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WATER BEETLE (COLEOPTERA) ASSEMBLAGES IN PONDS AND WETLANDS NEXT TO HIGHWAY CONSTRUCTIONS: EFFECT OF SITE AGE

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VÍZIBOGÁR-KÖZÖSSÉGEK (COLEOPTERA) VIZSGÁLATA AUTÓPÁLYA MELLETTI VIZES ÉLŐHELYEKEN: A VÍZTESTEK KORÁNAK HATÁSA

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ABSTRACT: In the recent study water beetles (Coleoptera) have been investigated in ten wetlands and ponds next to highway constructions. The main question related to the effect of site age on the water beetle assemblages. Five new (age < 5 years) and five old (age > 50 years) water bodies were chosen in southwestern Hungary next to the highway M7 and highway 8 respectively, to analyze their water beetle fauna. The samples were taken five times at each study site during the summer of 2007. Water beetle abundance and species number were compared at each study site with repeated measures ANOVA and the Rényi diversity index was used to analyze the difference of water beetle species diversity between new and old study sites. The results of repeated measures ANOVA showed a significantly higher beetle abundance in the old wetlands, but a higher species diversity was found in the new ponds.

KIVONAT: Jelen dolgozatban vízibogarak (Coleoptera) előfordulását vizsgáltuk autópálya melletti víztestekben. Fő célkitűzésünk az volt, hogy megállapítsuk, lehet-e különbséget kimutatni a különböző korú vizek vízibogár faunájában. Összesen 10 víztestet vizsgáltunk az M7-es autópálya mentén, amelyekből 5 újonnan alakult ki (kor < 5 év), öt pedig lényegesen régebbi volt (kor > 50 év). A mintavételezést 2007 nyarán végeztük. Minden víztestből 5 alkalommal gyűjtöttünk vízibogarakat kéziháló segítségével. A különböző víztestekben gyűjtött egyedszámokat és fajszámokat ismétléses (repeated measures) ANOVA módszerrel, míg a diverzitásokat a Rényi féle diverzitás-profilok alapján hasonlítottuk össze. Eredményeink azt mutatják, hogy a régebbi víztestekben szignifikánsan több vízibogár egyed fordult elő, azonban a Rényi féle diverzitás az új vizekben volt magasabb.

Key words: water beetles, ponds, wetlands, highway

Introduction

Roads and highways appear as major objects in the landscape and their ecological effects are extensive. The effect of roads and highway constructions on biota receives more and more attention in the 20th century, especially in countries where density of main roads and traffic is high. This appears often in small inland countries like Hungary. The road density of Hungary is very high and nowadays an intensive building of highways and roads can be observed in many parts of Hungary, often crossing areas which are presumed to be important for conservation, especially the wetland areas. The construction of highways develops many new water bodies and this offers the possibility to compare new and old wetlands and analyze the effect of site age on aquatic invertebrates. The effect of site age on water beetle assemblages was analyzed by FAIRCHILD et al. (2000) who found significant differences in water beetle species composition between younger and older ponds in the U.S. referring to site age. They found site age to be the most important factor influencing water beetle assemblages.

In this study we also concentrate on water beetles which constitute an important and large part of Hungary's macroinvertebrate biodiversity in freshwaters and ponds. Information about beetle colonisation and successional patterns within the beetle assemblage is very important, because the group can be regarded as indicator for habitat quality (FOSTER, 1987) at newly available sites, like the new ponds developed during the highway construction. The following questions were addressed to this study:

1. Is there any difference in water beetle abundance, species number and diversity between new and old wetlands/ponds?
2. How do the water beetle abundance, species number and diversity differ between the study areas? What is the effect of site age?

Materials and methods

The fieldwork of this study was carried out in south-western Hungary in the summer of 2007. All the investigated wetlands were situated next to highway M7 and highway 8, respectively. Their distance from the highway varied between 2 and 250 m. Some sections of highway M7 were constructed in the last years and certain parts were completed first in 2007, so that many newly developed water bodies occurred in the last month next to this highway. A total number of ten wetlands and ponds were chosen to investigate their water beetle fauna, five “new” and five “old”. The age of the new water sites varied between 2 and 5 years, while the old waters had an age of more than 50 years. Each of the five new ponds and two of the old lakes were constructed by human activity, whereas three of the old wetlands had a natural origin. The wetlands varied in size and the new ones were smaller than the old ones, nevertheless site age is assumed to be more important in influencing the water beetles than size of the water body. The relationship between pond area and biodiversity was investigated by OERTLI et al. (2002), who did not find a significant relation between pond area and species richness of aquatic Coleoptera. NILSSON and SVENSSON (1995) investigated Dytiscid assemblages and found species richness and abundance peaks in ponds areas between 10 and 100 m^2. The ponds investigated in this study were all larger than 200 m^2.

