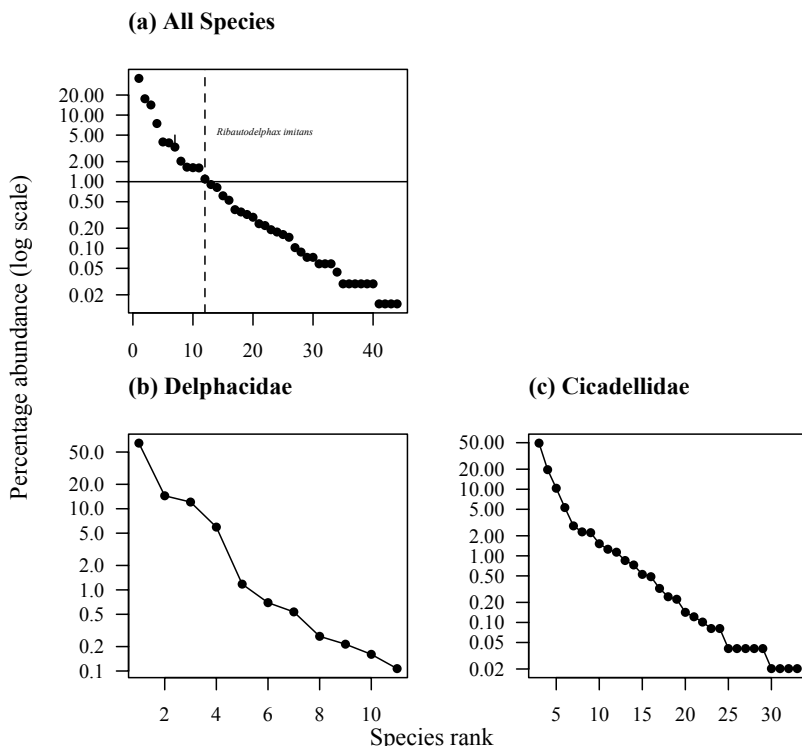
The site was notionally divided up into 10 plots from which four subsamples were taken (totalling 40) samples every two weeks from April – October 2011. Each sample was collected with a Vortis suction sampler (ARNOLD 1994) and consisted of 10 sixteen-second sucks (BROOK et al. 2008), covering a total area of 0.2 m<sup>2</sup> (10 × 0.02 m<sup>2</sup>). Each sample was emptied into a sweep net and then a pooter used to collect all adult Hemiptera for preservation in AGA (alcohol-glycerine-acetic acid) solution (GIBB & OSETO 2006) and later identified to species using identification keys of LE QUESNE (1960, 1965, 1969), LE QUESNE & PAYNE (1981), BIEDERMANN & NIEDRINGHAUS (2009) and KUNZ et al. (2011).

## Results

The sampling caught 7178 Auchenorrhyncha (leafhoppers, planthoppers and allies) from 43 species. Out of this sample, the majority were either Cicadellidae (leafhoppers) or Delphacidae (planthoppers) – although far fewer of the latter were collected. Of all these species, six have local status, and two were nationally scarce; notable A (occurring in 30 or fewer 10km squares) and notable B (occurring in 31 – 100, 10km squares). *Ribautodelphax imitans* – the focus of this study – and the rarest species is designated a Red Data Book (RDBK), Biodiversity Action Plan (BAP) 2007 and Natural Environment and Rural Communities (NERC) S.41: priority action species.

Coe Fen was dominated by less than 15 species; the majority recorded less than 25 times through the course of the field season. *Ribautodelphax imitans* however, was one of the more abundant species ranking seventh out of all Auchenorrhyncha recorded. The Shannon's equitability index was 0.603 suggesting a normal, moderately diverse community. In addition Whittaker plots were also used to determine evenness of species rank distributions within the community; they illustrated percentage abundances were typically low for most species (less than 1 %). Although plots suggest normal species distributions; shown by the moderate decline in log abundance with increasing rank. Slopes for all combined species, Delphacidae and Cicadellidae were -0.16 respectively (Fig. 3). Of all the delphacids on Coe Fen, *J. pellucida* was the most abundant; this species equating to ~36 % and 50 % of all delphacids sampled on Coe Fen, compared to *R. imitans* which had an overall abundance of ~3 %. *Arthaldeus pascuellus* (FALLÉN, 1826) was the commonest auchenorrhynchan overall, with 2431 specimens around 33 % of the total number of individuals or 50 % of all cicadellids.

