Endogaeic ground beetles fauna in oilseed rape field in Croatia

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Abstract

The abundance of ground beetles (Coleoptera, Carabidae) in oilseed rape field can be an important indicator of different agricultural measures in arable land fauna. Surveys about ground beetle fauna in Croatia are generally very scarce and only few research on oilseed rape were conducted. The aim of this study was to determine the endogaeic ground beetle fauna in oilseed rape field and to determine species abundance and frequency. The study was carried out in Podravina region of Croatia, from the end of May till the mid-September in 2015. Ground beetles were collected using endogaeic traps incorporated in the soil. Altogether, 487 individuals classified into 8 species were collected. Species with the highest abundance and frequency was *Brachinus (Brachinus) psophia* Audinet-Serville, 1821, which was classified as eudominant and constant species. The highest ground beetle abundance was observed in summer period. All of the species found were spring breeders, except for species *Trechus (Trechus) quadristriatus* (Schrank, 1781) which breeds in autumn.

Keywords: Croatia, endogaeic, fauna, ground beetles, oilseed rape

Introduction

Ground beetles are species rich and abundant in agricultural fields all over the world (Lövei and Sunderland, 1996). Most of the species are present on arable land and are eurivalent, therefore they are able to adapt in a variety of climatic conditions (Bažok et al., 2015). These insects prefer night activity, although some species are active only during the day. Of all the environmental factors, ground beetles are most affected by soil moisture (Luff, 1996 cited in Holland et al., 2002). Cultivated land contains a typical ground beetle fauna, despite the regular implementation of cultivation measures on arable land (Kromp, 1999). Ground beetles reflect changes in climatic conditions but the rate of change in their distributions is largely unknown.

Among aboveground or epigaeic arthropods, mainly ground beetles, rove beetles and spiders have a great potential as predator species to suppress pest populations

because of their high abundance and wide prey spectrum (Lang et al., 1999; Symondson et al., 2002 cited in Zaller et al., 2009). Besides hunting their prey aboveground, adult ground beetles frequently burrow beneath the soil and could potentially suppress pests belowground (Lee and Edwards, 2012; Schwerk and Dymitryszyn, 2015).

Most of the studies on epigaeic ground beetles inhabiting agricultural fields were performed using pitfall traps (Kromp, 1999). Compared with researches on epigaeic ground beetles of root crops and cereals (Bukejs and Balalaikins, 2008; Tamutis et al., 2007), less studies have been done on other crop types such as leguminous and oilseed crops (Haschek et al., 2012; Kromp, 1999).

In Croatia, the epigaeic ground beetles were investigated by using pitfall traps in order to determine their distribution, composition and abundance in different vegetation types, including forests (Šerić Jelaska, 2005), parks (Marković, 2009) and different crops such as sugar beet (Bažok et al., 2015; Kos et al., 2013), maize (Bažok et al., 2007; Kos et al., 2011) and barley (Kos et al., 2010). The most recent larger study occurred in the beginning of 1980‘s by Štrbac (1983) in which 31 species from 18 genera were determined. Surveys on endogaeic ground beetle fauna in Croatia are generally very scarce and only few types of research have been conducted on oilseed rape (Büchs et al., 2013; Juran et al., 2013). Büchs et al. (2013) found 72 species on differently managed oilseed rape fields using pitfall traps, endogaeic traps and emergence traps, but they did not state which species were caught by different traps. Juran et al. (2013) investigated endogaeic activity of the adult ground beetles in three differently managed oilseed rape fields and found that the endogaeic activity was the highest in „organic” system, followed by the „conventional“ and „integrated“ system. The authors, however, did not mention the species composition.

Considering the lack of information on endogaeic ground beetles in Croatia, this study aimed to determine endogaeic ground beetle fauna collected in oilseed rape field and to determine species abundance and frequency.

