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Cherrill, A. (2025) 'The Auchenorrhyncha (Hemiptera: Cicadomorpha and Fulgoromorpha) of Mose Farm, Shropshire: a baseline survey for the Sandscapes restoration project' *British Journal of Entomology and Natural History*, 38, pp. 207-226.

THE AUCHENORRHYNCHA (HEMIPTERA: CICADOMORPHA AND FULGOROMORPHA) OF MOSE FARM, SHROPSHIRE: A BASELINE SURVEY FOR THE SANDSCAPES RESTORATION PROJECT

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Abstract

A survey of Auchenorrhyncha was undertaken as a baseline for monitoring changes arising from a long-term landscape-scale restoration project at Mose Farm in Shropshire. Surveying was completed before work began to create a mosaic of acid grass-heath, scrub and species-rich grasslands. A total of 46 taxa were recorded, including several uncommon species new to the West Midlands. Rarefaction analyses suggested other species remained undetected at low frequency. There were no clear differences in the species composition across various grassland habitats and arable field margins, although arable field margins yielded a longer species list due, in part, to higher turnover (beta diversity) between sample sites. A small number of species were numerically dominant and indicative of nutrient enrichment. However, a range of species often associated with lowland dry acid grasslands were also present in low numbers. These may be expected to increase in abundance across the site as restoration progresses. Records of the Nationally Scarce species *Scottianella dalei* and *Ribautodelphax angulosa*, and the uncommon species, *R. imitans*, are discussed in relation to their known distributions and host plant preferences.

Introduction

The Auchenorrhyncha are numerically abundant in grassland and heath habitats (Waloff, 1980; Curry, 1987). They have potential to be useful indicators of environmental and botanical change because they are a relatively species rich group and include a mix of generalist and specialist species based on their requirements for feeding, oviposition, vegetation structure, and environmental conditions (Hollier *et al*., 2005). Previous studies have demonstrated that the Auchenorrhyncha respond to management in grasslands and other habitats (Morris, 1981, 1990; Morris & Plant, 1983), including habitat creation and restoration (Hollier *et al*., 1994; Nickel & Achtziger, 2005; Littlewood *et al*., 2006; Mulio & Cherrill, 2019). They are, however, less frequently studied as part of site assessments and monitoring programmes compared to other insect taxa, such as the Coleoptera (Drake *et al*., 2007).

There is growing emphasis on habitat and ecosystem restoration within the UK financed via Environmental Land Management Schemes, Biodiversity Net Gain and other mechanisms (POST, 2022a). Monitoring of insect assemblages can play a valuable role in assessing the effectiveness of management interventions (Majer *et al*., 2002). However, effective monitoring requires a rigorous baseline against which to monitor changes (Alexander, 2008).

The aim of the present study was to establish a baseline for the Auchenorrhyncha assemblage at the beginning of large-scale habitat creation at Mose Farm, Shropshire. The work has ambitious targets for creation of a range of habitats, but with a particular focus on mosaics of acid grass-heath, as part of the National

Trust's Sandscape Project within the West Midland's Mid Severn Sandstone Plateau National Character Area (Natural England, 2015). Mose Farm is predominantly arable, but also includes a range of permanent grasslands, hedges and small woods. The target is to create approximately 75 ha of dry acid grass-heath and scrub mosaic, alongside 25 ha of botanically rich meadows, funded through Countryside Stewardship payments. Within the National Character Area, lowland dry acid grassland and heathland are identified as priority opportunities for restoration and creation. There are an estimated 75 ha of lowland acid grassland and 266 ha of lowland heathland within the National Character Area (Natural England, 2015). Against this background, Mose Farm and the Sandscapes Project will make a significant contribution to the long-term enhancement of these habitats within the region.

Restoration at Mose Farm commenced in 2023 and is being delivered by a farmer on the National Trust's Dudmaston estate in partnership with the Sandscapes Project team. Successful establishment of the new habitats is expected to take many years (POST, 2022b). Central to management of the process is recording of an ecological baseline and subsequent monitoring. Repeat survey of the vegetation and associated invertebrates will form part of ongoing monitoring as the habitats develop. Baseline vegetation survey was undertaken in 2023 including habitat mapping and targeted botanical quadrating (Perry, 2023). More focused surveys were also undertaken for invertebrates (Jukes, 2023), including the Auchenorrhyncha for which results are presented in this paper.

The aims of the present paper are to provide a) a detailed inventory of the Auchenorrhyncha at Mose Farm, a typical lowland farm in the West Midlands, b) a baseline against which to monitor the progress of habitat creation, and c) to stimulate further studies on the long-term response of Auchenorrhyncha to landscape-scale restoration.

Study site

Mose Farm is located within the National Trust's Dudmaston estate in Shropshire (OS Grid Reference SO753912). Farming is focused on arable crops, although some grasslands are managed for hay and silage which is then sold off the farm.

The study area comprised 18 fields and 3 small mixed woodlands with a total area of approximately 90 ha (Fig. 1). A baseline survey of the habitat types using the UK Habitat Classification was conducted in the summer of 2023 (UKHab, 2023; Perry, 2023) and provides the habitat descriptions below. Soils are sandy in character and predominantly of the Bridgnorth Association comprising freely draining slightly acid sandy soils. The Salwick Association, a deep reddish loamy and slightly acidic soil, is also present. Soil pH measured at 22 points across 13 fields ranged from 5.8 to 7.0 with a mean and standard deviation of 5.8 ± 0.4. Soils of the Bridgnorth Association are typical of surviving heathland and acidic grasslands in the West Midlands. Heathland landscapes were present within the area until the early-nineteenth century when the land was enclosed (Chatters, 2021). Small areas persisted adjacent to the study site until the mid-twentieth century (Perry, 2023).

Of the 18 fields, ten were under arable cultivation, and eight were grasslands in 2023 (Fig. 1). The eight grassland fields were of three types within the UK Habitat Classification: Modified grassland (g4), *Arrhenatherum* neutral grassland (g3c5), and *Lolium-Cynosurus* neutral grassland (g3c6) (UKHab, 2023).

Modified grassland (g4): Two grassland fields had been managed as a Countryside Stewardship option (AB15 Fallow legume) for 3 (field 6276) and 10 years (field 8447)

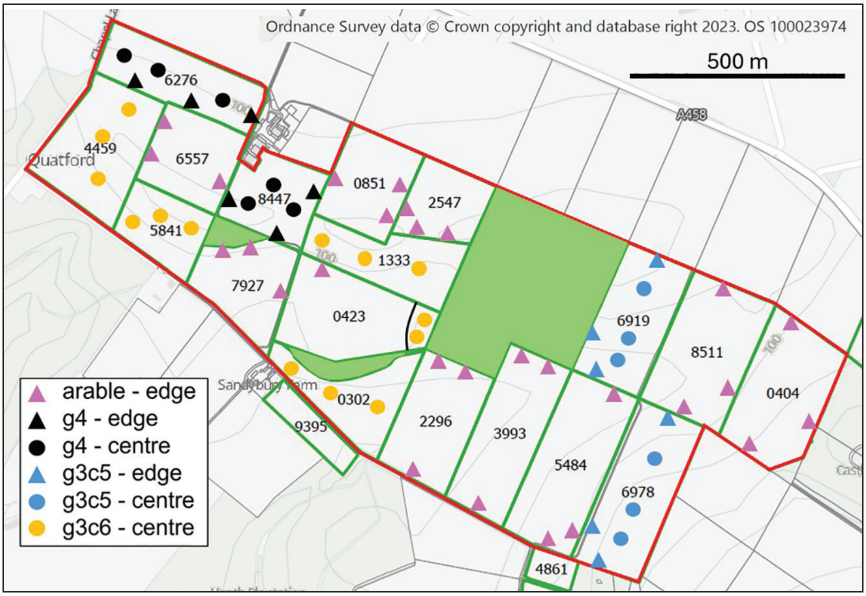

Fig. 1. The study area at Mose Farm (outlined in red) with the location of sample sites. The symbols show the habitat and whether samples were taken from the edges or centre of each field. Field boundaries are shown in green. Each field has a four-digit identifying number. Parcels shaded green are woodland. Field number 0423 was arable but had a small area managed as grassland (g3c6).

