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SEASONAL DYNAMICS AND HOST PLANT PREFERENCES OF POLYPHAGOUS HEMIPTERAN PESTS IN SMALL ORGANIC MIXED GARDENS IN WESTERN ROMANIA

Alexandra-Florentina TÎRNOVAN, Diana-Maria ARSINE, Laura VORNICU, Ana Maria VIRTEIU (ORCID: 0000-0001-5767-5250), Ioana GROZEA (ORCID: 0000-0002-2186-4364)

University of Life Sciences "King Mihai I" Timisoara, Romania

Corresponding authors: ioanagrozea@usab-tm.ro; anamaria.badea@gmail.com

Abstract. *Small mixed gardens offer heterogeneous resources for phytophagous Hemiptera, but information on their seasonal occurrence in western Romania is limited. We analyzed monthly totals recorded from April to October at six organically managed mixed-garden sites in Timiș County (Lenauheim, Lovrin, Gottlob, Nițchidorf, Sânnicolau Mare and Pesac). The six target taxa were Aphis gossypii, Eriosoma lanigerum, Corythucha ciliata, Metcalfa pruinosa, Nezara viridula and Halyomorpha halys. Species were surveyed using yellow sticky panels, direct visual counts or mechanical shake sampling, as appropriate. A total of 4,949 individuals were reported in the site-month dataset. Metcalfa pruinosa was the most abundant taxon (1,373 individuals; 27.7%), followed by A. gossypii (1,142; 23.1%). Combined observations peaked in June (1,417) and July (1,229), whereas both pentatomids showed their greatest counts in September. These data describe a pronounced within-season shift from spring and early-summer aphids and flatids to late-summer/early-autumn stink bugs. Host-plant associations were noted qualitatively and should not be interpreted as statistically demonstrated host preferences. The study provides a descriptive baseline for timing pest surveillance in diversified small gardens; standardized effort and repeated years will be needed to distinguish population effects from detection differences.*

Keywords*: Hemiptera; organic mixed gardens; seasonal abundance; pest monitoring; host-plant associations; western Romania.*

INTRODUCTION

Small organically managed gardens combine vegetables, ornamental plants and woody hosts over short distances. This habitat mosaic can support several hemipteran herbivores simultaneously, while seasonal changes in host condition alter where individuals are observed. Monitoring such systems is relevant for smallholder plant protection because pest presence does not necessarily coincide with economically important damage (GROZEA, 2015).

Aphis gossypii is polyphagous and exhibits substantial variation in host use (PĂLĂGEȘIU ET AL., 2000), including host-associated populations (LIU ET AL., 2017). The woolly apple aphid, *Eriosoma lanigerum*, is primarily associated with apple systems and is strongly influenced by local ecological conditions and natural enemies (LORDAN ET AL., 2015; WEARING ET AL., 2010). *Metcalfa pruinosa* exploits numerous cultivated and ornamental plants; surveys from Romania documented broad host diversity and particularly frequent occurrence in diverse plant habitats (VLAD AND GROZEA, 2016).

The invasive lace bug *Corythucha ciliata* is mainly associated with *Platanus trees*, and its European spread has been documented for decades (MACELJSKI, 1986). In contrast, the pentatomids *Nezara viridula* and *Halyomorpha halys* are wide-ranging feeders whose seasonal activity and sheltering behavior complicate monitoring in gardens and adjacent buildings (TODD, 1989; MUSOLIN, 2012; LESKEY AND NIELSEN, 2018). European records and regional observations also demonstrate the relevance of *H. halys* to western Romanian settings (DE MICHELE AND GROZEA, 2019).

This study aimed (i) to quantify the relative numerical contribution of six monitored species, (ii) to describe their monthly dynamics and changing community composition, and (iii) to compare cumulative counts across six garden sites. Qualitative field notes on plant associations are discussed separately from the quantitative site-month matrix

MATERIAL AND METHODS

The focus on mixed gardens is important because it differs from monitoring a single crop. The observed count for any one taxon can reflect attraction to a preferred resource, movement across neighboring host plants and the characteristics of a monitoring method. Therefore, the term "host-plant association" is more precise than "preference" unless comparable counts are collected from each potential host and availability is taken into account. The present analysis was designed to characterize surveillance patterns rather than to explain their physiological causes.

