

Species Composition of Spider (*Araneae*) Assemblages in Apple and Pear Orchards in the Carpathian Basin

S. BOGYA¹, CS. SZINETÁR² and V. MARKÓ¹

¹Department of Entomology, University of Horticulture and Food Industry,
H-1502 Budapest, P.O. Box 53, Hungary

²Department of Zoology, Dániel Berzsenyi Teachers' College, H-9700 Szombathely, Hungary

The species richness and composition of spider assemblages were investigated in the canopy, herbaceous-layer and at ground level when differently treated with pesticide and in abandoned apple and pear orchards in the Carpathian Basin. Furthermore attention was paid to the bark-inhabiting spider fauna. Altogether 20,283 individuals were collected belonging to 21 families; 165 spider species have been identified to species level and further nine spider taxa were determined up to generic level. More than 20% of the Hungarian spider fauna was represented in the orchards. In the canopies, 103 species were found in apple orchards and 70 species in pear orchards. The similarity (Jaccard index) between apple and pear in the canopy is 45%. The species richness in each orchard varied between 22 and 56 species. In the herbaceous layer, 66 species were found in apple orchards and 43 species in pear orchards.

Most of the species belonged to the families *Araneidae*, *Salticidae*, *Thomisidae*, *Theridiidae*. Species of hunting spiders were represented by 55%, web-building spiders by 45% of the entire fauna.

The canopy and the herbaceous layer inhabiting fauna overlapped. Out of the 76 herbaceous-layer inhabiting species, 59 occurred also in the canopy. The similarity (Jaccard index) in species composition between the canopy and the herbaceous-layer is 45%.

The most widely occurring species in orchard canopies in decreasing order were: *Philodromus cespitum*, *Theridion impressum*, *Theridion pinastris*, *Oxyopes heterophthalmus*, *Araniella opistographa*; on the bark: *Philodromus cespitum*, *Xysticus* spp. (*lanio*, *cristatus*), *Drassodes lapidosus*, *Theridion pinastris*, *Clubiona marmorata*; in the herbaceous-layer: *Xysticus* spp. (*cristatus*, *ulmi*), *Oxyopes heterophthalmus*, *Pisaura mirabilis*, *Mangora acalypha*, *Araneus diadematus*; on the ground-level: *Xysticus kochi*, *Titanoeca schineri*, *Pardosa agrestis*, *Alopecosa sulzeri*, *Harpactea rubicunda*. This species could play a role in the natural control of orchard pests in IPM systems in the Carpathian Basin.

Three species collected in the canopy of apple and pear orchards, *Enoplognatha latimana*, *Philodromus longipalpis* and *Euophrys monticola* were not recorded from Hungary until the present study.

Key words: Spider, *Araneae*, apple, pear.

The ecological basis of integrated pest management in orchards have been investigated for 30 years in Hungary. As part of a greater project (Apple Ecosystem Research), faunistic studies have been carried out to describe the species composition of apple orchards in Hungary since 1976. Mészáros et al. (1984) examined apple orchards in five localities, while Markó et al. (1995) investigated the coleopteran assemblages in apple and pear orchards in three localities. Altogether more than 2000 animal species were recorded. In latter project, the spiders were not studied until now.

Other studies reported 28 species from the canopy and herbaceous-layer of an apple orchard (Samu et al., 1997) and 28 species from the ground level of another apple orchard (Samu and Lóvei, 1995) in Hungary.

Spiders were reported from orchard ecosystems by many authors (reviewed by Bogya and Mols, 1996), but comprehensive spider fauna lists are rare. The existing lists focus mainly on the foliage-dwelling spiders only. From Europe Loomans (1978) (The Netherlands), Klein (1988) (Germany), Olszak et al. (1992) (Poland) and Angeli et al.

(1996) (Italy) presented a list of spiders occurring in the canopy of apple orchards. Outside of Europe, Hukusima (1961) (Japan), Dondale et al. (1979) (Canada) and McCaffrey and Horsburgh (1980) (USA) recorded spider lists from apple orchards. The overwintering spiders in and under the bark of apple trees were investigated by Koslinska (1967) and Loomans (1978). Little is known about the ground-dwelling spider fauna of apple and pear orchards; Zhao et al. (1993) and Samu and Lővei (1995) published some data.

Our aim was (I) to make a thorough faunistic study of spiders occurring in apple and pear orchards, (II) to describe the biodiversity of the spider assemblages of orchards differently treated with pesticides and in abandoned orchards, and (III) to determine the most widely occurring species.

Materials and Methods

The investigations took place in six Hungarian and one Romanian (Transylvania) orchards, which are located in woodland areas of medium height mountains, agricultural lowland environments and regularly flooded forest areas. The samples were collected at the following localities: Nagykovácsi (Lat. 47° 30' N, Long. 19° E; UTM: CT47) (abandoned, one apple and two pear plots), Sárospatak (Lat. 48° 20' N, Long. 21° 30' E; UTM: EU45) (conventional, one apple and one pear plot), Tura (Lat. 47° 40' N, Long. 19° 30' E; UTM: CT97) (conventional, one apple and one pear plot), Szigetcsép (Lat. 47° 20' N, Long. 19° E; UTM: CT43) (conventional, one apple and one pear plot), Kecskemét (Lat. 46° 40' N, Long. 20° E; UTM: DS09) (abandoned, one apple plot), Szarkás (Lat. 46° 40' N, Long. 20° E; UTM: DS09) (apple, two conventional and three IPM plots) and Beresztelke / Breaza (Transylvania, Romania) (Lat. 46° 40' N, Long. 24° 40' E; UTM: LM18) (apple, one conventional, one IPM, one untreated, one abandoned plot).

The beating method was carried out to collect spiders from the canopy by using Winkler-type umbrella ($d = 0.7$ m). Each orchard (except Beresztelke) was investigated by tapping 600 whole trees (100 in spring, 100 in summer and 100 in autumn) for two years. Additionally in Nagykovácsi and Szigetcsép samples were taken from April till October 12 times annually by beating 10 trees every time for three years. In Beresztelke the sample taking were performed 12 times by beating 10 trees in each plot in 1995.

Trapping on the bark (Nagy and Szentkirályi, 1982) was executed to investigate the bark inhabiting spider fauna in Nagykovácsi in 1978–82. Five-five traps which collected the spiders going upwards were placed around the trunk of apple trees in treated and untreated plots. Three additional traps, which collected the spiders going downwards were placed in the untreated plot. The traps were emptied weekly through the vegetation period.

Corrugated fiberboard bands were used to monitor the overwintering spiders on the trunk. The traps were placed around the trunk at about 20–25 cm height from the ground in autumn before the leaf fall and were collected 2–2.5 months later, after the first frost. Ten bands were placed in each plot of the investigated orchards (except at Beresztelke).

Sweep-netting was applied to collect spiders from the herbaceous-layer by using a triangular-shaped sweep net (0.3 m wide). Each orchard (except at Beresztelke) has been investigated by making 5 X 100 sweep net samples on three occasions (one in the spring, one

Table 1
The characteristics of the investigated orchards

Environment	Woodland in mountain of medium height			Agricultural lowland			Flooded forest area	
	Locality	Nagykovácsi natural, forest (Cesaro-Quercetum pubescentis)	Beresztelke agricult. fields	Tura agricultural fields	Szospataak agricultural fields	Kecskemét seminatural,	Szarkás Festucetum-saginatae	Szigetcsép flooded forest, agricult. fields
Neighboring habitats								
Fruit species	apple	pear	apple	pear	apple	apple	apple	apple
Year of planting	1967	1973	1979	1975	1950	1963	1981	1977
Size of plantation	5.8 ha	1.1 ha	total 42 ha	5 ha	20 ha	20 ha	2 ha; 4 ha	5.5 ha
Cultivars	G; Jt; S	N; B; H; S	H; Ha	Jt; Ap; Ep	V; B	Jt; S; St	I; Jg; Md	Jt; Jg; G; S
Planting system	8 x 5 m	7.5 x 5 m	7 x 4 m	10 x 5 m	5 x 4 m	5 x 4 m	5 x 4 m	4.5 x 2.5-3.5 m
Untreated	+	+	+	+	+	+	+	+
Conventionally treated								
IPM								
No. of treatments/year			7-12	8-10	8-10	-	7-8	8-10
Method	Bm; Sn; Tb; Bt	Bm	Bm; Sn; Tb	Bm; Sn; Tb	Bm; Sn; Tb	Bm; Sn; Tb	Bm; Sn; Tb; Pt	Bm; Sn; Tb
Years	1978-82; 1995-97	1995-97	1995	1996-97	1995-96	1996-97	1992-96	1995-97
Soil	clay	clay	loamy-clay	clay	clay	sandy	sandy	sandy-loam
Weed management	not managed	not managed	mowed	not managed	mowed	not managed	cultivated	sandy-loam mowed