up to and including 2023. They had periodically been sown with a mix of herbs and perennial rye grass with a prescribed cutting regime. Species sown in the legume fallow such as *Lolium perenne* and *Trifolium pratense* were still present but other species had colonised since such as *Agrostis capillaris* and *Poa trivialis*. Notably in field 6276, where there are areas of bare ground, *Rumex acetosella, Erodium cicutarium, Hypochaeris radicata, Trifolium arvense* and *Anisantha diandra* had established. Field 8447 appeared to be more nutrient-rich and was dominated by grasses; species that had colonised this ley included *Anthoxanthum odoratum*, *Arrhenatherum elatius*, *Holcus lanatus*, *Poa pratensis*, and *Vulpia bromoides*. The long-term management goal for these fields, with a combined area of 8.5 ha, is to create acid grassland and heathland mosaics with Countryside Stewardship option LH3.

Arrhenatherum neutral grassland (g3c5): This vegetation type was recorded in two fields (6919 and 6978). They had been managed under various agri-environment options as ungrazed permanent grassland since being taken out of arable cultivation as set-aside in the mid-1990s. Management involved topping with a tractor mounted mower but without collection of the arisings. The fields were characterised by species associated with less frequent management such as *A. elatius* and *Dactylis glomerata*, along with *L. perenne*, *A. capillaris*, *H. lanatus*, *T. pratense*, *Heracleum sphondylium*, *Anthriscus sylvestris* and *Rubus fruticosus*. Steeper ground supported occasional *R. acetosella*, *Centaurium erythraea*, *Pilosella officinarum*, *Lotus corniculatus* and *T. arvense*. The long-term management goal for these fields, with combined area of

12 ha, is to create acid grassland and heathland mosaics with Countryside Stewardship option LH3.

Lolium-Cynosurus neutral grassland (g3c6): This group of permanent grasslands comprised four fields (0302, 1333, 4459 and 5841), plus a small area at the east end of the cultivated field 0423 (Fig. 1). This latter area of grassland was on a slope unsuitable for cultivation and adjacent to woodland. These fields are thought to have been managed as hay meadow for up to 50 years, with aftermath grazing in some years more recently. Field 0302, and the east end of 0423, may have been cultivated up to the early 2000s. The two titular species, *L. perenne* and *Cynosurus cristatus*, were present but not dominant. Common grasses included *A. capillaris*, *H. lanatus*, *A. odoratum*, *A. elatius*, *Bromus hordeaceus*, and *D. glomerata*. Typical herbs were *Plantago lanceolata*, *H. radicata*, *Trifolium repens*, *Rumex acetosa*, *Vicia sativa*, *Crepis capillaris*, *Jacobaea vulgaris*, *Trifolium dubium, Trifolium campestre* and *Ranunculus bulbosus*. Some species more typical of dry acid grassland were also locally frequent, namely *R. acetosella* and *T. arvense*. The long-term management goal is to enhance these fields, with a combined area of 17.5 ha, as species-rich hay meadows with Countryside Stewardship option GS7.

Grassland field boundaries and margins: Field boundaries in the grassland fields were predominantly hawthorn hedges, although some fields abut a woodland along one boundary (Fig. 1). The hedge-bottom flora included species typical of rank grassland such as *H. sphondylium, A. sylvestris* and *R. fruticosus*, plus a mix of grasses found in the adjacent grassland. In some cases, there were vehicle access tracks along the field edges which created greater variation in sward height and more bare ground than in the field centres.

Arable field margins: The ten arable fields, with a combined area of 50 ha, were cultivated in a rotation of maize, winter barley, overwinter stubble, spring barley, oil seed rape, winter barley, and cover crop finishing with spring barley sown in 2023. Inputs in 2023 were limited to facilitate depletion of soil nutrients, but sufficient to support a harvest in mid-summer. A small number of field margins were sufficiently wide, and distinctive, to be mapped as Modified grassland (g4), *Arrhenatherum* neutral grassland (g3c5), or *Lolium-Cynosurus* neutral (g3c6) grassland. Narrower margins were not classified but were collectively of the broad UK Habitat Classification category Other Neutral grassland (g3c) (which encompasses g3c5 and g3c6) (A. Perry, personal communication). Thus, arable margins were thought to be more variable than other habitat types, but data describing this variation was incomplete. As for the grasslands, arable field boundaries were predominantly hawthorn hedges with a similar hedge-bottom flora.

Leafhopper sampling

Selection of sample sites: Stratification of sampling effort across major habitat types was based on discussion with project staff and a preliminary walk-over. A total of 66 sample points were identified based on a combination of convenience in establishing a route around the site and selection of sites representative of the different habitats present. All sample sites were a minimum of 75 m apart.

The basic approach was to take six samples within each field – three from the edge and three from the centre. Exceptions were a) that samples were taken only from the edges of the ten arable fields because these contained a crop of spring barley, b) samples were taken from only the centre of each of the four *Lolium-Cynosurus* neutral grasslands destined to be retained as species-rich grassland, and c) within arable field 0423, two of the samples were reallocated to the small area of *Lolium-Cynosurus* neutral grassland that had not been identified during the author's preliminary walkover survey (Fig 1).

Sampling of Auchenorrhyncha species: Samples were taken at each site on two dates: 17th July and 9th or 10th August 2023 when the vegetation was dry to the touch, the temperature was above 20C, and there was no more than a gentle breeze. A sample comprised 50 sweeps of a sweep net with the net being emptied after the first, and second, series of 25 sweeps. Sweep net samples were emptied into labelled cotton bags and frozen on return to the laboratory prior to sorting.

Samples from the centre of each grassland field were taken at points which were at least 10 m from an edge. Samples were distributed approximately at equal intervals along each field's longest axis. In mid-summer 2023, several of the grasslands had plots (approximately 50 m by 50 m) ploughed to create bare ground as the first stage in habitat restoration. These plots were unvegetated and were avoided when sampling.

Samples from the edges of the two Modified grasslands and the two *Arrhenatherum* neutral grasslands, included the base of hedges (where not constrained by overhanging branches and snagging species, such as bramble) and 2 m into the field. In the arable fields, an edge sample comprised sweeping the base of the hedge and any vegetation up to the cereal crop.

The Modified grasslands (g4) (fields 6276 and 8447) and one of the *Arrhenatherum* neutral grasslands (g3c5) (field 6919) had been mown prior to sampling leaving the sward 10–15 cm high at the time of the first sample (rising to 15–20 cm at the second). The centres of these three fields, plus those of the second *Arrhenatherum* neutral grassland (g3c5) (field 6978), were therefore resampled on 19th July 2024 when none had been mown, and again on 5th August 2024, by which time only two fields (6276 and 6978) remained unmown. As in 2023, ploughed plots were avoided.