Materials and methods

Sampling site

The research was carried out in 2015 on an oilseed rape field (field size 34.76 ha) at the locality Lukač in Podravina region (Virovitica–Podravina County, Croatia, field coordinates: 45°50′24″N, 17°24′0″E). The pre–crop on investigated field was winter wheat. The field was chosen to represent common crop rotation cultivation practices (4 year rotation: oilseed rape, wheat, sugar beet, corn) and agro–technical measures. In the county where the investigated field was located, the soils are gleyic luvisols (IUSS Working Group WRB, 2015) and contain a great amount of fine sand and coarse silt which requires conservation tillage.

Ground beetles trapping and identification

Endogaeic ground beetle sampling on the oilseed rape field was carried out with 4 perforated traps (Ø = 35 mm, h = 440 mm, size of perforations: 4 mm x 2 mm) (WB

PROBE II ® Trap, Trece Inc.), buried 44 cm into the soil, so that the top of the trap was in the soil top level. Trapping using endogaeic traps was performed from 22nd to the 38th week of the year. Four endogaeic traps were placed in squared manner: two traps at 20 m distance from the field edge and another two traps at 80 m distance from the field edge. The distance between traps was 50 m. The traps were inspected once a week and all ground beetles caught were collected, preserved in 96% ethanol, counted and identified. The identification of ground beetles species was done by a taxonomy expert Mr Teun van Gijzen, following the keys of Auber (1965), Bechyne (1974) and Harde and Severa (1984). Nomenclature verification was carried out according to Vigna Taglianti (2013).

Data analysis

Based on the total number of collected individuals and the number of each species the abundance and frequency were calculated. The abundance was calculated using the Balogh's formula (Balarin, 1974):

$$D=nA/N \times 100$$

where nA represents the number of individuals of species A, and N the total number of individuals of all recorded species. The results (eudominant, dominant, subdominant, recedent, subrecedent) were classified according to Tischler and Heydeman (Balarin, 1974). The frequency was calculated with the Balogh's formula (Balarin, 1974):

$$C=nsA/Ns \times 100$$

where nsA represents the number of samples that contained species A and Ns the total number of samples. The results (euconstant, constant, accessory and accidental) were classified according to Tischler (Balarin, 1974).

Results and discussion

During the sampling period, altogether 487 individuals of 8 ground beetle species belonging to 7 genera were collected in endogaeic traps (Table 1). The highest ground beetle catches started from 24th till 25th week of the year, followed by a period with high summer temperatures (from 26th till 28th week) (DHMZ, 2016) during which no specimens were caught. The population regained higher numbers again from 29th week till the end of trapping period (the flooding in 31st week resulted in no individuals caught). Ground beetles were caught in highest numbers in August (from 32nd till 35th week of the year), while the largest number of different species (5 species) caught in traps was in July (from 27th till 31st week). The most abundant species was *Brachinus (Brachinus) psophia* Audinet-Serville, 1821, followed by *Anchomenus* (*Anchomenus*) *dorsalis* (Pontoppidan, 1763). These species were classified as eudominant (Table 2). Both species also had the highest frequency and were classified as constant. All of the ground beetles found breed in the spring, except for the species *Trechus (Trechus) quadristriatus* (Schrank, 1781) which breeds in autumn.

Table 1. Weekly catches of endogaeic ground beetle fauna in oilseed rape field in Lukač, 2015

