Species Diversity of True Bugs on Apples in Terms of Plant Protection

Karel HRADIL[1], Václav PSOTA[2] and Pavla ŠŤASTNÁ[2]

[1]State Phytosanitary Administration, Jičín, Czech Republic; [2]Department of Zoology, Fisheries, Hydrobiology and Apiculture, Faculty of Agronomy, Mendel University in Brno, Brno, Czech Republic

Abstract

Hradil K., Psota V., Šťastná P. (2013): **Species diversity of true bugs on apples in terms of plant protection**. Plant Protect. Sci., **49**: 73–83.

Monitoring of species spectrum of true bugs (Heteroptera) on apple trees without pest management was conducted in 2010–2011. Two sites were selected – an abandoned orchard and a road alley near the village of Velké Bílovice (Břeclav district, Czech Republic). The capture of true bugs with a fogger device (Pulsfog) on five selected trees in each site was performed. The effective substance deltamethrin at concentration of 0.0025 g/l was applied to the tree crowns. Three collections (28/4, 20/5, and 9/7) in 2010 and two (11/5 and 23/6) in 2011 were done. Out of 55 detected species of true bugs, 43 species occurred in the alley and 29 in the orchard. Thirty-two species were predatory or partly predatory (58.18%), 22 species were phytophagous (40%), and one mycetophagous (1.82%).

Keywords: true bugs; *Malus domestica* L.; pests; species diversity

According to the orchard acreage, apples (*Malus domestica* L.) are the most commonly grown fruit in the Czech Republic. Besides productive apple orchards, those for many years left unmanaged can be found in the landscape, too. Apple trees are also commonly planted as alleys along roads. Untreated apple trees in abandoned orchards are a suitable environment for numerous insect species. Due to the absence of pesticide treatment, these populations can fully develop and throphic relationships among them are not restricted. From economic point of view, such trees can host a number of potential pests. On the other hand, some of them can be useful regulators of the pest population. In addition, indifferent species with only little or none economic significance can also occur here.

A number of surveys focused on the determination of species spectrum of true bugs (Heteroptera) in apple orchards have been performed. For example, in the state of Wisconsin (USA), Oatman *et al*. (1964) found 763 insect species on apple trees including 43 (5.6%) true bugs species. Jonsson (1983) found 46 true bug species within research performed with a knock-down method in apple orchards in Norway in 1979–1981, Kondorosy *et al*. (2010) performed research in apple orchards in England in 2001, 2002, 2004, and 2006 and detected 104 true bug species. Jahn (1998) used the knock-down technique for study of the occurrence of pests and their natural antagonists with the focus on true bugs in 1996–1997 and detected 22 species. Kinkorová and Kocourek (2000) monitored the occurrence of Heteroptera in an apple orchard in 1992–1995 and found 70 species of true bugs. Niemczyk (1999) assessed the species spectrum of predatory true bugs on apple trees and carried out performance in treated and untreated orchards in Poland.

MATERIAL AND METHODS

The true bug occurrence was monitored in South Moravia, near the village of Velké Bílovice (Břeclav district, Czech Republic), faunistic square 7167 (Fig-

Supported by the Internal Grant Agency, Mendel University in Brno, Czech Republic, Project No. TP4/2012.

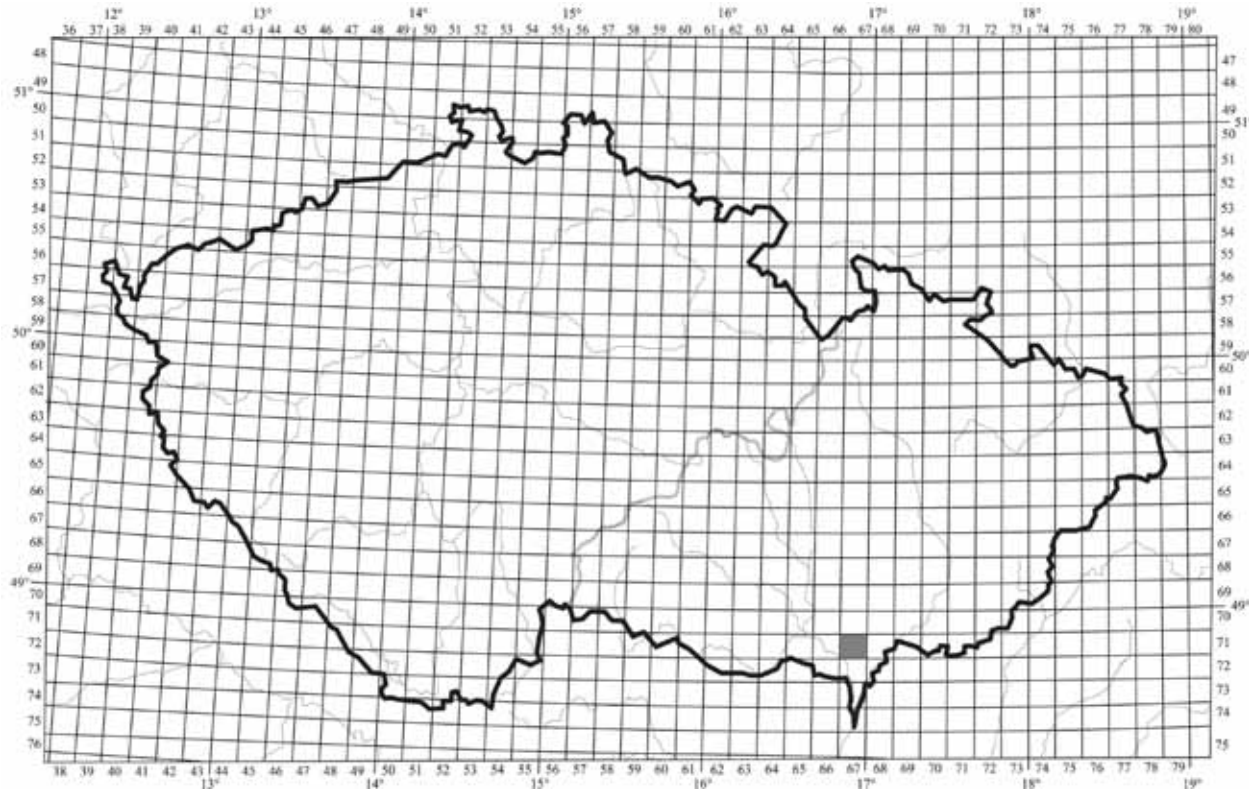

Figure 1. Location of study sites – faunistic square 7167 (grey spot)

ure 1), in two selected sites with apple trees grown without management. The first site, having been abandoned for more than 10 years, was situated 1.2 km north-east of the village outskirts (48°52'8.430"N, 16°55'7.752"E). Many trees in this site were heavily infested with apple clearwing moth *Synanthedon myopaeformis* (Borkhausen, 1789), some of the trees died from this pest attack. Apparent succession processes led to the heavy occurrence of dog rose (*Rosa canina*) and elder (*Sambucus nigra*). This orchard was surrounded by an irrigation reservoir from one side, a road and field from the other. The other one was an apple alley along the road surrounded by a field. It was situated approximately 1.6 km to the east of the Velké Bílovice village outskirts (48°50'5.020"N, 16°52'18.732"E). The beeline distance between the two places was 5.2 km.