Identification of Auchenorrhyncha species: Species of Auchenorrhyncha were identified by examination of male genitalia (where males were available) using Biedermann & Niedringhaus (2009), Wilson *et al*. (2015), Le Quesne (1960, 1965, 1969) and Le Quesne & Payne (1981). Identifications of *Ribautodelphax* were confirmed by national authorities. Females that were difficult to identify were assigned to the same species as accompanying males but only when a single species had been identified within the genus across all sample sites and both years (e.g. *Psammotettix*). Where more than one species was identified within a genus based on male specimens, records of 'difficult' females were retained at the genus level (e.g. *Streptanus* and *Ribautodelphax*). Females of the genus *Javesella* were separated to species by examination of the genital lobe. Separation of male specimens of *Macrosteles ossiannilssoni* and *M. sexnotatus* based on genitalia proved to be difficult. Males of these species were confirmed based on dissection of the apodemes on the second abdominal sternite. Female *Macrosteles* were recorded to genus. Identification of *Aphrodes* species requires precise morphological measurements (Bluemel *et al*. 2014) which could not be achieved in this study. All specimens of *Aphrodes* were recorded to genus only. A single male of the genus *Eupteryx* was found and identification was uncertain. This male and the more numerous females were therefore recorded to genus only.

Data analysis

Preparation of the species inventory: Data from July and August in the same year were combined to create a single list of Auchenorrhyncha species for each site. The combined within-year data from July and August for a single site is hereafter referred to as a 'sample'.

National status of Auchenorrhyncha species: The national rarity status of each Auchenorrhyncha species, last updated in 2021, was taken from the website of the Auchenorrhyncha Recording Scheme (www.ledra.co.uk). Less common species are classified as Nationally Rare/Red Data Book (15 or fewer hectad records), Nationally Scarce (subdivided into Notable A and Notable B with 16–30 and 31–100 hectad records respectively), and Local (species of restricted distribution and specialised habitat requirements). Species considered to be new to Shropshire were identified via correspondence with the County Recorder.

Habitat associations of individual species: The habitat associations of Auchenorrhyncha were obtained from the Pantheon database and studies by Maczey (2004) and Maczey *et al*. (2005).

Pantheon is an online tool used in site evaluation based on invertebrate species inventories (Webb & Lott, 2006; Heaver *et al*., 2017). Within Pantheon, species are associated with a Broad Biotope, Habitat and Resource types including soil humidity (dry, damp, wet, or variable), soil type (e.g. clay, sand, chalk, or calcareous), and soil base-status (acidic or base-rich). In addition, species showing a strong affinity, and thought to be indicative of specific habitats in good ecological condition, are listed within a Specific Assemblage Type (SAT). Information for the study site was obtained by submitting the overall species inventory for both years combined to the Pantheon online platform (Biological Records Centre https://pantheon.brc.ac.uk). Assessment of site condition using the SATs requires information on additional taxa (such as Coleoptera) which is not available in this study, but species of Auchenorrhyncha listed within SATs were identified as being relevant to the long-term goal of establishing mosaics of semi-natural habitat.

Habitat associations of grassland Auchenorrhyncha in England have been classified by Maczey (2004) and Maczey *et al*. (2005) based on their review of a wide range of literature. In this study we have used associations identified in the autecological accounts of Maczey (2004) and Maczey *et al*. (2005) as follows:

1. Dry grassland specialists: species with a general preference for dry grassland habitats with no distinction between acidic and calcareous grasslands, although several species have a dual classification as both dry and calcareous grassland specialists. Here two such species, *Rhytistylus proceps* and *Mocydia crocea*, are listed under the broader dry grassland category.
2. Eurytopic species: generalist grassland species, not associated with dry, acidic or calcareous grasslands.
3. Nitrophilic species: a non-exclusive group of grassland species occurring in nutrient rich grasslands.

Habitat-based assemblages: Data for 2023 and 2024 were analysed separately. For each year, total numbers of specimens per sample site were tabulated for each species. Mean numbers and species' frequencies of occurrence were summarised for each habitat in each year. Species frequencies within habitats were calculated based on the percentage of sites occupied as follows: I=1–20%, II=20–40%, III=40–60%, IV=60–80%, V=80–100%.

Numbers of sites for each habitat in 2023 were: Arable edges (n=28), Modified g4 grasslands edge (n=6), Modified g4 grasslands centre (n=6), *Arrhenatherum* neutral g3c5 grasslands edge (n=6), *Arrhenatherum* neutral g3c5 grasslands centre (n=6), and *Lolium-Cynosurus* neutral g3c6 grasslands centre (n=14). Numbers of sites per habitat in 2024 were: Modified g4 grasslands centre (n=6), and *Arrhenatherum* neutral g3c5 grasslands edge (n=6).

Variation in the species composition of leafhopper assemblages between sample sites in 2023 was explored using ordination techniques (Pisces Conservation, 2019). Taxa with three or fewer specimens were omitted (Poos & Jackson, 2012). Initial analyses using Correspondence Analysis revealed a short primary axis (<3 SD) suggesting that a linear technique was most appropriate, but Principal Components Analysis did not yield an interpretable sample biplot, probably because species' abundances were weakly correlated and 78% of observations were zero. Detrended Correspondence Analysis (DCA) was therefore applied following guidance in Lepš & Šmilauer (2003) and Zelený (2022) with down weighting of rare species.

Species richness and rarefaction: Patterns of species richness between habitats were investigated using the survey data from 2023. The number of taxa at each sample site was recorded based on the number of taxa identified to species-level plus the number of taxa recorded to genus only. Lists were also compiled following the same approach to give estimates of the number of taxa for groups of sample sites defined by habitat. These counts, were used as simple, easily understood, measures of alpha and gamma diversity respectively. Variation in species composition between sample sites within a habitat (also known as species-turnover or beta diversity) was estimated by dividing gamma diversity by mean alpha diversity (Magurran, 1988).

Variation in numbers of specimens and alpha diversity between habitats was investigated using the Kruskal-Wallis test with post-hoc pairwise contrasts using IBM SPSS v29. Rarefaction was also used to explore variation in species richness between habitat types. The iNEXT programme was run with default endpoints, q=0 (for species richness), 40 knots and 1000 iterations (Chao *et al.*, 2016; Hsieh *et al.*, 2016). This approach is useful in assessing adequacy of sampling, and differences in species-richness between habitats, when there is variation in numbers of samples and numbers of specimens per sample.

Results

The species inventory: In total, 2046 adult Auchenorrhyncha were collected and identified in 2023 (Table 1). Forty-four taxa were recorded including *Aphrodes* and *Eupteryx* identified to genus only. The samples were numerically dominated by a small number of species. The four most abundant species represented 71% of all specimens, and only eight species were represented by more than 1% of specimens.

In 2024, a further 280 specimens were identified from resampling of the Modified grasslands (g4) and *Arrhenatherum* neutral grasslands (g3c5). Two additional species (*Scottianella dalei* and *Ribautodelphax imitans*) were recorded (Table 2) giving a total of 46 taxa for 2023 and 2024 combined.

National status of Auchenorrhyncha species: Most of the species identified were regarded as common, but there were nine Local species and two Nationally Scarce species (*S. dalei* and *R. angulosa*) along with *R. imitans* (Tables 1 and 2). The latter is classed as Red Data Book Insufficiently Known (RDBK) (www.ledra.co.uk) indicating a suspicion it belongs to one of the RDB threat categories. The species is, however, now known to be more common than suspected and its status awaits revision (M. Wilson, personal communication). It can, nonetheless, still be regarded as a nationally uncommon species. *Macrosteles ossiannilssoni* and the two species of *Ribautodelphax* were new to the County of Shropshire.

