Leafhopper diversity in home gardens – results of a survey in four countries across Europe

(Hemiptera, Auchenorrhyncha)

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Summary: Despite urbanisation being one of the main drivers of habitat destruction and biodiversity loss, home gardens can provide habitat for a wide range of species. Here we report the results of a leafhopper survey in 12 gardens in four European countries (Germany, Serbia, Austria and Bulgaria). Sampling was conducted in a semi-standardised way across the summer 2020. In total, 143 Auchenorrhyncha species with 2,361 adult specimens were recorded, including several red-listed species. The number of species per garden varied between 9 and 58. On average, around 26 species were found. Leafhopper diversity was positively influenced by garden area, age, plant diversity, extensive management and the cover of forests and parks in the surroundings, but also by the number of sampling dates. We conclude that extensively managed home gardens across Europe can support diverse communities of leafhoppers which is crucial in times of severe insect declines.

Keywords: Fulgoromorpha, Cicadomorpha, home gardens, management intensity, plant diversity, urbanisation, Europe

1. Introduction

On a global scale, habitat destruction through urbanisation is considered as one of the main drivers of biodiversity loss (Grimm et al. 2008). By 2050, 80 % of the world's human population are expected to live in urban areas (United Nations Population Fund 2007). In urban areas, species assemblages are changing by the replacement of specialist species with generalists, leading to biotic homogenisation (McKinney 2002). Nevertheless, home gardens in villages and cities can provide habitat to a wide variety of plant species (Frey & Moretti 2019; Casanelles-Abella et al. 2021) and can host a diverse fauna, including pollinators (Majewska & Altizer 2020; Erickson et al. 2021), ground-dwelling invertebrates (Braschler et al. 2020) and birds (Chamberlain et al. 2004). This could also help mitigate the sharp decline in biodiversity documented from agricultural landscapes e.g. by Schuch et al. (2012), Hallmann et al. (2017), Leather (2018) and Kamp et al. (2021).

However, knowledge about the diversity and species composition of leafhoppers (Auchenorrhyncha) occurring in gardens is still limited. Their diversity is likely to be linked with plant diversity and management intensity including the mowing frequency of lawns, pesticide use and whether native or non-native plant species are prioritised. Therefore, the aim of this study was to collect data on leafhoppers in gardens across Europe and to assess the effects of management intensity, plant diversity, garden age and the surrounding landscape on their diversity and species composition.

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2. Study sites

2.1 Locations of the studied gardens

Due to restrictions to move and travel during the Covid-19 pandemic, we launched a joint project of the Arbeitskreis Zikaden Mitteleuropas e. V. (Central European Auchenorrhyncha Working Group) and decided to record the leafhopper fauna of our immediate surroundings, i.e., our home gardens. Finally, 12 gardens in four European countries were sampled: Eight of the gardens were located in Germany (one garden each in Burscheid, Frauenau, Göttingen, Konradsreuth, Langenfeld and Leipzig and two gardens in Landau/Pfalz), two in Serbia (Ribare, Zemun), one in Austria (Stetteldorf) and one in Bulgaria (Selyanin) (Fig. 1, Table 1). Six gardens were located in the centre or suburb of a city (> 15,000 inhabitants) and six in villages (< 4,000 inhabitants) or next to single houses (Table 1).

2.2 Characteristics of the studied gardens

The characteristics of the studied gardens and their surroundings were assessed via questionnaires that every participant completed (see summary in Table 1). Garden size varied between 100 and 4,690m^2. The lawn area that was sampled ranged from 30 to 1,100 m^2. Cover of woody species ranged from 10 to 75 %. The age of the gardens ranged between 5 and 120 years. In most cases (n = 8), garden lawns were mown between three and five times per year, the rest (n = 4) were mown between 6 and 10 times a year (Table 1). Plant species diversity of the lawns differed between "species poor" (< 10 plant species, 3 gardens), "intermediate" (10 – 20 species, 5 gardens) and "diverse" (> 20 species, 4 gardens). On average, within a radius of 500 meters around the gardens, residential areas were the predominant type of land use (45% of the area), followed by parks/forests (16%), sealed surfaces (13%), arable fields (13%), grassland (9%), other habitats (4%), and industry (2%). In total, the gardens thus represented a broad spectrum in terms of size, age, management and landscape context (Fig. 2).

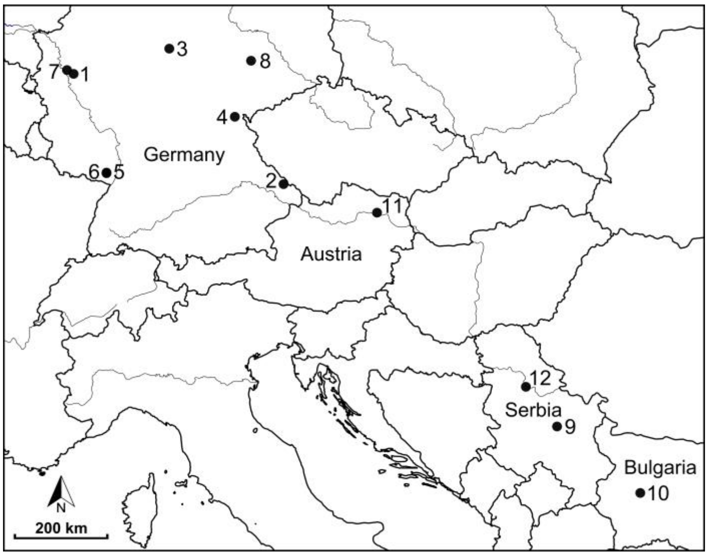

Fig. 1: Locations of the 12 gardens studied during the survey in 2020. Black lines: outlines of countries, grey lines: large rivers.

Fig. 2: Examples of the gardens that were sampled in this study: (a) Göttingen (G3), (b) Konradsreuth (G4), (c) Frauenau (G2), (d) Landau (G5), (e) Langenfeld (G7), (f) Stetteldorf (G11), (g) Ribare (G9), (h) Selyanin (G10). Photos: (a) S. Schuch, (b) R. Achtziger, (c) R. Biedermann, (d) V. Rösch, (e) F. Helbing, (f) A. Sára, (g) M. Jakovljević, (h) I. Gjonov.

Table 1: Garden characterisation: (a) General information: garden number (No), sampling location, name of cicadologist (name): FH = F. Helbing, RB = R. Biedermann, SS = S. Schuch, RA = R. Achtziger, VR = V. Rösch, ME = M. H. Entling, RvK = R. van Klink, MJ = M. Jakovljević, IG = I. Gjonov, AHS = A. and H. Sará, SM = S. Marinković; country (coun.), geographic coordinates (N/E), number of inhabitants (Inh.); (b) Leafhopper sampling: number of sampling dates in 2020 and sampling methods used, *only the lawn area was sampled; (c) Garden characterisation: total garden area (m²), lawn area (m²), lawn area that was sampled (m²). number of cuts per year, plant diversity of lawn: species poor (poor, < 10 species), intermediate (int, 10-20 species), diverse (div, > 20 species), cover of woody species (%), garden age (years); (d) Landscape context: Urbanity: v = village, sh = single house, su = suburb, cc = city centre; land cover adjacent to garden (%): park/forest, sealed surfaces, residential areas, industry, arable land, grassland, other.

