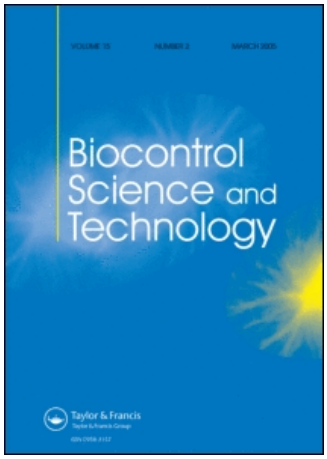

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New Essential Aphid Prey for *Anatis ocellata* and *Calvia quatuordecimguttata* (Coleoptera: Coccinellidae)

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Seven aphid species (Eucalipterus tiliae, Tuberculatus annulatus, Euceraphis betulae, Cavariella konoi, Acyrthosiphon ignotum, A. pisum, Macrosiphoniella artemisiae) *were tested as prey for larvae of* Anatis ocellata *and all were essential prey. Nine aphid species* (Chaitophorus tremulae, Cavariella konoi, Aphis farinosa, Eucalipterus tiliae, Euceraphis betulae, Macrosiphoniella artemisiae, Acyrthosiphon ignotum, Aphis spiraephaga, Aphis fabae) *were tested as prey for* Calvia quatuordecimguttata. *The former six species were 'essential' food, while the latter three aphid species were unsuitable food for* C. quatuordecimguttata. *The experiments were conducted under laboratory conditions with no choice of prey. Some of the checked 'essential' prey apparently do not represent food in the field as they occur in other habitats than the studied coccinellid species that are common on trees.*

Keywords: *essential prey, unsuitable prey, larval development duration, mortality*

INTRODUCTION

Early studies on food of predatory coccinellids published lists of prey based on observations of feeding or just their presence on the same plant (for example, Schilder & Schilder, 1928). Such studies did not give any idea of the nutritional suitability of the prey for the predator. The value of such lists was questioned by Thompson (1951; for more details see Hodek & Honek, 1996, p. 143). While this approach may be adequate for parasites, the suitability of prey for a predator should be discriminated from its acceptability. For example, *Aphis sambuci* (L.) is highly unsuitable for *Coccinella septempunctata* L. larvae and adults, in spite of being consumed (Hodek, 1956; 1957). Only quantitative data on predator's principal developmental parameters (at least rate of development, survival, reproductive capacity) indicate safely the adequacy of the prey. The 'essential' prey/food enables completion of larval development with low mortality and adequate oviposition of females, while the alternative prey/food serves just as a source of energy, thus survival increasing (Evans *et al*.,

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1999; Hodek, 1962, 1993; Mills, 1981). There are, of course, various levels of both types and intermediate cases (Hodek & Honek, 1996, p. 166).

The aim of this paper was to check whether the studied aphids represent 'essential' prey for two coccinellid species which are rarely studied. All aphid species were used for the first time as prey for *Anatis ocellata* (L.) and/or *Calvia quatuordecimguttata* (L.).

MATERIALS AND METHODS

Aphids used in experiments as prey were collected in the field (Table 1). *Anatis ocellata* (two females and a male) were collected from *Pinus sylvestris* and *Calvia quatuordecimguttata* (three females and two males) were collected from *Salix purpurea*, both near Ceske Budejovice, Czech Republic (49°N, 14°E). *A. ocellata* was kept in culture on *Tuberculatus annulatus* (L.) and *C. quatuordecimguttata* on *Cavariella konoi* (Takahashi). Newly hatched larvae were reared individually in 7-cm Petri dishes on the studied aphid species. Coccinellid larvae in each treatment were provided daily with fresh prey consisting of a mixture of aphid instars on a part of a plant. Time to pupation and survival to adult were recorded for individuals reared on each diet.

All experiments were conducted at a constant temperature of 25 ± 1°C and photoperiod of 18L:6D. Data were analysed by the LSD test (least significant difference test, $\alpha = 0.05$).

