Acta Phytopathologica et Entomologica Hungarica 38 (1–2), pp. 181–198 (2003)

Species Composition of Ground Dwelling Staphylinid *(Coleoptera: Staphylinidae)* Communities in Apple and Pear Orchards in Hungary

A. BALOG[1], V. MARKÓ[1],
CS. KUTASI[2] and L. ÁDÁM[3]

[1]Department of Entomology, Szent István University,
H-1052 Budapest, P.O. Box 53, Hungary (balogadalbert@hotmail.com, rovr@omega.kee.hu)
[2]Bakony Natural History Museum, Zirc, Hungary (btmz@almos.vein.hu)
[3]H-1098 Budapest, Aranyvirág sétány 7/I, Hungary

Species richness and composition of *Staphylinidae* communities were investigated at ground level when differently treated with pesticides and in abandoned apple and pear orchards in Hungary. Altogether 6099 individuals were collected belonging to 241 staphylinid species. 233 have been identified to species level and 8 staphylinid taxa were determined up to generic level.

More than 20% of the Hungarian staphylinid fauna was represented in the orchards. The similarity (Jaccard index) between apple and pear orchards at ground level were 54%. The species richness in each orchard varied between 23 and 100 species.

The most widely occurring species in orchard ground level were: *Dinaraea angustula, Palporus nitidulus, Tachyporus hypnorum, Sphenoma abdominale, Omalium caesum, Philonthus carbonarius, Drusilla canaliculata, Sepedophilus marshami, Mocyta orbata, Coprochara bipustulata, Mocyta fungi, Hyponygrus angustatus, Purrolinus laeticeps, Paraphallus linearis, Omalium cursor, Heterothops dissimilis* and *Atheta crassicornis.*

Keywords: Apple, pear, orchards, ground dwelling, *Coleoptera, Staphylinidae,* Hungary.

As part of a larger project (Apple Ecosystem Research), faunistic studies have been done to describe the species composition of arthropod assemblages in apple orchards in Hungary since 1976. Mészáros et al. (1984) examined apple orchards in five localities, Markó et al. (1995) investigated the Coleoptera communities in apple and pear orchards in three localities, while Bogya et al. (1999) presented data on species composition of apple and pear orchard inhabiting Araneae. Altogether, more than 2000 animal species were recorded in these three studies. However, there is little information on the structure of ground dwelling beetles, their diversity and abundance in apple and especially in pear orchards (Kádár and Szél, 1989; Kádár and Lővei, 1992; Kutasi et al., 2001).

Staphylinid beetles have been reported from orchard ecosystems by several authors (Galli, 1985; Reede, 1985; Majzlan and Holecová, 1993; Heyer, 1994; Knopp, 1997), but comprehensive fauna lists are rare. Andersen (1991) presented a list of staphylinid beetles occurring in agricultural ecosystems in Norway, namely spring barley, cabbage, carrot, potato, strawberries and grassland fields. The author found 103 000 specimens belonging to 226 staphylinid species. The most frequently found staphylinid species were *Aloconota*

0238–1249/2003/$ 20.00

gregaria, Anotylus rugosus, Athena fungi, Amischa analis, Tachinus signatus and *Philonthus cognatus.* Levesque and Levesque (1995, 1996) presented a list of staphylinid beetles occurring in raspberry plantations in Canada. The authors presented 81 species and 16,074 individuals (without the species of *Aleocharinae* subfamily). The most dominant were *Gyrohypnus angustatus* and *Tachinus corticinus.* There was a difference in species composition between the old and young plantations. In old raspberry plantations the species *Arpedium cribratum* was common whilst in young raspberry plantation the species *Neohyphus obscurus* and *N. hamatus* were most abundant.

There are frequent reports on Staphylinid beetles from cereal ecosystems in Europe. In wheat, the most abundant species were *Philonthus cognatus, Tachyporus hypnorum, T. chrysomelinus, T. obtusus* and *Stenus biguttatus* (Denis et al., 1990, 1991).

Andersen (2000) recorded the most frequent predator species of *Rhopalosiphum padi* in Norway as *Philonthus cognatus, Ph. atratus, Ph. ochropus* and *Ph. carbonarius.*

Krooss and Schaefer (1998) studied the effect of different farming systems in cereals, on the occurrence of staphylinid beetles. They found that in winter wheat the dominant species were *T. hypnorum, Oxytelus inustus, Lesteva longelitrata* and *Ph. fuscipennis.* In nonmanaged farming systems, the most frequent species, were: *Omalium rivulare, O. caesum, Ph. fuscipennis, Ph. rotundikollis, Ph. varius, Conosoma testeceum, Tachinus rufipes* and *Xantholinus linearis.*

The role of staphylinid species in cabbage intercropped with clover was studied by Booij et al. (1997) who found the most important species from the *Philonthus* group.

The parasitoid staphylinid species *Aleochara bilineata* and *A. bipustulata* were recorded in cabbage fields by Ahlstrom-Olsson and Jonasson (1992). In maize the most dominant species were *Neohypnus andinus* and species from the group *Anotylus* (Wardle et al., 1993).

In Hungary several faunistical investigations were carried out in natural ecosystems by Ádám (1996a, b). The author studied staphylinid fauna and identified 334 species from Őrség and 509 from Bükk National Park. However, the species composition of staphylinid assemblages in agricultural ecosystems in Hungary have not been studied to date.

Our aims were: (1) to make a thorough survey of the species composition of staphylinid beetles occurring in apple and pear orchards in Hungary, (2) to describe the biodiversity of the staphylinid communities of these orchards and (3) to determine the most widely occurring species in these orchards.

Materials and Methods

The investigations took place in 12 Hungarian orchards, which are located in woodland areas of medium height mountains (Bakonygyirót, Vámosmikola and Pókaszepetk), agricultural lowland environments (Györgytarló, Kecskemét, Tura, Újfehértó, Szentlőrinc) and regularly flooded areas (Szigetcsép). The samples were collected at the following localities: Bakonygyirót (lat. 47° 25' N, long. 17° 48' E, UTM: YN15) (a conventional apple plot), Kecskemét (lat. 54° 40' N, long. 19° 42' E, UTM: CS99) (an abandoned

apple plot), Szigetcsép (lat. 47° 16' N, long. 19° E, UTM: CT43) (a conventional apple and a pear plot), Tura (lat. 47° 36' N, long. 19° 36' E, UTM: CT97) (a conventional apple and a pear plot), Újfehértó (lat. 47° 49' N, long. 21° 30' E, UTM: ET59) (a conventional, an abandoned and an "IPM" apple plots), Györgytarló (lat. 48° 12' N, long. 21° 30' E, UTM: EU43) (a conventional apple and a pear plot), Szentlőrinc (lat. 46° 3' N, long. 18° E, YM30) (a conventional apple plot), Pókaszepetk (lat. 46° 56' N, long. 16° 58' E, UTM: XM49) (a conventional apple plot), Vámosmikola (lat. 48° N, long. 18° 52' E, UTM: CU31) (a conventional apple plot and near the edge of the orchards) *(Fig. 1).*

