Entomol.rom., **12**: 213-221, 2007 ISSN 1224 - 2594

Communities of beetles in plantations of fast growing plant species for energetic purposes

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Abstract

The communities of beetles were studied using pitfall trapping in six bio-energy plantations of fast growing trees (poplar) in the agricultural landscape of southern Bohemia (Central Europe). The plantations differs by the number of trees (400 – 10.000). The vicinity of plantations was different too. Three groups of habitats were determined. The first two plantations were surrounded by diverse landscape with water ecosystems, the next pair plantations were close to fields and pastures and the last two plantations were environed by cultural forest and fields. The program CANOCO version 4.51 for comparison was used for the statistical evaluation of the material. There were no found statistically evidential effect of the number of trees in plantations on beetle communities. The structure of communities of beetles in plantations with the different surrounding landscape and man effect strongly varies. This effect was statistically documented by the PCA method. The difference in beetle communities was found in the separate months too. The highest activity of beetles in plantations was during June-July. The frequency of ubiquitous species in plantations is clearly lower than in surrounding fields and pastures. Some stenotopic and protected species of beetles were found in plantations.

Key words: energy biomass plantations, epigeic beetles, communities, agricultural landscape, man impact, central Europe

Introduction

Bio-energy plants became economically efficient and attractive for farmers in Czech republic. The geographical position of the Czech republic is not very suitable for intensive agriculture due the fact that the most of agricultural areas are situated in submontaneous and less favourable areas. We have a new law for the producing of energy from renewable sources supporting this farming. Due to this background, growing of energy plants on arable land is discussed as potential alternative for the future perspective of Czech agriculture. The Czech government is highly interested to steering this development in a way to avoid further uniformization of cropping structure within agriculture and to prevent potential negative environmental effects too.

It is anticipated that replacing ex-arable land with native or introduced new species of biomass plant crops will affect the biodiversity. Agricultural land makes up a big proportion of Czechia´s countryside. There are no published data from the Czech Republic about the biodiversity of biomass plant crops. Some papers from abroad (e.g. Semere & Slater , 2007; Semere & Slater, 2007a) documented that the effect of biomass plant crops (e.g. *Miscanthus giganteus* and *Phalaris arundinacea*) are not negative and that the biodiversity is increasing by model invertebrates groups (e.g. ground beetles and butterflies) or some vertebrates (small mammals, birds). On the other side this effect is not the same by all vertebrate species and some of them avoid the plantations of biomass plant crops (e.g. some birds).

Communities of epigeic beetles were studied in energy plantations of trees in the vicinity of České Budějovice (Czech Republic). These beetles represent one of the ecologicallly most sensitive insect groups with many highly specialized taxa (Thiele, 1977; Šustek, 1994; Boháč, 1999; Boháč, 2003; Boháč et al., 2005; Holland, 2002; New, 2005).

The aim of our study was to investigate the ecological impact of plantations of biomass tree in the southern Bohemia and to determine how biomass energy trees affect on ex-arable land biodiversity.

Research sites and methods

Stand and site characteristics

Six plots of fast growing trees (poplar) were studied in the vicinity of České Budějovice in Southern Bohemia. The plots differs by the number of trees in groups (400 – 10.000), landscape character and surrounding biotopes (agricultural landscape mainly with different share forested and unforested land cover, etc.). The main characteristics of studied plots are described on the table 1.

Table 1

Characteristic of studied plots with fast growing trees in southern Bohemia. Surrounding landscape is determined by the extent of man effect in three groups. 1 – strongly affected (intensive Agriculture), 2 – medium effect of man, 3 – at least affected by man (wolds of streams, growths and meadows with ecotone bitotopes etc.)

Plot and its age, level of man effect	Number of trees	Characteristic of landscape
Plot 1. Lhenice (1999), 3	420	Wold with a stream
Plot 2. Rankov (1999), 3	550	Surrounded by a pond, field, alder trees and meadow
Plot 3. Čakov (2002), 1	500	Surrounded by a field and a pasture
Plot 4. Čakov (2005), 1	800	Surrounded by a field and a pasture
Plot 5. Chlumská hora (2003), 2	3680	Surrounded by a cultural forest and field
Plot 6. Krejcárka (1996), 2	10000	Surrounded by a cultural forest and field

The field plots are situated in an altitude 412-580 m a.s.l. Mean annual temperature was 10.0 ^{o} C, annual precipitation was 450 mm. The six experimental plots were established. The characteristic of studied plots is the next:

1. Plantation with 420 poplar trees (clone Jap 105 050, Oxford 494 and Jap 104 049) on humid, brown-sandy soils. The plantation is situated in a wold and it is surrounded by meadow and growings of willow and alder. The small stream flows on the south border of the plantation. The age of plantations – 8 years.
2. Plantation of 550 poplar trees (clone Oxford 494 and NE 44-466) on humid loam soil. The plantation is surrounded by field, meadow and alder growth. The pond is situated on the west side. The age of plantations – 8 years. .
3. Plantation of 412 poplar trees (clone Jap 104 049) on brown, sandy and loam soils. The surroundings of the plantations forms pasture and fields. The age of plantations – 6 years.
4. Plantations of 412 poplar trees (clone Jap 104 049) on brown sandy and loam soils. The surroundings of plantations forms partures and fields. The age of plantations – 2 years.
5. Plantations of 580 poplar (clone Jap 104 049), willow and alder trees on dry sandfy brown soils. The surroundings of plantations are forest with dominance of pine and and field. The age of plantations – 4 years.
6. Plantations of 486 poplar trees (clone Jap 104 049, Jap 105 050, Oxford 494) on brown sandy and loam soils. The surroundings of plantations forms spruce forest and fields. The age of plantations – 11 years.

Surrounding landscape is evaluated by the extent of man effect in three groups. 1 – strongly affected (intensive agriculture), 2 – medium effect of man, 3 – at least affected by man (wolds of streams, growths and meadows with ecotone bitotopes etc.) The degree of human impact on studied plots is briefly described in the Table 1.

Sampling and data analysis

The method of pitfall trapping was used for beetle sampling. A row of five pitfall traps (diameter 7 cm) was exposed in each plots at April 2007. Pitfall traps were filled with a mixture of ethylenglykol. The material from the traps was collected every month from April 2007 to October 2007.

The program CANOCO version 4.51 for comparison used for the statistical evaluation of the material; graphical outputs were elaborated by the CANODRAW and CANOPOST programs (ter Braak & Šmilauer 1998). We used DCA analysis for comparison of sites and direct RCA analysis for evaluation of time effect in season and for evaluation of management effect on species. For more transparency of graphical outputs the 21 species were visualized.

The degree of human impact will be studied by finding of frequency of species of different ecological groups (Hůrka et al., 1996; Boháč, 1999). For this, the species were divided into groups groups as follows:

- Group R1 (relic species) includes species remaining from communities of past period, e.g. species with arcto-alpine, boreomontane and boreoalpine occurrence, inhabiting mainly mountains and peatbogs, or only occurring in remains of forests stands, which because of their high species diversity resemble recent climax forests.

- Group R2 (specialists) encompasses species of both natural and managed forests.

- Group E (generalists or ubiquitous species) comprises eurytopic species that successfully occupy deforested sites and are also found in areas strongly affected by man.

The method of ecological analysis of beetle communities (Boháč, 1999) was used for evaluating of community structure particularly. Various characteristics (frequency of ecological groups according to their relation to the naturalness of biotopes, frequency of species with summer and winter activity of imagos, proportion of winged species, various body size groups, thermo- and hygropreference and geographical distribution) were used during this analysis. Increased influence of man was found to bring about an increase in the frequency of eurytopic species, an increase in the frequency of species with summer activity of imagos, and decrease in the proportion of species with winter activity of imagos. One peak in seasonal activity of staphylinids was found in biotopes with increased influence by man in contrast to two peaks in seasonal activity in semi-natural habitats. Furthermore, an increase was also seen in the proportions of winged species and individuals possessing a higher migrating ability, large body size (size Groups IV and V after Boháč, 1999), species with higher temperature and lower moisture preferences, and species with an area of occurrence wider than Europe. A decrease in the number of life forms was accompanied by a decrease in the beetle community index. More extensive human activity was also shown to bring about an alternation of the sex ratio.

The migration possibilities of studied animals was studied by mark-recapture technique. Selected species (*Carabus granulatus granulatus, Carabus violaceus violaceus,Platynus assimilis* and *Philonthus decorus*) were individually labelled with small dots on the elytra using a brush (diameter 0.5 mm) with a white or silver colour. The marked adults were let out in the vicinity of plantations (100 m from the plantations) in the afternoon and pitfall traps were controlled two days later in the morning. Two experiments were made in the mid of May on the plot 3 and 4.