Four specimens of *S. dalei* were swept from one of the Modified grasslands (field 6276) (Fig 1) on 5^{th} August 2024 before the grass was mown. The same field had also

Table 1. Species recorded in 2023 with national status (C, common, L, local, NS, Nationally Scarce), habitat associations from Maczey (2004) and Maczey *et al.* (2005) (N, nitrophilic, E, eurytopic, D, dry grassland) and Pantheon (habitat, soil humidity and type), and frequency of sites occupied as % and increments: I = 1–20%, II = 20–40%, III = 40–60%, IV = 60–80%, V = 80–100%. Species are ordered according to the total number of specimens (N_{TOT}).

Species	Status	Maczey	Pantheon resources		N_{TOT}	Frequency	
			Habitat	Soil		%	I–V
Euscelis incisus (Kirschbaum 1858)	C	E,N	Tall sward	Dry	979	90.9	V
Psammotettix confinis (Dahlbom 1850)	C	E,N	Tall sward	Dry	245	60.6	IV
Errastunus ocellaris (Fallen 1806)	C	E,N	Tall sward	Dry	123	57.6	III
Javesella pellucida (Fabricius 1794)	C	E,N	Tall sward	Damp	111	62.1	IV
Balclutha punctata (Fabricius 1775)	C	–	Tall sward	Dry	84	48.5	III
Deltocephalus pulicaris (Fallen 1806)	C	E,N	Tall sward	Dry	67	37.9	II
Zyginidia scutellaris (Herrich-Schaffer 1838)	C	E	Tall sward	Dry	54	40.9	III
Macrosteles females Fieber 1866	C	–	–	–	52	33.3	II
Macrosteles ossiannilssoni Lindberg 1954	L	–	Wetland	–	20	12.1	I
Macrosteles sexnotatus (Fallen 1806)	C	–	Tall sward	Dry	7	6.1	I
Macrosteles viridigriseus (Edwards 1924)	C	E	Tall sward	Variable	1	1.5	I
Dicranotropis hamata (Boheman 1847)	C	E	Tall sward	Variable	39	21.2	II
Doratura stylata (Boheman 1847)	C	D	Tall sward	Dry – Basic	33	19.7	I
Hyledelphax elegantula (Boheman 1847)	C	D	Tall sward	Dry	23	3.0	I
Aphrodes Curtis 1831	–	–	–	–	19	18.2	I
Sardius argus (Marshall 1866)	L	–	Tall sward	Dry	18	13.6	I
Philaenus spumarius (Linnaeus 1758)	C	E	–	–	17	15.2	I
Javesella dubia (Kirschbaum 1868)	C	E	Tall sward	Damp	17	12.1	I
Cicadula persimilis (Edwards 1920)	C	E,N	Tall sward	Dry	16	15.2	I
Mocydiopsis parvicauda (Ribaut 1939)	L	–	Tall sward	Dry – Acidic	14	7.6	I
Arthaldeus pascuellus (Fallen 1826)	C	E	Tall sward	Dry	12	12.1	I
Graphocraerus ventralis (Fallen 1806)	L	–	Tall sward	–	12	12.1	I
Neophilaenus lineatus (Linnaeus 1758)	C	E	Tall sward	Dry	10	12.1	I
Eupteryx Curtis 1833	–	–	–	–	9	9.1	I
Ribautodelphax females W. Wagner 1963	–	–	–	–	6	6.1	I
Ribautodelphax angulosa (Ribaut 1953)	NS	–	–	–	4	3.0	I
Mocydia crocea (Herrich-Schaffer 1836)	C	D	Tall sward	–	6	9.1	I
Allygus mixtus (Fabricius 1794)	C	–	Tall sward	–	6	9.1	I
Eupelix cuspidata (Fabricius 1775)	C	D	Short sward	Dry	5	4.5	I
Kosswigianella exigua (Boheman 1849)	L	D	Short sward	Dry	5	6.1	I
Macropsis fuscula (Zetterstedt 1828)	L	–	Tall sward	Dry	4	4.5	I
Athysanus argentarius Metcalf 1955	C	E	Tall sward	–	4	4.5	I
Stenocranus minutus (Fabricius 1787)	C	E	Tall sward	–	3	1.5	I
Anaceratagallia venosa (Fallen 1806)	C	D	Tall sward	Dry	3	1.5	I
Streptanus females Ribaut 1842	–	–	–	–	2	3.0	I
Streptanus aemulans (Kirschbaum 1868)	C	E	Tall sward	Damp	1	1.5	I
Streptanus sordidus Zetterstedt 1828	C	E	Tall sward	Damp	1	1.5	I
Agallia consobrina Curtis 1833	C	E	Tall sward	–	2	3.0	I
Anoscopus albifrons (Linnaeus 1758)	C	E	Tall sward	Dry	2	3.0	I
Muirodelphax aubei (Perris 1857)	L	–	Short sward	Dry – Sand	2	1.5	I
Anaceratagallia ribauti Ossiannilsson 1938	L	D	Tall sward	Dry	2	3.0	I
Grypotes puncticollis (Herrich-Schaffer 1834)	L	–	Canopy	–	2	3.0	I
Thamnotettix dilutior (Kirschbaum 1868)	C	E	Scrub	Dry	2	1.5	I
Evacanthus interruptus (Linnaeus 1758)	C	E	Tall sward	Dry	1	1.5	I
Rhytistylus proceps (Kitschbaum 1868)	C	D	Tall sward	Dry – Acidic	1	1.5	I

been sampled, but after mowing and with no specimens found, on two dates in the previous year.

Two male *R. angulosa* were found on each of 17th July and 10th August 2023. These males were found in two of the five permanent grasslands managed as hay meadow and classed as *Lolium-Cynosurus* neutral grassland (g3c6) (fields 0302 and 4459) (Fig. 1). The males were accompanied by five *Ribautodelphax* females, with another female found in a third *Lolium-Cynosurus* neutral grassland (field 1333). These fields were not sampled in the following year, but in 2024 two males (with two *Ribautodelphax* females) were swept from one of the *Arrhenatherum* neutral grasslands (g3c5) (field 6919) on 19th July.

In 2024, one male *Ribautodelphax imitans* was found on each of 19th July and 5th August from one of the resampled Modified grasslands (g4) (field 8447), with a *Ribautodelphax* female also found on 19th July.

Habitat associations of individual species: Within the Pantheon database, most species recorded in 2023 were associated with tall grassland swards and dry soils. Soil base-status featured for three species: *Mocydiopsis parvicauda* and *Rhytistylus proceps* were associated with acidic soils and *Doratura stylata* was associated with basic soils (Table 1). Two species, *Allygus mixtus* and *Thamnotettix dilutior*, were listed in the SAT for Scrub edges (F001); both being associated with scrub. One species, *Muirodelphax aubei*, was listed within the SAT for Bare sand and chalk (F111). No species were listed within other SAT of relevance to the long-term establishment of heathland habitats (namely Scrub heath and moorland F003 and Open short sward F112).

The more limited sampling in 2024, recorded *S. dalei*, a further species associated with tall grassland swards and dry soils, and *R. imitans* listed within Pantheon as being associated with dry, basic soils.

Information on habitat associations within Maczey (2004) and Maczey *et al.* (2005) were not available for all species, but the four most abundant species, and five of the six most abundant species recorded in 2023 were classified as nitrophiles indicative of eutrophic grassland (Table 1). The most abundant species were also classified as being eurytopic habitat generalists. Among the less frequently recorded species, the majority were eurytopic, but there were also nine species classed as dry grassland specialists (including *R. imitans*, recorded in 2024 only, which Maczey (2004) classed as a calcareous grassland specialist).

