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Distribution and bionomics of ladybird beetles (Col., Coccinellidae) living in an apple orchard near Budapest, Hungary[1]

By Z. Radwan and G. L. Lövei

Abstract

Field observations were taken in the apple orchard of the Research Institute for Plant Protection at Juliamajor near Budapest, to monitor the occurrence and activity of ladybird beetles and their developmental stages.

We found 620 individual adults of 14 species. The most abundant species were *Coccinella septempunctata*, *Adalia bipunctata*, *Adonia variegata*, and *Exochomus quadripustulatus*. Adult abundance ratios in treated vs. untreated blocks were 1 : 3.28. *C. septempunctata* and *A. bipunctata* were relatively more common to the treated block. Abundance curves showed two peaks, in May and in August. Egg laying began at Mid-May. Most eggs were found on the abaxial surface of the leaves. Five species of larvae were found, mostly *A. bipunctata*, which was considered the most important aphid predator. We found *C. septempunctata* larvae and pupae on the weed cover under the trees when they were absent from the canopy. Adult microhabitats reflected feeding preferences: *E. quadripustulatus* was found mainly on the trunk and branches (70.2 %) while *A. bipunctata* on leaves (90.3 %).

Community structure was identical to earlier findings (Lövei 1981). Observation was superior to beating: the latter collected about 30 % of the beetles observed on the canopy at the same time.

1 Introduction

Coccinellids are known as predators of aphids, coccids, spiders, and mites, and several successful introductions using coccinellids have been taken in biological control programs. Ladybirds were recorded in many fields and orchards. The ladybird fauna of apple orchards was also studied by several authors (see Hodek 1973; Lövei 1981). Most orchards supported 3–12 species, with an average diversity of d = 0.54 (Berger-Parker dominance index) (Lövei 1981). The most abundant species were *Coccinella septempunctata* L., *Adalia bipunctata* L., *Propylaea quattuordecimpunctata* L., and *Calvia quattuordecimguttata* L.

During three years, 1977–1979, Lövei (1981) found 11 species in a sprayed apple orchard block, and 10 in a non-sprayed control near Budapest, Hungary, with no significant differences in diversity but differences in abundance. He reported that sweep netting did not reveal the presence of coccinellids on orchard weeds.

The present work continued to monitor coccinellid species composition,

[1] Ecological Researches on Apple Orchards. No. 24.

U.S. Copyright Clearance Center Code Statement: 0044-2240/82/9402-0169 $ 02.50/0
Z. ang. Ent. 94 (1982), 169–175

ISSN 0044-2240 / InterCode: ZANEAE

relative population density, and seasonal abundance in the same apple orchard. We found a similar community structure, 14 species as adults, but only 5 species as larvae, mostly of *A. bipunctata.* We have also found larvae and pupae of *C. septempunctata* on weeds when they were absent from the canopy. Most authors considered the occurrence and activity of adults only (see HODEK 1973). Here we report data on microhabitat distribution of eggs, larvae and pupae as well as adults.

2 Material and methods

The population trends of coccinellids were studied in an apple orchard near Budapest, at the Juliamajor Farm of the Research Institute for Plant Protection. Observations were taken weekly, from mid-April to the end of October, to record the adults, larvae, pupae and eggs of coccinellids on 20 apple trees of 3 varieties (Jonathan, Golden and Starking). The search was made on 5 branches and trunk from each tree and conducted in midday under favourable wheather conditions. From the sampled trees, 10 were treated with insecticides (TR), and 10 were treated with fungicides only (UNT). For detailed descriptions of the orchard and surroundings, see LÖVEI (1981).

We recorded the microhabitats where coccinellid eggs, larvae, pupae and adults were found. Microhabitat categories were trunk, branches, twigs, leaves, and weed cover under the trees. Spatial co-occurrence of coccinellids and their possible prey organisms was also recorded.

3 Results

We recorded 620 individual adults of 14 species in 1980 (table 1). The diversity reflected by the Berger-Parker dominance index was 0.537. The UNT block had a larger population, the abundance ratio between TR and UNT equalled 1 : 3.28. The population increase in July resulted from the emergence of the new generation.