True bugs were trapped always during morning hours with the use of the agent containing pyretroid deltamethrin (50 g/l). This was added to the polyglycol aqueous solution containing 915.12 g/l dietylenglycol in the ratio of 1:3 in favour of water. Concentration of the effective substance deltamethrin in the application liquid was 0.0025 g/l. Aerosol was dispersed in crowns of selected trees using a fogger device (PULSFOG K-22-STD; pulsFog Dr. Stahl and Sohn GmbH, Überlingen, Germany). Stunned and killed arthropods fell on the plastic sheet placed under the tree. Further, 15 min after application, we shook the tree and the killed arthropods were collected. The material obtained was then kept in 70% alcohol and subsequently determined in the entomological laboratory.

One collection always contained the material from 5 trees in each site. In 2010, three collections were performed (28/4, 20/5, and 9/7), two in 2011 (11/5 and 23/ 6).

Compared to relative trapping methods, such as knock-down or use of various traps which allow to collect always only a certain per cent of the studied taxocenoses, the fogging method enabled us to study the complex abundance of arthropods occurring in apple tree crowns in the given terms. The results stated below show the dominance values of more significant species. The species dominance is characterised by the scale: ED = eudominant (> 10%), D = dominant (5–10%), SD = subdominant (2–5%), R = recedent (1–2%), SR = subrecedent (< 1%) (Tischler 1965). Species with plant protection importance and those interesting from faunistic viewpoint are discussed in detail in the following text.

RESULTS

In total, 55 species of true bugs (43 in the alley, 29 in the orchard) of 13 families were detected in the testing sites in 2010–2011 (Table 1). The Miridae family with 28 species was the most frequent (50.9%), representatives of the Anthocoridae (7 species, i.e. 12.72%) and Pentatomidae families (5 species, i.e. 9.09%) were substantially less frequent. Other families were represented by 1–3 species (1.8–5.45%).

Zoophagous and zoophytophagous species

Anthocoridae

The species *Anthocoris confusus* Reuter, 1884, as an adult detected only once in our collections, was probably a part of a complex of nymphs determined only at the level of family in the studied material. *Anthocoris confusus* is a zoophage living on various deciduous tree species such as *Salix* spp., *Fagus* spp., *Acer* spp., *Tilia* spp., *Quercus* spp., *Crataegus* spp., *Ulmus* spp., *Populus* spp., and *Fraxinus* spp. where it preys on aphids (Aphididea), leaf suckers (Psyllidae), and brooklice (Psocoptera) (Wachmann *et al.* 2006). Their occurrence on apple trees was reported by Niemczyk (1999).

Anthocoris nemoralis (Fabricius, 1794) formed 3.43% in the alley, 2.27% in the orchard, totally 3.11% of true bug captures (subdominant representation), it is a zoophage frequent on *Crataegus* spp., *Fraxinus* spp., and apple trees *Malus* spp., preying on various aphids, leaf suckers, thrips (Terebrantia) or mites (Acarina) (Wachmann *et al.* 2006). On apple trees, it was reported by Jonsson (1983) or Niemczyk (1999).

Orius (*Heterorius*) *minutus* (Linnaeus, 1758) was found only in collections from the alley (0.57%), in total it formed only 0.41% (subrecedent representation). It is a zoophagous species frequently occurring on deciduous trees where it looks for small insect and its eggs (Wachmann *et al.* 2006). It was also reported on apple trees by Niemczyk (1999) and Kinkorová and Kocourek (2000).

Orius spp. similarly as some of *Anthocoris* species, representatives of the *Orius* species occurred mostly as nymphs or females forming probably a complex of species, in the alley they were represented by 8%, in the orchard by 9.09%, totally 8.3% (dominant representation).

Temnostethus (*Temnostethus*) *pusillus* (Herrich-Schaeffer, 1835) was found only on apple trees in the alley where it formed 2.86% of captures, 2.07% in total (subdominant representation). It is a small zoophage frequently occurring on ash or apple bark where it preys on aphids, leaf suckers, and scale insects (Coccidae) (Wachmann *et al.* 2006).

Miridae

Atractotomus mali (Meyer-Dür, 1843) was found only in captures of true bugs in the alley (2%), summarily, its representation was recedent (1.45%). It is a zoophytophagous species living on *Malus* spp., *Crataegus* spp., *Pyrus* spp., *Prunus* spp., and *Sorbus* spp., it feeds on tiny caterpillars, eggs, mites, aphids, and leaf suckers (Wachmann *et al.* 2004). On apples in productive orchards, it was reported by e.g. Jonsson (1983), Jahn (1998), Niemczyk (1999), and Kondorosy *et al.* (2010).

Deraeocoris (*Deraeocoris*) *ruber* (Linnaeus, 1758) was found both in the alley (2.57%) and in the orchard (2.27%), in total it represented 2.49% of the true bug material (subdominant representation). It is a very common zoophagous species known in *Malus* spp., *Rubus* spp., *Sarothamnus* spp., *Urtica* spp., *Pinus* spp., *Larix* spp., *Thuja* spp., and *Juniperus* spp. It feeds on small insect, e.g. aphid family Lachnidae (Wachmann *et al.* 2004). It was reported by Kondorosy *et al.* (2010) from apple orchards in England and by Niemczyk (1999) from Poland.