Results

Epigeic beetle communities on studied plots

The number of species found in all studied plots was 137. Staphylinids and carabids were more numerous in comparison with other beetle families (58 and 32 species respectively). The number of occurred species was different in studied plots (Table 2). The highest number of species was found on plots 2, 1 (76, 76 species respectively). These plots represent plantations with surroundings very patchy and diverse. The number of species on the plots 3, 4 and 5 was very similar (58, 53 and 56 species respectively). Plots 3 and 4 represent smaller plantations surrounded by agricutural landscape (fields and pastures). The plot 5 belongs to greater after the number of trees and it is surrounded by cultural forest and field in the submontane area of Blanský forest Mts. It is evident that the lowest number of beetle species was found in plantations with great size and number of trees (6).

There are two main groups of epigeic beetles after dominant species in single plots (Table 2). The community of plantations situated in the wold, by pond or close to forest was slightely different from all other plots due dominance of hygrophilous species and stenotopic species (e.g. carabids of the *Platynus assimilis, Pterostichus oblongopunctatus*, staphylinids *Quedius fuliginosus, Paederus riparis* and *Philonthus decorus*).

The great species of the carabid beetles from genera *Carabus* and *Pterostichus* occur in smaller plots surrounded by the diverse landscape or on plots bordered by the cultural forest. The number of these species is less numerous on plots surrounded by fields and pastures only.

The forest species and species living in shadow biotopes are characteristic for staphylinids (e.g.species of the genera *Anthobium, Olophrum, Stenus, Lathrobium, Atheta* and *Oxypoda*) of plantations close to forest (5 and 6). Some other species

Table 2

Dominant carabid and staphylinid beetle species in studied plots on plantations of fast growing trees in southern Bohemia.

Plot	**Number of species and dominant species**
Plot 1. Lhenice (1999)	69 *Platynus assimilis* Paykull, 1790, R2 *Carabus granulatus granulatus* Linnaeus, 1758, E *Pterostichus oblongopunctatus* (Fabricius, 1787), R2 *Philonthus decorus* (Gravenhorst, 1802), R2 *Pterostichus nigrita* (Paykull, 1790), E *Carabus hortensis hortensis* Linnaeus, 1758, R2

Plot	Number of species and dominant species
Plot 2. Rankov (1999)	76 *Platynus assimilis* Paykull, 1790, R2 *Carabus granulatus granulatus* Linnaeus, 1758, E *Philonthus decorus* (Gravenhorst, 1802), R2 *Pterostichus melanarius* (Illiger, 1798), E *Carabus hortensis hortensis* Linnaeus, 1758, R2 *Carabus violaceus violaceus* Linnaeus, 1758, R2
Plot 3. Čakov (2002)	58 *Pterostichus melanarius* (Illiger, 1798), E *Poecilus versicolor* (Sturm, 1824), E *Poecilus cupreus* (Linnaeus, 1758), E *Philonthus cognatus* (Stephens, 1832) *Philonthus varians* (Paykull, 1789) *Omalium caesum* Gravenhorst, 1806, E
Plot 4. Čakov (2005)	53 *Pterostichus melanarius* (Illiger, 1798), E *Poecilus versicolor* (Sturm, 1824), E *Poecilus cupreus* (Linnaeus, 1758), E *Philonthus cognatus* (Stephens, 1832) *Philonthus varians* (Paykull, 1789) *Amara familiaris* (Duftschmid, 1812) *Pseudoophonus rufipes* (De Geer, 1774), E
Plot 5. Chlumská hora (2003)	56 *Platynus assimilis* Paykull, 1790, R2 *Carabus granulatus granulatus* Linnaeus, 1758, E *Pterostichus oblongopunctatus* (Fabricius, 1787), R2 *Philonthus decorus* (Gravenhorst, 1802), R2 *Carabus scheidleri scheidleri* Panzer, 1799, R2 *Omalium caesum* Gravenhorst, 1806, E
Plot 6. Krejcárka (1996)	41 *Platynus assimilis* Paykull, 1790, R2 *Carabus granulatus granulatus* Linnaeus, 1758, E *Pterostichus oblongopunctatus* (Fabricius, 1787), R2 *Philonthus decorus* (Gravenhorst, 1802), R2 *Carabus scheidleri scheidleri* Panzer, 1799, R2 *Paederus riparius* (Linnaeus, 1758), R2 *Quedius fuliginosus* (Gravenhorst, 1802), R2 *Nebria brevicollis* (Fabricus, 1792), E

occurred in pitfall traps in plantations close to water biotopes (1 and 2) not found in other plots (e.g. as some mycetophagous species as staphylinid beetle *Lordithon lunulatus*).