Coccinellids put their eggs on apple trees from the middle of May to the end of July. Eggs were first found on the under side of the branches near the trunk, later on the twigs and leaves (table 2). Eggs of *Exochomus quadripustulatus* L. were recorded on the trees infested with apple aphids, especially with woolly aphids, *Eriosoma lanigerum* Hausm. The number of eggs gradually increased till the end of June. Nearly all the eggs (98.6 %) were found on UNT trees. The first larvae appeared at the end of May and were recorded until the beginning of August, with a peak in July (fig. 1). Five species of larvae were determined during the breeding season sampled from the canopy, and one species under the trees (larvae of *Thea vigintiduopunctata* L.). *A. bipunctata* larvae were most abundant (50.29 %) on UNT trees, followed by *C. quattuordecimguttata* (25.74 %), *E. quadripustulatus* (13.7 %), *Adalia decempunctata* L. (9.7 %) and *C. septempunctata* (0.57 %). *A. bipunctata* larvae appeared first (end of May), and were present until the end of July. *E. quadripustulatus* larvae were found from the end of June till the first days of August; *C. quattuordecimguttata* larvae were sampled between 10 June and 31 July, those of *A. decempunctata* in July. One 3rd instar larva of *C. septempunctata* was found early in July.

Pupae of *C. quattuordecimguttata* appeared first, 10 June. *A. bipunctata* pupae were found in greatest numbers (72.0 % of all pupae) (fig. 1).

The majority of larvae (99.4 %) and pupae (98.5 %) was also recorded on UNT trees and only on the ones infested with aphids. 99.0 % of *A. bipunctata*

Table 1. Seasonal abundance of the coccinellid species in the apple orchard at Juliamajor. Numbers are the totals observed on 50 branches in the untreated block

Species	Months							Total	Relative abundance
	Apr	May	June	July	Aug	Sep	Oct		
Coccinella septempunctata	1	82	15	2	125	75	33	333	0.537
Adalia bipunctata	1	9	13	68	-	3	-	94	0.152
Adonia variegata	1	5	-	-	9	33	41	89	0.143
Exochomus quadripustulatus	-	10	8	7	13	6	13	57	0.092
Calvia quattuor-decimguttata	-	1	4	13	-	-	-	18	0.029
Adalia decempunctata	-	-	1	14	-	-	-	15	0.024
Hippodamia tredecimpunctata	-	-	-	-	-	-	7	7	0.011
Harmonia quadripunctata	-	-	-	2	-	-	-	2	0.003
Propylaea quattuor-decimpunctata	-	-	-	2	-	-	-	2	0.003
Scymnus apetzi	-	-	-	-	1	-	-	1	0.002
Semiadalia undecimnotata	-	-	-	-	-	-	1	1	0.002
Synharmonia conglobata	-	-	-	1	-	-	-	1	0.002
Total	3	107	41	109	148	117	95	620	1.000

larvae were found inside or on the leaves infested with *Dysaphis devecta* Walk. while 0.1 % on the trunk near *E. lanigerum* colonies and 0.9 % on *Dysaphis plantaginea* Pass.

E. quadripustulatus eggs, larvae, and adults were recorded on trees infested with *Aphis pomi* Deg. The majority of *C. quattuordecimguttata* larvae (97.6 %) were found inside or on the leaves infested with *D. devecta* while 2.3 % found on *E. lanigerum. A. decempunctata* larvae were observed on *D. plantaginea* (93.7 %) and *D. devecta* (6.35 %) colonies. Most *C. septempunctata* adults emigrated during the breeding season as few adults of larvae were found on *D. plantaginea.* No *Adonia variegata* L. larvae or adults were found during the breeding season.

P. quattuordecimpunctata, Synharmonia conglobata L. and *Harmonia quadripunctata* Pont. seemed to breed on apple aphids but in very low numbers, as newly emerged adults but no larvae were found.