“Apple cultivars: Ap: Asztraháni pirok, Ep: Egri pirok, G: Golden Delicious, I: Idared, Jt: Jonathan, Jg: Jonagold, Md: Mollies Delicious, S: Starking, St: Staymared”

“Pear cultivars: B: Bosc kobak, BG: Bella di Giugno, C: Clapp kedvelte, D: Diel vajkörte, H: Hardenpont téli vajkörte, Ha: Hardy vajkörte, N: Nyári Kálmán, P: Packham’s Triumph, S: Serres Olivér, V: Vilmos”

“Methods: Bm: beating method, Sn: Sweep netting, Tb: Treeband, Bt: Trapping on the bark, Pt: Pitfall trapping”

Table 2
List of spiders occurring in the canopy of apple and pear orchards (beating method)

	Nagykovácsi		Szigetcsép		Tura		Sárospatak		Kecskenét		Szarkis		Berezstelke	
	1995-97	Abandoned	1995-97	Conventional	1996-97	Conventional	1996-97	Conventional	1996-97	Abandoned	1995-96	Convent. & IPM	1995-96	Different
	apple	pear	apple	pear	apple	pear	apple	pear	apple	pear	apple	pear	apple	pear
Mimetidae														
Ero spp.	95								96					
Theridiidae														
Achaearanea lunata (Clerck, 1757)	95								97					
Diploena melanogaster (C.L. Koch, 1837)	95, 96, 97	95, 96, 97							96, 97					95
Enoplognatha latimana Hippa & Oksala, 1982		95			96	96, 97								95
Enoplognatha ovata (Clerck, 1757)														95
Enoplognatha (ovata-latimana) spp.	96	95, 96, 97	95, 96	95, 96		97			97		95	95		95
Seatoda albomaculata (Degeer, 1778)												95		
Seatoda bipunctata (Linnaeus, 1758)												95		
Seatoda triangulosa (Walckenaer, 1802)														95
Theridion bimaculatum (Linnaeus, 1767)														95
Theridion impressum L. Koch, 1881	95, 96		96	96, 97		97	97							95
Theridion (sisyphium-impressum) spp.	95, 96, 97	95, 96, 97	95, 96	95, 96, 97	96	96, 97	97	97	96	96, 97	95, 96	95, 96	95, 96	95
Theridion melanurum Hahn, 1831	96	95								96, 97				
Theridion (mystaceum) sp.	96, 97	95, 96, 97								97				
Theridion nigrovariegatum Simon, 1873	95, 96, 97	95, 96, 97	95, 96, 97	95, 96, 97						97				
Theridion pinastri L. Koch, 1872	95, 96, 97	95, 96, 97												
Theridion simile C.L. Koch, 1836														95
Theridion tinctum (Walckenaer, 1802)	95, 96, 97	95, 96, 97	95, 97	95, 97					96	96, 97	95, 96	95, 96	95, 96	95
Theridion varians Hahn, 1833		96, 97	96, 97	96, 97						96				95
Linyphiidae														
Araonchus humilis (Blackwall, 1841)														
Centromerus sylvaticus (Blackwall, 1841)														95
Erigone dentipalpis (Wider, 1834)														96
Frontinella frutetorum (C.L. Koch, 1834)	95, 96	95												

Table 2 (cont.)

	Nagykovácsi 1995-97		Szigetesp 1995-97		Tum 1996-97		Sárosatak 1996-97		Kecskenét 1996-97		Szarkis 1995-96		Berezstelke 1995	
	apple	pear	apple	pear	apple	pear	apple	pear	Abandoned	apple	Convent. & IPM	apple	Different	apple
<i>Linyphia triangularis</i> (Clerck, 1757)	96, 97	96												
<i>Meioneta rurestris</i> (C.L. Koch, 1836)		96	96	96		96, 97					95, 96			95
<i>Microlinyphia pusilla</i> (Sundevall, 1830)	96													
<i>Nerene</i> spp.	97													
<i>Porhomma microphtalmum</i> (O.P. Cambridge, 1871)	96			95										
<i>Erigoninae</i> spp.			96, 97											
<i>Linyphiinae</i> spp.	95, 96, 97	95, 96	95, 96, 97		96	96, 97			96, 97		96			
Tetragnathidae														
<i>Metellina segmentata</i> (Clerck, 1757)														95
<i>Pachygnatha degeeri</i> Sundevall, 1830														95
<i>Tetragnatha</i> spp.			95, 96, 97	95, 96, 97	97	97	96, 97	95, 96	96, 97	96				95
<i>Zygiella</i> spp.														
Araneidae														
<i>Agelenaea redii</i> (Scopoli, 1763)	95, 96		95, 96	95, 96	96									95
<i>Araneus angulatus</i> Clerck, 1757	95		95, 96											95
<i>Araneus diadematus</i> Clerck, 1757	95	96	95, 96, 97		96, 97									95
<i>Araneus marmoreus</i> Clerck, 1757														
<i>Araneus quadratus</i> Clerck, 1757														
<i>Araneus sturmi</i> (Hahn, 1831)	96, 97													
<i>Araneus triguttatus</i> (Fabricius, 1775)	95													
<i>Araneus</i> spp.	95, 96	95, 96, 97	95, 96, 97	95, 96, 97	97	97			96, 97		95, 96			95
<i>Aranella cucurbitina</i> (Clerck, 1757)	95, 96	95							96, 97					95
<i>Aranella opistographa</i> (Kulczynski, 1905)	96, 97	95, 96, 97							96					95
<i>Aranella</i> (<i>cucurbitina</i> - <i>opistographa</i>) spp.	95, 96, 97	95, 96, 97	95, 96, 97	95, 96, 97	96, 97	96, 97	96, 97	95, 96	96, 97		95, 96			95
<i>Argope lobata</i> (Pallas, 1772)														
<i>Cyclosa conica</i> (Pallas, 1772)	95, 96, 97	96, 97			97									
<i>Gibbaranea bituberculata</i> (Wälckenaer, 1802)			96		97				96, 97					

Table 2 (cont.)