Deraeocoris (*Knightocapsus*) *lutescens* (Schilling, 1837) was detected only in the alley, its representation was subrecedent (0.57%, totally 0.41%). This slight occurence was surprising as it is one of the most common of *Deraeocoris* species living both on deciduous trees such as *Tilia* spp., *Quercus* spp., *Acer* spp., *Corylus* spp., *Ulmus* spp., and *Malus* spp. and coniferous ones such as *Pinus* spp., *Larix* spp., *Juniperus* spp., and *Thuja* spp. It preys on caterpillars (Lepidoptera) and other larvae and also adults of various aphids and leaf suckers (Wachmann *et al.* 2004). Its occurrence in apple trees was reported by Jahn (1998) in the Czech Republic, and by Niemczyk (1999) in Poland.

Harpocera thoracica (Fallén, 1807) was found only in the alley (0.29%, totally 0.21%). This zoophytophagous species prefers oaks where it appears in the spring period, it sucks on buds but also feeds on pollen and occasionally hunts aphids (Wachmann *et al.* 2004).

Heterotoma planicornis (Pallas, 1772) was sporadically present in captures from the alley (0.29%)

Table 1. Summary of detected true bugs during 2010 and 2011

Trophic status	Family/species/date	Alley, orchard	28.4.2010	20.5.2010	9.7.2010	11.5.2011	23.6.2011	Total (pcs)	Total (%)	Dominance
	TINGIDAE Laporte, 1832									
p	*Physatocheila costata* (Fabricius, 1794)	a		1				1	0.21	SR
p	*Stephanitis (Stephanitis) pyri* (Fabricius, 1775)	a			1	11	16	28	5.81	D
		o				1		1	0.21	SR
p	*Tingis (Tingis) crispata* (Herrich-Schaeffer, 1838)	o					1	1	0.21	SR
	MIRIDAE Hahn, 1833									
p	*Apolygus lucorum* (Meyer-Dür, 1843)	o			1			1	0.21	SR
zp	*Atractotomus mali* (Meyer-Dür, 1843)	a					7	7	1.45	R
zp	*Atractotomus* sp.	o				2		2	0.41	SR
p	*Criocoris crassicornis* (Hahn, 1834)	a					1	1	0.21	SR
z	*Deraeocoris (Deraeocoris) ruber* (Linnaeus, 1758)	a			2	2	5	9	1.87	R
		o				3		3	0.62	SR
z	*Deraeocoris (Knightocapsus) lutescens* (Schilling, 1837)	a				1	1	2	0.41	SR
p	*Halticus saltator* (Geoffroy, 1785)	o					1	1	0.21	SR
zp	*Harpocera hellenica* Reuter, 1876	a				8		8	1.66	R
zp	*Harpocera thoracica* (Fallén, 1807)	a				1		1	0.21	SR
z	*Heterotoma planicornis* (Pallas, 1772)	a					1	1	0.21	SR
		o		1				1	0.21	SR
z	*Heterotoma* sp.	a					1	1	0.21	SR
		o		2			6	8	1.66	R
p	*Chlamydatus (Euattus) pullus* (Reuter, 1870)	a				1		1	0.21	SR
z	*Isometopus intrusus* (Herrich-Schaeffer, 1835)	a					1	1	0.21	SR
p	*Megaloceroea recticornis* (Geoffroy, 1785)	a					1	1	0.21	SR
		o		1				1	0.21	SR
zp	*Miridae* sp.	a				3	1	4	0.83	SR
		o		2	2		2	6	1.24	R
zp	*Orthonotus rufifrons* (Fallén, 1807)	a					1	1	0.21	SR
p	*Orthotylus (Orthotylus) prasinus* (Fallén, 1826)	a					4	4	0.83	SR
		o					2	2	0.41	SR
p	*Orthotylus* sp.	a					1	1	0.21	SR
		o					1	1	0.21	SR
z	*Phytocoris (Phytocoris) reuteri* Saunders, 1876	a					1	1	0.21	SR
zp	*Phytocoris (Ktenocoris) ulmi* (Linnaeus, 1758)	o			1			1	0.21	SR
zp	*Phytocoris* sp.	a		1		3	1	5	1.04	R
		o		3	3	6		12	2.49	SD
zp	*Pilophorus perplexus* Douglas & Scott, 1875	a			1		10	11	2.28	SD
zp	*Pilophorus* sp.	a			3		5	8	1.66	R
		o					4	4	0.83	SR
zp	*Psallus (Hylopsallus) perrisi* (Mulsant & Rey, 1852)	a		12				12	2.49	SD
zp	*Psallus (Hylopsallus) wagneri* Ossiannilsson, 1953	a		9				9	1.87	R
zp	*Psallus* sp.	a		5		1		6	1.24	R
p	*Stenodema (Brachystira) calcarata* (Fallén, 1807)	o			1			1	0.21	SR
p	*Stenotus binotatus* (Fabricius, 1794)	o					1	1	0.21	SR