C. septempunctata adults, larvae, and pupae were recorded on weeds infested with *Aphis fabae* Scop. in late July. Probably this caused that, in autumn, *C. septempunctata* appeared earlier on the canopy than the "true immigrant" *A. variegata.*

The most abundant hibernating species were *C. septempunctata, A. variegata,* and *E. quadripustulatus.* All three species were observed on apple trees until the beginning of November. *Hippodamia tredecimpunctata* L. and *Semiadalia undecimpunctata* Schneider were recorded until the end of October but in low numbers (table 1).

Table 2. The distribution in time and space of coccinellid eggs on apple trees at Juliamajor, untreated block

Date	Number of		Mean number /± S.D./ of eggs/cluster	Number of eggs /and clusters/ on			
	egg clusters	eggs		branches	twigs	leaves, abaxial surface	leaves, adaxial surface
14 May	2	18	9.0 ± 0	18 /2/	-	-	-
21 May	5	51	10.2 ± 9.7	4o /4/	11 /1/	-	-
29 May	6	71	11.8 ± 5.04	22 /1/	49 /5/	-	-
6 June	4	64	16.0 ± 10.7	-	12 /1/	10 /1/	42 /2/
12 June	5	104	20.8 ± 10.2	-	-	38 /1/	66 /4/
18 June	4	117	29.3 ± 15.1	-	-	16 /1/	101 /3/
28 June	7	171	24.4 ± 7.9	-	-	-	171 /7/
3 July	9	117	13.0 ± 8.6	-	-	-	117 /9/
8 July	1	12	12.0 ± 0	-	-	-	12 /1/
16 July	0	0	0	-	-	-	-
28 July	1	10	10.0 ± 0	-	-	-	10 /1/

All but 22 eggs were found on leaves infested with *D. devecta* 22 eggs were on *A. pomi*-infested leaves. Numbers observed on 5o branches.

The position where coccinellids were found reflected their feeding preferences. *E. quadripustulatus* was usually recorded on trunk (30.0 %), branches (40.2 %), and twigs (19.6 %). 10.2 % was found on leaves only. *A. bipunctata* was found on leaves (90.3 %), and on branches and trunk (9.7 %). *T. vigintiduopunctata* adults and larvae were found under the trees, especially on weed leaves infested with fungi.

The harmful effect of insecticide treatment was reflected in that we recorded

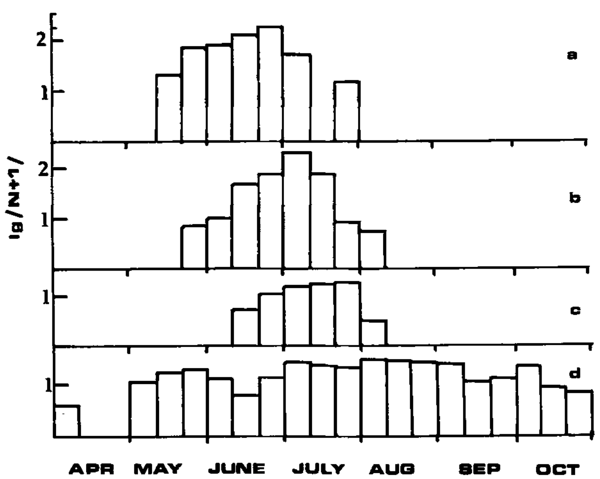


Fig. 1. Seasonal abundance of coccinellid developmental stages in the untreated block of the apple orchard. a: eggs, b: larvae, c: pupae, d: adults. Columns are the mean numbers on 50 branches/10 days

no coccinellids immediate after sprayings and no immature stages but a few egg batches were observed in TR block.