	Nagykovácsi		Szigetcsép		Tura		Sirospatak		Kecskemét		Szarkás		Berezstelke	
	1995-97	Abandoned	1995-97	Conventional	1996-97	Conventional	1996-97	Conventional	1995-96	Abandoned	1995-96	Convent. & IPM	1995	Different
	apple	pear	apple	pear	apple	pear	apple	pear	apple	pear	apple	apple	apple	apple
<i>Gibbaranea gibbosa</i> (Walckenaer, 1802)	96	96												
<i>Gibbaranea</i> spp.	95, 96, 97	95, 96, 97	97		97				96		95, 96			
<i>Hyposinga pygmaea</i> (Sundevall, 1832)	96			95, 96, 97			96		97					
<i>Larinioides patagiatus</i> (Clerck, 1757)				95, 96, 97	95, 96, 97									
<i>Larinioides</i> spp.				95, 96, 97	95, 96, 97									
<i>Mangora acalypha</i> (Walckenaer, 1802)	95, 96, 97	96, 97		97	96, 97		97		95, 96		95			95
<i>Nuctenea</i> spp.		95, 96												
<i>Zilla diodia</i> (Walckenaer, 1802)	95	95, 96									96			
Lycosidae														
<i>Autonia albimana</i> (Walckenaer, 1805)										96				
<i>Pardosa</i> spp.	95, 96			95			96			96, 97	96			
<i>Trochosa</i> spp.							96							
Pisauridae														
<i>Pisaura mirabilis</i> (Clerck, 1757)	96			96, 97	95, 96		96			96, 97				95
Agelenidae														
<i>Agelena</i> spp.											96			
Dictynidae														
<i>Dictyna arundinacea</i> (Linnaeus, 1758)										96, 97				
<i>Dictyna latens</i> (Fabricius, 1775)	95													95
<i>Dictyna uncinata</i> Thorell, 1856														95
<i>Dictyna</i> spp.														
<i>Nigma</i> spp.	95, 96, 97	95, 96		95, 96						96, 97	96			95
Oxyopidae														
<i>Oxyopes heterophthalmus</i> Latreille, 1804														95, 96
<i>Oxyopes ramosus</i> (Panzer, 1804)										96				
<i>Oxyopes</i> spp.	96, 97	96, 97			96, 97		96, 97			96, 97	95, 96			95

Table 2 (cont.)

	Nagykovácsi		Szigetcsép		Tura		Sárosputak		Kecskemét		Szarkás		Bereztelke	
	apple	pear	apple	pear	apple	pear	apple	pear	Abandoned	apple	Convent. & IPM	apple	Different	apple
Anyphaenidae														
<i>Anyphaena accentuata</i> (Walckenaer, 1802)	95, 96	95	95, 96	95, 96	96				96, 97	95				
Clubionidae														
<i>Cheiracanthium effosum</i> Herman, 1879									97					
<i>Cheiracanthium mildei</i> L. Koch, 1864	97		96			97			96, 97	95, 96				95
<i>Cheiracanthium</i> spp.	95, 96	95, 96, 97	95, 96, 97	95, 96, 97	95, 96, 97	96, 97			96, 97					95
<i>Clubiona brevipes</i> Blackwall, 1841														
<i>Clubiona comta</i> C.L. Koch, 1839		96												
<i>Clubiona diversa</i> O.P. Cambridge, 1862		96												
<i>Clubiona frutetorum</i> L. Koch, 1866			95, 97											95
<i>Clubiona lutescens</i> Westring, 1851														
<i>Clubiona marmorata</i> L. Koch, 1866	96, 97	95, 96												
<i>Clubiona pallidula</i> (Clerck, 1757)			95, 96											
<i>Clubiona</i> spp.	95, 96, 97	95, 96, 97	95, 96, 97	95, 97	96	97			97					95
Gnaphosidae														
<i>Aphantaulax seminigra</i> Simon, 1878														
<i>Drassodes</i> spp.	96		96						96	95				
<i>Scotophaeus scutulatus</i> (L. Koch, 1866)										95				
<i>Scotophaeus</i> spp.														95
Philodromidae														
<i>Philodromus aureolus</i> (Clerck, 1757)	95													
<i>Philodromus (aureolus)</i> spp.	95, 96, 97	95, 96, 97	95, 96, 97	95, 96, 97	96, 97	96, 97			96, 97	95, 96				95
<i>Philodromus cespitum</i> (Walckenaer, 1802)	95, 96	95	97						96, 97					95
<i>Philodromus dispar</i> Walckenaer, 1826														
<i>Philodromus emarginatus</i> (Schrank, 1803)		95												
<i>Philodromus longipalpis</i> Simon, 1870		95												

Table 2 (cont.)

	Nagykovácsi		Szigetcsép		Tura		Sárosputak		Kecskemét		Szarkás		Berszettek	
	apple	pear	apple	pear	apple	pear	apple	pear	Abandoned	apple	Convent. & IPM	apple	Different	apple
<i>Philodromus margaritatus</i> (Clerck, 1757)														
<i>Philodromus (margaritatus) spp.</i>	95, 96, 97	95, 96, 97	96	95, 96, 97	96	96, 97	96, 97	96	96, 97	95, 96	95, 96	95, 96	95	95
<i>Philodromus praedatus</i> O.P. Cambridge, 1871	95	96												
<i>Philodromus rufus</i> Walckenaer, 1826			95, 96	95										
<i>Philodromus (rufus) spp.</i>	96, 97	96, 97	95	95, 97										
<i>Tibellus spp.</i>			95, 96	95, 96, 97										
Thomisidae														
<i>Diaea dorsata</i> (Fabricius, 1777)	96													
<i>Diaea pictilis</i> (Banks, 1896)		96, 97												
<i>Diaea spp.</i>	96													
<i>Misumena vatia</i> (Clerck, 1757)	95, 96	95, 96, 97												
<i>Misumenops tricuspidatus</i> (Fabricius, 1775)	95, 96, 97	95, 96, 97	95, 96, 97	95, 96, 97	95, 96, 97	96, 97	96, 97	96, 97	96, 97	95, 96	95, 96	95, 96	95	95
<i>Ozyptila spp.</i>	95	95												
<i>Pistius truncatus</i> (Pallas, 1772)	95, 96, 97	95, 96, 97												
<i>Runcinia grammica</i> (C.L. Koch, 1837)														
<i>Synaema globosum</i> (Fabricius, 1775)	95, 96, 97	95, 96, 97												
<i>Thomisus onustus</i> Walckenaer, 1806		96, 97												
<i>Tmarus piger</i> (Walckenaer, 1802)	95, 96, 97	96, 97												
<i>Tmarus stellio</i> Simon, 1875		97												
<i>Tmarus spp.</i>	95, 96, 97	95, 96, 97	95	96										
<i>Xysticus kochi</i> Thorell, 1872			96											
<i>Xysticus lanio</i> C.L. Koch, 1835	96, 97													
<i>Xysticus ulmi</i> (Hahn, 1831)														
<i>Xysticus spp.</i>	95, 96, 97	95, 96, 97	95, 96, 97	95, 96, 97	96, 97	96, 97	96, 97	96, 97	96, 97	95, 96	95, 96	95, 96	95	95
Salticidae														
<i>Ballus chalybeius</i> (Walckenaer, 1802)	95, 96, 97	95, 96, 97	95, 96, 97	95, 96	96	96	96	96, 97	96, 97	95, 96	95, 96	95, 96	95	95

Table 2 (cont.)

	Nagykovácsi		Szigetcsép		Tura		Sárospatak		Kecskenét		Szarkis		Beresztelke	
	apple	pear	apple	pear	apple	pear	apple	pear	apple	pear	Convent. & IPM	apple	pear	Different
<i>Carriotus xanthogramma</i> (Latreille, 1819)	95, 96	95, 96, 97	95, 96, 97	95, 96, 97	96, 97	96, 97	96, 97	96, 97	96, 97	96, 97	95, 96	95, 96	95	95
<i>Eris nidicolens</i> (Walckenaer, 1802)	95, 96, 97	95, 96, 97	95, 96, 97	95, 96, 97	96, 97	96, 97	97	95, 96	96, 97	96, 97	95, 96	95, 96	95	95
<i>Euophrys aequipes</i> O.P. Cambridge, 1871										97				
<i>Euophrys frontalis</i> (Walckenaer, 1802)										97				
<i>Euophrys monticola</i> Kulczyński, 1884										97				
<i>Euophrys obsoleta</i> (Simon, 1869)			95, 96	95	96					97				
<i>Euophrys</i> spp.			95	95, 96			96			96, 97				
<i>Evarcha arcuata</i> (Clerck, 1757)	96													
<i>Evarcha falcata</i> (Clerck, 1757)			96, 97							97				
<i>Evarcha laetabunda</i> (C.L. Koch, 1846)										97				
<i>Evarcha</i> spp.			95							96, 97	96			
<i>Heliophanus auratus</i> C.L. Koch, 1835	96		95, 96	95, 96						97				
<i>Heliophanus cupreus</i> (Walckenaer, 1803)			96							97				
<i>Heliophanus flavipes</i> Hahn, 1832												96		
<i>Heliophanus</i> spp.	95, 96, 97	95, 96, 97	95, 96, 97	95, 96, 97	96, 97	96, 97	96, 97	95, 96	95, 96	96, 97	95	95		95
<i>Marpissa muscosa</i> (Clerck, 1757)														
<i>Pseudittus encarpatus</i> (Walckenaer, 1802)	95, 96, 97	95	95, 96	95, 96	96	96, 97	96, 97	96	95, 96	96, 97	95, 96	95, 96	95	95
<i>Salticus cingulatus</i> (Panzer, 1797)			95, 96	95										
<i>Salticus scenicus</i> (Clerck, 1757)														
<i>Salticus zebraneus</i> (C.L. Koch, 1837)														
<i>Salticus</i> spp.	95, 96, 97	95, 96, 97	95, 96, 97	95, 96, 97	96, 97	96, 97	96, 97	95, 96, 97	95, 96, 97	96, 97	95, 96	95, 96	95, 96	95
<i>Sititicus</i> spp.														
Number of species	56	52	47	33	28	27	22	22	22	55	39	39	37	37
Number of individuals	1720	2584	858	558	658	526	412	325	2993	434	434	664	664	664