Table 1 to be continued

Trophic status	Family/species/date	Alley, orchard	28.4.2010	20.5.2010	9.7.2010	11.5.2011	23.6.2011	Total (pcs)	Total (%)	Dominance
	NABIDAE A. Costa, 1853									
z	*Himacerus (Aptus) mirmicoides* (O. Costa, 1834)	o		1				1	0.21	SR
z	*Himacerus (Himacerus) apterus* (Fabricius, 1798)	a			4	1	14	19	3.94	SD
		o		4	4	24	4	36	7.47	D
z	*Nabis* sp.	o			1			1	0.21	SR
	ANTHOCORIDAE Fieber, 1836									
z	*Anthocoridae* sp.	a				16	44	60	12.45	ED
		o				16	1	17	3.53	SD
z	*Anthocoris confusus* Reuter, 1884	a				1		1	0.21	SR
z	*Anthocoris nemoralis* (Fabricius, 1794)	a				6	6	12	2,49	SD
		o				3		3	0.62	SR
z	*Anthocoris* sp.	a				1		1	0.21	SR
z	*Orius (Heterorius) minutus* (Linnaeus, 1758)	a					2	2	0.41	SR
z	*Orius* sp.	a	10	3		10	4	27	5.60	SD
		o	6			6		12	2.49	SD
z	*Temnostethus (Temnostethus) pusillus* (Herrich-Schaeffer, 1835)	a				4	6	10	2.07	SD
	ARADIDAE Brullé, 1836									
m	*Aneurus* (*Aneurodes*) *avenius avenius* (Dufour, 1833)	o					2	2	0.41	SR
	LYGAEIDAE Schilling, 1829									
p	*Kleidocerys resedae resedae* (Panzer, 1797)	a				1		1	0.21	SR
		o				1		1	0.21	SR
	OXYCARENIDAE Stål, 1862									
p	*Metopoplax origani* (Kolenati, 1845)	a				1		1	0.21	SR
	HETEROGASTRIDAE Stål, 1872									
p	*Platyplax salviae* (Schilling, 1829)	a					2	2	0.41	SR
	RHYPAROCHROMIDAE Amyot & Serville, 1843									
p	*Rhyparochromidae* sp.	o					1	1	0.21	SR
	PIESMATIDAE Amyot & Serville, 1843									
p	*Piesma maculatum* (Laporte, 1833)	a			1	1	14	16	3.32	SD
	COREIDAE Leach, 1815									
p	*Coreidae* sp.	a					1	1	0.21	SR
p	*Coreus marginatus marginatus* (Linnaeus, 1758)	a	3				1	4	0.83	SR
		o				1		1	0.21	SR
	RHOPALIDAE Amyot & Serville, 1843									
p	*Myrmus miriformis miriformis* (Fallén, 1807)	a					3	3	0.62	SR
	PENTATOMIDAE Leach, 1815									
p	*Graphosoma lineatum* (Linnaeus, 1758)	o				2		2	0.41	SR
p	*Palomena prasina* (Linnaeus, 1761)	a		1				1	0.21	SR
zp	*Pentatoma rufipes* (Linnaeus, 1758)	a			4		58	62	12.86	ED
		o		4			4	8	1.66	R
zp	*Rhaphigaster nebulosa* (Poda, 1761)	a					1	1	0.21	SR
z	*Troilus luridus* (Fabricius, 1775)	a					1	1	0.21	SR
	Total							481		

m – mycetophagous; z – zoophagous; zp – zoophytophagous; p – phytophagous; a – alley; o – orchard; ED – eudominant; D – dominant; SD – subdominant; R – recedent; SR – subrecedent

and orchard (0.76%), in total it was represented by 0.41% (subrecedent). It is an infrequent zoophagous species living mainly on various bushes, sometimes it also occurs on trees or plants such as *Urtica dioica*, *Sarothamnus scoparius*, *Rubus* spp., *Prunus spinosa*, *Crataegus* spp., *Alnus* spp., *Salix* spp., *Corylus* spp., and *Quercus* spp. where it feeds on various caterpillars (e.g. of the Iponomeutidae or Tortricidae families), aphids, and leaf suckers (Wachmann *et al.* 2004). Its occurrence on apple trees was reported by Kinkorová and Kocourek (2000) or Kondorosy *et al.* (2010).

Phytocoris (*Ktenocoris*) *ulmi* (Linnaeus, 1758) was detected only in the orchards, its representation in collections was only subrecedent (0.29%, in total 0.21%). It is a zoophytophage living on various trees e.g. *Crataegus* spp., *Prunus spinosa*, *Malus* spp., *Rubus* spp., *Corylus* spp., *Salix* spp., *Ribes* spp., *Sarothamnus* spp., *Pinus* spp., and *Juniperus* spp., occasionally feeding on mites, aphids, leaf suckers, and scale insects (Wachmann *et al.* 2004). On apple trees it was detected by e.g. Jonsson (1983).

Phytocoris (*Phytocoris*) *reuteri* (Saunders, 1876) was detected only in the alley. Its representation in captures was only subrecedent (0.29%, in total 0.21%). This zoophagous species known from deciduous trees, e.g. *Crataegus* spp., *Prunus spinosa*, *Sorbus aucuparia*, *Alnus* spp., *Quercus* spp., *Salix* spp., *Betula* spp., *Ulmus* spp., *Pyrus* spp., and *Malus* spp. where it feeds for example on apple leaf suckers (*Cacopsylla mali*) (Wachmann *et al.* 2004). On apples, it was reported by e.g. Niemczyk (1999).

Nymphs of various *Phytocoris* spp. appeared relatively frequently in the captures from the orchard and the alley. Their representation was subdominant in the studied taxocenosis (3.53%).

Pilophorus perplexus (Douglas & Scott, 1875) was detected only in the alley (3.14%), together with the nymphs of *Pilophorus* spp. (2.29%) which occurred also in the orchard and formed a more significant group of predatory true bugs, their share in the total frequency was 4.47% (subdominant representation). This zoophytophagous species populates deciduous trees and to a lesser extent also conifers. It feeds on aphids, scale insects, leaf suckers, and mites (Wachmann *et al.* 2004). On apples it was reported by e.g. Jonsson (1983) and Niemczyk (1999).

Psallus (*Hylopsallus*) *perrisi* (Mulsant & Rey, 1852) was detected only in the alley (3.43%). In the studied true bugs taxocenosis it was subdominant (2.49%). This zoophytophage is most frequent on English oaks (*Quercus robur*), also on *Crataegus* spp., *Acer* spp., or *Tilia* spp., it preys on aphids (Wachmann *et al.* 2004). Adults often migrate to apple trees (Jonsson 1983).

Psallus (*Hylopsallus*) *wagneri* (Ossiannilsson, 1953) was detected only in the alley (2.57%), its total share in the studied true bug taxocenosis was recedent (1.87%). This zoophytophagous insect is frequent on *Quercus robur* or *Crataegus* spp. (Wachmann *et al.* 2004).

Harpocera hellenica (Reuter, 1876). Moravia mer.: Velké Bílovice alley (7167), 11/5/2011, 6 M, 2 F, V. Psota leg., K. Hradil det. et coll. A zoophytophagous, ponto-mediterranean species, in Central Europe it was detected for the first time in Moravia in 2003 (Pavlov (7065), Pavlovské kopce Hills, Děvín) on English oaks (Kment *et al.* 2005). In 2009, it was also detected in Austria (Rabitsch 2010) on downy oaks (*Quercus pubescens*). Its typical hosts are various species of oaks, in Velké Bílovice several individuals were found on apple trees in the alley, probably random migration from oaks, similarly as in *Harpocera thoracica* also detected in captures from the apple trees. It was the second finding of this species in Moravia.

Nabidae

Himacerus (*Aptus*) *mirmicoides* (O. Costa, 1834), a non-specialised predator of various insects (Wachmann *et al.*, 2006), was detected only in the orchard, its ocurrence in captures was only subrecedent (0.29%, in total 0.21%). On apple trees, it was reported e.g. by Niemczyk (1999).