Habitat-based assemblages: In terms of the most frequently recorded species, there were no consistent differences in species composition between habitats (Table 3). Across all habitats sampled in 2023, the dominant species in each habitat (Table 3) broadly paralleled the overall pattern described in Table 1 for the whole study site. *Euscelis incisus* was both the most abundant, and most frequent, species in all habitats except field-centre samples of the Modified grasslands (g4). In 2023, this species was particularly abundant in samples from the *Lolium-Cynosurus* neutral grasslands (g3c6) and *Arrhenatherum* neutral grasslands (g3c5) (Table 3). This was reflected in the significantly larger total number of specimens collected from these sites in comparison to arable edges and modified grassland (g4) (Table 4). Repeat sampling of Modified grassland (g4) and *Arrhenatherum* neutral grassland (g3c5) in 2024 revealed results consistent with those from the previous year, albeit with the addition of the two uncommon species *S. dalei* and *R. imitans* (Table 2).

When running the DCA ordination analysis, fourteen taxa with three or fewer specimens were omitted (see Table 1). Eigen values for the first four axes were: 0.385, 0.215, 0.172, and 0.103, respectively, indicating a high proportion of the variation was explained by axis 1. Overall, the samples-biplot based on the first two axes

Table 2. Mean numbers of individuals of each species per site, their frequencies, and total numbers (N_{TOT}) within g4 and g3c5 habitats in 2024. The number of sample sites for each habitat (n) is shown at the head of each column. Species rankings are as in Table 1 with the addition of *Scottianella dalei* (Scott 1870) and *Ribautodelphax imitans* (Ribaut 1953) which were not recorded in 2023. Frequency across sites (I–V) is as defined in Table 1.

Species	UK Hab g4 Centre n = 6		UK Hab g3c5 Centre n = 6		N_{TOT} n = 12
	$\bar{x}$	*Freq*	$\bar{x}$	*Freq*	
Euscelis incisus	6.7	V	7.7	V	86
Psammotettix confinis	3.7	V	0.2	I	23
Errastunus ocellaris	0.8	II	1.0	III	11
Javesella pellucida	4.3	V	12.3	V	100
Deltocephalus pulicaris	1.5	II	–	–	9
Zyginidia scutellaris	0.8	IV	0.5	III	8
Macrosteles females	0.5	I	0.5	I	6
Macrosteles ossiannilssoni	0.2	I	–	–	1
Macrosteles sexnotatus	–	–	0.2	I	1
Dicranotropis hamata	–	–	0.7	III	4
Aphrodes sp.	0.3	I	0.3	II	4
Philaenus spumarius	–	–	0.2	I	1
Javesella dubia	0.3	I	–	–	2
Arthaldeus pascuellus	0.2	I	–	–	1
Graphocraerus ventralis	–	–	0.2	I	1
Neophilaenus lineatus	0.2	I	–	–	1
Eupteryx sp.	–	–	0.2	I	1
Ribautodelphax females	0.2	I	0.3	I	3
Ribautodelphax angulosa	–	–	0.3	I	2
Ribautodelphax imitans	0.3	II	–	–	2
Macropsis fuscula	0.2	I	–	–	1
Stenocranus minutus	–	–	0.2	I	1
Streptanus sordidus	–	–	0.2	I	1
Agallia consobrina	0.2	I	–	–	1
Anoscopus albifrons	0.2	I	–	–	1
Anaceratagallia ribauti	0.7	III	–	–	4
Scottianella dalei	0.7	I	–	–	4
Total number of specimens	131		149		280

(Fig. 2) confirmed there was a high degree of overlap between habitats in terms of their leafhopper assemblages. Assemblages from arable edges were more variable than those from other habitats as indicated by the wider spread of these sites in ordination space.

Interpreting the species-biplot (Fig. 3) in the context of mean abundance and frequencies for species in habitats (Table 3) is difficult because of the weak clustering of assemblages by habitat. In terms of the most abundant and frequent species, axis 1 represented a gradient of increasing abundance of *P. confinis*, *D. pulicaris* and *Z. scutellaris* but declining abundance of *E. incisus* (Fig. 3). The second axis represented a gradient of increasing abundance of *E. ocellaris*, and declining abundance of *B. punctata*. The tendency for *Arrhenatherum* neutral (g3c5) grasslands to have relatively low scores on axis 1 (Fig. 2) is reflected in the relatively high abundance of *E. incisus*, and low abundance of *P. confinis* and *Z. scutellaris* in these

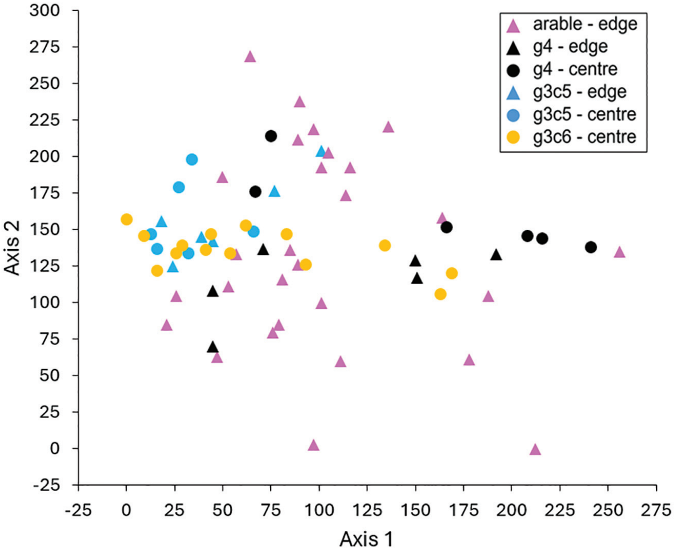

Fig. 2. DCA sample biplot showing the relative similarity of sample sites based on leafhopper assemblages. The symbols show the habitat and whether samples were taken from the edges or centre of each field.

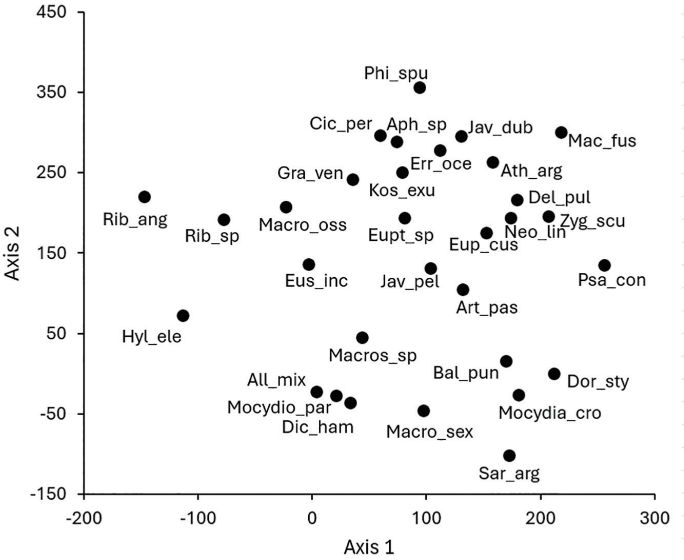

Figure 3. DCA species biplot showing the relative similarity of species distributions across samples. Species are labelled with abbreviated genus and species name based on Table 1. A suffix of 'sp' is used where specimens were identified to genus only.

Table 3. Mean numbers of individuals of each species per site (+ = < 0.1) and their frequencies within habitats in 2023. The number of sample sites (n) for each habitat is shown at the head of each column. Species ranking and frequency scores are as in Table 1.