(a) General information							**(b) Leafhopper sampling**				**(c) Garden characterisation**								**(d) Landscape context**							
No	**Location**	**name**	**coun.**	**N**	**E**	**Inh.**	**Number of sampling dates**	**Sweep netting**	**Hand catches**	**Suction sampling**	**Total garden area (m²)**	**Area of flower/veg beds (m²)**	**Lawn area (m²)**	**Lawn area sampled (m²)**	**Number of cuts / year**	**Plant diversity of lawn**	**Cover of woody species (%)**	**Garden age (years)**	**Urbanity**	**Park/Forest**	**Sealed surfaces**	**Residential areas**	**Industry**	**Arable land**	**Grassland**	**Other**
G1	Burscheid	FH	D	51.093453	7.147586	18,603	4	x	-	x	283	7	255	255	9	int	20	27	v	29	6	29	4	11	22	.
G2	Frauenau	RB	D	48.980480	13.292350	2,600	8	x	-	-	2000	100	600	600	5	div	20	50	sh	70	5	5	.	.	.	20
G3	Göttingen	SS	D	51.545310	9.947576	120,000	5	x	x	-	800	100	400	400	3.5	int	40	70	su	.	25	75	.	.	.	.
G4	Konradsreuth	RA	D	50.273931	11.846067	2,500	4	x	x	-	350	200	50	50	4	poor	75	45	v	.	.	75	.	.	.	25
G5	Landau 1	VR	D	49.201789	8.108235	46,881	5	x	x	-	370	200	80	80	3	div	25	100	cc	35	40	25	.	.	.	.
G6	Landau 2	ME	D	49.189863	8.099742	46,881	4	x	x	-	1,000	500	500	500	4	div	20	80	su	.	10	60	.	30	.	.
G7	Langenfeld	FH	D	51.138289	6.956375	59,178	4	x	-	x	101	63	31	31	4	poor	25	43	su	6	12	46	19	10	7	.
G8	Leipzig	RvK	D	51.320715	12.340147	600,000	6	x	x	-	366	34	232	232	8	int	10	120	cc	10	20	70	.	.	.	.
G9	Ribare	MJ	SRB	44.008803	21.282986	3,600	4*	x	x	-	2,600	1,500	1,000	30	6	int	30	40	v	.	.	50	.	25	25	.
G10	Selyanin	IG	BG	42.573177	23.720329	NA	5	x	-	x	1,650	550	1,100	1,100	4	int	30	40	v	50	20	30	.	.	.	.
G11	Stetteldorf	AHS	A	48.411678	16.018260	1,057	2	x	-	x	750	550	200	200	5	poor	50	5	v	.	15	20	.	65	.	.
G12	Zemun	SM, MJ	SRB	44.855050	20.377378	157,367	4*	x	x	-	4,690	4,100	3,500	30	10	div	20	65	su	.	.	50	.	.	50	.

3. Methods

3.1 Sampling methods

Samples were taken at least once per month from June to September 2020. In half of the gardens, 4 samplings were taken. In the other half, sampling occurred on 2, 5, 6 or 8 dates (Table 1). The sampling effort was not standardised but aimed at capturing all the leafhopper species present in each garden. Therefore, both the herbaceous vegetation in lawns and – with the exception of the two Serbian gardens (G9 and G12) – flower/vegetable beds as well as trees, hedges and shrubs were sampled. Sweep net samples were complemented by hand catches and in some cases (n = 3) suction sampling (Table 1).

3.2 Species identification

Leafhoppers were identified using Holzinger et al. (2003), Biedermann & Niedringhaus (2004), Kunz et al. (2011) and several original descriptions (for Bulgaria). The identification to species level of female specimens of several genera is not possible (Biedermann & Niedringhaus, 2004). Thus, if male specimens were present, females were assigned to the same species. If no males were found, females were only identified to genus level. If males of more than one species of a genus were present, the number of females was assumed to mirror that of males. The species' Red List status in Germany was derived from Nickel et al. (2016), for Austria from Holzinger (2009), information on host specificity and preferred vegetation stratum refers to Nickel & Remane (2002).

3.3 Data analysis

Since sampling was conducted in a non-standardised way, abundances are hard to compare between gardens. Therefore, we only analysed the species richness. In order to analyse possible relationships between leafhopper diversity and selected garden parameters, we used Spearman rank correlations, Kruskal-Wallis tests and Mann-Whitney-U-tests from the software package StatGraphics Centurion XVIII (StatGraphics Technologies, Inc. 1982-2018). These non-parametric statistical tests which have a lower sensitivity towards outliers were used since our sample size was low and the data were not normally distributed. In the two gardens from Serbia (G9 and G12) only the lawn area but no trees or shrubs were sampled. Therefore, they were only analysed concerning the leafhopper diversity of the herb layer (Table 2), but not for total species richness or species of woody plants. Due to the low overall sample size (n = 12), test results were regarded as significant if $p < 0.10$.

4. Results

4.1 Auchenorrhyncha diversity and composition

4.1.1 Species characteristics

In total, 143 Auchenorrhyncha species with 2,361 adult specimens were recorded in the 12 gardens in Germany, Austria, Serbia and Bulgaria (Table A1). 97 species (68 %) of the gardens' fauna are known to live in the herb layer, 41 species (28 %) in the tree and shrub layer and 5 species (3 %) migrate from herb to tree layer during their life cycle (Nickel 2003).

Across the German and Austrian gardens, 16 red-listed species were found, most of them in the Red List category near threatened (Holzinger 2009, Nickel et al. 2016), including *Hardya* *tenuis* (Fig. 3) and *Tettigometra virescens* (Fig. 4). However, the number of red-listed species per garden was low (0 to 4 species).

Non-native species were *Orientus ishidae* (from East Asia, in 3 gardens), *Graphocephala fennahi* (4 gardens), *Stictocephala bisonia* (2 gardens, both Nearctic origin) and *Hishimonus hamatus* (1 garden, from Asia). The latter was recorded in Landau, which is close to Neustadt a. d. Weinstraße where the species was first recorded in Germany in 2020 (Winterhagen, 2020). Also in Landau, *Synophropsis lauri* was found, which is one of the first records of this species for the federal state of Rhineland-Palatinate.

4.1.2 Species frequency and abundances

The most commonly found species across all gardens were *Deltocephalus pulicaris* (occurring in 10 of 12 gardens), *Arthaldeus pascuellus* (8), *Anaceratagallia ribauti* (8), *Psammotettix confinis* (7) and *Euscelis incisus* (7). These species are all widespread and abundant in meadows, pastures, lawns and other intensively managed grassland types in Central Europe (Nickel & Achtziger 1999, Nickel 2003). 52 % of the 143 leafhopper species were found in only one garden, followed by 27 species (19 %) in two, 18 species (13 %) in three and 13 species (9 %) in four gardens (Fig. 5).

