Published May 5, 2011

Klapalekiana, **47**: 55–66, 2011
ISSN 1210-6100

Distribution of carabid beetles in agricultural landscape: effect of non-crop habitat islands

Distribuce střevlíků v zemědělské krajině: význam neobdělávaných ostrovů uvnitř polí

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Coleoptera, Carabidae, species composition, species richness, biodiversity conservation, habitat preference, pitfall trapping, central Europe

Abstract. The presence of non-crop habitats in the agricultural landscape is crucial for maintaining biodiversity. In our study we investigated non-crop habitat islands of different sizes situated within one large crop field. We found out that even small non-crop habitat islands are able to provide suitable environment for many species of carabid beetles, which are unable to survive in crop fields. Twenty nine species of carabid beetles were collected in this study that were represented by at least 10 specimens, and of these, ten species strongly preferred non-crop habitats. The species composition of carabids even in small non-crop habitat islands differed significantly from that of field sites. In accordance with other authors, we suggest the conservation of existing non-crop habitats and even the creation of new ones. This is probably the best tool for enhancing biodiversity as well as for maintaining ecosystem services such as the biological control of pests in the agricultural landscape.

INTRODUCTION

Carabid beetles represent a group of epigeal arthropods, which can be highly beneficial in agroecosystems. Many species prey upon crop pests e.g. aphids (Holland 2002), when others are able to consume seeds of weeds (Honěk et al. 2003). Carabid beetles are a species rich and abundant group with diversified life strategies (Thiele 1977). Therefore, they are suitable as bioindicators and as model organisms for ecological research (Holland 2002; Rainio & Niemelä 2003).

The agricultural landscape extends over enormous areas of the Czech Republic (53.7% of total area) as is the case in most of the world (Vitousek et al. 1997; Lipský 2000; ČSÚ 2010). The increasing area of the Earth's surface used for crop production as well as increasing intensity of agricultural management was probably the main cause of decreasing species richness of many taxa including carabid beetles in the agricultural landscape in the 20th century (Tscharntke et al. 2005; Thiele 1977). In the last few decades there have been efforts to reduce species loss, and in Europe millions of euros are spent annually for this purpose (European Commission 2010; Kleijn et al. 2006). A major task for scientists is to assess which actions are effective for biodiversity conservation in the agricultural landscape.

The presence of non-crop habitats in the neighbourhood of crop fields frequently enhances biodiversity in those fields (Weibull et al. 2003). Even small non-crop habitat islands can host

diversified assemblages of insects and contribute to biodiversity conservation in the agricultural landscape, as demonstrated by Tscharntke et al. (2002) for butterflies. Unfortunately, there is lack of studies investigating the effect of non-crop habitat island size on diversity of particular taxa. This knowledge is crucial for effective conservation of habitat islands of sufficient size as well as for the creation of new ones.

In our field-scale study we investigate carabid beetle assemblages in 14 non-crop habitat islands of different sizes and in 5 stations in the field between islands. We hypothesize that non-crop habitat islands provide suitable conditions for additional species in comparison to field assemblages. Although this study presents only partial results of long-term sampling project, we suppose that our preliminary results from early summer display at least the spatial distribution of spring-breeding species reliably.

METHODS AND MATERIALS

Field sampling

This study was conducted in a field near Rovina village, Příbram district, Czech Republic. This field is notable for the presence of numerous non-crop habitat islands situated inside it (Fig. 1). The non-crop sites contain a number of large stones, which prevent them from being ploughed up. In 2009 the field was sown with rape. We selected 14 of these habitat islands and installed 3 pitfall traps in the central part of each selected island. Traps were 1 to 5 meters from each other according to non-crop habitat island size. Islands were selected according to their size, to include a range of sizes from small ones to large. Islands consist mainly of grasses, shrubs and trees; larger islands were covered mainly by forests and smaller ones were covered with shrubs and individual trees. We selected habitat islands with environmental conditions (vegetation cover) as similar as possible within study area. Further we established 5 control stations in the field between islands (Fig. 1). Each control station consisted of 2 pitfall traps placed 1 meter from each other. A lower number (2 instead of 3) of pitfall traps in field sites was used based on our preceding experiences with similar study system. Abundance of carabid beetles collected per trap in fields (in comparison to non-crop habitats) is frequently higher. Pitfall traps were made from round plastic pots 9.5 cm in diameter, covered with an aluminum roof supported on 4 nails. Traps were filled with 200 ml of propylene glycol and water solution as preservative fluid. Sampling was started on May 3, 2009 and was finished on June 8, 2009.