Study sites and biological material

Observations were supplied for six small mixed-garden locations in Timiș County, western Romania: Lenauheim, Lovrin, Gottlob, Nițchidorf, Sânnicolau Mare and Pesac. The field protocol described a garden composition including one apricot tree, one lilac shrub, one Japanese quince, ten tomato plants, ten pepper plants and five rose bushes. The accompanying notes additionally mention apple trees in relation to *E. lanigerum*; apple-tree presence and counts per site should therefore be checked in the field records. Gardens were described as organically managed. No coordinates, monitoring year, plot dimensions, pesticide history or weather series were supplied.

Sampling and data organization

Monthly numbers of individuals were reported separately by target species and monitoring site from April through October, giving 6 species × 6 sites × 7 months = 252 species–site–month cells. Yellow adhesive panels were indicated for aphids; direct visual observation and counting for the lace bug, woolly apple aphid and *M. pruinosa*; and mechanical shaking for the two larger pentatomids. The original notes also contain an earlier, superseded description of a soapy-water device; the shake-sampling description was used here following the subsequent explicit correction. Trap numbers, exposure duration, number of shaken plants, visit frequency and within-month aggregation rules were not documented. Accordingly, all analyses refer to monthly recorded totals, not standardized density, catch per unit effort or insect population size.

For interpretation of the monthly data, a zero was treated as an absence of recorded individuals in the relevant site–species–month cell, not as evidence that the species was biologically absent from the entire garden. Observation intervals are represented at the month level only; the source file did not identify individual visit dates. Where a monthly total may have combined several surveys, the number of within-month surveys remains unknown. This matters for comparison because weather and sampling duration can affect the probability of detecting mobile hemipterans.

Data analysis

Counts were summarized descriptively. Species-wide relative abundance was calculated as 100 × (species cumulative count)/(total count of all six species). For each species, the mean and sample standard deviation (SD; n = 6 sites) were calculated from seven-month cumulative totals per site; the coefficient of variation (CV) was calculated as 100 × SD/mean. Monthly totals were pooled across sites to describe phenology; within-month percentages were used to reveal seasonal shifts in taxonomic composition. Because species were assessed using different observation techniques and effort standardization could not be verified, cross-species comparisons are descriptive and should not be treated as formal differences in underlying population density. No significance tests were applied.

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RESULTS AND DISCUSSION

Cumulative abundance and between-site variation

The dataset comprised 4,949 recorded individuals over seven months. The greatest cumulative total belonged to *M. pruinosa* (1,373), followed by *A. gossypii* (1,142), *E. lanigerum* (769), *C. ciliata* (695), *H. halys* (531) and *N. viridula* (439). Table 1 summarizes proportions and variation among gardens. These rankings describe recorded individuals, not directly comparable biological densities, given the use of distinct sampling procedures.

Across the complete monitoring period, the two most frequently recorded taxa, M. pruinosa and A. gossypii, together accounted for 50.8% of all individuals. The three taxa showing their greatest counts in June or July (*M. pruinosa*, *E. lanigerum* and *C. ciliata*) represented 57.3% of the season-long total. Conversely, *H. halys* and *N. viridula* together contributed 19.6%, but were more concentrated in the late season. These percentages describe the structure of the recorded sample and should not be interpreted as the relative field population sizes of species assessed by different sampling techniques.

The species-specific coefficients of variation of the seasonal totals among the six gardens were comparatively low (5.2–13.9%). The lowest CV was recorded for *M. pruinosa*, whereas *N. viridula* had the largest relative variation. A small CV in cumulative counts does not necessarily imply stable occurrence during individual months: a species may show a pronounced seasonal maximum at every site yet produce similar seven-month totals. Thus, between-site dispersion and seasonal concentration are complementary, rather than interchangeable, descriptors.

Table 1

Descriptive statistics based on cumulative monthly counts at six sites (April-October)

Species	Total (n)	Share (%)	Site mean ± SD	CV (%)	Peak month
Aphis gossypii	1142	23.1	190.3 ± 15.8	8.3	May
Eriosoma lanigerum	769	15.5	128.2 ± 9.1	7.1	Jun
Corythucha ciliata	695	14.0	115.8 ± 11.7	10.1	Jul
Metcalfa pruinosa	1373	27.7	228.8 ± 12.0	5.2	Jun
Nezara viridula	439	8.9	73.2 ± 10.2	13.9	Sep
Halyomorpha halys	531	10.7	88.5 ± 9.5	10.8	Sep

Between-site values were relatively similar in the submitted matrices. This narrow range is a feature of the recorded values; the available metadata do not allow attribution of the differences to garden management, microclimate or plant composition. Caution is also required because consecutive months at a given location are not independent field replicates.