The samples were taken five times from July to October 2007, with intervals of 2–4 weeks between the samplings. For collecting water beetles a semi-quantitative sampling method was used (FORRÓ, 1997).

Water beetle samples were taken in each pond and at each sampling date by intensive sweeping with a long-handled pond net (mesh size = 0.5 mm) for 20-30 minutes. The sampling sites were all placed near the bank among macrophytes. Only adult beetles were collected, larvae were not accounted. The collected animals were preserved in 70% Ethanol and determined at species level in the laboratory.

For determination identification manuals from CSABAI (2000) and CSABAI et al. (2002) were used. Water beetle abundance, species number and diversity were defined for each study pond to analyse the effect of age on water beetles and compare new and old wetlands.

Repeated measures ANOVA and the Rényi diversity index (TÓTHMÉRÉSZ, 1995) were used to analyse the data and compare the beetle fauna in the different study sites. The Rényi Entropy calculation was carried out with the "R 2.6.0."- Program software package (http://www.r-project.org). Repeated measures ANOVA was made by using STATISTICA 7.0.

Results

The five samplings at the ten study areas resulted in a water beetle abundance of 656 individuals and 45 species (Table 1 and 2). The water beetle species belonged to 7 families, where the family of Dytiscidae was the most species-rich with 22 species. The family of Hydraenidae was not determined to species level. Considering the water beetle abundance and comparing new and old water sites (483 individuals in old waters and 173 individuals in new waters), we noticed that the old ones had a much higher abundance than new ones (Figure 1).

Table 1. Water beetle abundance and species numberaccording to families.

Family	Abundance new sites	Abundance old sites	Total abundance	No. of species new sites	No. of species old sites	Total number of species
Dytiscidae	69	166	235	18	18	22
Haliplidae	5	47	52	4	5	5
Helophoridae	21	0	21	2	0	2
Hydraenidae	11	14	25	n.a.	n.a.	n.a.
Hydrochidae	29	0	29	2	0	2
Hydrophilidae	34	57	91	8	10	12
Noteridae	4	199	203	2	2	2

Table 2. Number of captured individuals according to species

Family	Genus/Species	Abundance
Dytiscidae	*Agabus* sp. Leach, 1817	2
	Bidessus nasutus (Sharp, 1887)	19
	Colymbetes fuscus (Linnaeus, 1758)	8
	Dytiscus dimidiatus (Bergsträsser, 1778)	1
	Dytiscus marginalis (Linnaeus, 1758)	2
	Hydaticus seminiger (De Geer, 1774)	1
	Hydroglyphus geminus (Fabricius, 1792)	49
	Hydroporus angustatus (Sturm, 1835)	7
	Hydroporus palustris (Linnaeus, 1761)	4
	Hydroporus sp. Clairville, 1806	5
	Hygrotus decoratus (Gyllenhal, 1808)	15
	Hygrotus impressopunctatus (Schaller, 1783)	8
	Hygrotus inaequalis (Fabricius, 1776)	51
	Hyphydrus ovatus (Linnaeus, 1761)	2
	Ilybius subaeneus (Erichson, 1837)	2
	Ilybius fenestratus (Fabricius, 1781)	1
	Laccophilus hyalinus (De Geer, 1774)	16
	Laccophilus minutus (Linnaeus, 1758)	20
	Laccophilus poecilus (Klug, 1834)	11
	Porhydrus obliquesignatus (Bielz, 1852)	1
	Rhantus sp. Dejean, 1833	1
	Rhantus frontalis (Marsham, 1802)	1
Haliplidae	*Haliplus furcatus* (Seidlitz, 1887)	6
	Haliplus heydeni (Wehncke, 1875)	11
	Haliplus immaculatus (Gerhardt, 1877)	18
	Haliplus lineatocollis (Marsham, 1802)	4
	Peltodytes caesus (Duftschmid, 1805)	13
Helophoridae	*Helophorus longitarsis* (Woll, 1864)	10
	Helophorus brevipalpis (Bedel, 1881)	11
Hydraenidae	Hydraenidae sp. Mulsant, 1844	25
Hydrochidae	*Hydrochus crenatus* (Fabricius, 1792)	15
	Hydrochus flavipennis (Küster, 1852)	18
Hydrophilidae	*Anacaena limbata* (Fabricius, 1792)	36
	Enochrus bicolor (Fabricius, 1792)	5
	Enochrus melanocephalus (Olivier, 1792)	2
	Enochrus testaceus (Fabricius, 1801)	10
	Helochares lividus (Forster, 1855)	5
	Helochares obscurus (Müller, 1776)	11
	Hydrobius fuscipes (Linnaeus, 1758)	6
	Hydrochara caraboides (Linnaeus, 1758)	3
	Hydrochara flavipes (Steven, 1808)	1
	Laccobius minutus (Linnaeus, 1758)	10
	Limnoxenus niger (Zschach, 1788)	2
Noteridae	*Noterus clavicornis* (De Geer, 1774)	63
	Noterus crassicornis (Müller, 1776)	144