Species	Week of the year																Total
	22nd	23rd	24th	25th	26th	27th	28th	29th	30th	31st	32nd	33rd	34th	35th	36th	38th	
Anchomenus (*Anchomenus*) *dorsalis* (Pontoppidan, 1763)	19[a]	-[b]	-	12	-	-	-	-	33	25	1	1	1	1	1	-	94
Asaphidion (*Asaphidion*) *curtum* (Linnaeus, 1761)	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	2
Brachinus (Brachinus) crepitans (Linnaeus, 1758)	-	-	-	-	-	-	-	24	-	-	-	-	-	-	-	-	24
Brachinus (Brachynolomus) explodens Duftschmid, 1812	-	-	14	22	-	-	-	-	-	-	-	-	-	-	-	-	36
Brachinus (Brachinus) psophia Audinet-Serville, 1821	7	-	21	18	-	-	-	34	12	-	16	48	51	32	42	25	306
Clivina (Clivina) fossor fossor (Linnaeus, 1758)	4	-	-	-	-	-	-	3	3	-	-	-	-	-	-	-	10
Stenolophus (Stenolophus) teutonus (Schrank, 1781)	2	-	3	8	-	-	-	-	-	-	-	-	-	-	-	-	13
Trechus (Trechus) quadristriatus (Schrank, 1781)	-	-	-	-	-	-	-	-	-	-	-	1	1	-	-	-	2
Total	32	-	38	60	-	-	-	63	48	25	17	50	53	33	43	25	487

[a] Number of individuals; [b] Minus (-) - no catch.

Table 2. Endogaeic ground beetle population characteristics in oilseed rape field in Lukač, 2015

Species	D (%)[a]	Classification[b]	C (%)[c]	Classification[d]	Breeding period
Anchomenus (*Anchomenus*) *dorsalis* (Pontoppidan, 1763)	19.30	eudominant	56.25	constant	spring
Asaphidion (*Asaphidion*) *curtum* (Linnaeus, 1761)	0.41	subrecedent	6.25	accidental	spring
Brachinus (Brachinus) crepitans (Linnaeus, 1758)	4.93	subdominant	6.25	accidental	spring
Brachinus (Brachynolomus) explodens Duftschmid, 1812	7.40	dominant	12.50	accidental	spring
Brachinus (Brachinus) psophia Audinet-Serville, 1821	62.83	eudominant	68.75	constant	spring
Clivina (Clivina) fossor fossor (Linnaeus, 1758)	2.05	subdominant	18.75	accidental	spring
Stenolophus (Stenolophus) teutonus (Schrank, 1781)	2.67	subdominant	18.75	accidental	spring
Trechus (Trechus) quadristriatus (Schrank, 1781)	0.41	subrecedent	12.50	accidental	autumn

[a] D = abundance; [b] Classification of species abundance according to Tischler and Hydeman (Balarin, 1974): eudominant (> 10.00%), dominant (5.00%-9.99%), subdominant (1.00%-4.99%), recedent (0.50%-0.99%), subrecedent (0.01%-0.49%); [c] C = frequency; [d] Classification of species frequency according to Tischler (Balarin, 1974): euconstant (> 75%), constant (50%-74.99%), accessory (25%-49.99%), accidental (< 24.99%).

Species caught in endogaeic traps were smaller in size, varying from 2 mm to 8 mm. The nearest area where a similar study was conducted was Podravska Slatina, where Štrbac (1983) carried out a 3-year detailed research on ground beetle fauna in arable land. All 8 species identified in present investigation were previously detected by Štrbac (1983). He found 31 species belonging to 18 genera, of which the most important was species *Anisodactylus (Pseudanisodactylus) signatus* (Panzer 1796). However, no differentiation between epigaeic and endogaeic species was shown and all ground beetle species were presented together. The present study detected only 8 species; however, in the investigation only endogaeic species able to enter the probe (the probe perforations were 4 mm x 2 mm) were collected. Also, the research lasted for 1 year and was oriented towards establishing fauna in 1 field crop, the oilseed rape.