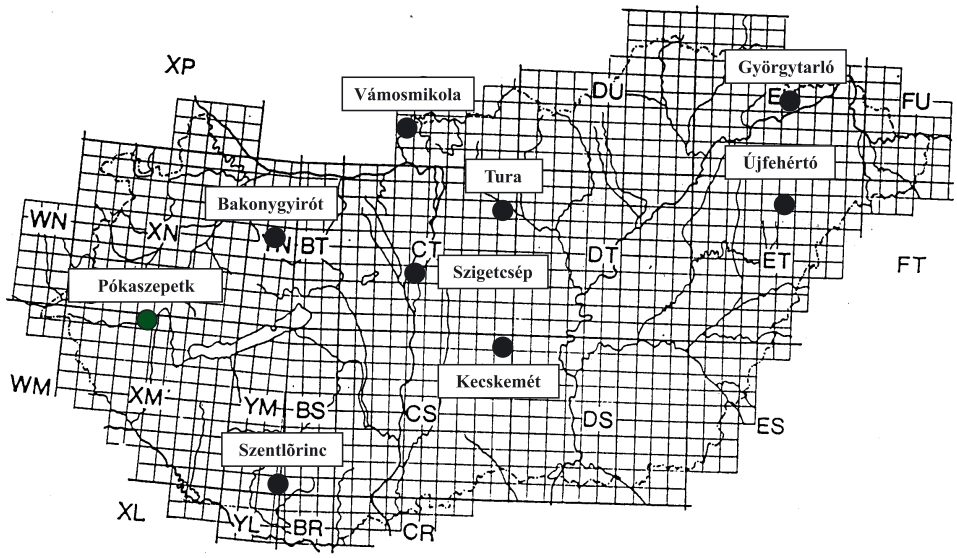

Fig. 1. The UTM map of Hungary with the investigated orchards

The pest management of the orchards was achieved mainly with broad spectrum, organophosphorus insecticides. However, three orchards were investigated in Újfehértó: a conventional, treated with broad spectrum insecticides, another, were some elements of IPM (mostly selective "green" and some "yellow" pesticides) were used, and an abandoned one.

Covered pitfall traps (300 cm^3 in size, 8 cm in diameter, half-filled with ethylene glycol 30% solution) were used to collect samples. Ten pitfall traps were placed into the rows in each orchard, except in Újfehértó and Vámosmikola where only six traps were used. Five traps were placed in the centre of the orchards, and five in the inner edges. Samples were collected from April until October in 1998–2001 and traps were emptied monthly.

Table 1 shows the characteristic of every investigated orchard.

The collected staphylinid individuals were identified to the lowest taxonomic level possible using Freude et al. (1964, 1974) and Tóth (1982, 1984).

The most common species in Hungarian orchards were considered either by investigating the total abundance and the frequency (number of localities where a species occurred).

Table 1

The characteristics of the investigated orchards

Locality	Bakonypirót	Kecskemét	Szigetcsép		Tura		Újfehértó	Györgytarló		Szentlőrinc	Pókaszepetk	Vámosmikola
Environment	Woodland in mountains	Agricultural lowland	Flooded forest area		Agricultural lowland		Agricultural lowland	Agricultural lowland		Agricultural lowland	Woodland in mountains	Woodland in mountains
Neighbouring habitats	Forest (R. pseudacacia)	Agricultural fields, ruderals	Agricultural fields		Agricultural fields ruderals, orchards		Agr. fields, orchards	Agricultural fields, orchards		Agricultural fields	Agricultural fields	Oak forests, orchards
Fruits species	apple	apple	apple	pear	apple	pear	apple	apple	pear	apple	apple	apple
Year of planting	1960	1963	1977	1988	1990	1990	1995	1950	1950	1992	1997	1988
Size of plantation	6 ha	20 ha	5.5 ha	4 ha	118 ha	5 ha	15 ha	20 ha	60 ha	1, 2 ha	53 ha	20, 25 ha
Cultivars	Jt, Bd, S	Jt, S, St	Jt, Jg, G, S	C, V, P, BG	Jt, Ap, Ep	B, D, V	G, Jt, S	Jt.	V, B	G, Gl, Ig, I	Jg, Es	I, E
Planting system	7×7 m	5×4 m	4.5× 2.5 m	6×4 m	8×4 m	7×4 m	5×2 m IPM 7×4 m C	10× 10 m	5×4 m	4×2 m	1.2×3.2 m	4×1.6 m
Abandoned		+					+					
Conventionally treated	+		+	+	+	+	+	+	+	+	+	+
IPM							+					
Treatments/year	10–15	–	12–17	12–13	10–12	8–10	15–16	10–12	10–12	10–14	9	14
Years of collection	1998–2001	1998–2000	1999–2001	1999–2001	1998–2000	1998–2000	1999–2001	1998–2000	1998–2000	1998–2000	2001	1999–2000
Pitfall traps/plot	10	10	10	10	10	10	6	10	10	10	10	6
Soil	Sandy	Sandy	Sandy-loam	Sandy-loam	Sandy-loam	Sandy-loam	Sandy	Clay	Clay	Clay	Clay	Clay
Weed management	Mw	NM	Mw	Mw	Cu	Cu	NM, Cu, Cu	Mw	Mw	Mw	Mw	Mw

Apple cultivars: Ap – Asztraháni piros, Bd – Budai domonkos, G – Golden Delicious, Gl – Gloszter, E – Éva, Ep – Egri piros, Es – Elstar, I – Idared, Jt – Jonathan, Jg – Jonagold, S – Starking, St – Staymared;
Pear cultivars: B – Bosc kobak, BG – Bella di giugno, C – Clapp kedveltje, D – Diel vajkörte, P – Packhamph's Triumph, V – Vilmos;
Planting system: C – Conventional, IPM – Integrated Pest Management;
Weed management: Cu – Cultivated, M – Managed, Mw – Mowed, NM – Not Managed

For presenting the frequency-abundance relationship power curve were fitted. In case of the individual orchards the staphylinid species with higher relative abundance than 5% were listed in decreasing order.

The Jaccard index (Krebs, 1989) was used to calculate the similarity in species composition between the apple and pear orchards.

Results and Discussion

Tables 2 and *3* show the species composition of staphylinid communities in the ground level of apple and pear orchards in Hungary. *Table 2* shows the staphylinid species occurring in the soil surfaces of apple and pear orchards, with sandy and sandy-loam soil, *Table 3* shows staphylinid species occurring in the orchards with clay soil.