For a survey of food specificity in both coccinellid species in the field samples were taken weekly from plants infested with aphids: twenty plants of *Artemisia vulgaris* and *Atriplex sagittata*, 10 trees of *Salix purpurea*, *S. caprea*, *Tilia europea*, *Betula pendula*, *Populus tremula*

TABLE 1. The effect of prey aphids on larval development of *Anatis ocellata* and *Calvia quatuordecimguttata*. Means followed by the same letter are not significantly different from one another (LSD test); n = 30

		Larval development			
		A. ocellata		*C. quatuordecimguttata*	
Aphid species	Host plants	Duration days[a] (min.–max.)	Mortality[b] (%)	Duration days[a] (min.–max.)	Mortality[b] (%)
Tuberculatus annulatus (L.)	*Quercus robur*	8.3 ± 0.6 a (8–9)	3		
Acyrthosiphon pisum (Harris)	alfalfa	8.4 ± 0.6 a (8–9)	7		
Acyrthosiphon igonotum Mordvilko	*Spiraea vanhoutei*	8.6 ± 0.6 a (8–9)	7		100
Euceraphis betulae (L.)	*Betula pendula*	8.4 ± 1 a (8–10)	3	11.8 ± 1 b (10–13)	17
Eucalipterus tiliae (L.)	*Tilia europea*	8.5 ± 1 a (8–10)	7	11.8 ± 1 b (10–13)	13
Cavariella konoi Takahashi	*Salix purpurea*	8.8 ± 1 a (8–10)	10	10.6 ± 0.6 a (10–12)	10
Macrosiphoniella artemisiae B. de F.	*Artemisia vulgaris*	8.9 ± 1 a (8–10)	10	12.1 ± 1 b (10–13)	20
Chaitophorus tremulae Koch	*Populus tremula*			10.2 ± 0.6 a (9–11)	7
Aphis farinosa Gmelin	*Salix caprea*			10.9 ± 1 a (10–13)	13
Aphis spiraephaga Müller	*Spiraea vanhoutei*				100
Aphis fabae Scopoli	*Atriplex sagittata*				100

[a]Till pupation.
[b]Till eclosion of adults.

TABLE 2 Observation of *Calvia quatuordecimguttata* in the field near Ceske Budejovice

		Number of							
		Eggs	Larvae	Pupae	Adults	Eggs	Larvae	Pupae	Adults
Aphid species	Host plant	1997				1998			
Tuberculates annulatus	*Quercus robur*	—	—	—	—	—	—	—	—
Acyrthosiphon pisum	alfalfa	—	—	—	—	—	—	—	—
Acyrthosiphon ignotum	*Spiraea vanhoutei*	—	—	—	—	—	—	—	—
Euceraphis betulae	*Betula pendula*	—	—	—	—	—	—	—	—
Eucalipterus tiliae	*Tilia europea*	—	—	—	—	—	—	—	1
Cavariella konoi	*Salix purpurea*	52	14	11	5	27	7	4	7
Macrosiphoniella artemisiae	*Artemisia vulgaris*	—	—	—	—	—	—	—	—
Chaitophorus tremulae	*Populus tremula*	—	11	4	6	—	9	4	3
Aphis farinosa	*Salix caprea*	—	—	—	—	—	—	—	1
Aphis spiraephaga	*Spiraea vanhoutei*	—	—	—	—	—	—	—	—
Aphis fabae	*Atriplex sagittata*	—	—	—	—	—	—	—	—

and *Quercus robur* at height below 2.20 m, 100 shoots of *Spiraea vanhoutei* and 5×50 sweeps from alfalfa.

Field observations were carried out in May through July 1997 and April through June 1998 near Ceske Budejovice, and in April through July 1999 near Sofia, Bulgaria (42°N, 23°E).

RESULTS

Larval mean developmental time and survival of *A. ocellata* and *C. quatuordecimguttata* fed with the studied species of aphids are given in Table 1. All seven aphid species tested were equally suitable as prey for *A. ocellata*. The larvae completed their development in 8.3–8.9 days ($F = 0.6$ d.f. $= 1$, $P = 0.47$), without significant differences among larvae fed different aphid species. Developmental time of *C. quatuordecimguttata* larvae differed significantly among individuals fed different aphid species ($F = 36$, d.f. $= 9$, $P < 0.0001$). The rate of larval development was quickest on *Cavariella konoi*, *Chaitophorus tremulae* and *Aphis farinosa*, followed by development on *Macrosiphoniella artemisiae*, *Euceraphis betulae* and *Eucalipterus tiliae*. In contrast, *Acyrthosiphon ignotum*, *Aphis spiraephaga* and *Aphis fabae* were unsuitable food; most larvae died in the second or third instar (Table 1).