Table 3
List of spiders occurring in the herbaceous layer of apple and pear orchards (sweep netting)

	Nagykovácsi 1995-96		Szigetsáp 1995-96		Tura 1996-97		Sárospatak 1995-97		Kesztenét 1996-97		Szarkás 1995-96	
	apple	pear	apple	pear	apple	pear	apple	pear	apple	pear	Abandoned	Conventional & IPM
Uloboridae												
<i>Uloborus walckenaerius</i> (Latreille, 1806)												
Theridiidae												
<i>Achaearanea lunata</i> (Clerck, 1757)		96										
<i>Diploena melanogaster</i> (C.L. Koch, 1837)			96		96						96	
<i>Enoplognatha latimana</i> Hippa & Oksala, 1982		96	95, 96		97						96, 97	
<i>Enoplognatha (ovata-latimana)</i> spp.			96		97							
<i>Theridion bimaculatum</i> (Linnaeus, 1767)												
<i>Theridion impressum</i> L. Koch, 1881												
<i>Theridion (sisyphium-impressum)</i> spp.		95, 96	95, 96		96, 97						97	96
<i>Theridion melanurum</i> Hahn, 1831											96	
<i>Theridion nigrovariegatum</i> Simon, 1873	95, 96		95									
<i>Theridion pinastri</i> L. Koch, 1872	95, 96	96			97						96, 97	
<i>Theridion sisyphium</i> (Clerck, 1757)												
<i>Theridion tinctum</i> (Walckenaer, 1802)	96				97							96
<i>Theridion varians</i> Hahn, 1833		95										
Linyphiidae												
<i>Erigone dentipalpis</i> (Wider, 1834)								95				
<i>Linyphia triangularis</i> (Clerck, 1757)	96	96			97							
<i>Meioneta rurestris</i> (C.L. Koch, 1836)								95				
<i>Neritene</i> spp.	95	95										96
<i>Tiso vagans</i> (Blackwall, 1834)								96				
<i>Linyphiinae</i> spp.		95						95, 96				
Tetragnathidae												
<i>Metellina segmentata</i> (Clerck, 1757)	96	95, 96			97						97	
<i>Tetragnatha</i> spp.	95, 96	95, 96	95, 96		97	96, 97					95, 96	97

Table 3 (cont.)

	Nagykovács 1995-96		Szigetcsép 1995-96		Tura 1996-97		Sárospatak 1995-97		Kecskemét 1996-97		Szatmár 1995-96	
	apple	pear	apple	pear	apple	pear	apple	pear	Abandoned	apple	Conventional & IPM	apple
<i>Pachygnatha</i> spp.			95									
Araneidae												
<i>Agalenatea redii</i> (Scopoli, 1763)		95, 96			97	97	97		96, 97	95, 96		95, 96
<i>Araneus diadematus</i> Clerck, 1757									96, 97	95, 96		95, 96
<i>Araneus quadratus</i> Clerck, 1757									97			
<i>Araneus</i> spp.	95, 96	95	95, 96	95					96			
<i>Araniella</i> (<i>cucurbitina</i> - <i>opistographa</i>) spp.	95, 96	95, 96			96, 97	97		95, 96	96			95
<i>Argiope bruennichi</i> (Scopoli, 1772)									96, 97			95, 96
<i>Argiope lobata</i> (Pallas, 1772)												
<i>Cercidia prominens</i> (Westring, 1851)		95										96
<i>Cyclosa conica</i> (Pallas, 1772)	95											95
<i>Gibbaranea bituberculata</i> (Walckenaer, 1802)			95, 96									95, 96
<i>Gibbaranea</i> spp.	95, 96		95	95	97				97			95, 96
<i>Hypsosinga pygmaea</i> (Sundevall, 1832)						96						
<i>Larinioides</i> spp.			95, 96	95, 96								95
<i>Mangora acalypha</i> (Walckenaer, 1802)			95, 96	95, 96	96, 97	96, 97	97	95	96, 97			96
<i>Neoscona adianta</i> (Walckenaer, 1802)												
<i>Singa hamata</i> (Clerck, 1757)												
<i>Zilla diodia</i> (Walckenaer, 1802)		96										
Lycosidae												
<i>Alopecosa</i> spp.										96		
<i>Pardosa</i> spp.	95	96			97	97		95, 96	96, 97			
<i>Pirata</i> spp.								97				
Pisauridae												
<i>Pisaura mirabilis</i> (Clerck, 1757)	95, 96	95, 96	95, 96	95, 96	96, 97	96, 97	96, 97	95, 96	96, 97	95, 96		95, 96
Dictynidae												
<i>Dictyna arundinacea</i> (Linnaeus, 1758)											96	
<i>Dictyna</i> spp.		95									96, 97	96

Table 3 (cont.)

	Nagykovácsi 1995-96		Szigetsép 1995-96		Tura 1996-97		Sárospatak 1995-97		Kecskemét 1996-97 Szarkás 1995-96	
	apple	pear	apple	pear	apple	pear	apple	pear	Abandoned	Conventional & IPM
Oxyopidae										
<i>Oxyopes heterophthalmus</i> Latreille, 1804									96	95, 96
<i>Oxyopes ramosus</i> (Panzer, 1804)					96, 97				96, 97	96
<i>Oxyopes</i> spp.									96, 97	95, 96
Anyphaenidae										
<i>Anyphaena accentuata</i> (Walckenaer, 1802)										
Clubionidae										
<i>Cheiracanthium mildei</i> L. Koch, 1864									97	
<i>Cheiracanthium pennyi</i> O.P. Cambridge, 1873	95								96, 97	95
<i>Cheiracanthium punctiorum</i> (Villers, 1789)	95, 96	95								
<i>Cheiracanthium</i> spp.	95	95, 96							97	
Gnaphosidae										
<i>Aphantaulax</i> spp.		95								
<i>Drassodes lapidosus</i> (Walckenaer, 1802)										96
Zoridae										
<i>Zora</i> spp.									97	
Philodromidae										
<i>Philodromus (aureolus)</i> spp.	95, 96	95, 96	95, 96	95, 96	96, 97	96, 97	96, 97	95, 96	96, 97	97
<i>Philodromus (margaritatus)</i> spp.		95							97	
<i>Philodromus dispar</i> Walckenaer, 1826	96									
<i>Tibellus oblongus</i> (Walckenaer, 1802)	95, 96	95, 96	95, 96	95, 96	97	96, 97	97	95, 96	96, 97	95, 96
<i>Tibellus</i> spp.										96
<i>Thanatus</i> spp.										96
Thomisidae										
<i>Herieus</i> spp.	96									
<i>Misumena vatia</i> (Clerck, 1757)	95, 96	95, 96	95, 96	95, 96				96	96, 97	

Table 3 (cont.)