Altogether 6099 individuals were collected belonging to 241 staphylinid species. 233 have been identified to species level and 8 staphylinid taxa were determined up to generic level. More than 20% of the Hungarian staphylinid fauna was represented in the sampled orchards. The similarity (Jaccard index) between apple and pear orchard inhabiting *Staphylinidae* was 54%. The species richness in each orchard varied between 23 and 100 species.

In apple orchards with sandy and sandy-loam soil the species with higher relative abundance than 5% in decreasing order were the following:

In Bakonygyirót (conventionally treated plot) 100 species were found, and the most abundant were *Palporus nitidulus, Coprochara bipustulata, Oligota pumilio, Sphenoma abdominale* and *Mocyta orbata.*

In Kecskemét (abandoned plot) 57 species were found, the most abundant were *Drusilla canaliculata, Sphenoma abdominale, Paraphallus linearis, Ocypus nitens* and *Sphenoma togata.*

In Pókaszepetk (conventionally treated plot) a total of 23 species were collected and the most common were *Dinaraea angustula, Palporus nitidulus, Oligota pumilio* and *Styloxys insecatus.*

In Szigetcsép (conventional plot) 50 species were found and the most widely occurring were *Palporus nitidulus* and *Drusilla canaliculata.*

In Újfehértó a total of 72 species were found (53 in untreated plot, 33 in conventional plot and 22 in IPM plot). Eleven species were recorded in all three plots. The most common species were *Dinaraea angustula, Mocyta orbata, Coprochara bipustulata* and *Palporus nitidulus* in conventionally treated plot. The number of collected individuals was the lowest in IPM plot and *Styloxys insecatus, Coprochara bipustulata* and *Dinaraea angustula* were the most commonly found species. *Omalium caesum, Drusilla canaliculata, Sphenoma abdominale, Podoxya vicina* and *Mocyta orbata* were the species with higher relative abundance than five percent in the untreated plot.

The species with higher abundance in apple orchards with clay soil were the following:

In Györgytarló (conventionally treated plot) 47 species were found and the most common were *Omalium caesum, Purrolinus laeticeps, Styloxys rugifrons, Meneidophallus roubali* and *Styloxys striatus.*

Table 2

List of staphylinid species occurring on the soil surface of apple and pear orchards with sandy and sandy-loam soil

Species	Bakonypirót CON apple	Kecskemét AB apple	Szigetcsép CON apple	Szigetcsép CON pear	Tura CON apple	Tura CON pear	Újfehértó AB apple	Újfehértó CON apple	Újfehértó IPM apple
Acrolocha minuta (Olivier, 1795)				00					
Alapsodus melanarius (Heer, 1839)		99				00			
Alapsodus winkleri (Bernhauer, 1906)		98, 99				99			
Aleochara bipustulata Gravenhorst, 1802	00								
Aleochara curtula (Goeze, 1777)	00, 01	99	01		00	00	99, 00		
Aloconota gracilenta (Erichson, 1839)	00						99		
Aloconota gregaria (Erichson, 1839)	98, 00	00	00	00		00			
Aloconota ruficrus (Stephens, 1832)	01								
Amischa analis (Gravenhorst, 1802)	00, 01		00	00				99, 00	
Amischa bifoveolata (Mannerhiem, 1831)				00					
Amischa decipiens (Sharp, 1869)	00			00					
Anotylus inustus (Gravenhorst, 1806)	98								
Anotylus nitidulus (Gravenhorst, 1802)	98								
Anotylus rugosus (Fabritius, 1775)	00								
Anotylus sculpturatus (Gravenhorst, 1806)				00					
Anotylus sp.	99								
Anthobium florale (Paykull, 1789)	00								
Astenus brevelytratus (Coiffait, 1960)	99, 00		01	00				99, 00	
Astenus longelitratus Gravenhorst, 1806	00								
Atheta aeneicollis (Erichson, 1837)						99			
Atheta crassicornis (Fabricius, 1792)	00	99, 00			00	00		00	
Atheta gagatina (Baudi, 1848)		00				00			99
Atheta ravilla (Erichson, 1839)						00			
Atheta sodalis (Erichson, 1837)	98								
Atheta sp.	01							00	00
Atheta triangulum (Kraatz, 1856)	00, 01			00	00	98, 00			
Atheta trinotata (Kraatz, 1856)									
Atheta xanthopus (Thomson, 1856)	98								

Table 2 (cont)

Species	Bakonypirót CON apple	Kecskemét AB apple	Szigetcsép CON apple	Szigetcsép CON pear	Tura CON apple	Tura CON pear	Újfehértó AB apple	Újfehértó CON apple	Újfehértó IPM apple
Bessopora annulare (Mannerheim, 1831)	00								
Bessopora filiforme (L. Redtenbacher, 1849)					99				
Bessopora haemorrhoum (Mannerheim,1831)					00				99
Bolitochara collaris (Paykull, 1800)							01		
Calodera aethiops (Gravenhorst, 1802)	01								
Carpelimus obesus (Kiessenwetter, 1844)				00				99	
Ceranota erythroptera (Gravenhorst, 1806)		99, 00							
Coprochara bipustulata (Linnaeus, 1761)	98, 99, 00, 01		01	00, 01	99, 00	98, 00	00, 01	99, 00	99, 01
Craetopycrus cornutus (Gravenhorst, 1802)	00			00					
Craetopycrus nitens (C. R. Sahlberg, 1832)	99, 00		00	00	99				
Craetopycrus rufospinus (Hochhuth, 1851)				00	00				
Craetopycrus spinosus (Erichson, 1840)			01						
Demosoma sp.				00					
Dexiogyia corticina (Erichson, 1837)					99				
Dinaraea angustula (Gyllenhal, 1810)	98, 99, 00, 01		00, 01	00, 01	00	00	00, 01	99, 00, 01	99, 00, 01
Distichalius flavicornis (Linnaeus, 1758)						98			
Drusilla canaliculata (Fabricius, 1787)		98, 99, 00	00, 01	00			00, 01	01	99
Enalodroma hepatica (erichson, 1839)		00							
Falagria caesa Erichson, 1837	00								
Falagria sulcatula (Gravenhorst, 1806)				00		00			
Gabrius femoralis (Hochhuth, 1851)		99					00		
Gabrius nigritulus (Gravenhorst, 1802)	98, 99, 00, 01			00	99				
Gabrius osseticus (Kolenati, 1846)		98, 99, 00			00	00			
Gabrius sp.	01	00		00					
Gabrius surveolens (Stephens, 1833)							00		
Gabrius suffragani Jay, 1913	00		00	00		00			
Gefyrobius denigrator (Gravenhorst, 1806)		99							
Goestiba circellaris (Gravenhorst, 1806)		00						99	
Hemistenus ludyi (Fauvel, 1886)		98, 99					00		
Hemistenus ochropus (Kiesenwetter, 1858)		00							