The five most abundant species were *Deltocephalus pulicaris* (972 individuals, in 10 gardens), *Psammotettix confinis* (283 individuals, in 7 gardens), *Arocephalus languidus* (170 individuals, only in 1 garden), *Errastunus ocellaris* (156 individuals, in 2 gardens) and *Eupteryx decemnotata* (120 individuals, in 5 gardens) (see Table A1, Appendix). The total number of individuals sampled ranged from 36 (G3, Göttingen) to 1,206 (G10, Selyanin) (Table 2).

Fig. 3: *Hardya tenuis* was found in Leipzig; it is listed as vulnerable in Germany (photo: G. Kunz).

Fig. 4: *Tettigometra virescens* was found in the two gardens in Landau. The species is listed as endangered in Germany (photo: G. Kunz).

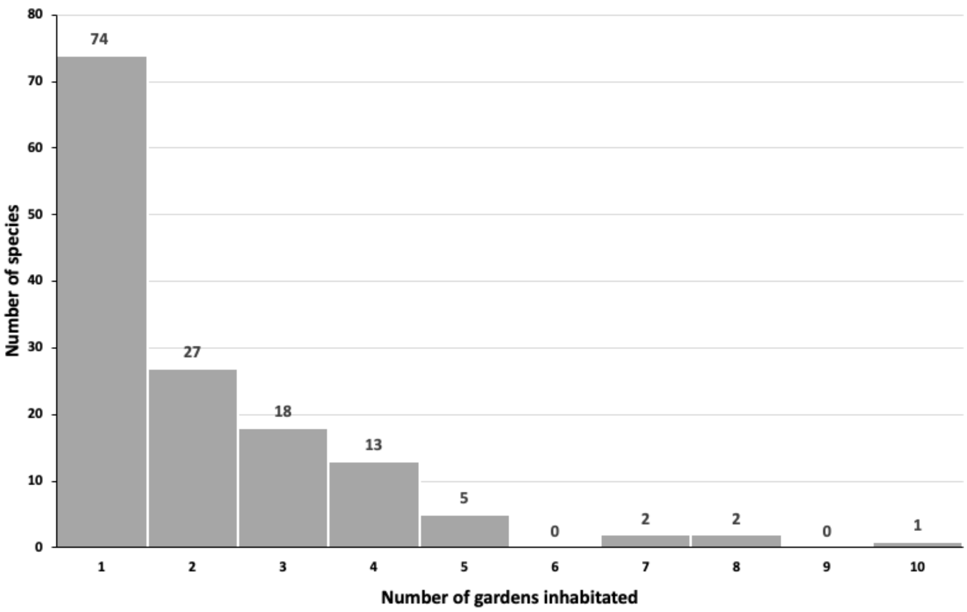

Fig. 5: Species occupancy of leafhopper occurrences in the 12 home gardens (n = 143 species).

4.1.3 Leafhopper diversity

The overall number of leafhopper species per garden varied between 9 (Ribare, Zemun, Serbia) and 57 (Selyanin, Bulgaria) (Table 2). On average 26.3 ± 15.9 species were found. The lower species richness of the gardens in Serbia can be explained by the fact that only the lawn area but no trees or shrubs were sampled (Table 1). Mean species per sampling date ranged between 4.3 (Ribare) and 34.3 (Selyanin) (mean 5.8 ± 3.2) and was highly correlated with the total number of species (Spearman rank correlation: $r_s = 0.879$, $p = 0.004$, $n = 12$). Leafhopper species richness per garden S_{total} was positively correlated with the number of sampling dates as well (Spearman rank correlation: $r_s = 0.550$, $p = 0.099$, $n = 10$; G9 and G12 excluded), indicating an influence of sampling effort. Mean species number did not differ between gardens that were sampled only by sweepnets ($n = 8$) and gardens sampled additionally with suction devices ($n = 4$) (Mann-Whitney-U-test: $W = 16.0$, $p = 0.932$, $n = 12$).

4.2 Relationships between leafhopper diversity and garden parameters

Species numbers were also positively correlated with total garden area ($r_s = 0.730$, $p = 0.029$, $n = 10$) and with the lawn area sampled ($r_s = 0.730$, $p = 0.029$, $n = 10$). The latter was also true for the number of species of the herb layer ($r = 0.805$, $p = 0.008$, $n = 12$). Total species richness tended to increase with garden age ($r_s = 0.413$, $p = 0.215$, $n = 10$) from about 15 species in recently established gardens to 30-40 species in gardens that were established 80-120 years ago (Fig. 6a). In line with this, the number of leafhopper species living on woody plants was positively correlated with garden age ($r_s = 0.936$, $p = 0.005$, $n = 10$; Fig. 6b). The cutting frequency of the lawn (number of cuts per year) showed a tendency to negatively affect leafhopper diversity in the herb layer ($r_s = -0{,}332$, $p = 0.272$, $n = 12$), but variability was high (Fig. 7). Species richness decreased from on average 20 species in gardens in which the lawn was cut 3-4 times per year to only 10 species in gardens with 10 cuts (Fig. 7).

Table 2: Leafhopper diversity parameters and sum of individuals per garden. n SD = number of sampling dates, S_{total} = number of species, $S_{herb\ layer}$ = number of species known to live in the herb layer, $S_{woody\ plants}$ = number of species known to live on woody plant species, S per SD = mean species number per sampling date, N_{total} = sum of individuals sampled. * = only herb layer/lawn was sampled, ** = no information for individual sampling dates available.

No	Location	Country	n SD	S_{total}	$S_{herb\ layer}$	$S_{woody\ plants}$	S per SD	N_{total}
G1	Burscheid	D	4	23	20	3	10.3	551
G2	Frauenau	D	8	35	26	9	**	156
G3	Göttingen	D	5	24	13	11	7.2	36
G4	Konradsreuth	D	4	14	10	4	6.0	106
G5	Landau 1	D	5	42	30	12	15.2	327
G6	Landau 2	D	4	43	30	13	20.8	341
G7	Langenfeld	D	4	11	8	3	5.3	512
G8	Leipzig	D	6	34	14	20	6.4	125
G9	Ribare	SRB	4	9*	9	0	4.3	67
G10	Selyanin	BG	5	58	51	7	34.3	1,206
G11	Stetteldorf	A	2	16	14	2	9.5	64
G12	Zemun	SRB	4	9*	9	0	4.5	79