	Nagykovács 1995-96		Szigetsép 1995-96		Tura 1996-97		Sárospatak 1995-97		Kecskemét 1996-97		Szatkás 1995-96	
	apple	pear	apple	pear	apple	pear	apple	pear	apple	pear	apple	Conventional & IPM
<i>Misumenops tricuspidatus</i> (Fabricius, 1775)	95, 96	95, 96	95, 96	95, 96	96, 97	96, 97	96, 97	95, 96	96, 97	96, 97	96	96
<i>Pistius truncatus</i> (Pallas, 1772)	95, 96											
<i>Runcinia grammica</i> (C.L. Koch, 1837)	95, 96								96			96
<i>Synaema globosum</i> (Fabricius, 1775)												
<i>Thomisus onustus</i> Walckenaer, 1806												
<i>Tmarus piger</i> (Walckenaer, 1802)	95, 96											95, 96
<i>Tmarus</i> spp.		95, 96										
<i>Xysticus cristatus</i> (Clerck, 1857)			95, 96	95							96	95, 96
<i>Xysticus kochi</i> Thorell, 1872											96	96
<i>Xysticus nimii</i> Thorell, 1872											96	96
<i>Xysticus striatipes</i> L. Koch, 1870											97	
<i>Xysticus ulmi</i> (Hahn, 1831)	95, 96											
<i>Xysticus</i> spp.	95, 96	95, 96	95, 96	95, 96	96, 97	96, 97	96, 97	95, 96	96, 97	96, 97	96, 97	95, 96
Salticidae												
<i>Ballus chalybeius</i> (Walckenaer, 1802)	95											
<i>Carhotus xanthogramma</i> (Latreille, 1819)	95, 96	95, 96	96, 97	96, 97	96, 97	96, 97	96, 97	96	96	96	96	96
<i>Eris nidicolens</i> (Walckenaer, 1802)	95, 96	96					96			96		
<i>Euophrys</i> spp.											96	
<i>Evarcha arcuata</i> (Clerck, 1757)	96	96									96	96
<i>Evarcha</i> spp.	95, 96	95, 96									96, 97	96
<i>Heliophanus cupreus</i> (Walckenaer, 1803)		95	95, 96	96							96, 97	96
<i>Heliophanus flavipes</i> Hahn, 1832			95, 96	95, 96							96, 97	96
<i>Heliophanus</i> spp.	95, 96	95, 96					96				96, 97	
<i>Salticus zebraneus</i> (C.L. Koch, 1837)		95										95
<i>Salticus</i> spp.	95, 96	95, 96									96, 97	95
Number of species	32	33	19	19	20	20	13	12	35	12	35	30
Number of individuals	359	404	377	298	119	416	83	140	1519	140	1519	579

Table 4

List of spiders occurring on the bark of apple and pear trees (trapping on the bark)

	Nagykovácsi 1978–82 Abandoned apple
Theridiidae	
<i>Dipoena melanogaster</i> (C.L. Koch, 1837)	81, 82
<i>Enoplognatha latimana</i> Hippa & Oksala, 1982	78, 79, 81
<i>Enoplognatha</i> (<i>ovata-latimana</i>) spp.	79, 80, 81
<i>Steatoda bipunctata</i> (Linnaeus, 1758)	81
<i>Theridion bimaculatum</i> (Linnaeus, 1767)	80
<i>Theridion nigrovariegatum</i> Simon, 1873	79
<i>Theridion pinastri</i> L. Koch, 1872	78, 79, 80, 81, 82
<i>Theridion suaveolens</i> (Simon, 1879)	80
<i>Theridion tinctum</i> (Walckenaer, 1802)	79, 81, 82
<i>Theridion</i> (<i>mystaceum</i>) sp.	79, 81
<i>Theridion</i> (<i>sisyphium-impressum</i>) spp.	78, 79, 80, 81, 82
<i>Theridion</i> spp.	78, 79, 81, 82
Linyphiidae	
<i>Araeonchus humilis</i> (Blackwall, 1841)	79
<i>Centromerus similis</i> Kulczynski, 1894	78
<i>Entelecara congenera</i> (O.P. Cambridge, 1879)	81
<i>Erigone atra</i> Blackwall, 1833	82
<i>Meioneta rurestris</i> (C.L. Koch, 1836)	78, 80
<i>Oedothorax apicatus</i> (Blackwall, 1850)	79
<i>Thyreosthenius parasiticus</i> (Westring, 1851)	81
<i>Trichoncoides piscator</i> (Simon, 1884)	81
<i>Erigoninae</i> spp.	81
<i>Linyphinae</i> spp.	78, 79, 80, 81, 82
Araneidae	
<i>Araniella</i> spp.	79, 80, 81
<i>Gibbaranea</i> spp.	79
<i>Hypsosinga pygmaea</i> (Sundevall, 1832)	78
Lycosidae	
<i>Pardosa agrestis</i> (Westring, 1862)	82
<i>Pardosa</i> spp.	79, 80, 81, 82
<i>Trochosa</i> (<i>terricola-ruricola</i>) spp.	80
Pisauridae	
<i>Pisaura mirabilis</i> (Clerck, 1757)	78, 79
Agelenidae	
<i>Agelena labyrinthica</i> (Clerck, 1757)	79, 80, 81
<i>Tegenaria agrestis</i> (Walckenaer, 1802)	79, 81, 82
<i>Tegenaria</i> spp.	81
Dictynidae	
<i>Dictyna</i> spp.	81

Table 4 (cont.)

	Nagykovácsi 1978–82 Abandoned apple
Titanoecidae	
Titanoeca schineri (L. Koch, 1872)	79
Clubionidae	
Clubiona marmorata L. Koch, 1866	78, 79, 80, 81, 82
Clubiona spp.	78, 79, 80, 81, 82
Gnaphosidae	
Drassodes lapidosus (Walckenaer, 1802)	79, 80, 81, 82
Drassodes spp.	78, 79, 80, 81, 82
Drassyllus pusillus (C.L. Koch, 1833)	79, 80
Zelotes spp.	78, 79, 80, 81
Philodromidae	
Philodromus aureolus (Clerck, 1757)	79
Philodromus cespitum (Walckenaer, 1802)	79, 80, 82
Philodromus emarginatus (Schrank, 1803)	80
Philodromus longipalpis Simon, 1870	79
Philodromus (aureolus) spp.	78, 79, 80, 81, 82
Philodromus (margaritatus) spp.	78, 79, 80, 81
Philodromus (rufus) spp.	80
Thanatus spp.	80
Tibellus oblongus (Walckenaer, 1802)	80
Thomisidae	
Diaea pictilis (Banks, 1896)	81
Misumena vatia (Clerck, 1757)	79, 80, 82
Misumenops tricuspidatus (Fabricius, 1775)	79
Pistius truncatus (Pallas, 1772)	81
Tmarus stellio Simon, 1875	82
Xysticus acerbus Thorell, 1872	79
Xysticus cristatus (Clerck, 1857)	79, 80
Xysticus lanio C.L. Koch, 1835	79, 80, 81, 82
Xysticus spp.	78, 79, 80, 81, 82
Salticidae	
Ballus chalybeius (Walckenaer, 1802)	78, 82
Carrhotus xanthogramma (Latreille, 1819)	82
Eris nidicolens (Walckenaer, 1802)	78, 79, 80, 81, 82
Heliophanus cupreus (Walckenaer, 1803)	80
Heliophanus flavipes Hahn, 1832	80
Marpissa muscosa (Clerck, 1757)	79, 82
Pseudotitius encarpatus (Walckenaer, 1802)	79, 81, 82
Salticus zebraneus (C.L. Koch, 1837)	79
Sitticus distinguendus (Simon, 1868)	82
Sitticus pubescens (Fabricius, 1775)	79
Number of species	57
Number of individuals	813

Table 5

List of spiders overwintering on the trunk of apple and pear trees (belt traps)