Subsequently samples were transported to Prague and were sorted to higher taxa (e.g. spiders, carabid beetles, other beetles, isopods, millipedes). Carabid beetles were determined to the species level according to Hůrka (1996). Specialists were consulted for determination of taxonomically complicated species (especially of the genus *Amara* Bonelli, 1810).

Data analyses

Prior to analyses, samples from each particular island (3 traps) and control station (2 traps) were pooled. Since two of the three traps on the largest island had been destroyed, we omitted samples from this island from the data analyses.

First of all we tested whether there is any pattern in similarity of carabid beetle assemblages related to habitat type and subsequently to the non-crop habitat size. In the latter analysis we specified field locations with size value 1 and to each island we attributed size value equal to its area in m^2. We used multidimensional ordination techniques. Species data were $\log_{10}$ transformed prior to analysis. The length of the gradient of the first axis (in DCA) was 3.0, therefore we used linear direct analysis (RDA) (Lepš & Šmilauer 2003). A randomisation test with 999 permutations was used to assess the statistical significance of results obtained from direct analysis. All analyses were performed using the software Canoco for Windows 4.5 (Lepš & Šmilauer 2003).

The effects of habitat and non-crop island size on species richness and specimen abundance were analysed with using a GLM (generalized linear model) with gaussian (GLM-n) or poisson (GLM-p) distribution where necessary (Crowley 2007). In addition to species richness obtained from particular samples we also analysed rarefied species richness, because there were large differences in the numbers of specimens collected in particular islands or field control stations. We rarefied each sample to the number of 20 specimens (the lowest number of specimens in one sample in our data set). In the analysis of habitat island size we specified field locations with size value 1 and to

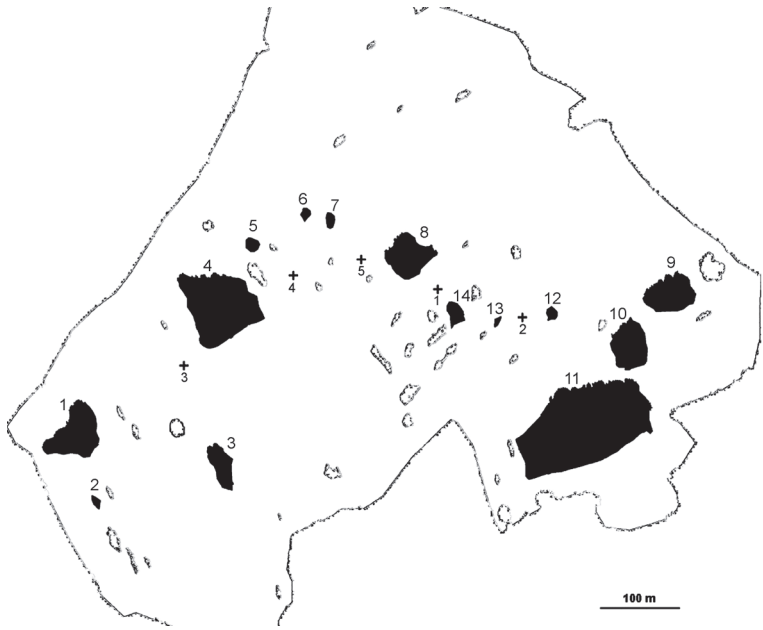


Fig. 1. Situation map of non-crop habitat island distribution in the studied field. Non-crop habitat islands under study are black filled, whereas unstudied islands are white filled. Control stations in the field are displayed as crosses.
Obr. 1. Situační mapa studované oblasti (pole nedaleko obce Rovina, okres Příbram). Studované neobhospodařované ostrovy uvnitř pole jsou vybarveny černě. Ostatní ostrovy uvnitř pole jsou vybarveny bíle (znázorněn jen obrys). Místa sběru vzorků, reprezentujících společenstvo střevlíků žijící uvnitř pole, jsou označena křížky.