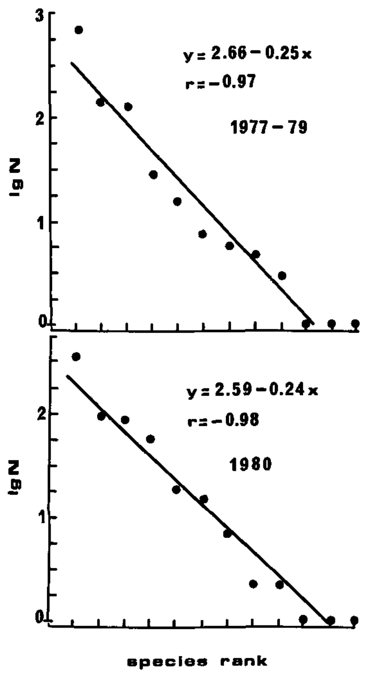
4 Discussion

The faunal composition was similar to the results of earlier samplings (LÖVEI 1981). The SØRENSEN's coefficient of similarity gave a value of 0.83, i. e. ten species were common to both series of samplings; *Coccinula quattuordecimpunctata* L. and *T. vigintiduopunctata* was absent from the 1980 observations (from trees only) while no specimens of *Scymnus apetzi* Muls. and *Semiadalia undecimnotata* L. recovered during the three years of beating. All species, however, are present in orchards in Europe (HODEK 1973).

The rank-abundance curves were similar, too; both fitted the logarithmic series (r = 0.97 for 1977–79; and 0.98 for 1980, fig. 2). No serious difference in diversity occurred.

Comparing the numbers observed and sampled by beating (fig. 3), we found that, as estimated earlier from a mass immigration of *C. septempunctata* (LÖVEI 1981), beating collected about 30 % of the beetles present on the canopy.

The position of coccinellid eggs followed the aphid infestation: from the appearance of aphids, the majority of eggs was laid on the under side of leaves. On UNT trees the coccinellid and aphid population level was similar in trend while no such relationship occurred in the TR block (KOZÁR, pers. observ.).



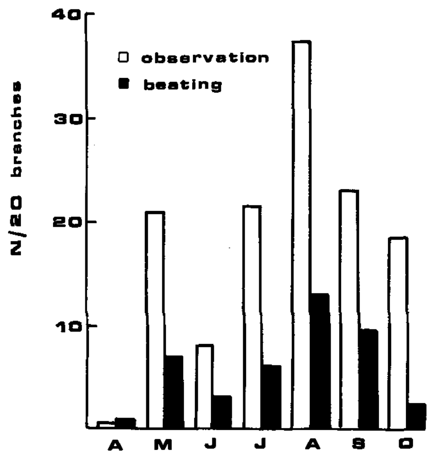


Fig. 2. Coccinellid dominance – diversity curves for the apple orchard at Juliamajor, reflected by a: beating, 1977–79; b: direct observation, 1980. Curves fitted by linear regression. – *Fig. 3.* Comparison of observation and beating in reflecting coccinellid abundance. Adults included only

From the observations it was probable that *A. bipunctata* can develop on *Dysaphis devecta*, and this aphid could be categorized as "essential food" not merely "alternative" recorded by Mills (1981) in England. Laboratory rearings proved this (Radwan, unpubl.). *E. lanigerum* and *D. plantaginea* can serve as alternative food for this coccinellid.

Mills (1981) recorded *E. quadripustulatus* on coccids only. Iperiti et al. (1977) suggested that the species may occupy a transitional position between coccido- and aphidophagy. This suggestion coincides with the fact that we found developmental stages of *E. quadripustulatus* on *A. pomi.*

C. quattuordecimguttata larvae were found on *D. devecta* and on the woolly apple aphid, so both may be categorized as "essential" prey. However, it is doubtful whether this species can develop on *E. lanigerum* only.

D. plantaginea and *D. devecta* can serve as essential preys for *A. decempunctata* also.

The weed cover provided reproduction sites for *C. septempunctata*, and acting as a reservoir, made possible the early autumn appearance of the species on the canopy. *A. variegata* which bred outside the orchard, appeared in late September only. However, the weed cover as predator reservoir may be less useful than hazardous as possible virus reservoir (Tamaki 1975).