The totals per garden, obtained by summing the same seven monthly periods, ranged from 738 individuals at Place 5 to 913 at Place 4. These comparisons are descriptive because the documentation does not establish equivalence of observation effort or identical availability of all potential hosts. The contrast between locations was smaller than the change in numbers between the principal seasonal peaks and the least active months. This finding argues for retaining monitoring throughout the growing season even when individual sites yield relatively similar end-of-season totals.

The geographical comparison is useful as a first descriptive assessment, but any locality ranking should be interpreted cautiously. A garden with more recorded individuals could reflect more suitable vegetation, favorable conditions during visits or a greater number of

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effective observations. Because exact exposure times of traps and numbers of inspected shoots or shaken plants were not documented, these alternatives cannot be separated. Standardizing effort in subsequent seasons would make it possible to examine site differences without conflating abundance and detectability.

Seasonal occurrence

Monthly totals rose from 177 in April to 694 in May and reached a maximum of 1,417 in June. A second substantial count occurred in July (1,229); abundance then decreased during August (403) and showed a renewed contribution from pentatomids in September (762). Figure 1 displays the distinct temporal profiles of each species. The June-July phase was dominated numerically by *M. pruinosa* and *E. lanigerum*, whereas September was particularly important for *H. halys* and *N. viridula*.

The cumulative April-July count was 3,517 individuals, equivalent to 71.1% of the season-long record, highlighting the numerical weight of the early and middle growing season. However, the taxonomic structure of this total was heterogeneous. April counts were confined mainly to *A. gossypii* and *M. pruinosa*, May showed a broader contribution from *E. lanigerum*, and June–July marked the strongest recorded period for the lace bug and planthopper. These changes indicate successive windows in which different field inspection methods are particularly relevant.

Species-specific maxima provide a more practical scheduling indicator than the overall monthly maximum. A. gossypii peaked in May (318 recorded individuals across sites), *E. lanigerum* in June (342), *C. ciliata* in July (288), and *M. pruinosa* in June (526). The late-season maxima were both in September: 222 individuals of *N. viridula* and 352 of *H. halys*. These maxima are derived from pooled monthly records, not from standardized rates, and therefore should guide timing of surveillance rather than estimates of comparative pest pressure.

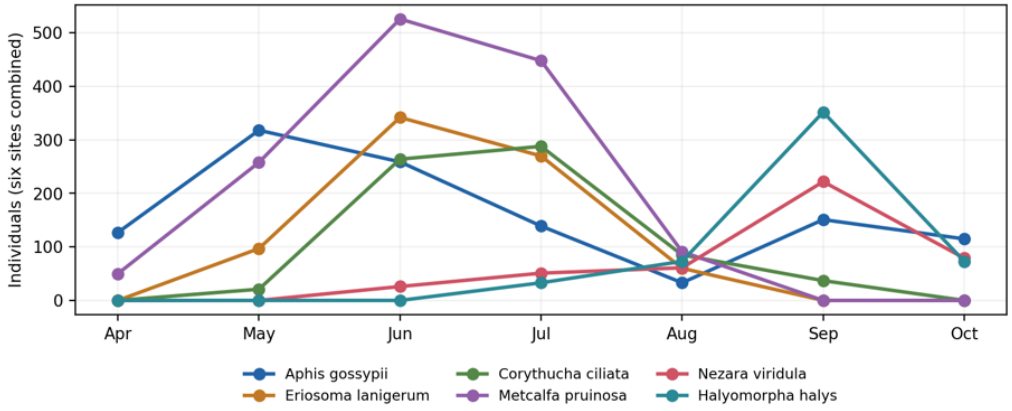


Figure 1. Monthly total numbers of the six hemipteran species pooled across the six monitoring sites. Values are recorded individuals, not standardized densities

The change in the relative composition of records is clearer when each month is standardized to 100% (Figure 2). This second graphic answers a different question from Figure 1: the share of each taxon in a given month, rather than its absolute temporal count. Dominant

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taxa therefore change even in months with fewer individuals. The pronounced contribution of late-season pentatomids is consistent with ecological literature emphasizing seasonal host use, reproductive activity and pre-overwintering behavior (TODD, 1989; MUSOLIN, 2012; LESKEY AND NIELSEN, 2018).