Himacerus (*Himacerus*) *apterus* (Fabricius, 1798) appeared in the alley (5.43%) as well as in the orchard (27.27%), it was the third most abundant eudominant species (14.5%) in the studied taxocenosis of true bugs. This zoophage occurs mainly on bushes and deciduous and coniferous trees, being a non-specialised predator mainly of aphids, leaf suckers, mites, but also eggs and larvae of insect (Wachmann *et al.* 2006). It was reported on apples in Poland e.g. by Niemczyk (1999).

Isometopidae

Isometopus intrusus (Herrich-Schaeffer, 1835) was detected only in the alley, its occurrence in captures was only subrecedent (0.29%, in total 0.21%); a zoophagous species living hidden in the bark of apple tree trunks and branches of *Malus* spp., *Pyrus* spp., *Prunus* spp., *Fraxinus* spp., *Alnus* spp., *Quercus* spp., and *Tilia* spp. where it searches for various eggs

and larvae, e.g. of woolly apple aphids (*Eriosoma lanigerum*) (Wachmann *et al.* 2004).

Pentatomidae

Pentatoma rufipes (Linnaeus, 1758) detected both in the alley (17.71%) and in the orchard (6.06%) was the second most abundant species. Its occurrence in the studied taxocenosis of true bugs was eudominant (14.5%). This zoophytophagous species looks for deciduous trees e.g. *Alnus* spp., *Betula* spp., *Carpinus* spp., *Corylus* spp., *Fagus* spp., *Quercus* spp., and fruit trees, where it lives as an unspecialised accidental predator (Wachmann *et al.* 2008). It was reported on apples by e.g. Jonsson (1983).

Rhaphigaster nebulosa (Poda, 1761) was detected only in the alley, in collections it had only subrecedent representation (0.29%, in total 0.21%), a zoophytophagous species occurring mainly on deciduous trees, sometimes it can cause a damage to vegetables, it often overwinters in human dwellings (Wachmann *et al.* 2008).

Troilus luridus (Fabricius, 1775) was found only in the alley, its occurrence in captures was subrecedent (0.29%, in total 0.21%). It is a zoophagous species living on deciduous and coniferous trees where it preys on caterpillars of various butterfly species (Wagner 1966; Wachmann *et al*. 2008).

Indifferent and phytophagous species

The assessment of species spectrum of true bugs in the studied sites showed in total 21 randomly occurred, indifferent species, i.e. 38% of the total number of species (14 species in the alley, i.e. 32%; 12 species in the orchard, i.e. 41% of the total of 29 detected species i.e.), that are not trophically related to woody hosts, e.g. apple trees.

Halticus saltator (Geoffroy, 1785), Moravia mer.: Velké Bílovice orchard (7167), 23/6/2011, 1 M, V. Psota leg., K. Hradil det. et coll. It is a north Mediterranean species extending even to Central Europe (Josifov 1986). Wagner (1973) reported this polyphagous phytophagous species as a pest on vegetable (*Cucumis sativus*) and decorative plants (*Calendula*, *Althea*). In 1925, it suddenly appeared abundantly in England as a pest on potatoes (Winchester) and beans (Grantchester, near Cambridge) (Nau 2009). Adults appear from July to August (Southwood & Leston 1959). In Europe, it is known from Albania, Austria, Bulgaria, Byelorussia, France, Great Britain, Germany, Hungary, Italy, Moldavia, the Netherlands, Poland, Romania, Russia (Central and South European territory), Serbia, Spain, and Ukraine, it occurs as far as Kazakhstan (Protić 1998; Aukema & Rieger 1999). There is only one mention from Slovakia about an undated finding from Sv. Jur locality (Országh 1966). In the Czech Republic its occurrence was previously reported only by Duda (1886) from Hradec Králové and Roubal (1957) from Prague-Břevnov in 1955. A new record on the Czech territory (Moravia) was proved by the present study after 56 years.

Harmful phytophagous species

Stephanitis (*Stephanitis*) *pyri* (Fabricius, 1775). Moravia mer.: Velké Bílovice, alley (7167), 9/7/2010, 1 F; ditto 11/5/2011 2 M, 8 F; ditto 23/6/2011, 3 M, 12 F, 1 nymph; Velké Bílovice, orchard (7167) 11/5/2011 1 M, V. Psota leg., K. Hradil det. et coll.

This Mediterranean species occurs in many countries namely of southern Europe, European part of Russia, it is also known in North Africa, Eastern Mediterranean region, and East-West Asia as far as Kazakhstan (Péricart 1983; Kment & Jindra 2005; Kment *et. al* 2005; Kment & Vahala 2006). In Bohemia, this species was lately known only from historical records from Cheb (Dalla Torre 1878), Prague (Duda 1884), Svijany, Turnov, Sobotka (Roubal 1967). Later on non-dated specimens from the locality Nová Huť (6049) were found in the collections of the National Museum (Kment *et al*. 2005). By 2006 this species was considered extinct in the Czech Republic (Kment & Vilímová 2006). In 2002 it was found on apple trees (*Malus domestica*) in Znojmo (7162) (Kment & Vahala 2006) and in 2006 on rowans (*Sorbus* sp.) in Brno-Černá Pole (6765) (Hradil *et al*. 2008).

This widely polyphagous species is known in the Mediterranean region as a pest mainly on woody plants of the Rosaceae family, namely on *Pyrus* spp., *Malus* spp., and *Prunus* spp. (but it also lives on *Cydonia* spp., *Armeniaca* spp., *Cerasus* spp., *Rosa* spp., *Crataegus* spp., *Sorbus* spp., *Rubus* spp., *Amygdalus* spp., *Castanea* spp., *Chaenomeles* spp., *Cornus* spp., *Cotoneaster* spp., *Juglans* spp., *Ligustrum* spp., *Populus* spp., *Quercus* spp., *Ribes* spp., *Robinia* spp., *Tilia* spp., *Ulmus* spp., and *Vaccinium* spp.) (Péricart 1983; Schaeffer & Panizzi 2000). Its larva and adults feed on the bottom side of leaves;

