# Chemical disturbances effects on community structure of rove beetles (*Coleoptera: Staphylinidae*) in Hungarian agricultural fields

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**Abstract.** The effects of broad spectrum and selective insecticides on rove beetles (*Coleoptera: Staphylinidae*) were compared in apple orchards and wheat fields from Hungary. The most common species in orchards were: *Omalium caesum, Dexiogyia corticina, Mocyta orbata, Coprochara bipustulata, Sphenoma abdominale, Drusilla canaliculata, Styloxys insecatus, Palporus nitidulus, Heterothops dissimilis, Mocyta fungi, Pella limbata, Pycnota vicina and Hemitropia sordida.*The number of species was high in control plots without any insecticide application and less in integrated pest management plots, where selective insecticides were used. In the wheat fields a total of 798 individuals belonging to 20 species were collected. The most widely occurring species were: *Staphylinus caesareus*, *Tachyporus hypnorum*, *Philonthus cognatus*, *Aloconota gregaria*, *Tachyporus chrysomelinus* and *T. obtusus*. Although species from *Tachyporus* spp. were dominant in cumulative samples, the activity density decreased considerably for the second half of the vegetation period. The fields' structure and the treatments have a significant role in forming the dominance of species. Also the dynamics of each species is highly influenced by the disturbances. These could be explained with different microclimatic and humidity tolerance of the species. The greater mobility of staphylinids may enable them to avoid pesticide treatments in individual fields. These factors (natural weed cower, the presence of the hedgerows and the flying ability of the species) can interact and offer optimal possibilities for predation in agricultural fields.

**Key words:** apple, broad spectrum, conventionally, selective insecticides, wheat

## Introduction

The effects of the insecticides on staphylinids were studied under laboratory conditions by Samsøe-Petersen (1993, 1995 a, 1995 b), Botha (1994), Botha & Plessis (1995), and in field experiences in cereal crops by Andersen (1982), Wikerman et al. (1987), Good & Giller (1991), Sunderland (1992).

The mortality, the egg production and fertility were studied on *Aleochara bilineate*. Insecticides increased the mortality; the egg production and fertility were also affected. Generally, insecticides / acaricides had a pronounced effect on the beetles whereas fungicides and herbicides were less detrimental. Exceptions were the insecticides Tedion V 18 and Kilval, classified as harmless, and the fungicides Morestan, Pomarsol forte and Afugan rated as moderately harmful. Among growth regulators Prosevor 85 was highly detrimental while Cycocel Extra and Rhodofix had no effect. Excepting Morestan, Pomarsol forte and Ustinex PA the pesticides did not affect the hatching of eggs (Samsøe-Petersen 1993).

Among the urea herbicides, however, several showed adverse effects on egg production and/or the hatch of laid eggs. The strongest effect was exerted by methabenzthiazuron that completely impeded egg hatching. Bromoxynil, pyridate and haloxyfod reduced survival, egg production and/or egg hatch to some degree, while carbaryl, which is also used as a plant growth regulator, killed all the beetles immediately. (Samsøe-Petersen 1995 a, 1995 b, Botha 1994, Botha & Plessis 1995).

In field experiences the effects of three insecticides (Pirimicarb, Deltametrin and Dimethoat) were compared on staphylinids. They presented a higher resistance in comparison to other predaceous groups like carabides or aranea (Andersen 1982, Wikerman et al. 1987, Good & Giller 1991). The most frequent staphylinid species used during the experiments were *Anotylus sculpturatus, Aloconota gregaria*, *Tachyporus chrysomelinus* and *T. obtusus.*

As part of a greater project (Apple Ecosystem Research), faunistic studies have been carried out to describe the species composition of arthropod assemblages in apple orchards in Hungary. Markó et al. (1995) investigated the *Coleoptera* communities in apple and pear orchards in three localities, while Bogya et al. (1999) present data about species composition of apple and pear orchard inhabiting Araneae. Altogether more than 2000 species were recorded. The insecticide tolerances of the species in apple and pear orchards are still unknown (Kutasi et al. 2001, Balog et al. 2003). It can be concluded that in Central-European agro-ecosystems these were not studied until today.

## Material and methods

### *Research area and sampling procedures*

Investigations were done in three apple orchards (conventionally treated, IPM treated and abandoned apple orchards) in Horticultural Research Station Újfehértó, Hungary, during 1999, 2000 and 2001. In conventionally treated orchards the pest management was based on the use of wide spectrum, mainly organophosphorus insecticides (dimethoate, cipermetrin + khlorpirifos, phosalone, methidathion, etc.) applied 16 times during the vegetation period in each year. In another orchard the insecticide pressure was lower and some elements of IPM were used 16 times in the vegetation period in each year. The most frequently applied insecticides in this growing system were: fenazaquin, lufenuron, triflumuron, triazamate.