Species	Arable Edge n = 28		UK Hab g4 Centre n = 6		UK Hab g4 Edge n = 6		UK Hab g3c5 Centre n = 6		UK Hab g3c5 Edge n = 6		UK Hab g3c6 Centre n = 14	
	x̄	Freq	x̄	Freq	x̄	Freq	x̄	Freq	x̄	Freq	x̄	Freq
Euscelis incisus	5.8	IV	4.8	V	6.3	V	35.0	V	29.2	V	26.0	V
Psammotettix confinis	2.0	III	12.8	V	4.5	V	1.5	III	2.7	V	4.2	IV
Errastunus ocellaris	1.4	III	6.2	IV	0.7	IV	1.3	III	3.8	V	0.9	III
Javesella pellucida	1.3	III	1.3	V	3.2	IV	0.8	IV	1.7	IV	2.4	IV
Balclutha punctata	1.3	III	–	–	3.3	V	0.2	I	1.0	IV	1.5	III
Deltocephalus pulicaris	0.8	II	1.2	IV	0.8	II	0.2	I	0.2	I	2.1	IV
Zyginidia scutellaris	0.9	II	1.2	V	1.2	III	1.0	II	0.5	III	0.5	II
Macrosteles females	0.5	II	1.7	II	0.8	II	1.0	III	1.0	III	0.7	II
Macrosteles ossiannilssoni	+	I	1.3	II	–	–	0.8	I	0.5	II	0.2	I
Macrosteles sexnotatus	0.2	I	0.3	I	–	–	–	–	–	–	–	–
Macrosteles viridigresus	–	–	–	–	–	–	–	–	0.2	I	–	–
Dicranotropis hamata	0.6	II	–	–	1.2	II	–	–	1.3	III	0.4	I
Doratura stylata	0.4	II	–	–	0.3	II	0.5	I	–	–	1.1	II
Hyledelphax elegantula	–	–	–	–	–	–	–	–	–	–	1.6	I
Aphrodes sp.	0.2	I	0.2	I	–	–	0.3	I	0.5	I	0.6	II
Sardius argus	0.4	I	0.3	I	–	–	–	–	–	–	0.4	II
Philaenus spumarius	0.5	II	–	–	–	–	0.2	I	0.3	II	0.1	I
Javesella dubia	0.1	I	–	–	0.3	I	–	–	1.3	I	0.3	II
Cicadula persimilis	0.2	I	–	–	0.2	I	0.8	III	0.8	III	–	–
Mocydiopsis parvicauda	0.5	I	–	–	0.2	I	–	–	–	–	–	–
Arthaldeus pascuellus	0.3	I	–	–	–	–	–	–	–	–	0.3	II
Graphocraerus ventralis	+	I	–	–	–	–	0.7	II	0.3	II	0.4	II
Neophilaenus lineatus	+	I	–	–	0.5	II	–	–	0.2	I	0.4	II
Eupteryx sp.	0.1	I	–	–	0.2	I	–	–	0.8	II	–	–
Ribautodelphax females	–	–	–	–	–	–	–	–	–	–	0.4	II
Ribautodelphax angulosa	–	–	–	–	–	–	–	–	–	–	0.4	II
Mocydia crocea	0.1	I	–	–	0.2	I	–	–	0.2	I	–	–
Allygus mixtus	0.1	I	–	–	–	–	–	–	0.2	I	0.1	I
Eupelix cuspidata	–	–	–	–	0.2	I	0.5	I	–	–	0.1	I
Kosswigianella exigua	0.1	I	–	–	–	–	–	–	–	–	0.1	I
Macropsis fuscula	0.1	I	–	–	–	–	–	–	–	–	–	–
Athysanus argentarius	0.1	I	–	–	–	–	–	–	0.2	I	–	–
Stenocranus minutus	0.1	I	–	–	–	–	–	–	–	–	–	–
Anaceratagallia venosa	–	–	–	–	–	–	0.5	I	–	–	–	–
Streptanus females	0.1	I	–	–	–	–	–	–	–	–	–	–
Streptanus aemulans	–	–	–	–	–	–	–	–	–	–	0.1	I
Streptanus sordidus	+	I	–	–	–	–	–	–	–	–	–	–
Agallia consobrina	+	I	0.2	I	–	–	–	–	–	–	–	–
Anoscopus albifrons	+	I	0.2	I	–	–	–	–	–	–	–	–
Muirodelphax aubei	0.1	I	–	–	–	–	–	–	–	–	–	–
Anaceratagallia ribauti	–	–	–	–	0.3	I	–	–	–	–	–	–
Grypotes puncticollis	–	–	–	–	–	–	–	–	0.3	II	–	–
Thamnotettix dilutior	0.1	I	–	–	–	–	–	–	–	–	–	–
Evacanthus interruptus	–	–	–	–	–	–	–	–	–	–	0.1	I
Rhytistylus proceps	–	–	–	–	–	–	–	–	0.2	I	–	–

Table 4. Total and mean numbers of specimens within each habitat in 2023 with alpha, beta and gamma diversity indices. The number of sample sites of each habitat is shown at the head of the column. Means on the same row with the same superscript letter are not significantly different in comparisons between habitats (based on the Kruskal-Wallis test, $P < 0.05$).

	Arable	UKHab g4		UKHabg3c5		UKHabg3c6	All
	Edge	Centre	Edge	Centre	Edge	Centre	sites
	n = 28	n = 6	n = 6	n = 6	n = 6	n = 14	n = 66
Total number of specimens	520	190	146	272	284	634	2046
Mean number of specimens (±SD)	18.6 ± 17.8[a]	31.7 ± 13.8[b]	24.3 ± 11.3[ab]	45.3 ± 36.7[b]	47.3 ± 24.1[b]	45.3 ± 28.9[b]	31.0 ± 25.1
Mean number of taxa (±SD) (alpha diversity)	6.2 ± 3.4[a]	6.0 ± 2.2[a]	7.5 ± 1.9[a]	5.5 ± 2.3[a]	9.0 ± 2.1[a]	7.5 ± 2.3[a]	6.8 ± 2.9
Species turnover (beta diversity)	5.2	2.0	2.4	2.7	2.4	3.2	6.2
Total number of taxa (gamma diversity)	32	12	18	15	22	24	42

sites (Table 3). Likewise, the tendency for samples from the centres of the Modified (g4) grasslands to have higher axis 2 scores compared to samples from the edges of these fields is reflected in the relative abundances of *E. ocellaris* and *B. punctata* (Table 3).

Species diversity: The mean number of taxa recorded per sample in 2023 (alpha diversity) did not differ between habitats (Table 4), although the inventories for each habitat (gamma diversity) varied from 12 species (Modified grassland g4) to 32 (arable edges). Most species occurred in low numbers and with low frequency (Table 1), hence gamma diversity within a habitat was dependent on the number of specimens captured, the number of sites sampled, and turnover in species composition between sample sites (beta diversity) (Table 4). For arable edges, the large number of sample sites, combined with high beta diversity (also evident in Fig. 2), contributed to the long list of species obtained, despite numbers of specimens per sample being relatively low (Table 4). Conversely, the lower estimates of gamma diversity for the centres of the Modified (g4) and *Arrhenatherum* neutral (g3c5) grasslands reflected both smaller numbers of samples and lower beta diversity, despite numbers of specimens per sample being higher than for arable edges (Table 4). In this context, rarefaction is a useful tool to explore relationships between gamma diversity and the numbers of specimens captured, although in this study the influence of the latter cannot be disentangled from the effects of beta diversity. Rarefaction also provides insights into the likelihood that further taxa were undetected.