All studied aphid species are newly checked 'essential' prey for *A. ocellata*, and six from nine studied aphids are newly checked 'essential' prey for *C. quatuordecimguttata*.

In the field, only two adults of *A. ocellata* were observed in colonies of *Tuberculatus annulatus* and one adult in a colony of *Eucalipterus tiliae* on the Vitosha Mountain near Sofia. Numerous eggs, larvae and adults of *C. quatuordecimguttata* were found in colonies of *C. konoi* and *C. tremulae* near Ceske Budejovice (Table 2). Adults of C. *quatuordecimguttata* were also recorded in colonies of *Eucalipterus tiliae* (one individual) and *Aphis farinosa* (one individual) (Table 2).

DISCUSSION

Successful larval development in laboratory experiments indicated the aphid species *Acyrthosiphon pisum*, *Cavariella konoi*, *Eucalipterus tiliae*, *Acyrthosiphon ignotum*, *Macrosiphoniella artemisiae*, *Euceraphis betulae* and *Tuberculatus annulatus* as 'essential' prey for *Anatis ocellata*. Experiments on larvae of *Calvia quatuordecimguttata* similarly established six aphid species (*C. konoi*, *Chaitophorus tremulae*, *Aphis farinosa*, *M. artemisiae*, *Euceraphis betulae* and *Eucalipterus tiliae*) as 'essential' prey for this coccinellid species. Three aphid species

(*Acyrthosiphon ignotum*, *Aphis spiraephaga* and *Aphis fabae*) were found to be unsuitable food for *C. quatuordecimguttata*. Kesten (1969) reported *Schizolachnus pineti* (F.) as suitable, while *Myzus persicae* (Sulz.) and *Rhopalosiphum padi* L. as less suitable prey aphids for *A. ocellata*. *Aphis urticaria* (Gmelin) and *A. rumicis* (L.) were tested as further suitable prey aphids in the laboratory (Kučera, 1955). In the field, *A. ocellata* was recorded to feed on several aphid species: *Dreyfusia nüsslini* (= *nordmannianae*) (*Eckstein*) and *Mindarus abietinus* Koch (Kucera, 1955), further *Pineus pini* (Gmelin), *Euceraphis punctipennis* (Zett.) and *Schizolachnus pineti* (F.) (Mills, 1981).

Majerus (1994) reported that in nature *A. ocellata* adults copulate and lay eggs on pines, prefering *Pinus silvestris*. In the late summer, when in England aphid numbers decline on *P. silvestris*, the newly emerged adults disperse to find food on deciduous trees. We assume that the tree aphids *C. konoi*, *E. tiliae*, *E. betulae* and *T. annulatus* may be natural prey for *A. ocellata* because *Salix* spp., *Tilia* spp., *Betula* spp. and *Quercus* spp. are common in mixed woods. Although the other three studied aphid species (*A. pisum*, *M. artemisiae*, *A. ignotum*) most probably do not represent food for *A. ocellata* in the field they are its 'essential' prey as was proven by successful larval development in laboratory.

Calvia quatuordecimguttata can develop well both on aphids (*Rhopalosiphum padi* (L.), *Hyalopterus pruni* (Geof.)) and psyllids (Semyanov, 1980). *Psylla* spp. were reported to be better food enabling faster larval development, greater weight of pupae and higher fecundity than the two aphids (Kuznetsov, 1975; Semyanov, 1980). According to the present results the studied tree aphids are probably natural food also for this coccinellid, but *M. artemisiae* apparently will not be natural prey of *C. quatuordecimguttata*.

The presence of coccinellid larvae or adults in the field in an aphid colony is not a sufficient indication to consider an aphid species to be essential prey. Stary (1995) and Kalushkov (1998) observed larvae and adults of *Adalia bipunctata* (L.) in colonies of *Aphis spiraephaga*, but the laboratory experiments ascertained that this prey is a very unsuitable food.