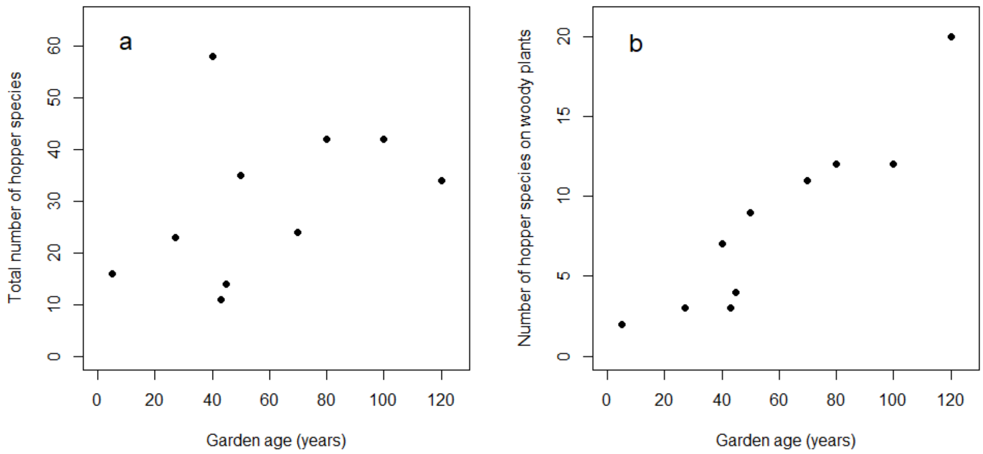

Fig. 6: Relationship between (a) overall leafhopper species richness (n = 10) and (b) number of species on woody plants (n = 10) and garden age.

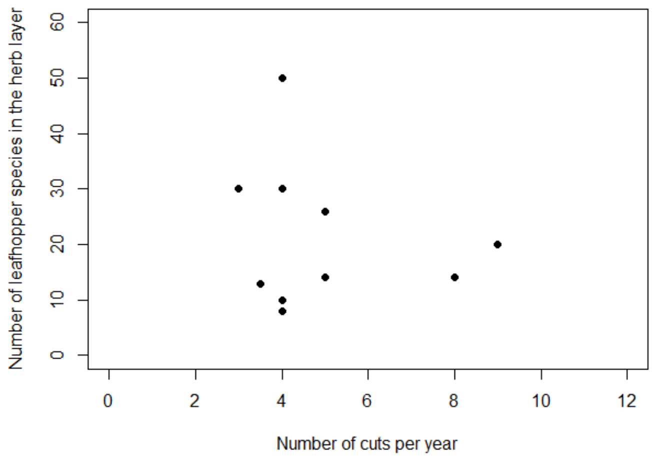

Fig. 7: Relationship between the number of leafhopper species of the herb layer and cutting frequency (n = 12).

No correlation could be found between either overall species richness or species living on woody plants with the cover of woody species in the gardens (Spearman rank correlations: p = 0.287, n = 10 and p = 0.568, n =12, respectively).

Regarding the influence of the habitat types adjacent to the gardens, we could find a significant positive correlation between the number of species in the herb layer and the proportion of adjacent park/forest area (r_s = 0.595, p = 0.049, n = 12). A marginally significant negative correlation could be found between the total number of leafhopper species and the proportion of industrial area in the vicinity of the garden (r_s = -0.547, p = 0.101, n = 10).

Furthermore, both the species richness in the herb layer and on woody plants was negatively correlated with the proportion of adjacent grassland (r_s = -0.623, p = 0.039, n = 12 and r_s = -0.615, p = 0.065, n = 10, respectively). Total leafhopper species richness did not differ between gardens in cities (30.4 species on average, n = 5) and villages/single houses (29.0 species on average, n = 5) (Mann-Whitney-U-test: W = 11.0, p = 0.834, n = 10).

Plant diversity of the lawn had a positive effect on leafhopper diversity in the herb layer ($S_{herb\ layer}$) (Fig. 8): The number of species of the herb layer increased from gardens with species poor lawns (n = 3) to gardens with lawns with an intermediate diversity (n = 5) and to gardens with diverse lawns (n = 4). However, the differences between medians were not significant (Kruskall-Wallis-test: p = 0.425).

5. Discussion

Our results clearly show that home gardens across Europe can host a wide variety of leafhopper species. The factors that were identified to influence the leafhopper diversity in gardens are summarised in Fig. 9. While most of the species recorded were unthreatened and occur in a wide range of habitats, several red-listed species (Holzinger 2009, Nickel et al. 2016) were found as well. Several non-native species were present, some known to be vectors of plant pathogens or to damage plants by their feeding or egg-laying activity (Nickel 2003).

Diversity in general was positively correlated with garden age and plant diversity, but lower on lawns which were exposed to a high cutting frequency. The average garden vegetation consists of about 70 % alien species (Loram et al. 2008a). Keeping in mind that many leafhopper species are highly host specific, this is an indication that native plants should be preferred when choosing garden plants (or should be promoted in case of self-greening).

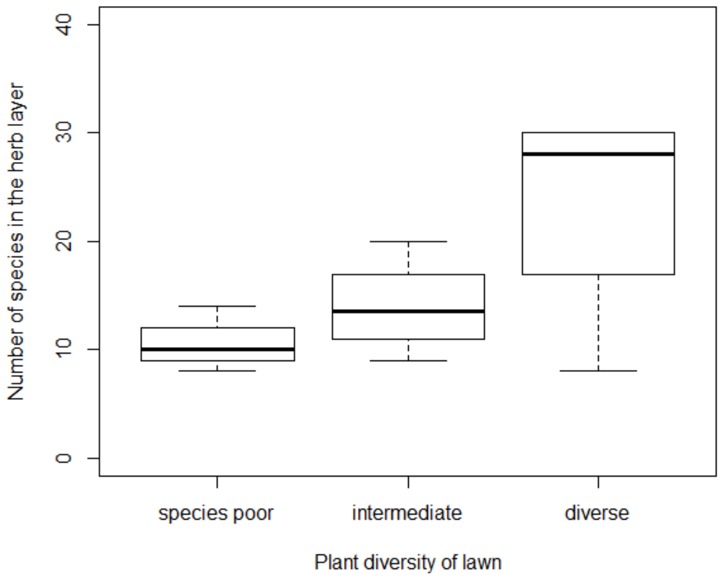

Fig. 8: Species richness in the herb layer for plant species poor, intermediate and diverse lawns per garden (n = 12; outlier G10 in figure excluded).