Studies in wheat fields were performed during 2006 and 2007 in four conventionally farmed plots (10 ha each) all surrounded by hedgerows with different size (two with 20m and two with 40m hedge). The soil structure was sandy-loam and the treatments consisted of foliar fungicides applied during the vegetation period.

Covered pitfall traps (300 $cm^3$ in size, 8 cm in diameter, half-filled with ethylene glycol 30% solution) were used to collect samples. In each orchard six pitfall traps were placed into the rows, three traps were placed in one row, while other three in the nearest as replicates, considered from the edge to the interior of the orchard at a distance of 10 m from each other. In the wheat fields 14 traps were used in two repetitions for each farm. The first trap was placed in the middle of the hedge; the second at the field margin, while the others towards the field centre at 5m intervals. Samples were collected from April until October in orchards and from April until August in wheat fields and emptied fortnightly. The collected *Staphylinids* were identified to the lowest taxonomic level possible. For identification the works of Freude et al. (1964, 1974) and Tóth (1982, 1984) were used.

### *Data analyses*

The differences between the homogeneity of variances were tested with Levene test. Since no significant difference was found ($P > 0.05$), the groups/plots were compared using Analysis of Variance (ANOVA). The similarities in species composition between the different plots and treatments were tested with O'Brien test (Tóthmérész 1993, 1995). In our case the dependent variables were the species richness in two differently treated orchards. Back-transformed means and $P < 0.01$ confidence limits are considered as statistically significant differences.

The similarity of staphylinid communities under the different chemical disturbances were studied with "Principal Coordinate Analyse" (PCoA) methods, the Jaccard's coefficient and Horn's index were calculated (Krebs 1989). The Jaccard's coefficient is used to compare the species composition of two communities using presence/absence binary data. These results can be derived from:

$$Sa = a / b+c-a$$

Where: $Sa$ = similarity Jaccard's coefficient, $a$ = the species number in both samples, $b$ = the species number in sample $b$, $c$ = the species number in sample c. If $Sa = 0$, the samples are completely different from each-other, if $S_a = 1$, the samples are completely similar.

The Horn's index is used to compare the species composition and the dominance structure of the communities, considering the relative abundance of species. These results can be derived from:

$$Ro = \frac{\sum (X_{ij} + X_{ik}) \log (X_{ij} + X_{ik}) - \sum X_{ij} \log X_{ij} - \sum X_{ik} \log X_{ik}}{(N_j + N_k) \log (N_j + N_k) - N_j \log N_j - N_k \log N_k}$$

Where: $Ro$ = Horn similarity index in samples $j$ and $k$, $Xij$, $Xik$ = the number of specimens belonging to species $i$ in samples $j$ and $k$, $Nj = \Sigma Xij$ = the total specimens in sample $j$, $Nk = \Sigma Xik$ = the total specimens in sample k (Krebs 1989).

## Results

During the investigation 743 specimens belonging to 73 species were collected.

In conventionally treated orchards 31 species and 169 specimens were collected, the dominant species were *Dexiogyia corticina, Mocyta orbata, Coprochara bipustulata* and *Palporus nitidulus.* In IPM orchards 21 species and 55 specimens were collected (dominants were *Dexiogyia corticina, Styloxys insecatus, Coprochara bipustulata* and *Sphenoma abdominale*), while in abandoned orchards 54 species and 519 specimens were captured (dominant species were *Omalium caesum,* *Drusilla canaliculata* and *Sphenoma abdominale*).

The highest specimen number was observed in abandoned plots and the lowest in the integrated pest management plot. The specimen number in conventionally treated plots showed an intermediary value. By comparing data from the different years we can observe that the species richness was the highest in abandoned orchards in 2002, and differed significantly ($F_{[2-15]} = 5.52$, $P < 0.01$) from the other years and plots. (Fig. 1).