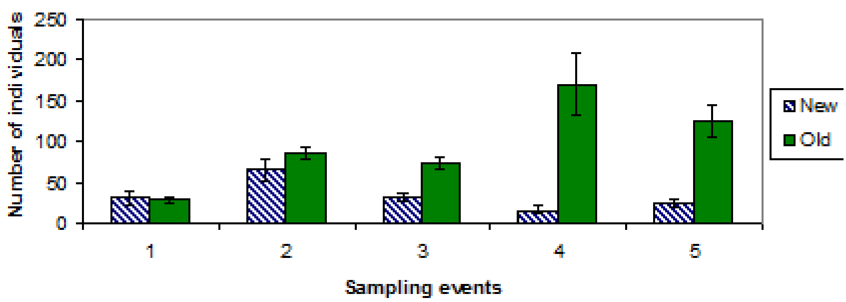

Fig. 1. Water beetle abundance in new and old wetlands

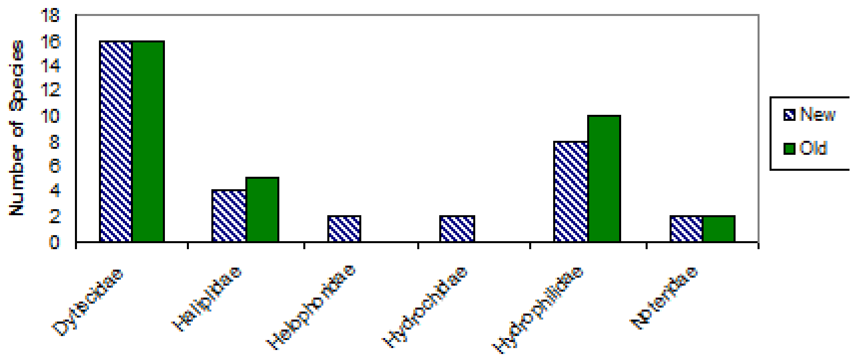

Fig. 2. Water beetle species number in each family

Repeated measures ANOVA was used to analyse the relationship between site age (old vs. new) and water beetle abundance and species number. The results showed a significant ($p < 0.05$) difference in water beetle abundance related to site age (Table 3 and Figure 3), but not for species number (Table 4 and Figure 4).

Table 3. Results of repeated measures ANOVA: Water beetle abundance

	SS	df	MS	F	p
Intercept	8606.720	1	8606.720	33.59900	0.000407
Age	1922.000	1	1922.000	7.50312	0.025481
Error	2049.280	8	256.160		
Time	937.280	4	234.320	1.07537	0.384941
Time*Age	1624.000	4	406.000	1.86326	0.141128
Error	6972.720	32	217.898		