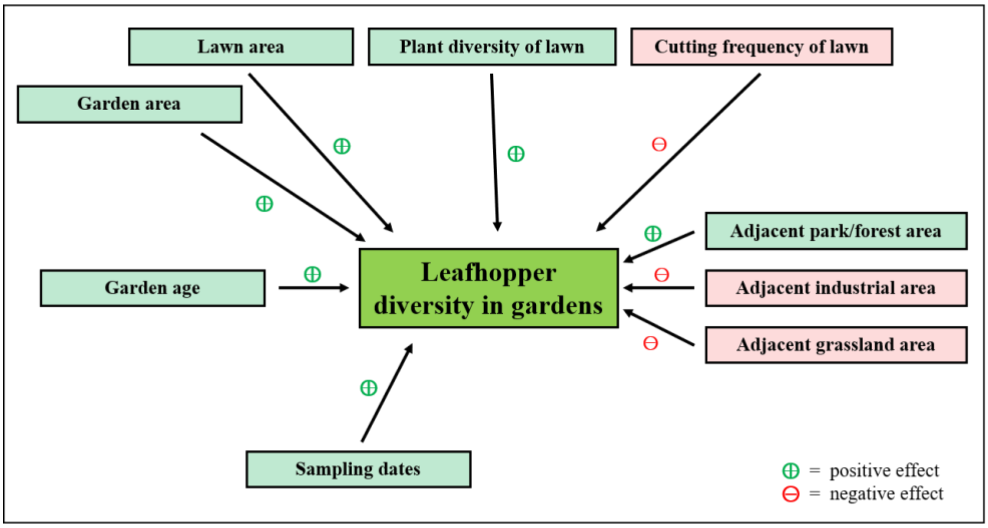

Fig. 9: Summary of potential factors that were identified to influence the diversity of leafhoppers in gardens across Europe.

The correlation of leafhopper diversity with garden age shows that habitat age but also management continuity are important factors influencing biodiversity. In older gardens, the tree and shrub layer as well as a diverse herb layer have had the time to develop (Loram et al. 2008a,b), which entails a more diverse leafhopper fauna. Our results are in line with other studies about insect diversity in gardens. For example, in an extensive survey of the invertebrate fauna in 61 gardens in the United Kingdom, Smith et al. (2006) showed that house age had a positive influence on the species richness of solitary wasps and that the diversity of leaf-mining insects was positively correlated with the number of trees.

Wintergerst et al. (2021) showed that species diversity of orthopterans on urban lawns was significantly lower on intensively mown meadows (four cuts of the entire area per year) than on less frequently and only partially mown meadows. Our results suggest that there is a similar relationship for leafhoppers and that lowering the cutting frequency and the extent of cutting supports leafhopper diversity on garden lawns.

Unsurprisingly, garden area and leafhopper diversity were positively correlated since a larger area can host more habitat niches and thus a higher diversity of species. Smith et al. (2005) found that garden size plays a decisive role in determining its structure and composition: larger gardens supported more different land cover types, had fewer sealed surfaces compared to the total garden area, were more likely to contain trees taller than 2 m, vegetable patches and compost heaps.

Finally, in addition to local effects, the landscape surrounding the gardens had an effect on leafhopper diversity: the cover of adjacent parks and forests had a positive effect, while industrial and grassland areas negatively influenced their diversity. The negative correlation with the cover of grasslands in the surroundings could be linked with the high management intensity of grasslands that reduces insect diversity (e.g. Biedermann et al. 2005).

6. Strengths and limitations of the study

All samplings were conducted by experienced cicadologists, i.e. every participant knew how to sample leafhoppers and was also familiar with their ecology. It can thus be assumed that the species lists of each garden were sufficiently complete for comparisons. On the other hand, the number of sampling events had a significant influence on the total number of species that were assessed. Sampling motivation probably was very high, since the study represented a collaborative task that helped to mitigate isolation during the Covid-19 pandemic.

The surveys took place in the cicadologists' home or institute gardens. People interested in entomology are likely to manage their garden in a more insect-friendly way. Therefore, the results may not entirely reflect the leafhopper diversity that is to be expected in more intensively managed European gardens.

7. Conclusions and management recommendations

This study clearly shows that extensively managed home gardens across Europe can support diverse communities of leafhoppers including red-listed species like *Eupteryx tenella* (Fig. 10) which is crucial in times of severe insect declines (Hallmann et al. 2017; Leather 2018).

Several easy management recommendations to support leafhopper diversity in home gardens can be derived from our results (largely in line with Turrini & Knop 2015):

1. Reduce cutting frequency or leave parts of the lawn unmown, e.g. along margins.
2. Do not fertilise the lawn, so that plant diversity can increase.
3. Prioritize native plant species in both the herb, shrub and tree layer.
4. Maintain habitat continuity, i.e. a complete remodelling of the garden should be avoided.

Most of these recommendations have the advantage that they can help to reduce the amount of garden work that is necessary over the course of the year.

Fig. 10: *Eupteryx tenella* is listed as vulnerable in Germany (photo: G. Kunz).

8. Zusammenfassung

Zikadendiversität in Gärten – Ergebnisse von Erfassungen in vier europäischen Ländern. Obwohl die Urbanisierung zu den Hauptursachen für die fortschreitende Lebensraumzerstörung und den Verlust der Artenvielfalt zählt, können Hausgärten eine Vielzahl von Arten beherbergen. Wir stellen hier die Ergebnisse einer Studie in 12 Gärten in vier europäischen Ländern (Deutschland, Serbien, Österreich und Bulgarien) vor. Die Probenahmen wurden im Sommer 2020 auf halbstandardisierte Weise durchgeführt. Insgesamt wurden 143 Zikadenarten mit 2.361 adulten Individuen erfasst, darunter mehrere gefährdete Arten. Die Anzahl der Arten pro Garten schwankte zwischen 9 und 58. Im Durchschnitt wurden etwa 26 Arten gefunden. Die Artenvielfalt der Zikaden wurde durch Gartenfläche und -alter, die Pflanzenvielfalt, eine extensive Bewirtschaftung und den Anteil and Wald- und Parkflächen in der Umgebung, aber auch durch die Anzahl der Probenahmetermine positiv beeinflusst. Extensiv bewirtschaftete Hausgärten können demnach vielfältige Zikadengemeinschaften beherbergen, was in Zeiten des gravierenden Insektenrückgangs von entscheidender Bedeutung ist.

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Table A1: List of Auchenorrhyncha species in the 12 home gardens that were studied. N = number of individuals, F = frequency, RL D / RL A = threat category of the Red List of threatened species in Germany (Nickel et al. 2016) and Austria (Holzinger 2009): * = least concern, V = near threatened, 3 = vulnerable, 2 = endangered, 1 = critically endangered, R = extremely rare, D = data deficient, NE = not evaluated, ◊ = non-native species, nomenclature follows Mühlethaler et al. (2018).