	Nagykovácsi 1996 Abandoned apple	pear	Szigetcsép 1997 Conventional apple	Tura 1996 Conventional pear	Sárospatak Conventional apple 1996	pear 1993-94, 96	Kecskemét 1996 Abandoned apple	Szarkás 1994-96 Conventional & IPM apple
Segestriidae								
Segestria bavarica C.L. Koch, 1843		96						
Theridiidae								
Steatoda albomaculata (Degeer, 1778)						94		
Steatoda bipunctata (Linnaeus, 1758)				96	96	94, 96		
Theridion bimaculatum (Linnaeus, 1767)						94		
Theridion pinastris L. Koch, 1872						93, 94		
Theridion tinctum (Walckenaer, 1802)		96				94		
Theridion (mystaceum) sp.		96		96		94		95
Theridion (sisyphium-impressum) spp.						94		96
Linyphiidae								
Neriere montana (Clerck, 1757)						94		
Neriere spp.		96				96		
Erigoninae spp.		96						
Tetragnathidae								
Tetragnatha spp.			97			93, 94, 96		
Zygiella spp.								96
Araneidae								
Araneus spp.		96						
Araniella opistographa (Kulczynski, 1905)						93		
Pisauridae								
Pisaura mirabilis (Clerck, 1757)						96		
Dictynidae								
Dictyna spp.		96		96		93, 94, 96		
Lathys humilis (Blackwall, 1855)		96						
Titanoecidae								
Titanoeca spp.								95
Anyphaenidae								
Anyphaena accentuata (Walckenaer, 1802)		96				94, 96		
Clubionidae								
Cheiracanthium mildei L. Koch, 1864				96		93, 96	96	94, 95, 96
Cheiracanthium spp.						93		
Clubiona brevipes Blackwall, 1841						94		
Clubiona compta C.L. Koch, 1839						94		
Clubiona genevensis L. Koch, 1866								95
Clubiona pallidula (Clerck, 1757)						94		
Clubiona phragmitis C.L. Koch, 1843						94		
Clubiona pseudoneglecta Wunderlich, 1994							96	
Clubiona spp.	96	96	97	96	96	93, 94, 96	96	94, 95
Gnaphosidae								
Aphantaulax spp.							96	95
Drassodes lapidosus (Walckenaer, 1802)							96	95
Drassodes spp.	96						96	94, 95
Micaria spp.							96	95
Scotophaeus scutulatus (L. Koch, 1866)								95
Scotophaeus spp.		96		96				95
Philodromidae								
Philodromus dispar Walckenaer, 1826		96						

Table 5 (cont.)

	Nagykovácsi 1996		Szigetcsép 1997	Tura 1996	Sárospatak		Kecskemét 1996	Szarkás 1994-96
	Abandoned apple	pear	Conventional apple	Conventional pear	apple 1996	pear 1993-94, 96	Abandoned apple	Conventional & IPM apple
<i>Philodromus (aureolus) spp.</i>	96	96	97	96	96	93, 94, 96	96	95, 96
<i>Philodromus (margaritatus) spp.</i>	96	96	97	96	96	93, 94	96	96
<i>Philodromus (rufus) spp.</i>	96	96		96				96
<i>Tibellus spp.</i>						94, 96		
Thomisidae								
<i>Diaea spp.</i>	96							
<i>Misumenops tricuspidatus</i> (Fabricius, 1775)		96	97	96	96	93, 94, 96	96	94, 95, 96
<i>Ozyptila praticola</i> (C.L. Koch, 1837)					96	96		
<i>Ozyptila spp.</i>						96		
<i>Pistius truncatus</i> (Pallas, 1772)	96	96		96				
<i>Synaema spp.</i>		96						95
<i>Tmarus spp.</i>		96						
<i>Xysticus spp.</i>						94, 96		
Salticidae								
<i>Eris nidicolens</i> (Walckenaer, 1802)						94		96
<i>Marpissa muscosa</i> (Clerck, 1757)					96		96	95
<i>Marpissa spp.</i>					96		96	
<i>Pseuditius encarpatus</i> (Walckenaer, 1802)						93	96	96
<i>Salticus zebraneus</i> (C.L. Koch, 1837)							96	95
<i>Salticus spp.</i>						94	96	94, 95
Number of species	7	19	5	11	7	27	11	19
Number of individuals	13	202	711	44	33	721	237	208

in the summer and one in the autumn) for two years. Additionally in Nagykovácsi and Szigetcsép samples were taken 12 times annually by making 3 X 33 sweep net samples for three years.

Pitfall trapping was performed to collect ground-dwelling spiders in Szarkás in 1992–95. Forty pitfall traps (0.08 m in diameter, halfway filled with ethylene-glycol 30% solution) were used and emptied weekly.

Additionally, hand picking was done in Nyirbogdány (in Szabolcs-Szatmár-Bereg County). The collected spiders were stored in 75% ethanol.

Table 1 shows the characteristics of every investigated orchards.

The collected spider individuals were identified to the lowest taxonomic level possible. Juveniles were identified mostly to generic level. Juveniles of the genus *Philodromus* were separated into three species groups as *Philodromus (aureolus)* which contains the species *Ph. aureolus*, *Ph. cespitum*, *Ph. praedatus*, *Ph. longipalpis*. *Philodromus (margaritatus)* which contains *Ph. margaritatus* and *Ph. emarginatus*. Finally *Philodromus (rufus)* which contains *Ph. rufus* and *Ph. albidus*. Juveniles of *Philodromus dispar* were identified until species level. Juveniles of *Enoplognatha ovata* and *Enoplognatha latimana* were considered as *Enoplognatha (ovata-latimana)*. Similarly juveniles of *Araniella cucurbitina* and *Araniella opistographa* were considered as *Araniella (cucurbitina-opistographa)*. *Theridion (mystaceum)* contains the juveniles of the species

Table 6

List of spiders occurring in the ground level of apple and pear orchards (pitfall trapping)

	Szarkás 1992–95 Conventional & IPM apple
Dysderidae	
Harpactea rubicunda (C.L. Koch, 1838)	92, 93, 94, 95
Theridiidae	
Steatoda albomaculata (Degeer, 1778)	92
Steatoda phalerata (Panzer, 1801)	92
Araneidae	
Argiope lobata (Pallas, 1772)	94
Lycosidae	
Alopecosa cursor (Hahn, 1831)	95
Alopecosa fabrilis (Clerck, 1757)	93
Alopecosa mariaae (Dahl, 1908)	95
Alopecosa sulzeri (Pavesi, 1873)	92, 93, 94, 95
Alopecosa spp.	92, 93, 94, 95
Arctosa perita (Latreille, 1799)	92, 93, 94, 95
Hogna radiata (Latreille, 1819)	95
Pardosa agrestis (Westring, 1862)	92, 93, 94, 95
Pardosa lugubris (Walckenaer, 1802)	93
Pardosa spp.	92, 93, 94, 95
Trochosa robusta (Simon, 1876)	92
Trochosa terricola Thorell, 1856	92, 94, 95
Xerolycosa miniata (C.L. Koch, 1834)	92, 93, 94, 95
Xerolycosa nemoralis (Westring, 1861)	92, 93, 94
Xerolycosa spp.	92, 94
Agelenidae	
Agelena gracilens C.L. Koch, 1841	93
Agelena labyrinthica (Clerck, 1757)	92, 94
Tegenaria agrestis (Walckenaer, 1802)	93, 94
Tegenaria spp.	93
Titanoecidae	
Titanoeca schineri (L. Koch, 1872)	92, 93, 94, 95
Oxyopidae	
Oxyopes heterophthalmus Latreille, 1804	92, 93, 94
Clubionidae	
Cheiracanthium spp.	94
Clubiona spp.	94
Gnaphosidae	
Drassodes lapidosus (Walckenaer, 1802)	92
Drassodes villosus (Thorell, 1856)	92, 93, 94, 95
Drassyllus praeficus (L. Koch, 1866)	92, 94
Gnaphosa mongolica Simon, 1895	95
Haplodrassus signifer (C.L. Koch, 1839)	93, 95
Trachyzelotes pedestris (C.L. Koch, 1837)	92, 93, 94, 95
Zelotes apricorum (L.Koch, 1876)	93

Table 6 (cont.)