they suck out the plant tissues and cause creation of chlorotic spots on the upper leaf surface. The bottom side of the infected leaves is covered with brown to black bug excrements. Heavy infestation can reduce photosynthesis, cause aesthetical damage, and lead to premature leaf drop (Aysal & Kivan 2008). This species goes through 5 larval phases (instars) in one year, depending on weather it can have 1–4 (most frequently 2) generations, overwintering as adults. This species has also natural antagonists, for example a specialised predator is a rare *Stethoconus pyri* (Mella, 1869) (Miridae), and especially common species of the Anthocoridae family (*Anthocoris* spp., *Orius* spp.), e.g. *Orius niger* (Wolff, 1811) (Péricart 1983; Schaeffer & Panizzi 2000). The population of *Stephanitis* (*Stephanitis*) *pyri* detected on apple trees in an abandoned orchard in Velké Bílovice (in 2010–2011) suggests that this so far neglected, in Moravia slowly spreading species, can overwinter under favourable conditions at some locations, especially with an insufficient occurrence of predators (e.g. true bugs from the Anthocoridae family) and reproduce massively. To date, Velké Bílovice has been the third known site with the occurrence of *Stephanitis* (*Stephanitis*) *pyri* (Fabricius, 1775) in South Moravia.

DISCUSSION

Based on nutritional requirements of true bugs, the material included 32 predatory or partly predatory species (58.18%), i.e. 17 zoophagous (30.91%) and 15 zoophytophagous (27.27 %) species, 22 phytophagous (40%), and 1 mycetophagous (1.82%) species. In the alley, 15 zoophagous (34.9%), 13 zoophytophagous (30.2%), and 15 phytophagous (34.9%) species were present. It means that totally 28 predatory or partly predatory species (65.1%) occurred there. Nine zoophagous (31.03%), 6 zoophytophagous (20.69%), 13 phytophagous (44.83%), and 1 mycetophagous (3.45%) species were detected in the orchard. In total, 15 predatory or partly predatory species (51.72%) were determined in the orchard.

The total quantitative assessment of the trophic profile of the individual species of true bugs acquired in the orchard and alley showed that the zoophagous, zoophytophagous, phytophagous, and mycetophagous species formed 47.72, 35.06, 16.8, and 0.42%, respectively. In the alley, the zoophytophagous species made 38.86%, zoophagous 42.28%, and phytophagous species 18.86%. In the orchard, zoophytophagous took 25%, zoophagous 62.12%, phytophagous 11.36%, and mycetophagous species 1.52%.

The above given survey suggests that zoophagous and zoophytophagous species prevailed in the testing sites (65.1% in the alley, 51.72% in the orchard), on the other hand, most of the detected phytophagous species in the apple tree crowns occurred randomly as they were trophically associated with other plant species. Zoophagous and zoophytophagous species also dominated quantitatively (in the alley they formed 81.15% and in the orchard 87.12%), captures from the apple tree crowns also contained nymphs, and can be thus considered as a natural component of apple tree crown fauna of true bugs.

Predatory and occasionally predatory species contributing to the regulation of numerous populations of sucking and leaf eating insect are an important component of tree crown entomofauna. Nymphs and adults of the Anthocoridae family (30.29%), nymphs and adults of the predatory bug *Himacerus apterus* (Fabricius, 1798) (11.4%) (Nabidae), and nymphs of zoophytophagous species of *Pentatoma rufipes* (Linnaeus, 1758) (14.5%) (Pentatomidae) were most abundand (eudominant representation) among the predators in our collections. The share of other species in the total number of predatory species was 1–4%.

Anthocoris nemorum (Linnaeus, 1761), *Deraeocoris lutescens* (Schilling, 1837), *Himacerus apterus* (Fabricius, 1798), *Orius minutus* (Linnaeus, 1758), and also *Atractotomus mali* (Meyer-Dür, 1843) were the most abundant zoophagous and zoophytophagous species found by Jahn (1998) in the experimental sites. He interrelated a high occurrence of phytozoophagous species *Orthotylus marginalis* Reuter, 1883 and zoophytophagous *Psallus ambiguus* (Fallén, 1807) with the mass incidence of apple leaf suckers. Kinkorová and Kocourek (2000) found a dominant occurrence of predatory true bugs *Orius minutus* (Linnaeus, 1758), *Orius vicinus* (Ribaut, 1923), *Orius laticollis* (Reuter, 1884), *Heterotoma planicornis* (Pallas, 1772) and with a higher abundance of aphids also *Himacerus apterus* (Fabricius, 1798) on apples. Species *Anthocoris nemorum* (Linnaeus, 1761) and adult female of the predator of the genus *Nabis*, namely *Nabis pseudoferus* Remane, 1949, were less abundant. In 1979–1981 Jonsson (1983) found a number of predatory species in apple orchards, the dominant being the species of the family Mi-

riadae *Campylomma verbasci* (Meyer-Dür, 1843), *Atractotomus mali* (Meyer-Dür, 1843), *Orthotylus marginalis* Reuter, 1883, *Blepharidopterus angulatus* (Fallén, 1807), *Phytocoris tiliae* (Fabricius, 1777), *Psallus ambiguus* (Fallén, 1807), *Psallus perrisi* (Mulsant & Rey, 1852), and *Anthocoris nemorum* (Linnaeus, 1761) (Anhocoridae). In the investigated apple trees, Kondorosy *et al*. (2010) reported as dominant zoophagous and zoophytophagous species of true bugs, the represenatives of the Anthocoridae and Miridae families: *Orius vicinus* (Ribaut, 1923), *Atractotomus mali* (Meyer-Dür, 1843), *Anthocoris nemorum* (Linnaeus, 1761), *Heterotoma planicornis* (Pallas, 1772), *Phytocoris reuteri* Saunders, 1876, *Phytocoris longipennis* Flor, 1861, *Orthotylus marginalis* Reuter, 1883, *Blepharidopterus angulatus* (Fallén, 1807), and *Deraeocoris ruber* (Linnaeus, 1758).

Predatory true bugs in chemically untreated apple orchards may constitute as much as 90% of all predatory insects in apple tree crowns, the occurrence of these species in intensive plantings treated with a wide spectrum of insecticides is only very low perhaps except for species of the genera *Orius* spp. and *Campylomma verbasci* (Meyer-Dür, 1843). According to Niemczyk (1999), some predatory species, such as *Anthocoris* spp., *Orius* spp., *Blepharidopterus angulatus* (Fallén, 1807), and *Pilophorus perplexus* Douglas & Scott, 1875, may occur even in a relatively high quantity when orchards are treated under the principles of the integrated protection (IPM).