each island attributed a size value equal to its area in m^2. Habitat island size was $\log_{10}$ transformed prior to analyses. Suitable models were selected according to lowest AIC score. Analyses were performed in R 2.11 (R Development Core Team 2007).

Finally we classified species by their affinity to the non-crop habitat island or to the field. Species with 10 or more individuals collected were examined for proportion of specimens collected in the islands and in the field. Species for which at least 90% of individuals were collected in a particular habitat were classified as habitat specialists. The remaining species were classified as "indifferent" in their habitat preferences.

RESULTS

In total we collected 2785 individuals of carabid beetles of 63 species (see Appendix). There is a visible difference in the species composition of carabid beetle assemblages inhabiting non-crop habitats and field (Fig. 2). In addition, species composition of large islands is the most dissimilar to that of the field sites (Fig. 2). Habitat (field or non-crop site) explains 39.6% of variability in species composition data (RDA, P = 0.001, F = 10.48). Non-crop habitat island size explain 10.6% of variability in species composition data when controlled for effect of habitat by covariate (RDA, P = 0.001, F = 3.21). This indicates that habitat type and non-crop habitat island size are important predictors of species composition of carabid beetles assemblages.

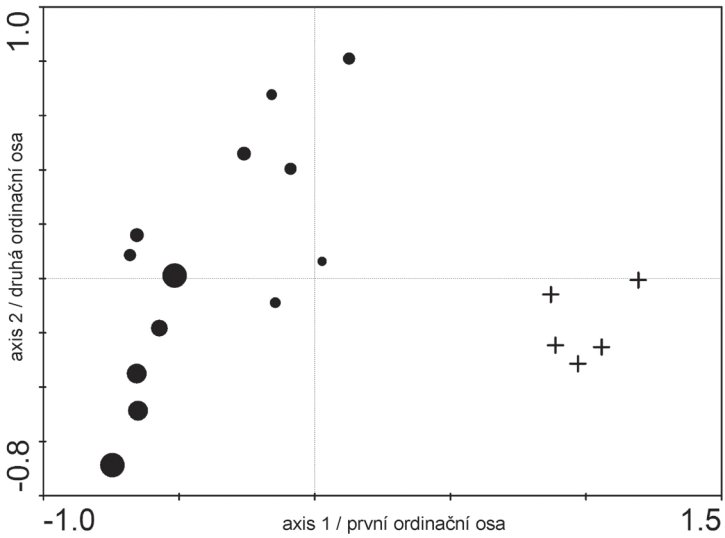


Fig. 2. Effect of habitat and non-crop habitat island size on carabid beetles assemblages. Non-crop habitat islands in ordination diagram (PCA) are depicted by black dots, size of the dots corresponds to real habitat island size. Control stations in the field are depicted by crosses. The first axis explains 44.8% of the variability in the data, whereas the second axis explains 14.6% of the variability.
Obr. 2. Vliv biotopu a velikosti neobhospodařovaných ostrovů na složení společenstev střevlíků. Společenstva neobhospodařovaných ostrovů jsou na ordinačním diagramu (PCA) znázorněna tečkami. Velikost tečky odpovídá velikosti ostrova, na kterém byli střevlíci sbíráni. Společenstva střevlíků sbíraná uvnitř pole jsou reprezentována křížky. První osa vysvětluje 44,8 % variability v datech a druhá osa vysvětluje 14,6 % variability v druhových datech.