Majerus (1994) considers as 'essential' prey only those used by the predator as food in the field. He gives as example *Acyrthosiphon pisum* that is suitable food for 23 coccinellid species in the laboratory but in Britain only seven coccinellid species feed on this aphid in the field. This limitation is not included in Hodek's (1962, 1973) definition of 'essential' food (given in introduction). We follow here this concept (Hodek, 1993; Hodek & Honek, 1996).

Suitable prey not visited by the predator in the field can be successfully used in laboratory cultures for releases in biocontrol or integrated pest management and thus their inclusion in the list of essential preys is useful. As a 'by-product' of the present study, about 300 specimens of *A. ocellata* and about 200 specimens of *C. quatuordecimguttata* were released on the sampling localities.

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REFERENCES

Evans, E.W., Stevenson, A.T. & Richards, D.R. (1999) Essential versus alternative food of insect predators: benefits of a mixed diet. *Oecologia* **121,** 107–112.

Hodek, I. (1956) The influence *of Aphis sambuci* L. as prey of the ladybird beetle *Coccinella septempunctata* L. *Acta Societatis Zoologicae Bohemoslovacae* **20,** 62–74 (in Czech, English summary).

HODEK, I. (1957) The influence *of Aphis sambuci* L. as food for *Coccinella 7-punctata* L. II. *Acta Societatis Entomologicae Čechosloveniae* **54,** 10–17 (in Czech, English summary).
HODEK, I. (1962) Essential and alternative food in insects. *Verhandlungen des XI. Internationalen Kongress für Entomologie, (Wien 1960)* **3,** 39–40.
HODEK, I. (1973) *Biology of Coccinellidae.* Academia, Prague & Dr. W. Junk, The Hague, 260 pp.
HODEK, I. (1993) Prey and habitat specificity in aphidophagous predators (a review). *Biocontrol Science and Technology* **3,** 91–100.
HODEK, I. & HONĚK, A. (1996) *Ecology of Coccinellidae.* Kluwer Academic, Dordrecht, 464 pp.
KALUSHKOV, P. (1998) Ten aphid species (Sternorrhyncha: Aphididae) as prey for *Adalia bipunctata* (Coleoptera: Coccinellidae). *European Journal of Entomology* **95,** 343–349.
KESTEN, U. (1969) Zur Morfologie und Biologie von *Anatis ocellata* (L.) (Coleoptera, Coccinellidae). *Zeitschrift für Angewandte Entomologie* **63,** 412–445.
KUČERA, V. (1955) Die Tannentrieblaus und ihr Feind der Marienkäfer *Anatis ocellata* L. *Papers of the Czechosiovak Forest Research Institute* **8,** 107–114 (in Czech, German summary).
KUZNETSOV, V.N. (1975) Fauna and ecology of coccinellids (Col., Coccinellidae) in Primorye region. *Trudy Biologopochvennogo Instituta* **28:** 3–24 (in Russian).
MAJERUS, M.E.N. (1994) *Ladybirds.* Harper Collins, London, 367 pp.
MILLS, N.J. (1981) Essential and alternative foods for some British Coccinellidae (Coleoptera). *Entomologist's Gazette* **32,** 197–202.
SCHILDER, F.A. & SCHILDER, M. (1928) Die Nahrung der Coccinelliden und ihre Beziehung zur Verwandtschaft der Arten. *Arbeiten der Bioiogischen Reichsanstalt für Land- und Forstwirtschaft* **16,** 213–282.
SEMYANOV, V.P. (1980) Biology, of *Calvia quatuordecimguttata* L. *Entomologicheskoe Obozrenie* **59,** 757–763 (in Russian).
STARY, P. (1995) Natural enemy spectrum *of Aphis spiraephaga* (Hom.: Aphididae), an exotic immigrant aphid in Central Europe. *Entomophaga* **40,** 29–34.
THOMPSON, W.R. (1951) The specificity of host relations in predaceous insects. *Canadian Entomologist* **83,** 262–269.