Table 2 (cont)

Species	Bakonypirót CON apple	Kecskemét AB apple	Szigetcsép CON apple	Szigetcsép CON pear	Tura CON apple	Tura CON pear	Újfehértó AB apple	Újfehértó CON apple	Újfehértó IPM apple
Hemistenus sp.				00					
Hemitropia sordida (Marsham, 1802)	98, 99, 00, 01			00	00		99	99	99
Hesperophilus gallicus (Gravenhorst, 1806)				00					
Heterothops dissimilis (Gravenhorst, 1806)	00, 01	99, 00	00		99, 00	98	99, 00	00	99, 00
Hyponygrus angustatus (Stephens, 1833)	98, 99, 00, 01	98	00	00		99	99, 00	99	99
Hyponygrus fracticornis (O. F. Müller, 1776)	00								
Ilyobates subopacus Palm, 1935	01								
Lathrimaeum atrocephalum (Gyllenhal, 1827)	99				00	00			
Lathrobium boreale Hochhuth, 1851	99								
Lathrobium brunnipes (Fabritius, 1792)	01								
Lathrobium castaneipenne Kolenati, 1846	01								
Lathrobium fovulum Stephens, 1833	00								
Lathrobium sp.	00								
Leptacinus batychrus (Gyllenhal, 1827)								99	
Leptacinus intermedius Donisthorpe, 1936								00	
Leptacinus sulcifrons (Stephens, 1833)	98								
Leptobium gracile (Gravenhorst, 1802)						98			
Leucoparyphus silphoides (Linnaeus, 1767)						00			
Liogluta crassicornis (Gyllenhal, 1827)		99							
Liogluta longiuscula (Gravenhorst, 1802)	00								
Liogluta oblongiuscula (Sharp, 1869)	98, 99, 00								
Meneidophallus roubali (Coiffait, 1956)	00	98, 99, 00		01				99	
Microdota ganglbaueri (Brundin, 1948)		00							
Microdota pittionii (Scheerpeltz, 1950)	99								
Microsaurus cruentus (Olivier, 1795)						00			
Microsaurus longicornis (Kraatz, 1857)		99							
Microsaurus ochripennis (Ménétries, 1832)	98			01					
Mniobates forticornis (Lacordaire, 1835)		99	00	00, 01					
Mocyta fungi (Gravenhorst, 1806)	98, 00, 01			00	00	00	99, 00	99, 00, 01	00
Mocyta negligens (Mulsant et Rey, 1873)								00	

Table 2 (cont)

Species	Bakonypirót CON apple	Kecskemét AB apple	Szigetcsép CON apple	Szigetcsép CON pear	Tura CON apple	Tura CON pear	Újfehértó AB apple	Újfehértó CON apple	Újfehértó IPM apple
Mocyta orbata (Erichson, 1837)	99, 00, 01		00, 01	00, 01	99, 00	99, 00	99, 00, 01	99, 01	99
Mycetoporus splendidus (Gravenhorst, 1806)	01		00	00	99, 00		00		99
Mycetoporus forticornis (Fauvel, 1875)	98	99					99		
Mycetoporus longula (Mannerheim, 1831)	01								
Mycetoporus phaedra Gravenhorst, 1802	98								
Mycetoporus piceola (Rey, 1883)	98	00			99		99	99	
Mycetoporus sp.				00, 01					
Mycetota laticollis (Stephens, 1832)			00			00			
Myopinus elongatulus (Stephens, 1834)								99	
Ocypus brunnipes (Fabritius, 1781)		98, 99, 00	00	01			00		
Ocypus nitens (Schrank, 1781)		98, 99, 00		00					
Ocypus olens (O. F. Müller, 1764)			00	01					
Ocypus ophthalmicus (Scopoli, 1763)		00							
Ocypus pedator (Gravenhorst, 1802)		98, 99	01						
Oligota pumilio Kiessenwetter, 1858	00, 01		01						
Oligota pusillima (Gravenhorst, 1806)					00				
Olophrum assimile (Paykull, 1800)				00					
Omalium caesum Gravenhorst, 1806	98, 00, 01	99, 00		00	99, 00	98, 99, 00	99, 00, 01	99, 00, 01	99, 00
Omalium cursor (O. F. Müller, 1776)	98, 01	99	00		99, 00	98, 99, 00	00		
Ontholestes haroldi (Eppelseim, 1884)	99					00	00		
Ontholestes murinus (Linnaeus, 1758)			01						
Othius laeviusculus (Stephens, 1833)	00								
Othius punctulatus (Goeze, 1777)				00	99	00			
Oxypoda acuminata (Stephens, 1832)	99, 00, 01								
Oxypoda opaca (Gravenhorst, 1802)	01								
Oxypoda vitata Mörkel, 1842						00			
Oxytelops tetracarinatus (Black, 1799)	00, 01	99	00	00		00			
Pachnida nigella (Erichson, 1837)	01								
Paederus fuscipes Curtis, 1826			01	00, 01		00	00		
Paederus littoralis Gravenhorst, 1802		98, 99, 00							

Table 2 (cont)

Species	Bakonypirót CON apple	Kecskemét AB apple	Szigetcsép CON apple	Szigetcsép CON pear	Tura CON apple	Tura CON pear	Újfehértó AB apple	Újfehértó CON apple	Újfehértó IPM apple
Palporus nitidulus (Fabritius, 1781)	98, 00, 01	99	00, 01	00, 01	99, 00	99, 00		99, 00, 01	99, 00, 01
Paratrogophloeus obscurus (Stephens, 1834)	00			00					
Paracyusa rubicunda (Stephens, 1832)	98								
Pella laticollis (Mörkel, 1842)							01		
Pella limbata (Paykull, 1789)				00			00, 01		01
Philhygra balcanicola (Scheetpeltz, 1968)	00			00					99
Philonthus aeneus (De Geer, 1774)			01				00		
Philonthus carbonarius (Gravenhorst, 1802)	99, 00, 01	99	00, 01	98, 00, 01	99	98, 99, 00	99, 00		00
Philonthus cognatus (Stephens, 1832)	99, 00, 01	99	01	00, 01		99, 00			01
Philonthus corruscus (Gravenhorst, 1802)				01			00		
Philonthus debilis (Gravenhorst, 1802)	98, 00			98, 00		00	99		
Philonthus mannerheimi (Fauvel, 1869)					00	98, 99, 00			
Philonthus pachycephalus (Nordmann, 1837)						00			
Philonthus quisquiliarius (Gyllenhal, 1810)			00	00					
Philonthus spermophili (Ganglbauer, 1897)						98			
Philonthus succicola (Thomson, 1860)			00	00		99			
Philonthus umbratilis (Gravenhorst, 1802)	98								
Philonthus varians (Paykull, 1789)						00	00		
Philonthus intermedius (Lacordaire, 1835)						00			
Philonthus laminatus (Creutzer, 1799)						99, 00	99		
Plataraea dubiosa (G. Benick, 1935)			01				00		
Platydracus fulfipes (Scopoli, 1763)							00		
Platydracus stercorarius (Olivier, 1795)		98, 99					00, 01		
Pycnota paradoxa (Mulsant et Rey, 1861)				00					
Pycnota vicina (Kraatz, 1858)		99, 00, 01	00	00, 01	99, 00	00	99, 01	01	
Polychara sparsa (Heer, 1839)		98, 00, 01	00		98	00		01	01
Pseudocypus fulvipennis (Erichson, 1840)		98	99						
Pseudocypus fuscatus (Gravenhorst, 1802)							00, 01		
Pseudocypus mus (Brullé, 1832)				01					
Pseudocypus penetrans (O. F. Müller, 1776)			00						