The difference between numerical abundance and proportional representation is especially apparent in September. The two pentatomids together accounted for 574 of the 762 recorded individuals (75.3%), whereas in July they contributed only 84 of 1,229 (6.8%). An increase in percentage share can partly result from the decline of other species, but the September pentatomid counts also rose in absolute terms. Considering Figure 1 together with Figure 2 therefore prevents interpreting an increasing proportion as necessarily equivalent to increasing numbers.

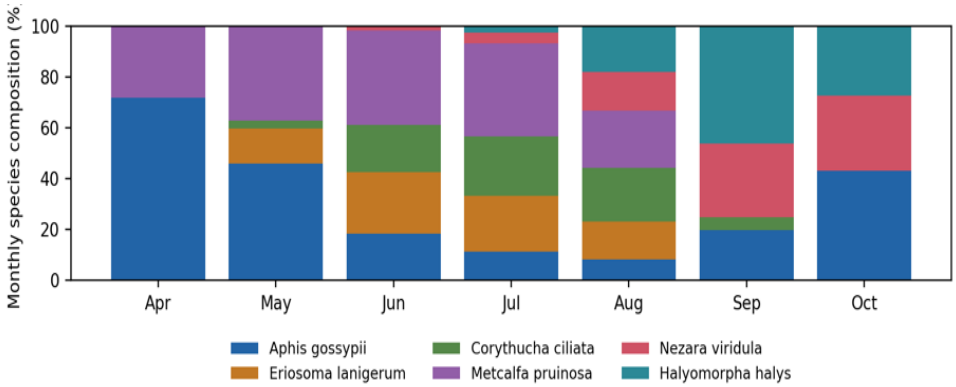


Figure 2. Relative monthly species composition (% of the total number of recorded individuals in each month)

The spring signal was not a single-species phenomenon: A. gossypii was present in all months, with a particularly strong May contribution, while *M. pruinosa* showed a marked June maximum and continued high numbers in July. *E. lanigerum* and *C. ciliata* also had strong mid-season counts, although the latter requires verification of the plant association listed in the field notes. In contrast, neither pentatomid showed its main maximum in midsummer; both reached a September peak. This demonstrates why a survey restricted to the high-abundance June interval would miss the main seasonal signal of the two stink bugs.

A. gossypii remained detectable during the full April-October period, unlike *E. lanigerum*, for which the supplied tables contained no September or October records. *Metcalfa pruinosa* was last recorded in August, while *C. ciliata* was recorded through September. Both pentatomids persisted in October, albeit at counts well below their September maxima. This temporal separation suggests that monitoring planned only for spring or only for summer would underrepresent some taxa even within the same small-garden landscape.

Care is required when discussing declines. For example, a reduced count in August may reflect lower detection, movement to adjacent vegetation or changes in the developmental stages being encountered, rather than mortality or control efficacy. The dataset contains no weather or natural-enemy measurements from which to test such explanations. It is nevertheless appropriate to describe the chronological shift in detected individuals and to identify the months when each taxon was most frequently recorded.

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Differences among monitoring sites

Table 2 focuses on spatial totals and dominant taxa; it does not repeat the seven-month time series plotted in the figures. Differences among locations were modest relative to the seasonal changes visible in Figure 1. However, no inferential conclusion can be drawn about locality effects without consistent sampling effort and more independent monitoring seasons.

All six localities showed *M. pruinosa* as the taxon with the highest seven-month count. This consistency is noteworthy at the descriptive level because the gardens were situated in different settlements. Nevertheless, the overall site totals cannot be treated as a balanced experimental comparison: the dataset provides one seasonal series per garden and lacks within-garden independent sampling replicates. In particular, applying an analysis of variance to individual months as though they were independent site replicates would risk pseudoreplication and artificially narrow uncertainty estimates.