The rarefaction curves for each habitat, based on sampling in 2023, show extrapolated estimates of gamma diversity continuing to rise beyond the total number of specimens obtained (Fig. 4). This suggests that continued sampling would have yielded further taxa within each habitat, albeit that these undetected species would likely have been represented by small numbers of individuals. Estimates of the number of species rose most rapidly with increasing sample size for arable edges. Pairs of rarefaction curves with non-overlapping 95% confidence intervals can be interpreted as being significantly different. Arable edges were significantly more diverse than the centres of Modified grasslands (g4) and centres of *Arrhenatherum* neutral grasslands (g3c5) (Fig. 4).

Overall, there was a tendency for 'edge samples' to be more diverse than those taken from field centres, although the centres of *Lolium-Cynosurus* neutral grasslands (g3c6) were of comparable diversity to the edges of the other two grassland habitats (Table 4, Fig. 4).

Discussion

The study yielded an inventory of 46 taxa of Auchenorrhyncha including three species new to Shropshire: *M. ossiannilssoni*, *R. angulosa*, and *R. imitans* (Tables 1 and 2). Of these, *M. ossiannilssoni* is likely to be under recorded because of reliance on examination of the apodemes of the second abdominal sternite for separation from *M. sexnotatus*. Overall, nine species were found to be Local on a national scale. Two were Nationally Scarce (*S. dalei* and *R. angulosa*) and one was of uncertain status but nationally uncommon (*R. imitans*). The study site is a typical farm within the West Midlands hence the result highlights the relative paucity of records and the potential to extend the known distribution of many species through further survey within the region.

In common with other studies of Auchenorrhyncha, and ecological assemblages in general (Magurran, 1988), most species were found in low numbers (Dittrich & Helden, 2016; Brown *et al.*, 1992; Cherrill & Sanderson, 1994). The samples were dominated by a small number of species (Table 1). There was a tendency for species richness to be greater in 'edge' samples (Table 4, Fig. 4). Assemblages in arable margins were also more variable than in other habitats (Fig. 2). Both observations probably reflected the greater botanical and structural variation often associated with ecotones (Kark, 2013). This interpretation is supported by the baseline vegetation survey where more than one UKHab vegetation type was recorded within arable margins (Perry, 2023).

Rarefaction analysis suggests that further survey would have revealed the presence of additional species (Fig. 4). Any additional species were likely to have been found in very low numbers, although sampling with a sweep net may have underestimated the abundance and richness of species living close to the ground. Use of a vacuum sampler and pitfall traps may have yielded a different pattern of species abundance (Cherrill & Sanderson, 1994; Stewart, 2002).

The habitat associations of individual species suggest that the grasslands were relatively eutrophic (Table 1). The most frequent and abundant species were classed as eurytopic and nitrophilic associated with nutrient enriched grassland. The majority of species were also associated with tall swards and dry soils, with a number of species classed as dry grassland specialists. These results accord with site conditions in the baseline survey (Perry, 2023). The study site is a commercial farm where the soils are predominantly dry, sandy and free draining. Arable field margins comprised tall, rank vegetation, while the *Lolium-Cynosurus* neutral grasslands (g3c6) were managed with a single annual hay-cut. The Modified grasslands (g4) and *Arrhenatherum* neutral grasslands (g3c5) were managed by topping several times per year rather than a full hay-cut. The most common species, *E. incisus*, is thought to benefit from moderate levels of cutting (Maczey, 2004) or grazing (Brown *et al.*, 1992).

Within Pantheon, and the autecological accounts of Maczey (2004), *P. confinis* and *E. ocellaris* are associated with tall grasses, avoiding short swards, although both species can occur in short acidic grassland (Waloff & Solomon, 1973). The most

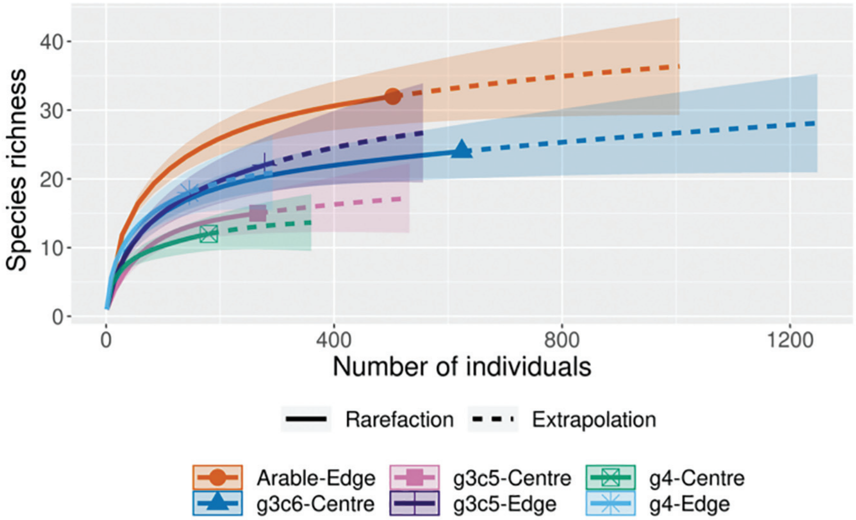

Figure 4. Rarefaction curves for each habitat based on species abundance data collected in 2023 at Mose Farm. The shaded envelope around each curve is the 95% Confidence Interval.

abundant planthopper, *J. pellucida*, is one of the few species consistently recorded from intensively managed grasslands and has a high dispersal ability (Waloff, 1973; Maczey, 2004; Reynolds *et al*., 2017). Dispersal may also contribute to the high frequencies of *B. punctata* and *Z. scutellaris*. Adult *B. punctata* overwinter on conifers before dispersing to feed on a range of grasses in the spring (Le Quesne, 1969; Nickel, 2003). The study site contained mixed woodlands and others were immediately adjacent (Fig 1). *Zyginidia scutellaris* is also a widespread species which has been recorded undergoing seasonal migration in Europe (della Giustina, 2002) and has been found in large numbers in aerial traps in England (Reynolds *et al*., 2017; Waloff, 1973).

The distribution of host plants used for feeding and oviposition have been shown to influence the composition of Auchenorrhyncha assemblages (Brown *et al*., 1992; Cherrill & Rushton, 1993; Sanderson *et al*., 1994). The present study failed to find clear differences in the assemblages of Auchenorrhyncha between the major habitats as defined using the UK Habitat Classification. The same few eurytopic, generalist species tended to dominate each of the habitats (Table 3). This may reflect the relatively broad nature of the habitat classification, and the fact that the grassland types, and arable margins, shared many plant species in common. It is tempting to associate the occurrence of some of the less frequently encountered species with a specific habitat. However, it is likely many of these species would be found more widely with further sampling, and others have a high dispersal ability and may be 'vagrants' (Waloff, 1973; Reynolds *et al*., 2017). Likewise, caution is required against over-interpretation of the higher abundance of *E. incisus* in the *Lolium*-*Cynosurus* neutral grasslands (g3c6) and *Arrhenatherum* neutral grasslands (g3c5) (Table 3). This may have reflected differences in vegetation structure since this can influence the susceptibility of specimens to capture by sweep netting (Stewart, 2002). It is, however, worth focusing on the records for the rarer species in the study, namely *S. dalei*, *R. angulosa*, and *R. imitans*.

Within the NBN Atlas, *S. dalei* has a distinctly southern distribution with the most northerly record being near Basildon in Essex, although the County Recorder reports a first record from Shropshire in 2022 (K. Fowler, personal communication). The field (6276) where it was recorded had been managed under agri-environment option AB15 Two-year legume fallow for three years up to 2023. This field has the poorest agricultural soils on the farm and is already reverting to semi-natural acidic grassland within patches of bare ground. Information on the ecology of *S. dalei* is limited. Biedermann and Niedringhaus (2009) gives 'moist sites' as a habitat in Germany, while Le Quesne (1969) notes the species as being characteristic of 'open places' in England. Within the Pantheon database, *S. dalei* is associated with tall swards and dry soils.