garden no.	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**				
	Burscheid	**Frauenau**	**Göttingen**	**Konradsreuth**	**Landau 1**	**Landau 2**	**Langenfeld**	**Leipzig**	**Ribare**	**Selyanin**	**Stetteldorf**	**Zemun**	**N**	**F**	**RL D**	**RL A**
FULGOROMORPHA																
Cixiidae																
Cixius distinguendus Kirschbaum, 1868	.	.	.	.	1	.	.	.	.	.	.	.	1	1	V	
Asiracinae																
Asiraca clavicornis (Fabricius, 1794)	.	.	.	2	1	1	.	.	.	6	.	.	10	4	*	
Stenocraninae																
Stenocranus minutus (Fabricius, 1787)	4	.	.	.	.	.	.	.	.	62	.	.	66	2	*	
Delphacidae																
Acanthodelphax spinosa (Fieber, 1866)	.	.	.	1	1	.	.	.	.	3	.	.	5	3	*	
Dicranotropis divergens Kirschbaum, 1868	.	4	.	.	.	.	.	.	.	.	.	.	4	1	3	
Dicranotropis hamata (Boheman, 1847)	.	.	.	.	6	5	.	4	.	18	.	.	33	4	*	
Javesella pellucida (Fabricius, 1794)	.	1	3	1	.	.	.	1	.	.	.	.	6	4	*	
Javesella sp. female	1	.	.	.	.	.	.	.	.	.	.	.	1	1	*	
Megadelphax sordidula (Stål, 1853)	.	.	.	.	.	1	.	.	.	.	.	.	1	1	V	
Megamelus notula (Germar, 1830)	.	.	.	1	.	.	.	.	.	.	.	.	1	1	*	
Muellerianella brevipennis (Boheman, 1847)	.	6	.	.	.	.	.	.	.	.	.	.	6	1	*	
Muellerianella fairmairei (Perris, 1857)	4	.	.	.	.	.	.	.	.	2	.	.	6	2	*	
Ribautodelphax albostriata (Fieber, 1866)	.	.	.	.	.	.	.	.	.	37	.	.	37	1	*	
Ribautodelphax imitans (Ribaut, 1953)	.	.	.	.	.	.	.	.	.	.	5	.	5	1	*	V
Xanthodelphax flaveola (Flor, 1861)	.	.	.	.	.	.	.	.	.	3	.	.	3	1		
Xanthodelphax straminea (Stål, 1858)	2	.	.	.	.	.	.	.	.	.	.	.	2	1	V	
Dictyopharidae																
Dictyophara europaea (Linnaeus, 1767)	.	.	.	.	.	.	.	.	.	.	.	1	1	1		
Issidae																
Issus coleoptratus (Fabricius, 1781)	.	.	2	.	.	2	.	1	.	.	.	.	5	3	*	
Scorlupella discolor (Germar, 1821)	.	.	.	.	.	.	.	.	.	4	.	.	4	1		
Tettigometridae																
Tettigometra virescens (Panzer, 1799)	.	.	.	.	2	5	.	.	.	.	.	.	7	2	2	
Tropiducidae																
Trypetimorpha occidentalis Huang & Bourgoin, 1993	.	.	.	.	.	.	.	.	.	1	.	.	1	1		
CICADOMORPHA																
Cercopidae																
Cercopis sanguinolenta (Scopoli, 1763)	.	.	.	.	.	.	.	.	.	3	.	.	3	1		
Cercopis vulnerata Rossi, 1807	.	1	.	.	.	.	.	.	.	.	.	.	1	1	*	
Aphrophoridae																
Neophilaenus campestris (Fallén, 1805)	.	.	.	.	1	10	.	.	.	.	3	.	14	3	*	*
Neophilaenus lineatus (Linnaeus, 1758)	.	.	.	.	.	.	.	.	.	2	.	.	2	1	*	
Aphrophora alni (Fallén, 1805)	.	11	.	1	3	3	.	.	.	7	.	.	25	5	*	
Lepyronia coleoptrata (Linnaeus, 1758)	.	.	.	.	.	.	.	.	2	1	.	.	3	2		
Philaenus spumarius (Linnaeus, 1758)	.	4	.	.	8	6	.	.	.	.	1	.	19	4	*	*

garden no.	1 Burscheid	2 Frauenau	3 Göttingen	4 Konradsreuth	5 Landau 1	6 Landau 2	7 Langenfeld	8 Leipzig	9 Ribare	10 Selyanin	11 Stetteldorf	12 Zemun	N	F	RL D	RL A
Membracidae																
Smiliinae																
Stictocephala bisonia Kopp & Yonke, 1977	.	.	.	.	2	2	.	.	.	.	.	.	4	2	◊	
Cicadellidae																
Aphrodinae																
Anoscopus carlebippus Guglielmino & Bückle, 2015	.	.	.	.	.	.	.	.	.	2	.	.	2	1		
Anoscopus flavostriatus (Donovan, 1799)	.	.	.	.	.	.	.	.	.	4	.	.	4	1	*	
Anoscopus serratulae (Fabricius, 1775)	4	.	.	.	1	.	1	.	.	.	.	.	6	3	*	
Aphrodes bicincta (Schrank, 1776)	.	.	.	.	.	.	.	.	.	.	1	.	1	1	*	D
Aphrodes makarovi (Zachvatkin, 1948)	.	.	.	.	.	.	.	.	.	11	.	.	11	1	*	
Aphrodes sp. female	.	.	.	.	2	1	.	.	.	3	.	.	6	3		
Cicadellinae																
Cicadella viridis (Linnaeus, 1758)	1	1	.	.	.	.	.	.	.	8	.	.	10	3	*	
Graphocephala fennahi Young, 1977	.	.	2	20	1	.	1	.	.	.	.	.	24	4	◊	
Deltocephalinae																
Alebra wahlbergi (Boheman, 1845)	.	.	1	.	.	.	.	1	.	.	.	.	2	2	*	
Allygidius mayri (Kirschbaum, 1868)	.	.	.	.	.	.	.	.	.	2	.	.	2	1		
Allygus modestus Scott, 1876	1	.	.	.	.	.	.	.	.	.	.	.	1	1	*	
Arocephalus languidus (Flor, 1861)	.	.	.	.	.	.	.	.	.	170	.	.	170	1		
Arocephalus longiceps (Kirschbaum, 1868)	.	2	.	.	.	.	.	.	.	19	.	.	21	2	*	
Arthaldeus pascuellus (Fallén, 1826)	2	1	1	1	5	8	4	.	.	11	.	.	33	8	*	
Arthaldeus striifrons (Kirschbaum, 1868)	.	.	.	.	.	.	.	.	.	66	1	.	67	2		V
Athysanus argentarius Metcalf, 1955	.	1	.	.	.	.	.	.	.	.	.	.	1	1	*	
Balclutha punctata (Fabricius, 1775)	4	6	4	.	1	.	.	1	.	.	.	.	16	5	*	
Balclutha sp./female	.	.	.	.	.	.	.	.	.	14	.	.	14	1		
Chiasmus conspurcatus (Perris, 1857)	.	.	.	.	.	.	.	.	.	1	.	.	1	1		
Cicadula persimilis (Edwards, 1920)	.	1	.	.	.	.	.	.	.	54	.	.	55	2	*	
Cicadula sp. female	.	.	.	.	.	.	.	.	.	.	1	.	1	1		
Colobotettix morbillosus (Melichar, 1896)	.	1	.	.	.	.	.	.	.	.	.	.	1	1	V	
Deltocephalus pulicaris (Fallén, 1806)	375	.	1	52	7	26	477	12	2	5	14	.	971	10	*	*
Doratura homophyla (Flor, 1861)	.	.	.	.	.	.	.	.	.	1	.	.	1	1	*	
Doratura sp.	.	.	.	.	.	.	.	.	.	.	.	13	13	1		
Doratura stylata (Boheman, 1847)	.	5	.	.	.	.	.	.	.	11	.	3	19	3	*	
Elymana sulphurella (Zetterstedt, 1828)	.	11	.	.	.	.	.	.	.	.	.	.	11	1	*	
Emelyanoviana mollicula (Boheman, 1845)	.	.	.	.	34	9	.	.	.	.	.	.	43	2	*	
Errastunus ocellaris (Fallén, 1806)	.	.	.	.	.	.	.	.	.	155	1	.	156	2	*	*
Eupelix cuspidata (Fabricius, 1775)	.	.	.	.	.	.	.	.	.	2	.	.	2	1		
Euscelidius variegatus (Kirschbaum, 1858)	.	.	.	.	1	3	.	.	.	.	.	.	4	2	*	
Euscelis incisus (Kirschbaum, 1858)	1	.	.	.	2	.	.	1	2	57	7	1	71	7	*	*
Fieberiella florii (Stål, 1864)	.	.	.	.	1	3	.	5	.	.	.	.	9	3	*	
Fieberiella septentrionalis W. Wagner, 1963	.	.	1	5	.	.	2	.	.	.	.	.	8	3	*	
Graphocraerus ventralis (Fallén, 1806)	.	14	.	.	.	.	.	.	.	2	.	.	16	2	*	
Handianus flavovarius (Herr.-Schäffer, 1835)	.	.	.	.	.	.	.	.	.	4	.	.	4	1	NE	
Hardya signifer (Then, 1897)	.	.	.	.	.	.	.	.	.	2	.	.	2	1		
Hardya tenuis (Germar, 1821)	.	.	.	.	.	.	.	1	.	.	.	.	1	1	3	
Hesium domino (Reuter, 1880)	.	1	.	.	.	.	.	.	.	.	.	.	1	1	V	