The abundance of some of the species established in the research does not correspond with the results of the study conducted by Štrbac (1983). While this investigation found *T. quadristriatus* (Schrank, 1781) only in August and in a very low abundance, the same species was reported by Štrbac (1983) as the most abundant in 1 year of his study. Other most abundant species detected by Štrbac (1983) were *A. signatus* (Panzer, 1796) and *Poecilus (Poecilus) cupreus* (Linnaeus, 1758), which were not found in this investigation. Štrbac (1983) also reported *A. dorsalis* (Pontoppidan, 1763) presence only in alfalfa fields and not in wheat or sugar beet fields. In the present investigation the species *A. dorsalis* (Pontoppidan, 1763) was found in the oilseed rape field with an abundance of 19.30% in the population of endogaeic ground beetles. Other species found in the same area by Štrbac (1983) and confirmed by this research were *Brachinus (Brachinus) crepitans* (Linnaeus, 1758), *Brachinus (Brachynolomus) explodens* Duftschmid, 1812 and *Clivina (Clivina) fossor fossor* (Linnaeus, 1758), detected in both studies in lower numbers.

As the major genus of abundant predator species in oilseed rape fields Alford et al. (2008) listed the genus *Pterostichus* Bonelli 1810. Present investigation identified *B. psophia* Audinet-Serville, 1821 as the most abundant endogaeic species, meaning genus *Brachinus* Weber 1801 being the most represented. Species *B. psophia* Audinet-Serville, 1821 was not reported by Štrbac (1983). According to Pizzolotto et al. (2005), the species prefers habitats between 40 and 100 m above sea level, with dry and hot summer. Its occurrence was detected in Albania, Austria, Bosnia and Herzegovina, Bulgaria, Corsica, Croatia, Cyprus, Czech Republic, European Turkey, French mainland, Moldova, Romania, south Russia, Sardinia, Sicily, Slovakia, Slovenia, Ukraine, Serbia, Kosovo and Montenegro (Vigna Taglianti, 2013). Apfelbeck (1904) reported that *Brachinus (Brachinus) elegans* Chaudoir 1842 (cited as *Brachynus (Brachynus) ganglbaueri* Apfelbeck, 1904) occurs together with *B. crepitans* (Linnaeus, 1758) and *B. psophia* Audinet-Serville, 1821. This investigation did not detect *B. elegans* Chaudoir 1842, possibly because the species is most abundant in March, as described by the same author, while this research began in May.

There are two studies conducted by Bűchs et al. (2013) and Juran et al. (2013) in which the ground beetle fauna of oilseed rape fields in Croatia has been investigated. Bűchs et al. (2013) found 72 species on differently managed oilseed rape fields using pitfall (epigaeic) traps, endogaeic traps and emergence traps. Juran et al. (2013) found that the endogaeic activity was highest in „organic" system, followed by the

„conventional“ and „integrated“ systems. Both studies, however, did not report on the species composition.

The investigation on ground beetle fauna in sugar beet fields was carried out by Kos et al. (2013). They used pitfall and endogaeic traps and found species *Pseudoophonus (Pseudoophonus) rufipes* (De Geer 1774) and species of the genus *Bembidion* Latreille, 1802 being the most abundant. However, they did not specify which species were collected by endogaeic traps strictly. The total pitfall catches in their investigation were about 3 to 4 times richer in number of taxa, compared to endogaeic traps. Generally, the absence of smaller species of ground beetles, such as these found in present research, in pitfall traps is interpreted by their ability to avoid traps (Luff, 1975), their ability to perceive the edge of the trap (Halsall and Wratten, 1988) and their capacity to escape from the pitfall trap (Petruška, 1969 cited in Thiele, 1977).

Conclusions

Endogaeic ground beetle species generally did not receive much attention as did epigaeic species found in pitfall traps, so the data on their presence, distribution, abundance, life cycle and feeding habits are mostly missing. This study presents 8 endogaeic species found in oilseed rape field in 2015. Species *B. psophia* Audinet-Serville, 1821 and *A. dorsalis* (Pontoppidan, 1763 were designated as most abundant and frequent at investigated locality. Only one species (*T. quadristriatus* (Schrank, 1781)) found was an autumn breeder, while other 7 species had breeding period in spring. Since the data about endogaeic ground beetle fauna in oilseed rape fields in Croatia are generally scarce, presented results serve as a valuable contribution to the knowledge of endogaeic ground beetle fauna in oilseed rape.

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