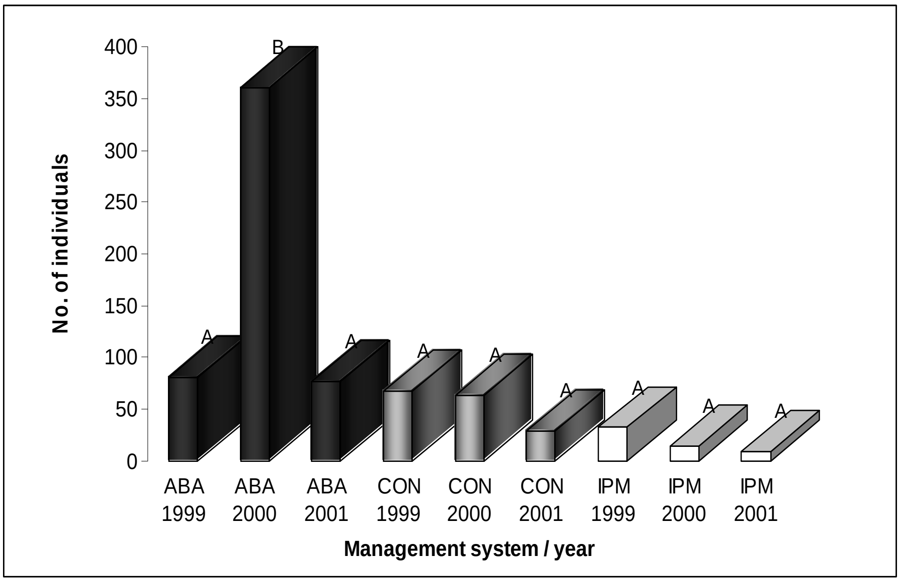


***Figure no.1.*** The activity-density of rove beetles caught with each pitfall traps in each year of investigation (ABA – Abandoned apple orchard, CON – Conventionally treated apple orchard, IPM – Integrated Pest Management apple orchard)

Considering each plot separately from the investigation period we can observe that the activity density was the greatest in May and June when the highest insecticide pressure was applied (Fig. 2).

The structure of the staphylinid communities (Jaccard) and the forming dominance (Horn) differed significantly for different years and management systems ($F_{[2-15]} = 1.96$, $P < 0.01$) (Fig. 3).

In wheat fields a total number of 798 individuals and 20 species of rove beetles were collected. Six species were dominant with a relative abundance of 65%. These were: *Staphylinus caesareus*, *Tachyporus hypnorum*, *Philonthus cognatus*, *Aloconota gregaria*, *Tachyporus chrysomelinus* and *T. obtusus*. Although species from *Tachyporus* spp. were dominant in cumulative samples, the activity density decreased considerably for the second half of the vegetation period. Species with larger body size (*S. caesareus* and *P. cognatus*) preferred hedgerows, while small species (*A. gregaria* and *Tachyporus spp.*) were frequent in wheat. From the hedge toward the field interior the activity density presented similar values for farms with different hedgerows (Fig. 4.).

## Discussions

Our studies demonstrate that the most common, and perhaps functionally the most important species of *Staphylinidae* in the three studied orchards of Hungary were *Dexiogyia corticina, Mocyta orbata, Coprochara bipustulata, Palporus nitidulus Sphenoma abdominale, Staphylinus caesareus*, *Tachyporus hypnorum*, *Philonthus cognatus*, *Aloconota gregaria*, *Tachyporus chrysomelinus* and *T. obtusus*. The insecticide overtake has low effect on the species richness and abundance of staphylinids in conventionally treated orchards and wheat fields but the forming structure and dominance of the communities differs. Considering separately the pest management control (conventional and IPM) or the absence of it (abandoned orchards) the highest number of species was observed in abandoned orchards while in conventionally treated and integrated orchards were less species.

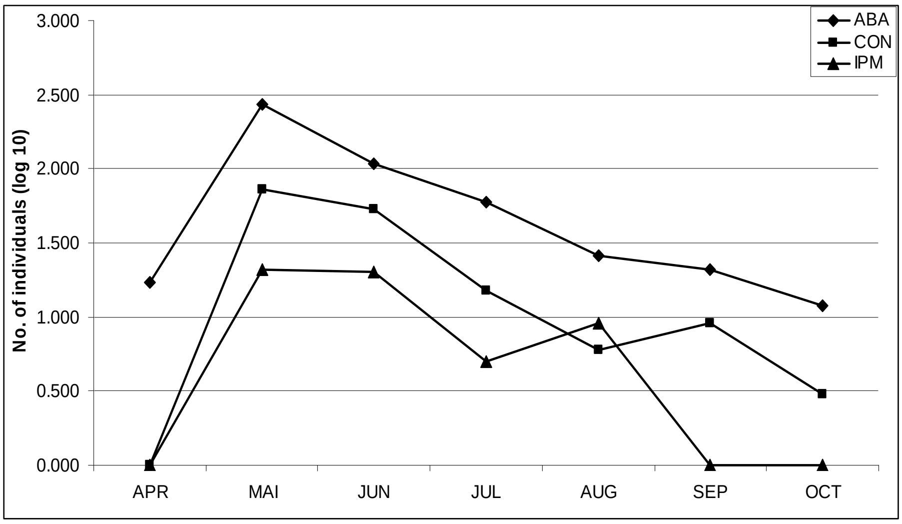


***Figure no.2*** The activity-density of rove beetles collected in diferently treated orchards in the cumulated years of investigation. See fig. 1 for abbreviations.