Jahn (1998) found on apples numerous species with no closer relation to pome fruits, e.g. *Kleidocerys resedae* (Panzer, 1797), *Piesma maculatum* (Laporte, 1833), *Lygus pratensis* (Linnaeus, 1758), and *Orthops kalmii* (Linnaeus, 1758). Kinkorová and Kocourek (2000) classified the species of *Malacocoris chlorizans* (Panzer, 1794), *Megalocoleus tanaceti* (Fallén, 1807), *Coreus marginatus* (Linnaeus, 1758), *Corizus hyscyami* (Linnaeus, 1758), and *Palomena prasina* (Linnaeus, 1761) detected in the apple tree orchard as dominant phytophages. Jonsson (1983) also detected on apple trees many phytophagous species such as *Elasmucha grisea* (Linnaeus, 1758), *Piesma maculatum* (Laporte, 1833), *Lygus wagneri* Remane, 1955, *Orthops basalis* (A. Costa, 1853), *Plagiognathus arbustorum* (Fabricius, 1794), and *Stenodema holsata* (Fabricius, 1787). Kondorosy *et al*. (2010) reported *Palomena prasina* (Linnaeus, 1761) as a dominant phytophagous species on apple trees.

To this category Jonsson (1983) and Kondorosy *et al*. (2010) assigned a polyphagous species *Lygus rugulipennis* Poppius, 1911, which was also mentioned by Kinkorová and Kocourek (2000) as a prevailing phytophagous species on apple trees. These authors also recorded a dominant occurrence of a zoophytophagus species *Campylomma verbasci* (Meyer-Dür, 1843) which with lack of natural preys can also act as a pest. Jonsson (1983) determined it as a prevailing species of true bugs (even 51.6%) on apple trees in Norway. *Campylomma verbasci* (Meyer-Dür, 1843) is one of few true bug species capable to survive in intensively treated orchards (Niemczyk 1999). Many studies have reported this species as a useful predator of spider mites *Panonychus ulmi* (C.L. Koch, 1836), thrips, and aphids (e.g. Niemczyk 1978, 1999; Arnoldi *et al*. 1992), although it was confirmed as a pest on apple trees in Canada as early as in 1938 (Niemczyk 1978). In Europe, however, *C. verbasci* (Meyer-Dür, 1843) began to be considered a pest only in the Netherlands in 1993 (Helsen & Blommers 2001), in Spain in 1995 (Torres *et al*. 1999), and Belgium and Bulgaria in 1996 (Schaefer & Panizzi 2000) as it was confirmed that young nymphs attack ovaries in blossoms and young fruits causing their deformations during growing, namely in the variety Golden Delicious.

Regular monitoring of harmful organisms on pome fruits ensured by the State Phytosanitary Administration in the Czech Republic, includes study of two true bug species – the above mentioned *Campylomma verbasci* (Meyer-Dür, 1843) and *Lygocoris* (*Lygocoris*) *rugicollis* (Fallén, 1807)/= *Plesiocoris rugicollis* (Fallén, 1807), which, however, were not found on apple trees within this study (2010–2011). Of our captures, only *Stephanitis* (*Stephanitis*) *pyri* (Fabricius, 1775) can be classified as a species mentioned in the literature as harmful for apple trees.

Acknowledgement. The authors would like to express thanks to Vladimír Hula, Jana Niedobová, and Lukáš Nytra for their help in field and to Eva Sapáková for grammer revision.

References

Arnoldi D., Stewart R.K., Boivin G. (1992): Predatory mirids of the green apple aphid *Aphis pomi*, the two-spotted spider mite *Tetranychus urticae* and the European

red mite *Panonychus ulmi* in apple orchards in Québec. Entomophaga, **37**: 283–292.

Aukema B., Rieger C. (eds) (1999): Catalogue of the Heteroptera of the Palaearctic Region. Vol. 3. Cimicomorpha II. The Netherlands Entomological Society, Amsterdam.

Aysalt T., Kivan M. (2008): Development and population growth of *Stephanitis pyri* (F.) (Heteroptera: Tingidae) at five temperatures. Journal of Pest Science, **81**: 135–141.

Dalla Torre K. (1878): Entomologische Notizen aus dem Egerlande. Jahres-Bericht des Natur-Historischen Vereins „Lotos", **27**: 91–208.

Duda L. (1884): Soustavný přehled českého hmyzu polokřídlého (Hemiptera – Heteroptera). Výroční zpráva c. k. gymnázia v Hradci Králové.

Duda L. (1886): Beiträge zur Kenntnis der Hemipteren-Fauna Böhmens (16. Fortsetzung und Schluss.). Wiener Entomologische Zeitung, **5**: 257–262.

Helsen H.H.M., Blommers L.H.M. (2001): An attempt to prevent mating of the mullein bug *Campylomma verbasci* (Heteroptera: Miridae) in Dutch apple orchards. Proceedings of the Section Experimental and Applied Entomology of the Netherlands Entomological Society New Amsterdam, **12**: 65–69.

Hradil K., Kment P., Bryja J., Roháčová M., Baňař P., Ďurčovák K. (2008): New and interesting records of true bugs (Heteroptera) from the Czech Republic and Slovakia IV (Nové a zajímavé nálezy ploštic (Heteroptera) z České republiky a ze Slovenska IV). Klapalekiana, **44**: 165–206.

Jahn O. (1998): Výskyt škůdců a jejich přirozených nepřátel v neošetřovaném jabloňovém sadu se zaměřením na řád ploštice (Heteroptera). Final report for postgraduate studies. Státní rostlinolékařská správa, Brno. Zpravodaj, **10**: 20–26.

Jonsson N. (1983): The bug fauna (Hem., Heteroptera) on apple trees in south-eastern Norway. Fauna Norvegica, Series B, **30**: 9–13.

Josifov M. (1986): Verzeichnis der von der Balkanhalbinsel bekannten Heteropterenarten (Insecta, Heteroptera). Faunistische Abhandlungen, **14**(6): 61–93.

Kinkorova J., Kocourek F. (2000): The effect of integrated pest management practices in an apple orchard on Heteroptera community structure and population dynamics. Journal of Applied Entomology, **124**: 381–385.

Kment P., Jindra Z. (2005): New and interesting records of true bugs (Heteroptera) from Turkey, southeastern Europe, Near and Middle East. Acta Entomologica Musei Nationalis Pragae, **45**: 3–16.