garden no.	1	2	3	4	5	6	7	8	9	10	11	12				
	Burscheid	**Frauenau**	**Göttingen**	**Konradsreuth**	**Landau 1**	**Landau 2**	**Langenfeld**	**Leipzig**	**Ribare**	**Selyanin**	**Stetteldorf**	**Zemun**	**N**	**F**	**RL D**	**RL A**
Hishimonus hamatus Kuoh, 1976	.	.	.	.	.	1	.	.	.	.	.	.	1	1	◊	
Japananus hyalinus (Osborn, 1900)	.	.	1	.	1	.	.	.	.	.	.	.	2	2	*	
Jassargus flori (Fieber, 1869)	.	.	.	.	.	.	.	.	4	.	.	.	4	1	*	
Jassargus obtusivalvis (Kirschbaum, 1868)	.	.	.	.	3	2	.	.	.	63	.	.	68	3	*	
Jassargus pseudocellaris (Flor, 1861)	2	8	.	.	.	.	.	.	.	.	.	.	10	2	*	
Lamprotettix nitidulus (Fabricius, 1787)	.	.	1	.	.	.	.	.	.	.	.	.	1	1	*	
Macrosteles laevis (Ribaut, 1927)	1	4	.	.	.	5	.	.	.	.	.	.	10	3	*	
Macrosteles sexnotatus (Fallén, 1806)	.	2	.	.	.	.	.	.	.	.	.	.	2	1	*	
Macrosteles sp. female	.	.	.	.	.	.	.	.	.	1	.	.	1	1		
Macrosteles viridigriseus (Edwards, 1922)	10	.	.	.	.	.	.	.	.	.	.	.	10	1	V	
Mocydia crocea (Herrich-Schäffer, 1837)	.	.	1	.	.	.	.	.	.	1	.	.	2	2	*	
Mocydiopsis sp./female	.	.	.	.	.	.	.	.	.	22	.	.	22	1		
Neoaliturus fenestratus (Herr.-Schäffer, 1834)	.	.	.	.	2	7	.	.	3	35	.	5	52	5	V	
Neoaliturus guttulatus (Kirschbaum, 1868)	.	.	.	.	.	.	.	.	.	1	.	.	1	1		
Ophiola decumana (Kontkanen, 1949)	.	.	.	.	.	.	.	.	.	.	.	1	1	1	*	
Opsius stactogalus Fieber, 1866	.	.	.	.	.	.	.	.	.	.	1	.	1	1	*	V
Orientus ishidae Matsumura, 1902	.	.	1	.	6	4	.	.	.	.	.	.	11	3	◊	
Phlepsius intricatus (Herrich-Schäffer, 1838)	.	.	.	.	.	.	.	.	.	2	.	.	2	1		
Phlepsius sp. female	.	.	.	.	.	.	.	.	.	1	.	.	1	1		
Pithyotettix abientinus (Fallén, 1806)	.	.	.	.	.	.	.	2	.	.	.	.	2	1	*	
Psammotettix alienus (Dahlbom, 1850)	.	.	.	.	.	.	.	.	18	.	.	29	47	2	*	
Psammotettix confinis (Dahlbom, 1850)	66	7	.	.	.	7	8	.	1	204	22	.	315	7	*	*
Psammotettix helvolus (Kirschbaum, 1868)	.	.	.	.	25	8	.	4	.	.	.	.	37	3	*	
Recilia coronifer (Marshall, 1866)	.	.	.	.	.	.	.	.	.	3	.	.	3	1	*	
Streptanus aemulans (Kirschbaum, 1868)	.	.	.	.	.	.	.	.	.	6	.	.	6	1	*	
Streptanus sordidus (Zetterstedt, 1828)	.	.	.	.	.	1	.	.	.	.	.	.	1	1	*	
Synophropsis lauri (Horváth, 1897)	.	.	.	.	5	.	.	.	.	.	.	.	5	1	*	
Turrutus socialis (Flor, 1861)	.	.	.	.	.	.	.	.	.	31	.	.	31	1	*	
Verdanus abdominalis (Fabricius, 1803)	.	15	.	.	.	.	.	.	.	8	.	.	23	2	*	
Idiocerinae																
Acericerus heydenii (Kirschbaum, 1868)	.	.	.	.	.	.	.	1	.	.	.	.	1	1	*	
Acericerus ribauti Nickel & Remane, 2002	.	.	1	.	.	2	.	1	.	.	.	.	4	3	*	
Idiocerus lituratus (Fallén, 1806)	.	1	.	.	.	.	.	.	.	.	.	.	1	1	*	
Idiocerus stigmaticalis Lewis, 1834	.	2	.	.	.	.	.	.	.	.	.	.	2	1	*	
Metidiocerus rutilans (Kirschbaum, 1868)	.	2	.	.	.	.	.	.	.	.	.	.	2	1	*	
Populicerus confusus (Flor, 1861)	.	10	.	.	.	.	.	.	.	.	.	.	10	1	*	
Macropsinae																
Macropsis infuscata (Zetterstedt, 1828)	.	1	.	.	.	.	.	.	.	.	.	.	1	1	*	
Oncopsis subangulata (J. Sahlberg, 1871)	.	.	.	.	.	.	.	1	.	.	.	.	1	1	*	
Megophthalminae																
Agallia consobrina Curtis, 1833	.	.	1	.	20	4	.	.	.	.	.	.	25	3	*	
Agallia sp. female	.	.	.	.	.	.	.	.	.	1	.	.	1	1	*	
Anaceratagallia frisia (Wagner, 1939)	.	.	.	.	.	.	.	.	10	.	.	12	22	2		
Anaceratagallia ribauti (Ossiannilsson, 1938)	5	.	.	.	.	3	2	1	25	43	1	14	94	8	*	*
Megophthalmus scabripennis Edwards, 1915	.	.	.	.	.	.	.	.	.	5	.	.	5	1		
Megophthalmus scanicus (Fallén, 1806)	3	.	1	3	.	.	1	.	.	.	.	.	8	4	*	