The major aphidophagous coccinellid was *A. bipunctata*: most larvae and pupae found belonged to this species. *C. septempunctata* larvae and pupae as well as adults were not common on the canopy, though few of them bred on *D. plantaginea*, and the species' larvae developed on *D. plantaginea* diet in the laboratory. Most of the adults emigrated or bred on aphids of weeds. This coincides with the findings of Iperti (1978).

In 1980, no serious aphid reduction by coccinellids occurred. The prospering weed cover attracted *C. septempunctata* which, when lacking grassy vegetation, may invade the apple trees and remain there longer (Savioskaya 1966). This points to the importance of weed cover management in the orchard.

Zusammenfassung

Zur Verbreitung und Lebensweise der Marienkäfer (Col., Coccinellidae) in einer Apfelanlage bei Budapest

Es wurden im Untersuchungsareal 620 adulte Marienkäfer, die zu 14 Arten gehörten, ermittelt. Die Arten höchster Abundanz waren: *Coccinella septempunctata, Adalia bipunctata* und *Exochomus quadripustulatus.* Das Abundanzverhältnis der Imagines zwischen chemisch behandelten und unbehandelten Parzellen betrug 1:3.28. *C. septempunctata* und *A. bipunctata* waren relativ häufiger im behandelten Block. Die Abundanzkurven zeigten zwei Maxima in den Monaten Mai und August. Die Eiablage begann Mitte Mai; die meisten Eier wurden auf die Unterseite der Blätter gelegt. Larvenformen wurden von nur 5 Arten beobachtet. Sie gehörten in der Mehrzahl der Fälle zu *A. bipunctata,* die sich als wichtigster Aphidenfeind erwies. Die Larven und Puppen von *C. septempunctata* wurden unter den Bäumen an Unkrautpflanzen gefunden und traten in Baumkronen nicht auf. Die Mikrohabitats der Adulten zeigten eine Übereinstimmung mit der Wirtswahl: *E. quadripustulatus* hielt sich meist an Ästen auf (70.2 %), während die Adulten von *A. bipunctata* an Blättern zu finden waren.

Die Struktur der Artengemeinschaft war identisch mit der früher festgestellten (Lövei 1981). Die Beobachtungen ergaben bessere Resultate als die früher durch Abklopfen gewonnenen Werte. Letztere lieferten nur etwa 30 % der in der Baumkrone tatsächlich ermittelten Zahl der Käfer.

Acknowledgements

We thank Dr. F. Kozár for encouragement, Dr. V. Rácz, Mrs. Á. Sisák, T. Győri, and V. Bogdány for their help during the field work, and Mrs. Á. Nagy for carefully typing several drafts of the manuscript.

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Gamma irradiating elm billets reduces their attractancy to the smaller elm bark beetle, *Scolytus multistriatus* (Marsham)

By J. R. J. FRENCH, P. J. ROBINSON and G. MINKO

Abstract

Irradiating elm billets with gamma rays had a significant effect in reducing the attractancy of these billets to inflight adults of the smaller elm bark beetle *Scolytus multistriatus* (Marsham). The temperature at which the fresh billets were stored prior to the beetle exposure had little effect. Irradiated billets, irrespective of storage temperature, had significantly fewer holes than the freshly cut billets. There were significant differences associated with the location of the billets in the field, but these differences were smaller than those associated with irradiation.

1 Introduction

Stressed and dying elm emit volatiles that are attractive to the smaller elm bark beetle, *Scolytus multistriatus* (Marsham) (MEYER and NORRIS 1967), though the addition of volatiles produced by boring female beetles greatly increases the rate of attack of both males and females (PEACOCK et al. 1971). Components of the latter volatiles have been isolated and identified, and a synthetic aggregant pheromone, Multilure, developed (PEARCE et al. 1975; BRAND et al. 1979) but as yet the components of primary host-produced odours remain to be characterized (PEACOCK 1975). However recent field trapping with Multilure baits in North America (J. W. PEACOCK pers. communic.) and the United

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Z. ang. Ent. 94 (1982), 175–179

ISSN 0044-2240 / InterCode: ZANEAE