Kment P., Bryja J., Hradil K., Jindra Z. (2005): New and interesting records of true bugs (Heteroptera) from the Czech Republic and Slovakia III. Klapalekiana, **41**: 157–213.

Kment P., Vahala O. (2006): Faunistics Records from the Czech Republic – 213. Heteroptera: Tingidae. *Stephanitis* (*Stephanitis*) *pyri* (Fabricius, 1775). Klapalekiana, **42**: 337–338.

Kment P., Vilímová J. (2005): Heteroptera (ploštice). In: Farkač J., Král D., Škorpík M. (eds): Červený seznam ohrožených druhů České republiky. Bezobratlí. Agentura ochrany přírody a krajiny ČR, Praha: 139–146.

Kondorosy E., Markó V., Cross J.V. (2010): Heteropteran fauna of apple orchards in South-East England. Acta Phytopathologica et Entomologica Hungarica, **45**: 173–193.

Nau B.S. (2009): An historical influx of *Halticus saltator* Geoffroy? by the late E.A.Butler (Edited version of an article by Butler in Entomologist's Monthly Magazine, **61**: 276–279, 1925). HetNews 14: 5.

Niemczyk E. (1978): *Campylomma verbasci* Mey-Dur (Heteroptera-Miridae) as a predator of aphids and mites in apple orchards. Polskie Pismo Entomologiczne, **48**: 221–235.

Niemczyk E. (1999): Occurrence and effectiveness of some predatory bugs (*Heteroptera*) in apple orchards. Integrated Plant Protection in Orchards IOBC/wprs Bulletin, **22**(6): 21–29.

Oatman R., Legner E.F., Brooks R.F. (1964): An eological study of arthropod populations on apple in northeastern Wisconsin: insect species present. Journal of Economic Entomology, **57**: 978–983.

Országh I. (1966): Príspevok k poznaniu fauny bzdôch (Heteroptera) Jurského šúru a priľahlých svahoch Malých Karpát. Entomological Problems, **6**: 37–75.

Péricart J. (1983): Faune de France et régions limitrophes. Vol. 69. Hémiptères Tingidae Euro-Méditerranéens. Fédération Française des Sociétés de Sciences Naturelles, Paris.

Protić L. (1998): Catalogue of the Heteroptera fauna of Yugoslav countries. Part one. Natural History Museum, Belgrade.

Rabitsch W. (2010): *Harpocera hellenica* Reuter, 1876 (Heteroptera: Miridae) – Neu für Österreich. Beiträge zur Entomofaunistik, **11**: 93–96.

Roubal J. (1957): Výsledek faunisticko-ekologických studií ploštic *Dicyphus pallicornis* Fieb., *D. annulatus* (Wlff.), *Gampsocoris punctipes* (Germ.) a *G. culicinus* Seidenst. na náprstnících *Digitalis purpurea* L., *D. grandiflora* Mill. a jehlici *Ononis spinosa* L. v Čechách (Ergebnisse der faunistisch-oekologischen Studien über die Wanzen *Dicyphus pallicornis* Fieb., *D. annulatus* (Wlff.), *Gampsocoris punctipes* (Germ.) und *G. culicinus* Seidenst. auf dem *Digitalis purpurea* L., *D. grandiflora* Mill. und *Ononis spinosa*). Časopis Československé Společnosti Entomologické, **54**: 126–131.

Roubal J. (1967): Fauna ploštic (Insecta: Heteroptera) severních Čech. Sborník severočeského muzea – Přírodní vědy, **3**: 127–159.

Schaefer C. W., Panizzi A.R. (eds) (2000): Heteroptera of Economic Importance. CRC Press, Boca Raton.

Southwood T.R.E., Leston D. (1959): Land and Water Bugs of the British Isles. Frederick Warne and Co., London.

Tischler W. (1965): Agrarökologie. Gustav Fischer Verlag, Jena.

Torres X., Sarasúa M.J., Avilla J. (1999): The role of *Campylomma verbasci* (Herrich-Schäffer) in pear and apple orchards. Integrated Plant Protection in Orchards. IOBC/wprs Bulletin, **22**(6): 13–143.

Wagner E. (1966): Wanzen oder Heteropteren. I. Pentatomomorpha. In: Dahl F. (ed.): Die Tierwelt Deutschlands. Bd. 54. Gustav Fischer Verlag, Jena.

Wagner E. (1973): Die Miridae Hahn, 1831, des Mittelmeerraumes und der Makaronesischen Insel (Hemiptera, Heteroptera). Teil 2. Entomologische Abhandlungen Staatliches Museum für Tierkunde, Dresden, **39** (Suppl.): 1–421.

Wagner E. (1975): Die Miridae Hahn, 1831, des Mittelmeerraumes und der Makaronesischen Inseln (Hemiptera, Heteroptera). Teil 3. Entomologische Abhandlungen Staatliches Museum für Tierkunde Dresden, **40** (Suppl.): 1– 483.

Wachmann E., Melber A., Deckert J. (2004): Wanzen. Band 2. Cimicomorpha. Die Tierwelt Deutschlands und der angrezenden Meeresteile. 75. Teil. Goecke & Avers, Keltern.

Wachmann E., Melber A., Deckert J. (2006): Wanzen. Band 1. Dipsocoromorpha, Nepomorpha, Gerromorpha, Leptopodomorpha, Cimicomorpha (Teil 1). Die Tierwelt Deutschlands und der angrezenden Meeresteile. 77. Teil. Goecke & Evers, Keltern.

Wachmann E., Melber A., Deckert J. (2007): Wanzen. Band 3. Pentatomomorpha I. Die Tierwelt Deutschlands und der angrezenden Meeresteile. 78. Teil. Goecke & Evers, Keltern.

Wachmann E., Melber A., Deckert J. (2008): Wanzen. Band 4. Pentatomomorpha II. Cydnidae, Thyreocoridae, Plataspidae, Acanthosomatidae, Scutelleridae, Pentatomidae. Die Tierwelt Deutschlands und der angrezenden Meeresteile. 81. Teil. Goecke & Evers, Keltern.

Received for publication May 9, 2012
Accepted after corrections January 30, 2013

Corresponding Author:

Ing. Karel Hradil, Ph.D., Státní rostlinolékařská správa, Havlíčkova 56, 506 01 Jičín, Česká republika;
E-mail: karel.hradil@miletin.cz