There is significantly higher species richness in the field in comparison to non-crop habitat islands and small non-crop habitat islands were more species rich in comparison to the large non-crop islands (GLM-n; effect of habitat $P = 0.002$; effect of island size $P = 0.008$; $R^2 = 0.60$) (Fig.3a). This pattern disappeared if species richness of particular sites is corrected for sample size. There is no apparent effect of habitat or habitat island size on rarefied species richness (GLM-n; Fig.3b). This is caused by the negative effect of non-crop habitats and non-crop habitat island size on number of individuals collected in particular site (GLM-p; effect of habitat $P < 0.001$; effect of island size $P = 0.023$; $R^2 = 0.71$).

DISCUSSION

Our results confirm that non-crop habitat islands inside fields represent alternative environments for carabid beetles, contrasting with areas of arable soil. Significant difference in species composition of insect assemblages between crop fields and non-crop habitat islands has been previously reported (Tscharntke et al. 2002), but the effect of habitat size has rarely been studied.

Although, species richness of non-crop habitat islands is not superior to the species richness of field sites, different species of carabid beetles occur in non-crop habitats. Ten out of

the 29 species that were represented by at least 10 specimens strongly prefer non-crop habitats (Table 1) and 17 out of 63 species were collected only in non-crop habitat islands. Even small non-crop habitat islands (tens m^2) represent suitable environment for many carabid beetle species, which are not able to persist inside arable fields. Moreover, many species occurring in the field are dependent on non-crop habitats for at least part of their life cycle e.g. reproduction or overwintering (Geiger et al. 2009; Pywell et al. 2005). Only a minority of carabid species living in agricultural landscape are able to spend whole their life on arable land (Holland 2002). The importance of non-crop habitats especially for overwintering carabid beetles is apparent from the many-times higher densities of beetles in non-crop habitat islands during winter (Andersen 1997), whereas during summer there are higher activity-densities in field interiors.

Although the partial results presented here for data collected in early summer (May to June) may not be fully representative for particular species, we suggest that the overall pattern of spatial distribution of species in our study system is unbiased. The effect of habitat