Table 2 (cont)

Species	Bakonypirót CON apple	Kecskemét AB apple	Szigetcsép CON apple	Szigetcsép CON pear	Tura CON apple	Tura CON pear	Újfehértó AB apple	Újfehértó CON apple	Újfehértó IPM apple
Pseudocypus vagans (Heer, 1839)			01						
Purrolinus laeticeps (Reitter, 1908)	00	99		00		98	99	99	
Purrolinus tricolor (Fabricius, 1787)	01						00, 01		
Raphirus scintillans (Gravenhorst, 1806)						00			
Quedius fuliginosus (Gravenhorst, 1802)						99	00, 01		
Quedius laticollis (Gravenhorst, 1802)			01				00		
Quedius levicollis Brullé, 1832	98, 00								
Quedius meridiocarpathicus (Gravenhorst, 1806)		99, 00	01	01					
Quedius molochinus (Gravenhorst, 1802)		99		00		98			
Rabigus pullus (Nordmann, 1837)			00	98, 00					
Raphirus limbatoides (Coiffait, 1963)						98			
Raphirus nitipennis Stephens, 1833				00		00			
Rugilus immunis Stephens, 1833							00		
Rugilus orbiculatus (Paykuli, 1789)	99, 00								
Rugilus rufipes Germar, 1835		99			99	98			
Scopaeus bicolor Baudi, 1848	99								
Scopaeus debilis Hochhuth, 1851	99								
Scopaeus minutus Erichson, 1840	00								
Scopaeus sp.					00				
Semiris fusca (Gravenhorst, 1806)			00	00					
Sepedophilus immaculatus (Stephens, 1832)		99							
Sepedophilus marshami (Stephens, 1832)		99, 00		00	99	98, 99, 00	00	99	99
Sepedophilus obtusus (Luze, 1902)		00							
Sepedophilus pedicularius (Gravenhorst, 1802)							99		
Sericoderus lateralis (Gyllenhal, 1827)	01								
Sphenoma abdominale Mannerheim, 1831	98, 99, 00, 01	00	01	00	98, 99, 00	00	99, 00, 01	00, 01	99, 00
Sphenoma togata (Erichson, 1837)		99			00	00			
Staphylinus caesareus (Cederhielm, 1798)	00								
Stenus ater Mannerheim, 1831	01		00	00				99	
Stenus biguttatus (Linnaeus, 1758)	99								

Table 2 (cont)

Species	Bakonypirót CON apple	Kecskemét AB apple	Szigetcsép CON apple	Szigetcsép CON pear	Tura CON apple	Tura CON pear	Újfehértó AB apple	Újfehértó CON apple	Újfehértó IPM apple
Stenus clavicornis (Csopoli, 1763)		98, 99, 00					00, 01		
Stenus juno (Paykull, 1789)	98								
Stenus providus Erichson, 1839				00, 01					
Styloxys insecatus (Gravenhorst, 1806)	98, 00, 01		00	98, 00, 01		98, 00	01		99, 00
Styloxys rugifrons (Hochhuth, 1849)			01	00					
Styloxys striatus (Strom, 1768)	98, 99, 00, 01		00			99, 00		01	
Sunius melanocephalus (Fabritius, 1792)					00				
Tachinus corticinus Gravenhorst, 1802	00	98, 99	00	98, 00, 01	99				
Tachinus fimetarius Gravenhorst, 1802	00			01		99, 00			
Tachinus rufipes (Linnaeus, 1758)						00			
Tachyporus chrysomelinus (Linnaeus, 1758)					99				
Tachyporus formosus Matthews, 1838						00			
Tachyporus hypnorum (Fabritius, 1775)	98, 99, 00, 01	99	00, 01	00, 01	98, 99, 00	99, 00	99, 01	99	
Tachyporus marginellus Stephens, 1832				01					
Tachyporus pusillus Gravenhorst, 1806			01	01					
Tachyporus solutus Erichson, 1839			00	00	99	99, 00			
Trianthus lepidus (Gravenhorst, 1802)		98, 99, 00		00	99		99		
Tetratopeus rufonitidus (Reitter, 1909)				00					
Trogophloeus pusillus (Gravenhorst, 1802)	00								
Typholinus laevigatus (Gravenhorst, 1802)	99, 00, 01			00, 01					
Xantholinus coiffaiti (Franz, 1966)	99			00	00				
Xantholinus linearis (Olivier, 1795)	00, 01	98, 99, 00		00	98, 99, 00	98, 99, 00	00	99	
Xantholinus longiventris (Heer, 1839)	99, 00, 01	99	00, 01	00, 01	99	99	00	00, 01	

Explication: AB – Abandoned
CON – Conventional
IPM – Integrated Pest Management

Table 3

List of Staphylinid species occurring on the soil surface of apple and pear orchards with clay soil