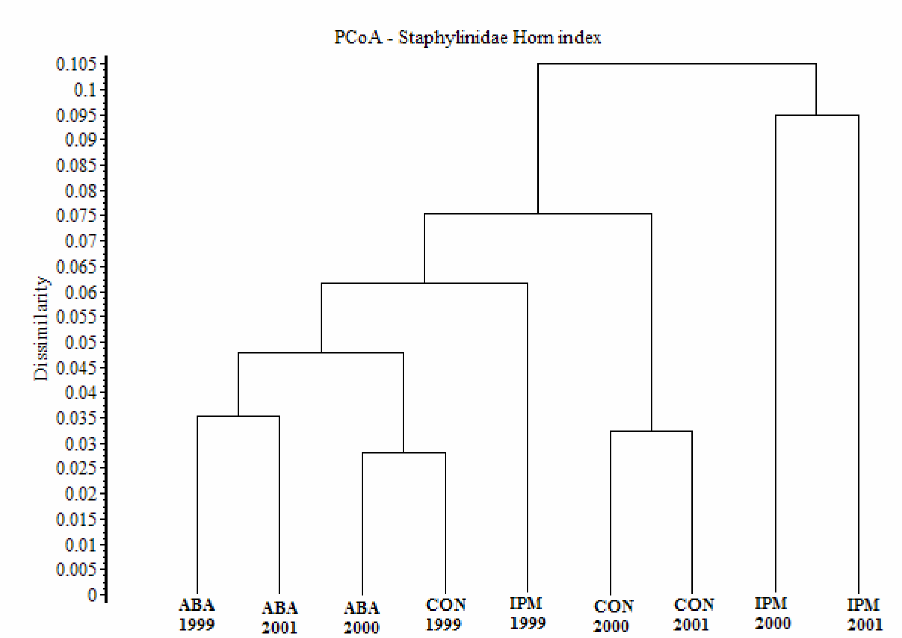


*Figure no.3* The forming dominance (Horn's index) of rove beetles communities in differently treated apple orchards from Hungary.

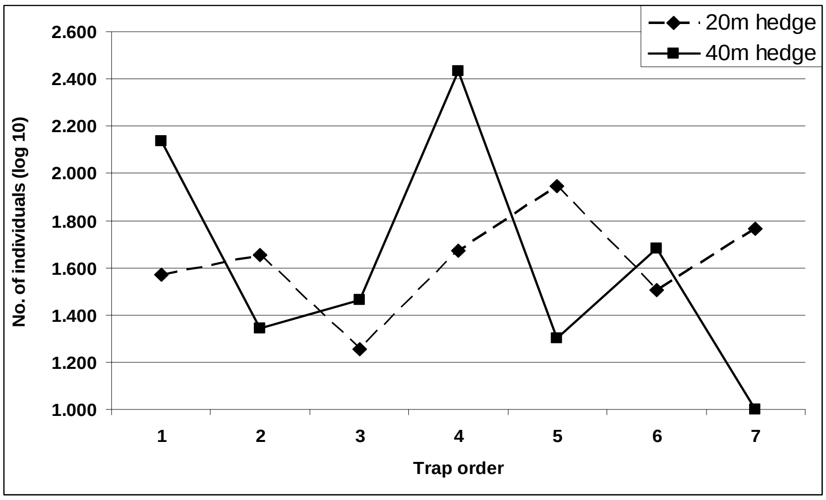


*Figure no.4* The activity-density of rove beetles collected in wheat ecosystems with different size of hedherows.

Weed cover of the field margins has a positive influence on staphylinid assemblage in orchards and wheat. The orchard structure, the hedgerows (weed cover) and the treatments have a significant role in forming the dominance of species. Also the dynamics of each species are highly influenced by the disturbances (treatments, weed management). The greater mobility of staphylinids, which fly more readily than the most Coleoptera, may enable them to avoid pesticide treatments in individual fields. Such ability has been observed on *Tachyporus* spp (Sunderland 1992, Shah et al. 2003). The interaction of different environmental factors such as natural weed cower, the presence of the hedgerows and the flying ability of the species potentially influence the predator-prey relations in agricultural fields. Structurally more complex systems allow the coexistence of predator and prey species resulting in higher species richness (Godfray 1994, Prasad & Snyder 2004).

We are aware that the sampling methodology used by us does not allow the detection of all species, especially those with reduced area recruitments and fossorials. Further researches are necessary to identify the ecological background of this phenomenon in agricultural fields.

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