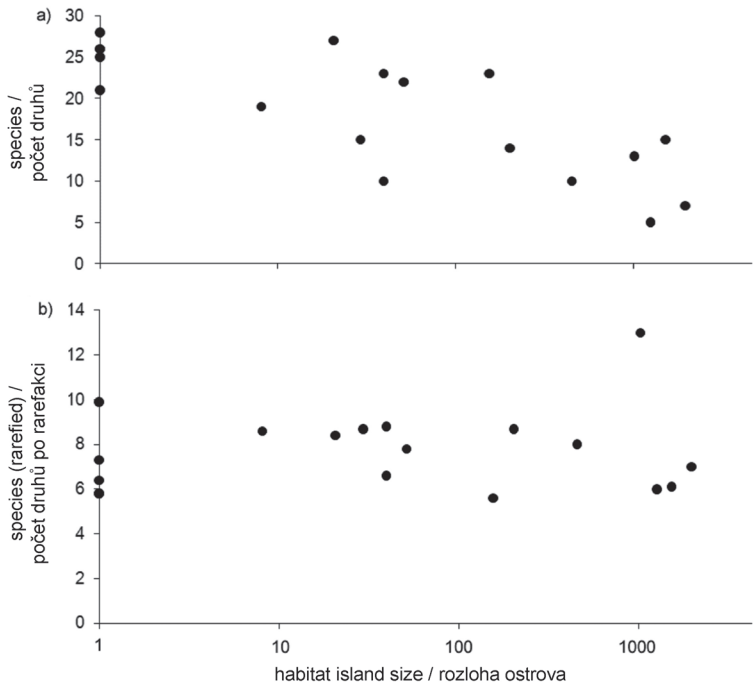


Fig. 3. Effect of habitat island size on species richness of carabid beetles assemblages. Habitat island size is displayed on logarithmic scale. Figure a) displays number of collected species in relation to non-crop habitat island size. Figure b) displays rarefied species richness (to 20 individuals) in relation to non-crop habitat island size.
Obr. 3. Vliv velikosti neobhospodařovaného ostrova na druhové bohatství střevlíků. Velikost ostrovů je zobrazena v m^2 na logaritmické škále. Společenstvům sebraná uvnitř pole jsou arbitrárně zobrazena jako ostrovy o velikost 1 m^2. Obrázek a) ukazuje počet sebraných druhů střevlíků ve vztahu k velikosti neobhospodařovaného ostrova. Obrázek b) ukazuje počet druhů střevlíků ve vztahu k velikosti neobhospodařovaného ostrova při použití rarefakce (metody umožňující porovnávat druhové bohatství společenstev reprezentovaných vzorky o rozdílné velikosti tak, že je velikost vzorku pro všechna společenstva simulací snížena na stejnou úroveň, v tomto případě 20 jedinců).

Table 1. Habitat preferences of particular carabid beetle species. Species are classified according to their habitat preferences as field species (F), indifferent species (I) and non-crop habitat species (N). Criterion for N or F classification is at least 90% of individuals collected in a particular habitat. Remaining species are classified as I.
Tabulka 1. Biotopové preference nejpočetnějších druhů střevlíků. Druhy sebrané v počtu alespoň deseti jedinců byly klasifikovány na polní (F), nevyhraněné (I) a preferující neobhospodařované ostrovy (N). Jako kritérium pro zařazení do kategorie N a F byla zvolena hranice 90 % jedinců sebraných v příslušném biotopu. Zbylé druhy byly zařazeny do kategorie I.

Species / druh	Number of collected individuals / počet sebraných jedinců	Proportion of individuals inhabiting non-crop islands / podíl jedinců daného druhu sebraných uvnitř ostrovů	Classification / klasifikace
Agonum sexpunctatum (Linnaeus, 1758)	13	0.08	F
Amara aenea (De Geer, 1774)	42	0.33	I
Amara communis (Panzer, 1797)	13	0.69	I
Amara convexior Stephens, 1828	21	0.90	N
Amara montivaga Sturm, 1825	15	0.13	I
Amara ovata (Fabricius, 1792)	24	0.38	I
Amara similata (Gyllenhal, 1810)	120	0.10	F
Anchomenus dorsalis (Pontoppidan, 1763)	90	0.03	F
Badister bullatus (Schrank, 1798)	22	0.95	N
Bembidion lampros (Herbst, 1784)	28	0.43	I
Brachinus explodens Duftschmid, 1812	14	0.07	F
Calathus fuscipes (Goeze, 1777)	49	0.96	N
Calathus melanocephalus (Linnaeus, 1758)	43	0.98	N
Carabus granulatus Linnaeus, 1758	24	0.21	I
Carabus hortensis Linnaeus, 1758	36	1.00	N
Carabus nemoralis Müller, 1764	18	0.94	N
Harpalus affinis (Schrank, 1781)	21	0.10	F
Harpalus quadripunctatus Dejean, 1829	10	1.00	N
Harpalus honestus (Duftschmid, 1812)	12	0.50	I
Harpalus latus (Linnaeus, 1758)	20	1.00	N
Harpalus tardus (Panzer, 1797)	49	0.88	I
Platynus assimilis (Paykull, 1790)	21	0.52	I
Poecilus cupreus (Linnaeus, 1758)	961	0.07	F
Poecilus versicolor (Sturm, 1824)	767	0.76	I
Pseudoophonus rufipes (De Geer, 1774)	10	0.90	N
Pterostichus melanarius (Illiger, 1798)	128	0.29	I
Pterostichus oblongopunctatus (Fabricius, 1787)	46	0.93	N
Pterostichus strenuus (Panzer, 1797)	34	0.68	I
Trechus quadristriatus (Schrank, 1781)	10	0.30	I

and non-crop habitat island size on assemblage similarity is qualitatively the same for the data set used in this study and the data set for the whole season (May to September; unpublished data).