garden no.	1	2	3	4	5	6	7	8	9	10	11	12				
	Burscheid	**Frauenau**	**Göttingen**	**Konradsreuth**	**Landau 1**	**Landau 2**	**Langenfeld**	**Leipzig**	**Ribare**	**Selyanin**	**Stetteldorf**	**Zemun**	**N**	**F**	**RL D**	**RL A**
Typhlocybinae																
Alebra coryli Le Quesne, 1976	.	.	.	.	.	1	.	.	.	.	.	.	1	1	*	
Alebra wahlbergi	.	.	.	.	.	.	2	.	.	.	.	.	2	1	*	
Arboridia sp. female	1	.	.	.	3	.	.	2	.	2	.	.	8	4		
Arboridia velata (Ribaut, 1952)	.	.	2	.	.	.	.	.	.	.	.	.	2	1	*	
Chlorita paolii (Ossiannilsson, 1939)	.	.	.	.	.	.	.	2	.	.	.	.	2	1	*	
Dikraneura variata Hardy, 1850	.	.	1	.	.	1	5	3	.	.	.	.	10	4	*	
Edwardsiana crataegi (Douglas, 1876)	.	.	.	.	.	3	.	2	.	.	.	.	5	2	*	
Edwardsiana diversa (Edwards, 1914)	.	.	.	.	.	.	.	1	.	.	.	.	1	1	*	
Edwardsiana prunicola (Edwards, 1914)	.	1	.	.	.	.	.	.	.	.	.	.	1	1	*	
Edwardsiana rosae (Linnaeus, 1758)	.	.	.	5	.	.	.	6	.	.	.	.	11	2	*	
Edwardsiana sp.	.	.	.	.	.	.	.	1	.	.	.	.	1	1		
Empoasca decipiens Paoli, 1930	.	.	.	10	24	13	.	23	.	.	.	.	70	4	*	
Empoasca pteridis (Dahlbom, 1850)	2	.	.	.	1	3	.	.	.	.	.	.	6	3	*	
Empoasca vitis (Göthe, 1875)	.	.	.	.	33	52	.	9	.	.	1	.	95	4	*	*
Eupteryx atropunctata (Goeze, 1778)	.	.	.	.	.	.	.	.	.	2	.	.	2	1	*	
Eupteryx aurata (Linnaeus, 1758)	.	10	.	.	1	.	.	.	.	.	.	.	11	2	*	
Eupteryx calcarata Ossiannilsson, 1936	.	1	.	.	2	.	.	.	.	.	1	.	4	3	*	*
Eupteryx curtisii (Flor, 1861)	.	.	.	.	.	.	.	.	.	6	.	.	6	1	*	
Eupteryx cyclops Matsumura, 1906	.	11	1	.	.	.	.	.	.	.	.	.	12	2	*	
Eupteryx decemnotata Rey, 1891	.	.	1	2	37	74	.	6	.	.	.	.	120	5	*	
Eupteryx filicum (Newman, 1853)	.	.	2	.	.	.	.	.	.	.	.	.	2	1	*	
Eupteryx florida Ribaut, 1936	.	.	3	.	23	6	.	.	.	6	.	.	38	4	*	
Eupteryx notata Curtis, 1837	9	.	.	.	1	1	.	.	.	6	1	.	18	5	*	*
Eupteryx stachydearum (Hardy, 1850)	.	2	.	.	.	1	.	.	.	.	.	.	3	2	*	
Eupteryx tenella (Fallén, 1806)	.	.	.	.	.	15	.	.	.	.	.	.	15	1	V	
Eupteryx urticae (Fabricius, 1803)	1	6	.	.	6	.	.	3	.	.	.	.	16	4	*	
Fagocyba cruenta (Herrich-Schäffer, 1838)	.	.	.	.	.	2	.	.	.	.	.	.	2	1	*	
Fruticidia bisignata (Mulsant & Rey, 1855)	.	.	.	.	.	1	.	1	.	.	.	.	2	2	*	
Hauptidia distinguenda (Kirschbaum, 1868)	.	.	.	.	.	.	.	9	.	.	.	.	9	1	*	
Kybos lindbergi (Linnavuori, 1951)	.	.	.	.	.	.	.	1	.	.	.	.	1	1	*	
Kybos strigilifer (Ossiannilsson, 1941)	.	1	.	.	.	.	.	.	.	.	.	.	1	1	*	
Linnavuoriana sexmaculata (Hardy, 1850)	.	1	.	.	.	.	.	.	.	.	.	.	1	1	*	
Ribautiana debilis (Douglas, 1876)	.	.	.	.	23	13	2	5	.	.	.	.	43	4	*	
Ribautiana tenerrima (Herrich-Schäffer, 1834)	.	.	1	.	3	3	.	8	.	.	.	.	15	4	*	
Ribautiana ulmi (Linnaeus, 1758)	.	.	1	.	.	.	.	.	.	.	.	.	1	1	V	
Typhlocyba quercus (Fabricius, 1777)	.	.	.	2	.	.	.	.	.	.	.	.	2	1	*	
Zonocyba bifasciata (Boheman, 1851)	.	.	2	.	.	.	.	.	.	.	.	.	2	1	*	
Zygina flammigera (Geoff. in Fourcroy, 1785)	.	.	.	.	1	4	.	1	.	.	.	.	6	3	*	
Zygina hyperici (Herrich-Schäffer, 1836)	.	.	.	.	21	.	.	.	.	.	.	.	21	1	*	
Zygina schneideri (Günthart, 1974)	.	.	.	.	.	.	.	1	.	.	.	.	1	1	*	
Zyginella pulchra Löw, 1885	.	.	.	.	3	.	.	4	.	.	.	.	7	2	*	
Zyginidia pullula (Boheman, 1845)	.	.	.	.	.	.	.	.	.	4	3	.	7	2		*
Zyginidia scutellaris (Herrich-Schäffer, 1838)	50	.	.	.	3	19	9	.	.	.	.	.	81	4	*	