Species	György-tarló CON apple	György-tarló CON pear	Szent-lőrinc CON apple	Póka-szepetk CON apple	Vámos-mikola ED apple	Vámos-mikola CON apple
Alapsodus kirbii (Stephens, 1832)				01	00	
Alapsodus melanarius (Heer, 1839)					99	
Alapsodus morsitans (Rossi, 1790)			00		99, 00	
Aleochara curtula (Goeze, 1777)	99	99				
Aleochara lateralis Heer, 1839				01		
Amischa analis (Gravenhorst, 1802)				01		
Amischa bifoveolata (Mannerhiem, 1831)			00			
Amischa decipiens (Sharp, 1869)				01		
Anotylus inustus (Gravenhorst, 1806)			99, 00			
Anotylus sculpturatus (Gravenhorst, 1806)			99, 00			
Astenus brevelytratus (Coiffait, 1960)			98			
Atheta aeneicollis (Erichson, 1837)	98	98				
Atheta crassicornis (Fabricius, 1792)	99	99	00			99
Atheta triangulum (Kraatz, 1856)	98		00			
Atheta trinotata (Kraatz, 1856)			00			
Baeoglena praecox (Erichson, 1839)			00			
Bolitobius castaneus (Stephens, 1832)			00	01		
Brachida exigua (Heer, 1839)					99	
Coprochara bipustulata (Linnaeus, 1761)			99	01		99
Cordalia obscura (Gravenhorst, 1802)				01		
Dinaraea angustula (Gyllenhal, 1810)	98, 00	98		01	00	99, 00
Drusilla canaliculata (Fabricius, 1787)	98	00	99, 00	01	99, 00	99
Falagria sulcatula (Gravenhorst, 1806)				01		
Falagrioma thoracica (Stephens, 1832)			99, 00			
Gabrius femoralis (Hochhuth, 1851)						99
Gabrius osseticus (Kolenati, 1846)	98, 99				99	99
Gabrius surveolens (Stephens, 1833)	00				00	
Gabrius suffragani Jay, 1913	99		99			
Gauropterus fulgidus (Fabritius, 1787)	00					
Heterothops dissimilis (Gravenhorst, 1806)	98				99	
Heterothops niger Kraatz, 1868			00			
Hyponygrus angustatus (Stephens, 1833)	98, 99	00		01		
Ilyobates nigricollis (Paykull, 1800)	99, 00		99, 00			
Ilyobates subopacus Palm, 1935		98				
Lathrimaeum atrocephalum (Gyllenhal, 1827)			98			99
Lathrobium boreale Hochhuth, 1851	98		00			
Liogluta crassicornis (Gyllenhal, 1827)			99		99	
Medon fusculus (Mannerheim, 1831)	99	98, 99	98			
Meneidophallus roubali (Coiffait, 1956)	98, 99, 00	98, 99, 00			99	
Micropeplus marietti Jaquelin du Val, 1857			98, 99, 00			
Mniobates forticornis (Lacordaire, 1835)		99				
Mocyta fungi (Gravenhorst, 1806)	99	99	98, 99	01		
Mocyta negligens (Mulsant et Rey, 1873)						

Table 3 (cont)

Species	György-tarló CON apple	György-tarló CON pear	Szent-lőrinc CON apple	Póka-szepetk CON apple	Vámos-mikola ED apple	Vámos-mikola CON apple
Mocyta orbata (Erichson, 1837)	99	99	98, 99, 00			
Mycetodrepa alternans (Gravenhorst, 1802)	98, 99					
Mycetoporus splendidus (Gravenhorst, 1806)	98		99			
Mycetoporus clavicornis (Stephens, 1832)			99	01		
Mycetoporus forticornis (Fauvel, 1875)		98				
Mycetoporus nigricollis (Stephens, 1835)			99			
Mycetota laticollis (Stephens, 1832)	99	99	98			
Oligota pumilio Kiessenwetter, 1858			00	01		
Olophrum assimile (Paykull, 1800)					99, 00	99, 00
Omalium caesum Gravenhorst, 1806	98, 99	98, 99, 00	98, 99, 00			99
Omalium cursor (O. F. Müller, 1776)	98, 99	98, 99	00	01		
Ontholestes haroldi (Eppelseim, 1884)					99	
Othius punctulatus (Goeze, 1777)	99		98			
Oxypoda acuminata (Stephens, 1832)	98	98, 00	98, 99, 00			
Oxypoda opaca (Gravenhorst, 1802)			00			
Oxytelops tetracarinatus (Black, 1799)		99		01		
Paederus fuscipes Curtis, 1826		00				
Paederus littoralis Gravenhorst, 1802			99		99	99
Paederus schoenherri Czwalina, 1889						00
Palporus nitidulus (Fabritius, 1781)	99, 00	99, 00	99, 00	01	00	
Pella limbata (Paykull, 1789)						99
Philonthus carbonarius (Gravenhorst, 1802)	98, 99, 00	98, 99	99		99, 00	
Philonthus cognatus (Stephens, 1832)	98		99		00	
Philonthus cruentatus (Gmelin, 1790)			99			
Philonthus mannerheimi (Fauvel, 1869)					00	
Philonthus nigritus (Runde, 1835)	00					
Philonthus ochropus (Gravenhorst, 1802)			00			
Philonthus succicola (Thomson, 1860)	98, 99	98, 99				
Philonthus laminatus (Creutzer, 1799)	98	98				
Plataraea dubiosa (G. Benick, 1935)					99	
Platydracus stercorarius (Olivier, 1795)					99, 00	99, 00
Pseudocypus fulvipennis (Erichson, 1840)					99	
Pseudocypus fuscatus (Gravenhorst, 1802)					99	
Pseudocypus mus (Brullé, 1832)			98, 00		99	99, 00
Pseudocypus penetrans (O. F. Müller, 1776)					00	
Proteinus brachypterus (Fabritius, 1792)	99		99			
Purrolinus laeticeps (Reitter, 1908)	98, 99	98	99, 00		99	99
Purrolinus tricolor (Fabricius, 1787)					00	00
Raphirus scintillans (Gravenhorst, 1806)					99	
Quedius curtipennis Bernhauer, 1908					99	99
Quedius levicollis Brullé, 1832			00			
Quedius meridiocarpathicus (Gravenhorst, 1806)			00			
Raphirus limbatoides (Coiffait, 1963)	98, 00				99	
Raphirus nitipennis Stephens, 1833			99, 00			
Rugilus rufipes Germar, 1835					99	

Table 3 (cont)

Species	György-tarló CON apple	György-tarló CON pear	Szent-lőrinc CON apple	Póka-szepetk CON apple	Vámos-mikola ED apple	Vámos-mikola CON apple
Rugilus similis (Erichson, 1839)		98				
Rugilus subtilis (Erichson, 1840)			99, 00		00	
Sepedophilus marshami (Stephens, 1832)	98	00	98, 99		99, 00	99, 00
Sepedophilus testaceus (Fabritius, 1792)	99					
Sphenoma abdominale Mannerheim, 1831	98, 00	00		01		99
Staphylinus caesareus (Cederhielm, 1798)			00		99, 00	
Staphylinus dimidiaticornis (Gemminger, 1851)			00			
Staphylinus erytropterus (Linnaeus, 1758)		98				
Stenus ater Mannerheim, 1831			99			
Stenus clavicornis (Csopoli, 1763)		98, 99	99			
Styloxys insecatus (Gravenhorst, 1806)		98		01		99, 00
Styloxys rugifrons (Hochhuth, 1849)	98, 99	98, 99				
Styloxys striatus (Strom, 1768)	98, 99, 00	98, 99, 00	99			00
Sunius fallax (Lokay, 1919)			00			
Tachinus corticinus Gravenhorst, 1802		99		01	99, 00	
Tachinus rufipennis Gyllenhal, 1810	98				99	
Tachinus rufipes (Linnaeus, 1758)	99				99	99
Tachyporus chrysomelinus (Linnaeus, 1758)	99	99			99	99, 00
Tachyporus hypnorum (Fabritius, 1775)	98, 99	98, 99	98, 99	01	99	
Tachyporus solutus Erichson, 1839	99		99			
Trogophloeus heidenreichi L. Benick, 1934		99				
Typholinus laevigatus (Gravenhorst, 1802)			99, 00		00	00
Xantholinus linearis (Olivier, 1795)	99	00	99			00
Xantholinus longiventris (Heer, 1839)	00	98	99, 00	01		99