The presence of non-crop habitats in the agricultural landscape is crucial for biodiversity conservation (Duelli & Obrist 2003, Tscharntke et al. 2002). The presence of non-crop habitats in the surrounding landscape has an even stronger effect on the diversity of arable fields than does intensity of agricultural management (Purtauf et al. 2005). In accordance with other authors we assessed that almost half of the carabid species occurring in the agricultural landscape are dependent on the existence of non-crop habitats (Duelli & Obrist 2003). These species include forest specialists as well as generalist species intolerant of the disturbance regime of crop fields (Thiele 1977). Moreover, non-crop habitats could act as refuges during field disturbances (e.g. tillage or pesticide application) and subsequently specimens from non-crop habitats could spill-over back into arable field where they could act as natural enemies of pests (Lee et al. 2001).

ACKNOWLEDGEMENTS. The study was financially supported by IGA grant #201042110006. We are grateful to P. Saska (Praha) and P. Moravec (Litoměřice) for assistance with determination of carabid beetles, and to J. Knappová (Praha) and the reviewer for their valuable comments on the manuscript.

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SOUHRN

V souvislosti se změnou způsobu hospodaření v kulturní krajině došlo v Evropě v průběhu druhé poloviny 20. století k snížení biodiverzity mnoha skupin organizmů. Přítomnost mimoprodukčních biotopů v intenzivně obhospodařované zemědělské krajině se zdá být zásadní pro zachování stávajícího druhového bohatství.

Tento článek prezentuje předběžné výsledky studie zkoumající vliv velikosti mimoprodukčních ostrovů uvnitř pole na společenstvo střevlíků. Pomocích zemních pastí naplněných propylenglykolem bylo studováno 14 ostrovů různé velikosti (od desítek po tisíce m^2) porostlých stromy a křovinami. Dále bylo sebráno 5 kontrolních společenstev na lokalitách uvnitř pole, aby bylo možné porovnat druhové složení společenstev ostrovů s těmi z pole (obr. 1). Data použitá v tomto článku byla sbírána od začátku května do poloviny června.

Zjistili jsme, že i malé neobdělávané ostrovy uvnitř pole hostí druhy, které nejsou schopné žít v poli. Ostrovy byly silně preferovány 10 z 29 druhů střevlíků, které jsme sebrali ve více něž 10 jedincích (Tabulka 1). Druhové složení společenstev střevlíků se výrazně lišilo mezi polem a ostrovy (RDA; $F = 10{,}48$; $P = 0{,}001$), významný vliv na složení společenstva střevlíků měla i velikost ostrova (RDA; $F = 3{,}21$; $P = 0{,}001$). Společenstva uvnitř pole byla druhově bohatší než společenstva ostrovů (GLM-n; $P = 0{,}002$) a společenstva menších ostrovů byla druhově bohatší než společenstva větších ostrovů (GLM-n; $P = 0{,}008$) (obr. 3a). Tento jev byl však způsoben rozdíly v počtech brouků sebraných na jednotlivých lokalitách, přičemž výrazně více jedinců bylo sebráno na poli a malých ostrovech než na ostrovech velkých. Když byl vliv různého počtu jedinců ve společenstvech odstraněn pomocí rarefakce, nebyl patrný žádný rozdíl v druhovém bohatství mezi ostrovy různé velikosti ani mezi ostrovy a polem (GLM-n; obr. 3b).

Neobhospodařované ostrovy zkoumané v naší studii nabízejí vhodné životní podmínky pro druhy, které se běžně v polích nevyskytují. Jedná se jak o druhy vázané na lesnaté či křovinaté biotopy, tak o druhy otevřených biotopů, ale zřejmě citlivé na narušení prostředí působené zemědělským obhospodařováním. Je zajímavé, že některé druhy vyskytující se běžně v polích,

v našem studovaném území preferovali neobhospodařované ostrovy (např. *Pseudoophonus rufipes* (De Geer, 1774)). Částečně to může být způsobeno i relativně krátkým obdobím sběru dat na počátku léta, přičemž prostorová distribuce některých druhů se může měnit v průběhu sezóny. Je ovšem zřejmé, že ochrana stávajících neobhospodařovaných ostrovů uvnitř polí či dokonce tvorba ostrovů nových, je vhodným nástrojem k udržení stávající druhové diverzity v zemědělské krajině.