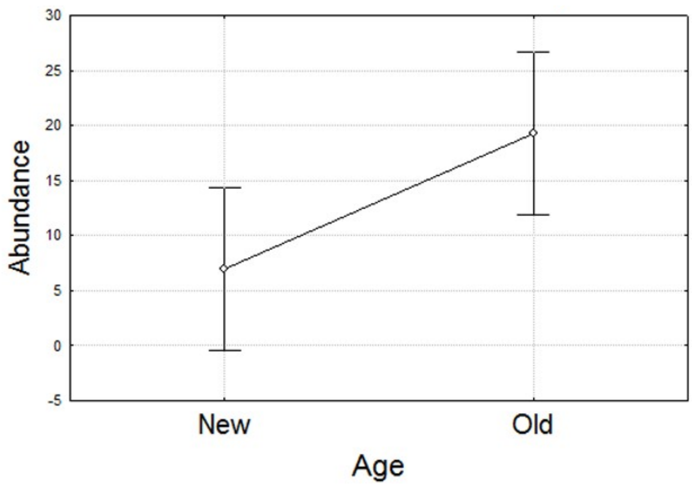

Fig. 3. Water beetle abundance new vs old study sites

Table 4. Results of repeated measures ANOVA: Water beetle species number

	SS	df	MS	F	p
Intercept	968.0000	1	968.0000	34.37500	0.000377
Age	81.9200	1	81.9200	2.90909	0.126475
Error	225.2800	8	28.1600		
Time	25.4000	4	6.3500	1.14724	0.352279
Time*Age	44.2800	4	11.0700	2.00000	0.118219
Error	177.1200	32	5.5350		

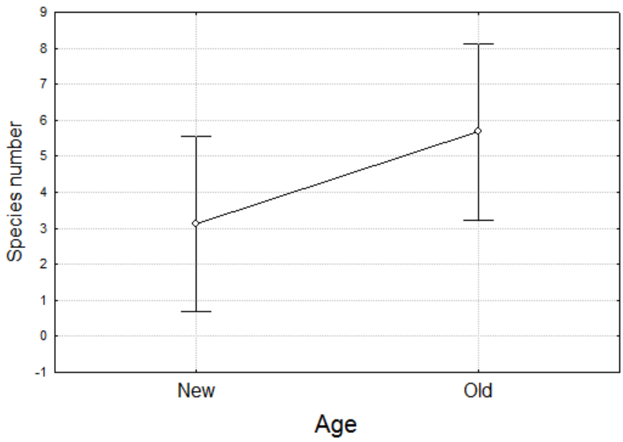

Fig. 4. Water beetle species number new vs old study sites

Figure 5 shows the curves of the Rényi diversity for the five new and five old wetlands together. The new wetlands showed a higher diversity than the old ones. This was true for rare and more frequent species at the same time.

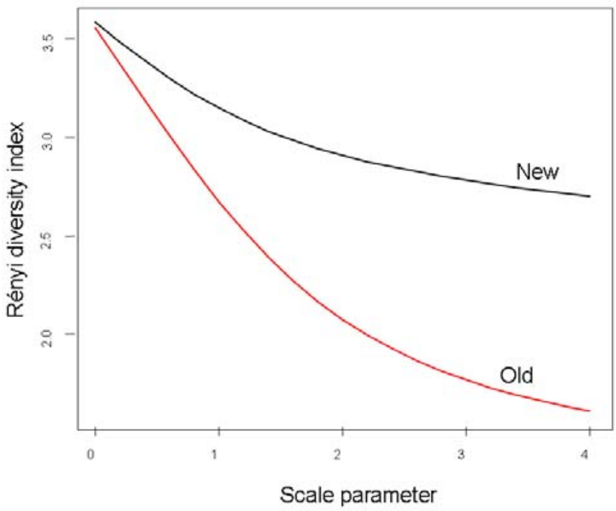

Fig. 5. Rényi diversity of new and old study sites

Discussion

The aim of this study was to investigate water beetles in ponds and wetlands next to highway constructions and the main question related to the effect of site age on the water beetle fauna.

The first question to be answered in this study is about the difference in water beetle abundance, species number and diversity between new and old sites. The results of the higher Rényi diversity index in the new sites can be explained by the two water beetle families, Hydrochidae and Helophoridae, which only occurred in the newly developed ponds (Figure 2, Table 1). These families are assumed to be one of the first colonizers in newly developed waters (HANSEN, 1999), potentially explaining their absence in the old study sites, where they were already displaced by other water beetle species. Furthermore potentially there was no fish present in the new ponds, which probably leaded to higher invertebrate diversity (COLLINSON et al. 1995, BATZER and WISSINGER, 1996). NILSSON (1984) found a decrease in water beetles species richness with increasing maturity of vegetational succession, which can be observed in our old study sites.