Sampling illustrated differences in life cycles between the two main groups of Auchenorrhyncha: planthoppers showed a June-July peak whereas cicadellids had a July-August peak population with smaller peaks approximately eight weeks previous in each group. The life cycle of *R. imitans* (Fig. 4a) appears to mirror that of other delphacids. In 2011 there were two peaks; a late peak in June-July, preceded by an earlier – much smaller – April peak. At the late peak 91 individuals were found (14<sup>th</sup> July 2011) and at the earlier just 12 individuals were sampled (21<sup>st</sup> April 2011), a three sample average abundance of 48 and 9 respectively. The life cycles of other Auchenorrhyncha were also modelled, and the justifications for those species based on the total abundance of each species, in this case the nine most abundant species life cycles were observed. The profiles of each species



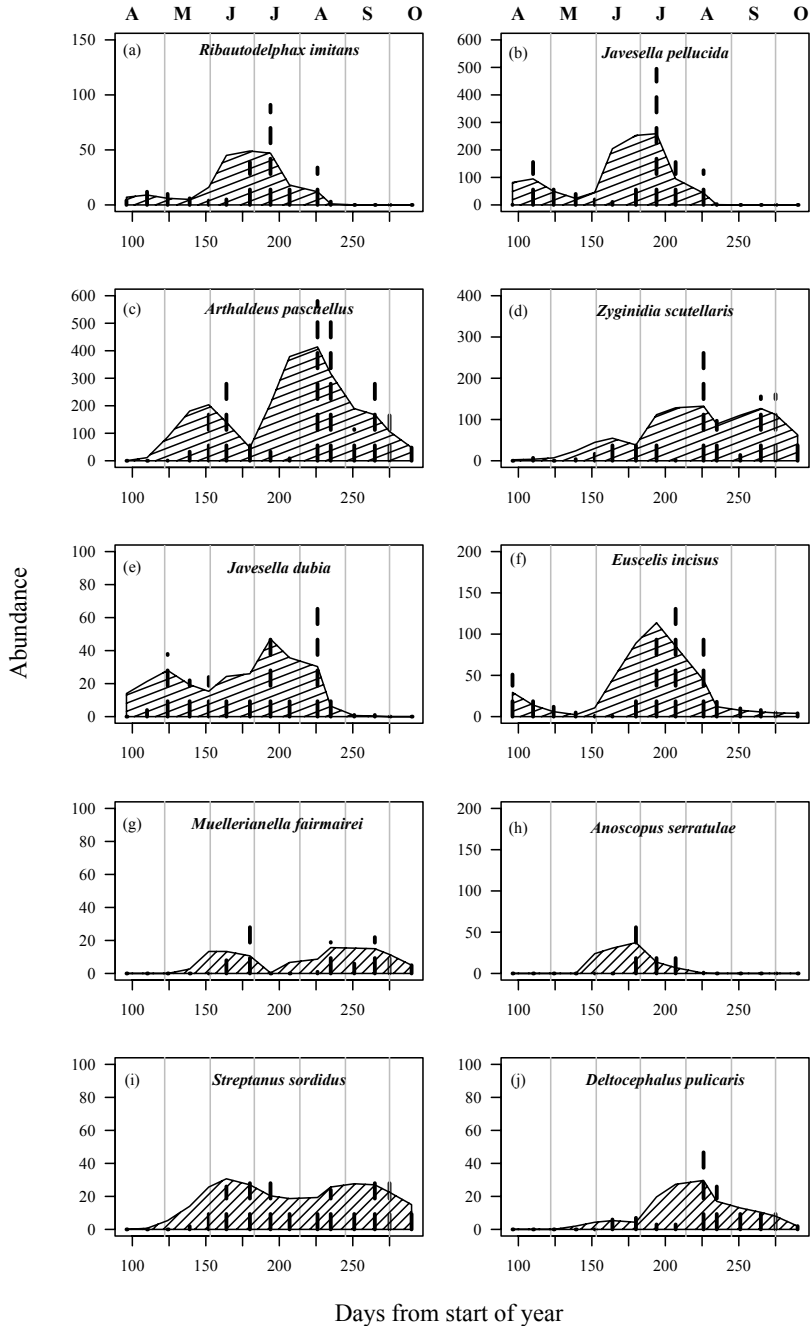
**Fig. 3:** Percentage rank abundance of (a) all Auchenorrhyncha on Coe Fen. (b) Delphacidae and (c) Cicadellidae grouped separately. *Ribautodelphax imitans* is represented on (a) with a small arrow.