Explication: AB – Abandoned, CON – Conventional; ED – Edge; IPM – Integrated Pest Management

In Szentlőrinc (conventionally treated plot) 62 species were identified and the most abundant were *Ocypus olens, Typhlolinus laevigatus, Mycetoporus splendidus, Purrolinus laeticeps* and *Oligota pusillima.*

In Tura (conventional plot) 46 species were found and the most common were *Paraphallus linearis, Sphenoma abdominale, Mocyta orbata, Omalium caesum* and *Podoxya vicina.*

In Vámosmikola (conventionally treated plot and orchard edge) 55 species were identified (43 near the edge of the orchard, 27 in the middle of the orchard and 15 species were present in both plots). In the centre of the orchard the most common species were *Platydracus stercorarius, Sphenoma abdominale, Pseudocypus mus, Dinaraea angustula* and *Sepedophilus marshami.* The most abundant species in the grassy edge were *Platydracus stercorarius, Olophrum assimile* and *Drusilla canaliculata.*

One hundred and twenty-five species were found in pear orchards (79 in Szigetcsép, 39 in Györgytarló and 68 in Tura). The species, occurred most often in Szigetcsép were *Phallolinus longiventris, Palporus nitidulus, Dinaraea angustula, Styloxys insecatus* and *Paraphallus longiventris.*

In Györgytarló the species *Omalium caesum, Purrolinus laeticeps, Dinaraea angustula, Aleochara curtula* and *Meneidophallus roubali,* in Tura *Omalium caesum, Philonthus mannerheimi, Oxytelops tetracarinatus* and *Omalium cursor* occurred with higher relative abundance than 5%.

In the total from all the orchards, the most abundant species [with high relative abundance (%)], were as follows: *Omalium caesum* (8.39%), *Drusilla canaliculata* (8.13%), *Sphenoma abdominale* (6.54%), *Palporus nitidulus* (6.12%), *Dinaraea angustula* (4.72%), *Paraphallus linearis* (4.66%), *Mocyta orbata* (3.53%), *Coprochara bipustulata* (3.26%), *Platydracus stercorarius* (2.61%), *Phallolinus longiventris* (2.08%), *Oligota pumilio* (1.98%), *Podoxya vicina* (1.80%), *Tachyporus hypnorum* (1.64%) and *Olophrum assimile* (1.59%). These species represent 57.06% of the total catch.

The most widely occurring staphylinid species, which were found in most of the investigated 16 plots were: *Dinaraea angustula* (14 plots), *Palporus nitidulus* (13 plots), *Tachyporus hypnorum* (13 plots), *Sphenoma abdominale* (13 plots), *Omalium caesum* (12 plots), *Philonthus carbonarius* (12 plots), *Drusilla canaliculata* (12 plots), *Sepedophilus marshami* (12 plots), *Mocyta orbata* (11 plots), *Coprochara bipustulata* (11 plots), *Mocyta fungi* (11 plots), *Hyponygrus angustatus* (11 plots), *Purrolinus laeticeps* (11 plots), *Paraphallus linearis* (10 plots), *Omalium cursor* (10 plots), *Heterothops dissimilis* (10 plots) and *Atheta crassicornis* (10 plots). The frequency-abundance relationship of orchard inhabiting staphylinid species is given in *Fig. 2.* Species which were found in seven or more plantations were never represented in the total catch with low abundance. On the other hand, all the first eight species in the dominance order occur in more than 10 investigated places.

Comparison of our data with the results from other agroecosystems in Europe indicates that there is large variability between the composition of staphylinids. From the 14

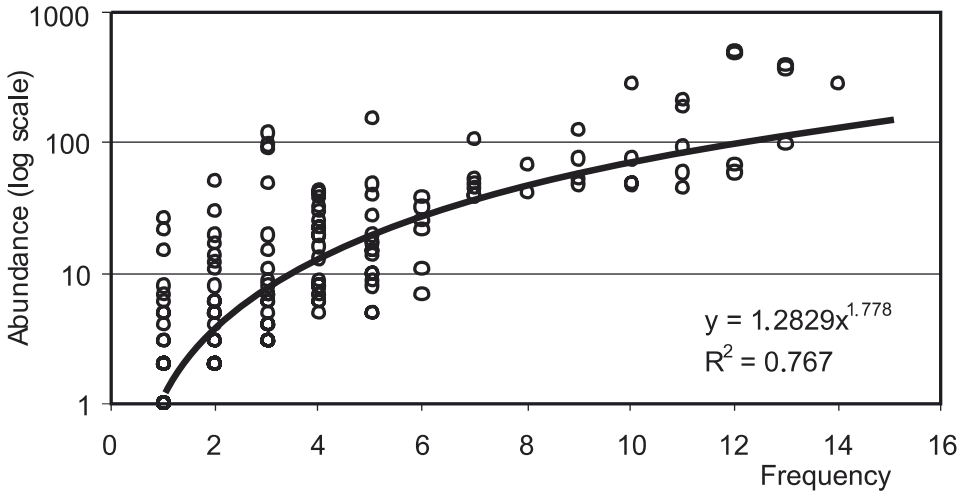

Fig. 2. Relationship between the frequency of occurrence and the total abundance of orchard inhabiting stapylinid species in Hungary

species considered abundant in apple and pear orchards in Hungary only *Omalium caesum, Drusilla canaliculata, Olophrum assimile* and *Tachyporus hypnorum* were reported as common in European agricultural fields. We can conclude too, that although the dominant staphylinids in Hungarian apple and pear orchards belong to disturbance-resistant species, the staphylinid fauna in these habitats can not be considered uniform. There are significant differences in species composition and especially in dominance order also within Hungary (Kutasi et al., 2001).

Further research is needed to describe the theoretical and practical background of protection and application of Staphylinidae communities in the agroecosystems.