Jako apendix k této práci je připojena kompletní tabulka sumarizující počty jedinců jednotlivých druhů sesbíraných na zkoumaných lokalitách (14 ostrovů a 5 polních lokalit).

Appendix. Complete list of all carabid beetles sampled in particular sites. Site numbers correspond to Fig. 1.
Apendix. Seznam střevlíků sesbíraných na jednotlivých lokalitách. Čísla lokalit v tabulce odpovídají číslům lokalit na Obr. 1.

Species / druh	Isl1	Isl2	Isl3	Isl4	Isl5	Isl6	Isl7	Isl8	Isl9	Isl10	Isl11	Isl12	Isl13	Isl14	F1	F2	F3	F4	F5
Agonum muelleri (Herbst, 1784)	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	1	2	0	2
Agonum sexpunctatum (Linnaeus, 1758)	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	2	3	4	3
Amara aenea (De Geer, 1774)	0	0	0	0	2	1	8	0	0	0	0	0	2	1	6	6	5	7	4
Amara communis (Panzer, 1797)	1	1	0	0	1	2	1	0	0	0	0	0	2	1	1	1	2	0	0
Amara convexior Stephens, 1828	2	4	0	3	2	0	2	0	4	0	0	0	0	2	0	2	0	0	0
Amara curta Dejean, 1828	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0
Amara familiaris (Duftschmid, 1812)	0	0	4	0	1	0	0	0	0	0	0	0	0	0	2	1	0	1	0
Amara littorea C. G. Thompson, 1857	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1
Amara lunicollis Schiödte, 1837	1	0	0	0	0	0	0	0	1	2	0	0	0	2	1	0	0	0	0
Amara montivaga Sturm, 1825	0	0	0	0	0	0	0	2	0	0	0	0	0	0	2	5	1	1	4
Amara municipalis (Duftschmid, 1812)	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Amara nitida Sturm, 1825	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	1	0	0
Amara ovata (Fabricius, 1792)	0	3	0	0	2	1	3	0	0	0	0	0	0	0	1	6	4	0	4
Amara plebeja (Gyllenhal, 1810)	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	1	0
Amara similata (Gyllenhal, 1810)	3	1	0	0	1	0	4	0	0	0	0	0	2	1	25	36	11	17	19
Amara tibialis (Paykull, 1798)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1
Anchomenus dorsalis (Pontoppidan, 1763)	0	0	0	0	0	0	2	0	0	0	0	0	1	0	28	29	6	6	18
Anisodactylus binotatus (Fabricius, 1787)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	1	0
Badister bullatus (Schrank, 1798)	0	3	2	0	1	6	7	0	0	0	0	0	0	2	0	0	1	0	0
Badister lacertosus Sturm, 1815	0	0	0	1	1	1	1	0	1	1	0	0	0	0	0	0	0	0	0
Bembidion lampros (Herbst, 1784)	1	0	1	0	2	4	0	0	0	0	0	0	3	1	3	2	3	2	6
Bembidion obtusum Audinet-Serville, 1821	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	2	0
Bembidion properans (Stephens, 1828)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0
Bembidion quadrimaculatum (Linnaeus, 1761)	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0
Brachinus explodens Duftschmid, 1812	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	6	4	2	1