are shown in figure 4: (b) *Javesella pellucida*, (c) *Arthaldeus pascuellis*, (d) *Zyginidia scutellaris*, (e) *Javesella dubia*, (f) *Euscelis incisus*, (g) *Muellerianella fairmairei*, (h) *Anoscopus serratulae*, (i) *Streptanus sordidus* and (j) *Deltocephalus pulicaris*. The majority of species were bivoltine, with the exception of *Z. scutellaris* which had three generations, and *A. serratulae* which appeared to have just one.

## Discussion

Rarity is not caused by one universal factor – there are many reasons for it. Within a community, species can be numerically rare (lower abundance than allospecifics), rarity can be mediated by habitat specificity, and geographically species can be widespread or restricted (CUNNINGHAM & LINDENMAYER 2005). Within communities species may not be numerically abundant; the majority of species are rare when compared to the dominant few – but are they in fact rare? In this study *R. imitans* is a potential example of one species that is locally abundant (albeit not dominant) but restricted in its range for some reason. The exact reasons for the rarity of *R. imitans* are unknown.

Although rarity is commonplace, the reasoning behind persistence of rare species through space and time is not always so simple. Potentially rare species can only persist if their



**Fig. 4:** Phenograms of the 10 commonest Auchenorrhyncha on Coe Fen. The vertical lines show raw abundance, and the shaded area the three date rolling average abundance.

environment is ecologically stable (HARRISON et al. 2008) and species can be restricted because of their specificity or range limitations. Some species are highly specialised, requiring a subset of habitat characteristics in order to persist – for example these can be specific habitat gradients or host plants. Host plant drivers are unlikely to be the cause of *R. imitans* rarity, because of the geographically widespread host plant – tall fescue *Schedonorus (Festuca) arundinaceus* (DEN BIEMAN 1987). Species can also be rare, because geographically they are at the edge of their range; where the environment is at the limit of their ecological tolerances (GOULSON et al. 2005). The overlapping adult generations and community structure skewed in favour of *J. pellucida* could however suggest competitive interactions.

This study provided a unique look at how the life cycles of Auchenorrhyncha differentiate *R. imitans* from others in its community. It illustrated that there are considerable overlaps in adult generations in both the cicadellid and delphacid groups. Phenology can help mediate competition between species, however it can also aggravate competition (DUDLEY et al. 1990). Moreover, phenology can be altered by climate change; thus leading to the uncoupling of phenological relationships, and a trophic mismatch (EDWARDS & RICHARDSON 2004). This is potentially more of an issue when one species is reliant upon the other; such as with pollinators and plants (KUDO & IDA 2013). Although understanding more about the interactions between those species that overlap – and those that do not – would enable a better understanding of how interactions drive the structure of similar grassland Auchenorrhyncha communities.

Detailed surveying of sites during delphacid peak abundance periods could help return more records for this species, certainly in the UK and potentially in the rest of Europe. Understanding more about the habitats and distributions of this species would enable a better understanding of rare species distributions in Auchenorrhyncha.

## Zusammenfassung

*Ribautodelphax imitans* (RIBAUT, 1953) (Hemiptera: Delphacidae) ist eine in ihrem gesamten Verbreitungsgebiet seltene Spornzikadenart, der in Großbritannien vorrangige Bedeutung im Naturschutz zukommt. Nach der Entdeckung eines Vorkommens der Art in Cambridge im Jahr 2010 wurde eine Studie zur Phänologie der Art und zu ihrer Einnischung in die lokale Zikadenartengemeinschaft durchgeführt. Dort ist die Art nicht selten, sondern eine der häufigsten Spornzikadenarten der Fläche, dominant ist allerdings *Javesella pellucida* (FABRICIUS, 1794). Der Grund für die Seltenheit von *R. imitans* auf nationaler Ebene bleibt unklar, möglicherweise sind starke interspezifische Interaktionen mit anderen zeitgleich auftretenden Arten ein wesentlicher Faktor.

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