Scottianella dalei was recorded (using the name *Paraliburnia dalei*) within a detailed three-year study of the Auchenorrhyncha of an acidic grassland at Silwood Park, Berkshire (Waloff & Solomon 1973). In two years, *S. dalei* was found to be one of the ten most numerous species, although as in the present study, the samples were dominated by three or four species, and *S. dalei* was never one of the most abundant. Waloff & Solomon (1973) reared *S. dalei* through several generations on *Agrostis tenuis* (now *A. capillaris*) in cage experiments using potted plants. At Mose Farm, this grass was one of the most frequently recorded within the Modified grassland habitat and is widespread across Mose Farm. Kunz *et al*. (2011) also give *Festuca rubra* as a host in Germany. *Festuca rubra* occurred infrequently at Mose Farm but *F. ovina* is being sown with *Agrostis castellana*, a species often confused with *A. capillaris*, as part of habitat creation work raising the possibility that *S. dalei* may spread. The recent appearance of *S. dalei* in Shropshire may reflect expansion related to climate change or under-recording. The males are distinctive and easily identified (Kunz *et al*., 2011) hence range expansion appears a more likely explanation.

The presence of two species of *Ribautodelphax* merits further investigation. Both records represent significant expansions of their known range.

The host plant preferences of *Ribautodelphax* species were established by Bieman (1987) using field observations and caged monocultures of potential hosts in the Netherlands. *Ribautodelphax angulosa* is Nationally Scarce and are no NBN records in the Midlands or further north. *Ribautodelphax angulosa* is thought to be monophagic on *Anthoxanthum odoratum*. This grass is frequent across all habitats sampled at Mose Farm and so *R. angulosa* may be expected to be found more widely within the study site.

Ribautodelphax imitans is rare throughout its European range (Nickel & Remane, 2002; Dittrich, 2016). Although thought to be under-recorded (M. Wilson, personal communication), there are few records in the NBN and the species is listed in Section 41 of the NERC Act as a species of principal importance for nature conservation (Gov.UK, 2022). The planthopper is thought to be monophagic on *Schedonorus* (*Festuca*) *arundinaceus* although Bieman (1987) recorded some limited success when cultured on *Festuca rubra*. Field observations in the UK appear to confirm that the species is restricted to *S. arundinaceus* (Dittrich, 2016). The causes of the national rarity of *R. imitans* are not fully understood, but field observations and laboratory experiments suggest that competition with generalist species, such as *J. pellucida*, may be a factor (Dittrich & Helden, 2020). *Ribautodelphax imitans* was one of the most abundant species at a fen site in Cambridgeshire where *S. arundinaceus* was the dominant grass (Dittrich & Helden, 2016). The host plant is widespread in the UK and is typically associated with relatively damp, neutral or basic soils (Stace, 2019).

Schedonorus arundinaceus has not been recorded at Mose Farm, where the soil is dry and slightly acidic (Perry, 2023). Stace (2019) notes that *S. arundinaceus* was frequently used in hay meadow seed mixes and may persist in agricultural landscapes as relict populations. But the farmer at Mose reports that *S. arundinaceus* has not been sown for at least 50 years (M. Bebb, personal communication). Very few *R. imitans* were captured (Table 2) and this may reflect a similarly sparse occurrence of *S. arundinaceus*. It is also possible that *R. imitans* has an unknown alternative host.

Overall, the present study gives a snapshot of the Auchenorrhyncha on an arable farm in the West Midlands. The survey provides a baseline against which to monitor changes in the assemblage as landscape restoration progresses over future decades. Key target habitats in the National Trust's landscape restoration project are mosaics of acid grass-heath and scrub. Pantheon provides a list of Auchenorrhyncha species thought to be indicative of the Specific Assemblage Type (SAT) for Scrub heath and moorland (F003) and Open short sward (F112) in favourable ecological condition. Not surprisingly none of these species were recorded in this baseline study. However, two species found at Mose Farm are listed in the SAT for Scrub edges (F001) (*A. mixtus* and *T. dilutior*) and one species is listed within the SAT for Bare sand and chalk (F111) (*M. aubei)* (Table 1).

Many of the species recorded at Mose Farm appear to be typical of dry grasslands more generally (Table 1) and may increase their distribution, and abundance, within the study site as habitat creation progresses. For example, Nickel (2003) and Le Quesne (1969) give nutrient poor acid sites, including heath, as habitats for *S. argus* in central Europe and the UK respectively. In Shropshire, *A. albifrons* and *D. pulicaris* were abundant in samples from grazed dry grass heath on the Long Mynd (Zentane *et al*., 2016; Cherrill, unpublished data 2013–2015). Sampling of dry, acidic grass-heath mosaic at Kinver Edge found *P. confinis*, *D. pulicaris* and *Arthaldeus pascuellus* to be abundant, with *P. confinis* numerous in an adjacent hay meadow (Cherrill, unpublished data 2015). At Prees Heath Common, *D. stylata*, *E. cuspidata*, *A. albifrons*, *R. proceps*, *J. dubia*, *M. parvicauda*, *H. elegantula*, *K. exigua*, S. *aemulans*, *S. sordidus* and *Z. scutellaris* were present in a patchwork of remnant and restored acidic grassland and heath (Mulio & Cherrill, 2019). *Doratura stylata* also commonly occurs in acidic grasslands where its host plants are *A. capillaris* and *F. rubra* (Waloff & Solomon 1973), despite it being associated with basic soils in Pantheon (Table 1).

Further work, building on the Pantheon database, is required to clarify what an Auchenorrhyncha assemblage at an acidic grass-heath site in West Midlands would look like when in favourable condition. This will provide a benchmark against which to assess future monitoring results. Further work is therefore planned to investigate the assemblages on existing heaths within the surrounding National Character Area. Additional surveys at Mose Farm will focus on monitoring changes associated with the landscape restoration and obtaining a fuller understanding of the distribution and ecology of the Auchenorrhyncha species present.

Acknowledgements

This report would not have been possible without the help of the Sandscapes Project team: Martyn Bebb, James Lawrence, Sue Briggs, Ewan Chapman, and Andrew Perry. I am also grateful to Keith Fowler (County Recorder) for confirming new county records, Dr Alvin Helden and Prof Alan Stewart for assistance in confirming the identification of species of *Ribautodelphax*, and Dr Mike Wilson for information on the status of *Ribautodelphax imitans*.

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SHORT COMMUNICATION

Rare insects from an area of Sphagnum mire on Bodmin Moor, East Cornwall (VC2), including *Euconnus denticornis* (Müller, P. W. J. & Kunze, 1822) (Col., Staphylinidae: Scydmaeninae) new to Cornwall. – A Botanical Cornwall Group excursion to East Moor, Altarnum (SX2076), 22.viii.2025, enabled sampling of the insects associated with the extensive mire system along the western fringes. A sample of Sphagnum moss retained for later examination under a microscope was found to contain three tiny insects: the beetle *E. denticornis* and bug *Pachycoleus waltli* (Fieber) (Hemiptera: Dipsocoridae) – both with Nationally Rare status – as well as the uncommon Sphagnum bug *Hebrus ruficeps* Thomson (Hebridae). *E. denticornis* has never been reported from Cornwall previously while this is only the second Cornish record for *P. waltli* and the first from VC2. – KEITH N. A. ALEXANDER, 57 Treffry Road, Truro TR1 1WL, UK. Email: keith.n.a.alexander@outlook.com.