	Szarkás 1992–95 Conventional & IPM apple
Zelotes electus (C.L. Koch, 1839)	92
Zelotes longipes (L. Koch, 1866)	93
Zelotes subterraneus (C.L. Koch, 1833)	93
Zelotes spp.	92, 93, 94, 95
Philodromidae	
Thanatus arenarius Thorell, 1872	92, 93, 94, 95
Thomisidae	
Misumena vatia (Clerck, 1757)	94
Xysticus acerbus Thorell, 1872	92
Xysticus kochi Thorell, 1872	92, 93, 94, 95
Xysticus sabulosus (Hahn, 1832)	95
Xysticus spp.	92, 93, 94, 95
Salticidae	
Aelurillus v-insignitus (Clerck, 1757)	92
Euophrys spp.	93
Number of species	40
Number of individuals	1215

Th. mystaceum. Juveniles of the family *Linyphiidae* were separated into two subfamilies as *Linyphiinae* spp. and *Erigoninae* spp. Females of *Trochosa terricola* or *Trochosa ruricola* were indicated as *Trochosa* sp. The spiders were placed in the collection of S. Bogya.

The most widely occurring species were considered either by investigating the number of localities and years they occurred. The frequency of occurrence in different orchards and years was calculated and the species which were found with a frequency of more than 60% are listed.

For the calculations of the similarities in species composition between different stratas and plants the Jaccard index was used (Krebs, 1989).

Results and Discussion

Based on a comparison of our results with those of other faunistic studies, it can be concluded that the family composition of the spider assemblages are rather similar. Members of the family *Theridiidae*, *Linyphiidae*, *Araneidae*, *Thomisidae*, *Philodromidae* and *Salticidae* dominate. However, members of the family *Linyphiidae* are more numerous in Western Europe, than in Central or South Europe, while the family *Salticidae* shows an opposite trend. The ratio's of web-building and hunting spiders are about 30–40% and 60–70%, respectively.

Tables 2–6 show the composition of spider assemblages based on the collection methods used and treatments in the different strata (canopy, herbaceous-layer, ground

level) of apple and pear orchards. Altogether 165 species and further 9 taxa were identified from the 20,283 individuals collected. This number represents more than 20% of the total Hungarian spider fauna. The bibliographic check list of the Hungarian spider fauna contains 714 spider species (Samu and Szinetár, 1998), three species presented here are new to that list: *Enoplognatha latimana* Hippa and Oksala, 1982; *Philodromus longipalpis*, Simon, 1870; *Euophrys monticola* Kulczynski, 1884. The followings rare species were found which were reported only once from Hungary until the present study: *Diaea pictilis* Banks, 1896 (one male /01.06.81./, two male /23.05.97./ in Nagykovácsi) (Szinetár, 1995); *Tmarus stellio* Simon, 1875 (one female in Kecskemét /19.07.96/ and one male /15.07.82./ in Nagykovácsi) (Chyzer and Kulczynski, 1918); *Sitticus distinguendus* Simon, 1868 (one female and one male /30.09.82./ in Nagykovácsi) (Chyzer and Kulczynski, 1918). Further rare species were *Alopecosa fabrilis* Clerck, 1757 (one male /02.11.93/ in Szarkás) and *Theridion suaveolens* Simon, 1879 (one female /29.07.80./ in Nagykovácsi).

Most of the *Philodromus (aureolus)* belonged to the species *Ph. cespitum*, only a few other members of the group were found. From the group *Philodromus (rufus)*, only the species *Ph. rufus* was found. Most of the *Araniella (cucurbitina-opistographa)* belonged to *Araniella opistographa*. From the group *Enoplognatha (ovata-latimana)* only *E. latimana* was found within the boundary of Hungary. Only one adult *Theridion sisyphium* was found from the group *Theridion (sisyphium-impressum)*, the others were identified as *Th. impressum*.

One hundred and three species belonging to 16 families and 64 genera were found in the canopy of apple trees, while 70 species belonging to 13 families and 50 genera were found in the canopy of pear trees. The majority of the species in the canopy belonged to the families *Theridiidae*, *Araneidae*, *Salticidae*, and *Thomisidae*. The most widespread species in decreasing order were: *Philodromus cespitum*, *Theridion impressum*, *Th. pinastris*, *Oxyopes* spp., *Araniella opistographa*. The ratio in number of species of the two main guilds, web-building and hunting spiders in case of apple trees was 45:55%, while in case of pear trees was 43:57% of the entire canopy fauna. In the investigated orchards the total number of species in the canopy varied between 22 and 56 in apple and 22 and 52 in pear orchards. The Jaccard similarity between apple and pear canopy spider assemblages was 45%.

Previous faunistic studies in Hungary registered three additional species that were not found by us: *Silometopus reussi* Thorell, 1871; *Yllenus vittatus* Thorell, 1875; *Salticus quagga* Miller, 1971, from the canopy and herbaceous-layer (Samu et al., 1997).

Between the species list of canopy and herb-layer inhabiting spiders considerable overlap was found. The similarity in species composition between the canopy and the herb-layer was 45%. Out of the 76 herb-layer inhabiting species 59 occurred in the canopy, too.

Forty-six species belonging to 14 families and 32 genera were found overwintering in the corrugated paper belt traps. The most widely occurring species in decreasing order were: *Clubiona* spp. *Cheiracanthium mildei*, *Philodromus (aureolus)*, *Philodromus (margaritatus)*, *Misumenops tricuspidatus*. Few of them, mainly clubionid species (*Clubiona phragmitis*, *Cl. genevensis*, *Cl. pseudoneglecta*, *Segestria bavarica*, *Lathys humilis*), were found only with this method. In our work, species from the families

Theridiidae, *Clubionidae*, *Thomisidae* and *Philodromidae* overwintered under the bark of the apple and pear trees. However, species from the families *Araneidae* and *Salticidae* overwinter outside of the tree. Previous studies revealed that species of the families *Dictynidae*, *Linyphiidae* and *Theridiidae* dominated in Poland (Koslinska, 1967) while *Theridiidae*, *Philodromidae*, *Dictynidae* and *Clubionidae* dominated in The Netherlands (Loomans, 1978) on the trees during the winter.

Fifty-seven species belonging to 13 families and 41 genera were found in the bark traps. An additional species *Pardosa palustris* Linnaeus, 1758 was found by hand picking from the trunk in an apple orchard in Nyírbogdány. The most common species were: *Philodromus (aureolus)*, *Xysticus* spp., *Drassodes* spp., *Theridion pinastri*, *Clubiona* spp. The species composition was similar to both the canopy and herbaceous-layer which indicates close relationship between the canopy and the herbaceous-layer through the entire vegetative period. However, some typical ground dwelling spiders as *Lycosidae*, *Gnaphosidae* and *Agelenidae* occurred frequently on the trunk of the trees.

In the herbaceous-layer of apple orchards there were 66 species belonging to 15 families and 47 genera, while in case of pear orchards 43 species belonging to 12 families and 38 genera were found. The majority of the species in the herbaceous-layer belonged to the families *Theridiidae*, *Araneidae*, *Salticidae* and *Thomisidae*. The most widespread species in the herbaceous-layer were: *Xysticus* spp., *Oxyopes* spp., *Pisaura mirabilis*, *Mangora acalypha*, *Araneus diadematus*. The ratio of the two guilds, web-building and hunting spiders in case of apple trees was 59:41%, while in case of pear trees was 42:58% of the entire herbaceous-layer inhabiting fauna. In the investigated orchards the total number of species in the herbaceous-layer varied between 13 and 36 in apple and 12 and 34 in pear orchards. The similarity between apple and pear herbaceous-layer inhabiting spider assemblages was 35%.

Forty species belonging to 12 families and 26 genera were found on the ground-level. The most frequently occurred species were *Xysticus kochi*, *Titanoeca schineri*, *Pardosa agrestis*, *Alopecosa sulzeri*, *Harpactea rubicunda*.