Table 1

Descriptive statistics based on cumulative monthly counts at six sites (April–October)

Site	All species (n)	Overall share (%)
Place 4	913	18.4
Place 6	866	17.5
Place 1	835	16.9
Place 3	819	16.5
Place 2	778	15.7
Place 5	738	14.9

Plant associations and implications for monitoring

Field notes associated A. gossypii mainly with roses, *E. lanigerum* with apple, *H. halys* with apricot and pepper, and *N. viridula* with tomato and lilac. These observations suggest where scouting may be fruitful but do not estimate host preference, because plant-specific counts and measures of available foliage were not provided. The proposed occurrence of *C. ciliata* on Japanese quince particularly requires confirmation through specimen identification and plant-specific records: Platanus remains the major established host for the species (EPPO, 2026; MACELJSKI, 1986). Mere presence on a plant does not demonstrate reproduction or feeding on that host.

Earlier Romanian research documented a broad suite of hosts for *M. pruinosa* (VLAD AND GROZEA, 2016). A field-based organic system survey can therefore benefit from monitoring both herbaceous and woody plants. For *H. halys*, organic-farm studies also emphasize changes in attraction throughout the growing season and the importance of matching sampling periods to host phenology (LESKEY AND NIELSEN, 2018; PHILIPS ET AL., 2016). The occurrence of both pentatomids through October in the submitted dataset supports maintaining late-season inspection rather than ending pest surveillance in midsummer.

In mixed gardens, proximity of perennial plants and annual vegetables may create opportunities for movement among resources as plant development progresses. The present observations indicate which taxa and plants were encountered together, but the absence of host-specific counts prevents estimation of preference indices, infestation rates or differential reproductive success. Even when a species is regularly found on a plant, additional evidence such as feeding stages and population development is required to distinguish a true developmental host from a temporary resting or transit plant.

For applied pest monitoring, a practical approach would be to maintain yellow panels throughout periods of aphid activity, inspect the relevant foliage directly for sessile colonies and immature forms, and standardize shake sampling on the plants visited for stink bugs. The methods should remain taxon-specific while the recording system uses comparable units of monitoring effort. For instance, the field log can record captures per panel per exposure day, direct counts per fixed number of leaves or shoots, and shaken individuals per specified plant and number of strokes. All values could then be linked to plant phenology and visible symptoms. These refinements would support interpretation of temporal peaks as changes in detection-standardized abundance rather than simply fluctuations in raw monthly totals.

The distinction between polyphagy and observed occupancy is also important. A highly polyphagous species may be encountered on many garden plants without using all of them equally for development. Conversely, a specimen collected from a surface or shrub may be a transient visitor. Documentation of nymphs, feeding traces, reproduction and repeated plant-specific encounters would considerably strengthen any claim of an established host association. This is especially relevant for atypical host records such as the Japanese quince attribution for *C. ciliata*, which should not be generalized without independent confirmation.

Three limitations should be explicit. First, counts were gathered with different techniques and unknown effort, so interspecific rankings are not estimates of equal-area density. Second, information was compiled for one April-October monitoring series; no interannual generalization is possible. Third, records lack replicate counts per plant species, weather series and plant-injury measurements. A future design could document the number of sticky panels, exposure days, standardized shaking effort and visual-count duration, while recording host-specific occurrence and damage in parallel. Such information would permit stronger comparisons and analyses of host associations.

From a management standpoint, the results justify a staged surveillance schedule rather than a single survey date. Early visits should prioritize aphids on actively growing tissues, June–July visits should include direct inspection for planthoppers and lace bugs, and late-August-October checks should retain shake sampling and visual inspection for pentatomids. The priority sequence is supported by the observed timing, whereas the effectiveness of any control measure was not assessed in this study. The field records should therefore be presented as baseline surveillance evidence rather than as a test of control efficacy.

CONCLUSIONS

Over the six gardens, 4,949 hemipteran individuals were recorded during April–October. *M. pruinosa* represented the largest share of the records, followed by A. gossypii. Monthly totals peaked in June, while the two monitored pentatomids reached their greatest recorded abundance in September. The seasonal turnover supports differentiated monitoring schedules: focused spring–summer assessment of aphids, flatids and lace bugs, followed by intensified checks for stink bugs in late summer and autumn. Reported plant associations are useful field indications, but preference cannot be confirmed quantitatively from site-level totals. Future observations should standardize sampling effort and document host-specific counts and damage.

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