Calathus fuscipes (Goeze, 1777)	4	1	14	0	7	1	8	1	1	0	0	2	0	8	1	1	0	0	0
Calathus melanocephalus (Linnaeus, 1758)	1	0	1	0	7	5	9	1	3	0	0	4	8	3	1	0	0	0	0
Carabus cancellatus Illiger, 1798	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
Carabus convexus Fabricius, 1775	1	0	4	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Carabus granulatus Linnaeus, 1758	0	0	0	0	1	2	1	0	0	0	0	0	1	0	1	2	11	4	1
Carabus hortensis Linnaeus, 1758	2	0	18	1	6	0	2	1	0	0	0	1	0	5	0	0	0	0	0
Carabus nemoralis Müller, 1764	0	0	0	0	4	0	1	6	0	3	1	1	0	1	0	1	0	0	0
Clivina fossor (Linnaeus, 1758)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
Harpalus affinis (Schrank, 1781)	0	0	0	0	1	0	0	1	0	0	0	0	0	0	3	6	2	2	6
Harpalus distinguendus (Duftschmid, 1812)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
Harpalus quadripunctatus Dejean, 1829	0	0	0	8	1	0	0	0	1	0	1	0	0	0	0	0	0	0	0
Harpalus honestus (Duftschmid, 1812)	0	0	0	0	2	0	0	0	0	0	0	0	4	0	0	0	6	0	0
Harpalus latus (Linnaeus, 1758)	0	0	0	6	0	5	3	3	0	0	0	2	0	0	0	0	0	0	0
Harpalus signaticornis (Duftschmid, 1812)	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	2	0	0	2
Harpalus tardus (Panzer, 1797)	0	3	15	0	4	2	11	2	0	0	0	2	3	1	0	2	1	1	2
Laemostenus terricola (Herbst, 1784)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
Leistus ferrugineus (Linnaeus, 1758)	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Licinus depressus (Paykull, 1790)	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
Loricera pilicornis (Fabricius, 1775)	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	2	0	1
Microlestes minutulus (Goeze, 1777)	0	1	0	0	0	0	0	0	0	0	0	0	2	1	0	0	0	0	0
Nebria brevicolis (Fabricius, 1792)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0
Notiophilus biguttatus (Fabricius, 1799)	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Notiophilus palustris (Duftschmid, 1812)	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Oxypselaphus obscurus (Herbst, 1784)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Panagaeus bipustulatus (Fabricius, 1775)	0	0	0	0	2	3	0	3	0	0	0	0	0	1	0	0	0	0	0
Philorhizus crucifer (Lucas, 1846)	0	0	0	0	0	0	0	0	0	0	0	0	1	3	0	0	0	0	0
Platynus assimilis (Paykull, 1790)	0	0	6	0	2	0	3	0	0	0	0	0	0	0	2	2	5	1	0
Poecilus cupreus (Linnaeus, 1758)	0	9	0	0	15	8	13	1	2	0	0	0	18	4	83	307	84	174	243

Species / druh	Isl1	Isl2	Isl3	Isl4	Isl5	Isl6	Isl7	Isl8	Isl9	Isl10	Isl11	Isl12	Isl13	Isl14	F1	F2	F3	F4	F5
Poecilus versicolor (Sturm, 1824)	0	24	3	0	88	83	95	58	15	12	1	24	34	144	51	76	10	22	27
Pseudoophonus rufipes (De Geer, 1774)	0	5	0	0	0	0	0	2	0	0	0	0	0	2	1	0	0	0	0
Pterostichus melanarius (Illiger, 1798)	1	8	5	2	0	8	7	0	0	0	0	1	0	5	21	11	24	19	16
Pterostichus niger (Schaller, 1783)	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Pterostichus nigrita (Paykull, 1790)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8	0	0
Pterostichus oblongopunctatus (Fabricius, 1787)	1	0	3	0	10	1	14	0	2	1	0	10	0	1	1	1	0	1	0
Pterostichus strenuus (Panzer, 1797)	0	0	1	0	3	5	8	0	0	0	0	0	2	4	2	2	3	2	2
Pterostichus vernalis (Panzer, 1796)	0	1	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0
Syntomus truncatellus (Linnaeus, 1761)	0	1	0	0	0	0	0	1	0	0	0	0	1	1	0	0	0	0	0
Trechus quadristriatus (Schrank 1781)	0	0	0	0	0	0	0	0	0	0	0	0	2	1	1	0	4	2	0