Previous faunistic study in Hungary reported 17 additional species that were not found by us: *Enoplognatha thoracica* Hahn, 1833; *Robertus lividus* Blackwall, 1836; *Diplostyla concolor* Wider, 1834; *Alopecosa accentuata* Latreille, 1817; *Alopecosa pulverulenta* Clerck, 1757; *Alopecosa trabalis* Clerck, 1757; *Pardosa agricola* Thorell, 1856; *Pardosa hortensis* Thorell, 1872; *Pardosa monticola* Clerck, 1757; *Pardosa paludicola* Clerck, 1757; *Pardosa prativaga* L. Koch, 1870; *Pardosa pullata* Clerck, 1757; *Pardosa riparia* C. L. Koch, 1833; *Trochosa ruricola* Degeer, 1778; *Coelotes longispinus* Kulczynski, 1897; *Agroeca cuprea* Menge, 1873; *Drassyllus villicus* Thorell, 1875 from the ground level (Samu and Lővei, 1995). As these two studies sampled only two different orchards further research is needed to complete the list of ground dwelling spiders of apple and pear orchards.

Studies of abandoned and commercial orchards were undertaken in different regions and with different sampling efforts, but it was obvious that there were more species and individuals in the unsprayed than in any of the commercial orchards studied. However, in same cases (e.g. in Szigetcsép), because of the diverse surroundings in contradiction to the commercial treatments the species richness of spider assemblages could be rather high. There were markedly more species and individuals of theridiid

spiders in the untreated orchards. Simultaneously pirate spiders (*Ero* spp.) that prey on theridiids were found only in the untreated orchards, too. Some species, mainly hunting spiders (e.g. *Philodromus (aureolus)*, *Misumenops tricuspidatus*, *Xysticus* spp. *Salticus zebraneus*) were common and widespread independently from the treatments.

In previous studies Szentkirályi and Kozár (1991) found 54 species of natural enemies in apple orchards, while Markó et al. (1995) found 74 predaceous beetles in the canopies of apple and pear orchards in Hungary. Present study describing the faunistical composition of *Araneae* assemblages occurring in apple and pear orchards in the Carpathian Basin refer to high diversity (165 spider species) of this predator group. It can be concluded that spiders are important potential natural control agents, which could play an important role in orchard integrated pest management systems in the future. Further research is needed to describe the theoretical and practical background of protection and application of spider assemblages in these agroecosystems.

Acknowledgements

The work was supported by grants from the Hungarian Scientific Research Fund (OTKA) (23885 and SZO 17691), TEMPUS 11256 and the Production Ecology “Sandwich” Ph.D. Program of the Wageningen Agricultural University. The authors are grateful to Dr. F. Szentkirályi who operated the bark traps.

Finally the critical comments on the manuscript by Prof. Dr. J. C. van Lenteren, Dr. M. Kosztarab and Dr. F. Samu were highly appreciated.

Literature

- Angeli, G., Forti, D. and Pesarine, C. (1996): Ragni epigei (*Araneae*) in meleti e pereti del Trentino [Epigeic spiders (*Araneae*) in apple and pear orchards in Trentino]. *Redia* 79, 113–121.
- Bogya, S. and Mols, P. J. M. (1996): The role of spiders as predators of insect pests with particular reference to orchards: A review. *Acta Phytopath. Entomol. Hung.* 31, 83–159.
- Chyzer, K. and Kulczynski, L. (1918): *Ordo Araneae*. In: *A Magyar Birodalom Állatvilága. III. Arthropoda.* 33. Budapest, Kir. Magyar. Term. tud. Társ.
- Dondale, C. D., Parent, B. and Pitre, D. (1979): A 6-year study of spiders (*Araneae*) in a Quebec apple orchard. *Can. Entomol.* 111, 377–380.
- Hukusima, S. (1961): Studies on the insect association in crop field XXI. Notes on spiders apple orchards. *Jpn. J. Appl. Entomol. Zool.* 5, 270–272.
- Klein, W. (1988): Erfassung und Bedeutung der in den Apfelanlagen aufgetretenen Spinnen (*Araneae*) als Nützlinge im Grossraum Bonn [The incidence and importance of apple-orchard-inhabiting spiders (*Araneae*) as beneficial organisms in the Bonn area]. Friedrich Wilhelms Universität Bonn, pp. 134.
- Koslinska, M. (1967): Badania nad fauna zimujaca pod kora i w korze jabloni. Czesc II. Badania nad pajeczakami (*Arachnida*) [Investigations of fauna overwintering in and under the bark of apple trees. Part II. Studies on Arachnida]. *Pol. Pismo Entomol.* 37, 586–602.
- Krebs, C. J. (1989): *Ecological Methodology*. Harper and Row Publishers, New York, pp. 654.
- Loomans, A. (1978): Spinnen in appelbomgaarden [Spiders in apple orchards]. MSc Thesis Wageningen Agricultural University, pp. 108.
- Markó, V., Merkl, O., Podlussány, A., Víg, K., Kutasi, Cs. and Bogya, S. (1995): Species composition of Coleoptera assemblages in the canopies of Hungarian apple and pear orchards. *Acta Phytopath. Entomol. Hung.* 30, 221–245.

- McCaffrey, J. P. and Horsburgh, R. L. (1980): The spider fauna of apple trees in central Virginia. *Environ. Entomol.* 9, 247–252.
- Mészáros, Z., Ádám, L., Balázs, K., Benedek, Ilona M., Csikai, Cs., Draskovits, Ágnes D., Kozár, F., Lővei, G., Mahunka, S., Meszleny, A., Mihályi, F., Mihályi, K., Nagy, L., Oláh, B., Papp, J., Papp, L., Polgár, L., Zeinab Radwan, Rác, V., Ronkay, L., Solymosi, P., Soós, Á., Szabó, S., Szabóky, Cs., Szalay-Marzsó, L., Szarukán, I., Szelényi, G., Szentkirályi, F., Sziráki, Gy., Szőke, L. and Török, J. (1984): Results of faunistic and floristical studies in Hungarian apple orchards (Apple Ecosystem Research No. 26.). *Acta Phytopath. Entomol. Hung.* 19, 91–176.
- Nagy, L. and Szentkirályi, F. (1982): A közönséges fülbemászó (*Forficula auricularia*, L.: Orthopteroidea, Dermaptera) előfordulása és jelentősége különböző típusú almásokban [Occurrence and significance of the common earwig (*Forficula auricularia*, L.: Orthopteroidea, Dermaptera) in different apple orchards]. *Növényvédelem* 18, 394–401. (in Hungarian)
- Olszak, R. W., Luczak, L., Niemczyk, E. and Zajac, R. Z. (1992): The spider community associated with apple trees under different pressure of pesticides. *Ekol. Pol.* 40, 265–286.
- Samu, F. and Lővei, G. (1995): Species richness of a spider community: Extrapolation from simulated increasing sample effort. *Eur. J. Entomol.* 92, 633–638.
- Samu, F. and Szinétár, Cs. (1998): Bibliographic check list of the Hungarian spider fauna. *Bull. Br. Arachnol. Soc.* (in press)
- Samu, F., Rác, V., Erdélyi, Cs. and Balázs, K. (1997): Spiders of the foliage and herbaceous layer of an IPM apple orchard in Kecskemét-Szarkás, Hungary. *Biol. Agric. Hort.* (in press)
- Szentkirályi, F. and Kozár, F. (1991): How many species are there in apple insect communities?: testing the resource diversity and intermediate disturbance hypotheses. *Ecological Entomol.* 16, 491–503.
- Szinétár, Cs. (1995): Data to the Araneae fauna of Őrség (Western Hungary). *Savaria* 22, 245–251.
- Zhao, B. G., Yan, Y. H. and Shi, Z. W. (1993): Studies on beneficial arthropods on the ground of an apple orchards and relative predation. *J. Fruit Sci.* 10, 146–149. (in Chinese)