In contrast, significantly higher beetle abundances could be shown in the old wetlands especially caused by the high abundances of Noteridae. The species *Noterus crassicornis* does not prefer colonizing newly developed water bodies (SCHMIDL, 1992, DETTNER, 1997) what might explain their absence in the new ponds.

This field study showed that water beetles colonize new ponds and wetlands next to highways and that site age might be an important factor in determining water beetle abundance and diversity. Our results (higher species diversity in the new water sites) might be used in wetland conservation efforts: It could be important developing new water bodies, because they can be regarded as important habitats for macroinvertebrates and, as the study showed, for many water beetle species.

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References

BATZER, D.P. - WISSINGER, S.A. (1996): Ecology of insect communities in nontidal wetlands. – Annual Reviews of Entomology 41: 75–100 pp.

COLLINSON, N.H. – BIGGS, J. – CORFIELD, A. – HODSON, M.J. – WALKER, D. – WHITFIELD, M. – WILLIAMS, P.J. (1995): Temporary and permanent ponds: an assessment of the effects of drying out on the conservation value of aquatic macroinvertebrate communities. – Biological Conservation 74: 125–133 pp.

CSABAI, Z. (2000): Vízibogarak kishatározója I. (Coleoptera: Haliplidae, Hygrobiidae, Dytiscidae, Noteridae, Gyrinidae). – Vízi Természet- és Környezetvédelem sor., 15. köt., Környezetgazdálkodási Intézet, Budapest, 277 pp.

CSABAI, Z. – GIDÓ, Z. – SZÉL, G. (2002): Vízibogarak kishatározója II. (Coleoptera: Georissidae, Spercheidae, Hydrochidae, Helophoridae, Hydrophilidae). – Vízi Természet- és Környezetvédelem sor. 16. köt., Környezetgazdálkodási Intézet, Budapest, 206 pp.

DETTNER, K. (1997): Insecta: Coleoptera: Noteridae. In: SCHWOERBEL, J.: Süsswasserfauna von Mitteleuropa Band 2, 3 and 4. Gustav Fischer Verlag, Stuttgart: 97–126 pp.

FAIRCHILD, G.W. - FAULDS, A.M. - MATTA, J.F. (2000): Beetle assemblages in ponds: effects of habitat and site age. – Freshwater Biology 44: 523–534 pp.

FORRÓ, L. (1997): A Nemzeti Biodiverzitás-monitorozó Rendszer V. Rákok, szitakötők és egyenesszárnyúak. – Magyar Természettudmányi Múzeum, Budapest. 35–49 pp.

FOSTER, G.N. (1987): The use of Coleoptera records in assessing the Conservation Status of wetlands. – Proceedings – The use of Invertebrates in Site Assessment for Conservation: 8–18 pp.

HANSEN, M. (1999): Fifteen new genera of Hydrophilidae (Coleoptera), with remarks on the generic classification of the family. – Entomologica scandinavica 30: 121–172 pp.

NILSSON, A.M. (1984): Species richness and succession of aquatic beetles in some kettle-hole ponds in northern Sweden. – Holarctic Ecology 7: 149–156 pp.

NILSSON, A.M. - SVENSSON, B. (1995): Assemblages of dytiscid predators and culicid prey in relation to environmental factors in natural and clear-cut boreal swamp forest pools. – Hydrobiologia 308: 183–196 pp.

OERTLI, B. – JOYE, D.A. – CASTELLA, E. – JUGE, R. – CAMBIN, D. – LACHAVANNE, J.-D. (2002): Does size matter? The relationship between pond area and biodiversity. – Biological Conservation 104: 59–70 pp.

SCHMIDL, J. (1996): An analysis of community structure and habitat-preference of adephage water beetles (Coleoptera) in central Europe. – Proceedings of XX. International Congress of Entomology 352 p.

TÓTHMÉRÉSZ, B. (1998): On the characterization of scale dependent diversity. – Abstracta Botanica 22: 149–156 pp.