Acknowledgements

The authors are grateful to Dr. Helen Yeo (HRI) for critical and linguistic reviews of the manuscript. This project was funded by the Ministry of Education of Republic of Hungary (NKFP 4/008).

Literature

Ádám, L. (1996a): Staphylinidae (Coleoptera) of the Bükk National Park. The Fauna of The Bükk National Park, pp. 231–257.

Ádám, L. (1996b): The species of Staphylinidae from Őrség (Coleoptera). Savaria, Szombathely, pp. 1–25.

Ahlstrom-Olsson, M. and Jonasson, T. (1992): Mustard meal mulch – a possible cultural method for attracting natural enemies of Brasilia root flies in to brassica crops. Buletin OILB-SROP 15, 171–175.

Andersen, A. (1991): Carabidae and Staphylinidae (Col.) frequently found in Norwegian agricultural field. New data and review. Fauna Ser. B 38, Oslo, pp. 65–76.

Andersen, A. (2000): Predation by selected Carabid and Staphylinid species on the aphid *Ropalosiphum padi* in laboratory and semifield experiments. Journal of Appl. Entomology, Berlin, pp. 265–273.

Bogya, S., Szinetár, Cs. and Markó, V. (1999): Species composition of spider (Araneae) communities in apple and pear orchards in the Carpathian Basin. Acta Phytopath. Entomol. Hung. 34, 99–121.

Booij, C. J. H., Noorlander, J. and Theunissen, J. (1997): Intercropping cabbage with clover: effects on ground beetles. Biological Agriculture and Horticulture 15, 261–268.

Denis, P. and Wratten, S. D. (1991): Field manipulation of population of individual staphylinid species in cereals and their impact on aphid populations. Ecological Entomology 16, 17–24.

Denis, P., Wratten, S. D. and Sotherton, N. W. (1990): Feeding behaviour of the staphylinid beetle *Tachyporus hypnorum* in relation to its potential for reducing aphid numbers in wheat. Ann. appl. Biol. 117, pp. 267–276.

Freude, H., Harde, W. K. and Lohse, G. A. (1964): Die Käfer Mitteleuropas. Band 4 Staphylinidae I. Goecke and Evers, Krefeld, pp. 1–264.

Freude, H., Harde, W. K. and Lohse, G. A. (1974): Die Käfer Mitteleuropas. Band 5 Staphylinidae II. Goecke and Evers, Krefeld, pp. 1–381.

Galli, P. (1985): Integrated plant protection in Baden-Wurttemberg apple growing. Training, advisory services and experiments within the framework of a model plan for introducing an integrated procedure into commercial fruit growing. Schriftenreihe-des-Bundesministers-für-Ernahrung-Landwirtschaft-und-Forsten-A-Angewandte-Wissenschaft, No. 319, pp. 54–65.

Heyer, W. (1994): Occurrence of epigeal predatory arthropods in apple orchards – a basic approach to a risk assessment. N. des D. Pflanzenschutzdienstes, 81–86.

Kádár, F. and Lővei, G. L. (1992): Light trapping of carabids (Coleoptera: Carabidae) in an apple orchard in Hungary. Acta Phytopathologica et Entomologica Hungarica 27, 343–348.

Kádár, F. and Szél, Gy. (1989): Carabid beetles (Coleoptera, Carabidae) collected by light traps in apple orchards and maize stands in Hungary. Folia Entomolgica Hungarica L, pp. 27–36.

Knopp, M. (1997): Research on integrated pest management of apple and peaches in the highlands of Yemen. Institut fur Pflanzenproduction in den Trope und Subteran, pp. 17–21.

Krebs, C. J. (1989): Ecological Methodology. Harper and Row Publishers, New York.

Krooss, S. and Schaefer, M. (1998): The effect of different farming systems on epigeic arthropods: a five-year study on the rove beetles fauna (Coleoptera: Staphylinidae) of winter wheat. Agriculture, Ecosystems and Environment 69, 121–133.

Kutasi, Cs., Balog, A. and Markó, V. (2001): Ground dwelling Coleoptera fauna of commercial apple orchards. Integrated Fruit Production. IOBC/wprs Bulletin Vol. 24, pp. 215–219

Levesque, C. and Levesque, D. I. (1995): Abundance, diversity and dispersal power of rowe beetles (Col: Staphylinidae) in a raspberry plantation and adjacent sites in eastern Canada. Journal of Kansas Entomological Society, pp. 355–370.

Levesque, C. and Levesque, D. I. (1996): Seasonal dynamics of rove beetles (Col: Staphylinidae) in a raspberry plantation and adjacent sites in eastern Canada. Journal of Kansas Entomological Society, pp. 285–301.

Majzlan, O. and Holecová, M. (1993): Artropodocenoses of an Orchards Ecosystem in Urban Agglomeration. Ecologia (Bratislava) 12, 121–129.

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.

Mészáros, Z. (redigit), Ádám, L., Balázs, K., Benedek, M. I., Csikai, Cs., Draskovits, D. Á., Kozár, F., Lővei, G., Mahunka, S., Meszleny, A., Mihályi, F., Mihályi, K., Nagy, L., Oláh, B., Papp, J., Polgár L., Radwan, Z., Rácz, V., Ronkay, L., Solymoi, P., Soós, Á., Szabó, S., Szabóky, Cs., Szalay-Marzsó, L., Szarukán, I., Szelényi, G., Szentkirályi, F., Sziráki, Gy., Szőke, L. and Török, L. (1984): Result of faunistical and floristical studies in Hungarian apple orchards. (Apple ecosystem research No. 26). Acta Phytopathologica Academiae Scientiarium Hungaricae 19, 91–176.

Reede, R. H. (1985): Integrated pest management in apple orchards in the Netherlands: a solution for selective control of tortricids. Mededeling-Laboratorium-voor-Entomologie-Wageningen. No. 493, pp. 1–105.

Tóth, L. (1982): Magyarország Állatvilága – Fauna Hungariae, Holyvák II. – Staphylinidae II. VII (6), Akadémiai Kiadó, Budapest, pp. 1–110.

Tóth, L. (1984): Magyarország Állatvilága – Fauna Hungariae, Holyvák III. – Staphylinidae III. VII (11), Akadémiai Kiadó Budapest, pp. 1–142.

Wardle, D. A., Nicholson, K. S. and Yeates, G. W. (1993): Effect of weed management strategies on some soil-associated arthropods in maize and asparagus ecosystems. Pedobiologia 37, 257–269.

Wickerman, G. P., Coombes, D. S., Turner, G., Mead-Briggs, M. A. and Edwards, J. (1987): The effect of pirimicarb, dimethoat and deltametrin on Carabidae and Staphylinidae in winter wheat. In: XXXIX International Symposium on Crop Protection, 52, pp. 213–223.