The low number of carabid species characteristic for fields and pastures with smaller body size (e.g. genera *Amara, Poecilus, Calathus* and *Pseudoophonus*) was indicated on plantations surrounded by fields and pastures (plots 4 and 5). Some species from another beetle families belong to subdominant in beetle communities on all plots (e.g. *Geotrupes stercorarius* from the family *Geotrupidae* and curculionid beetle *Otiorhynchus singularis*).

Ordination of beetle samples

Ordination of beetle samples on studied plots with the different number of trees and the diverse character of the surrounding landscape indicates great similarity of variants with the different surrounding landscape and resulting man impact (Fig. 1). There are three pairs of biotopes after the beetle communities. The first pair is represented by beetle communities on plantations situated close to the harmonious and diverse landscape (plots 1 and 2). The characteristic species of these communities are some stenotopic species (e.g. carabid beetle *Platynus assmilis*, staphylinid species *Olophrum assimile*, etc.) and great *Carabus* species (e.g. *Carabus hortensis hortensis, C. violaceus violaceus*). Some psychrophilous species with winter activity are typical for beetle communites on these plots (e.g. staphylinid beetle *Olophrum assimile*).

The second pair of biotopes after beetle communities is imaged by plantations situated close

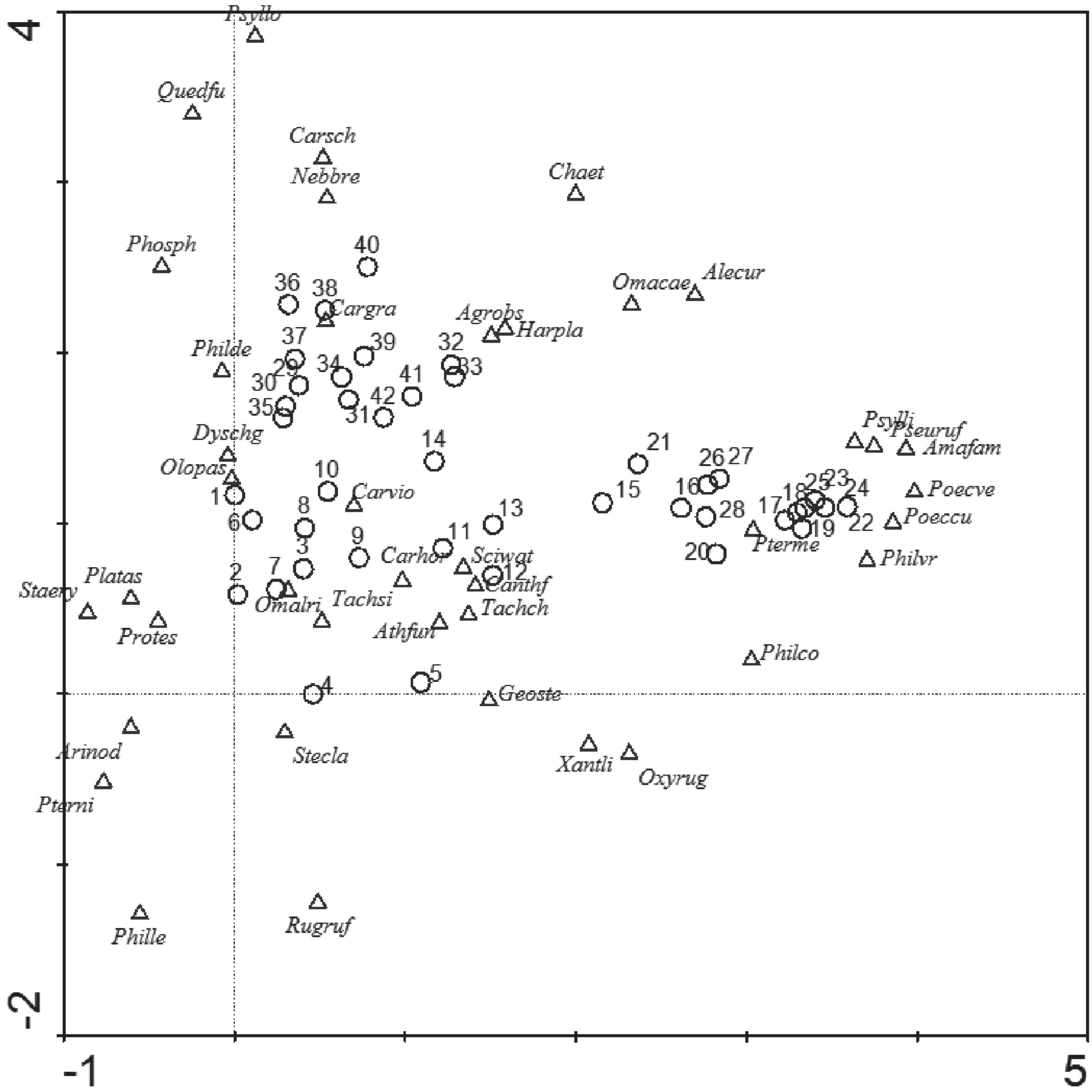

Fig. 1. Ordination of beetle samples in studied plots in different months (circles 1-7: plot 1, circles 8-14: plot 2, circles 15-21: plot 3, circles 22-28: plot 4, circles 29-35: plot 5, circles 36-42: plot 6. Abbreviations of species are the next: Agrobs – *Agriotes obscurus*, Cargra – *Carabus granulatus*, Carhor – *C. hortensis*, Carsch – *C. scheidleri*, Carvio – *C. violaceus*, Harpla – *Harpalus latus*, Psyllo – *Psylliodes affinis*, Nebre – *Nebria brevicollis*, Chaet – *Chaetocnema concinna*, Phosph – *Phosphuga atrata*, Philde - *Philonthus decorus*, Dyschg – *Dyscirius globosus*, Omacae – *Omalium caesum*, Alecur – *Aleochara curtula*, Quedfu – *Quedius fuliginosus*, Olopas – *Olophrum assimile*, Pseuruf – *Pseudoophonus rufipes*, Amafam – *Amara familiaris*, Poecve – *Poecilus versicolor*, Poeccu – *P. cupreus,* Pterme – *Pterostichus melanarius*, Philvr – *Philonthus varians*, Sciwat – *Sciodrepoides watsoni*, Canthf – *Cantharis fusca*, Platas – *Platynus assimilis*, Staer – *Staphylinus erythropterus*, Omalri – *Omalium rivulare*, Tachsi – *Tachinus signatus*, Athfun – *Atheta fungi*, Protes – *Prosternon tesselatus*, Philco – *Philonthus cognatus*, Arinod – *Aridius nodifer*, Stecla – *Stenus clavicornis*, Geoste – *Geotrupes stercorarius*, Xantli – *Xantholinus linearis*, Oxyrug – *Oxytelus rugosus*, Pterni – *Pterostichus nigrita*, Phille – *Philonthus lepidus*, Rugruf – *Rugilus rufipes*, Tachch – *Tachyporus chrysomeloides.*

to the agricultural landscape formed by fields and pastures mainly (3 and 4). The characteristic species are typical eurytopic (e.g. carabids *Poecilus versicolor* and *P. cupreus*, *Pterostichus melanarius, Amara familiaris*) or species living in the dung (e.g. staphylinid species *Philonthus varians*).

The third pair of biotopes after beetle communities empassed plantations situated close to forest biotopes (plots 3 and 4). Some forest species are representative (e.g. carabus species *Pterostichus oblongopunctatus* or staphylinid species *Philonthus decorus*). The protected carabid species *Carabus scheidleri scheidleri* occurs in these plantations only.

Ordination of beetle species after selected months

Ordination of beetle species after months of the year indicate the clear differences in the separate months (Fig. 2). The highest activity of beetles was found in June-July and the lowest in April-October. The absence of the second higher activity in the autumn is typical for man affected biotopes.

carabids *Carabus hortensis hortensis, Platynus assimilis,* staphylinids *Olophrum assimile, Philonthus decorus,* etc.). On the other site some eurytopic species are typical for these plantations too (e.g. carabidd species *Carabus granulatus granulatus,* staphylinids *Atheta fungi, Tachinus signatus, Rugilus rufipes,* etc.).

The effect of man on beetle communities after the frequency of different ecological groups

The ecological structure of beetle communities discovered by the pitfall trapping in individual plots differed very distinctly (Fig. 4). The stenotopic species of the Group R1 was not found. The fre-

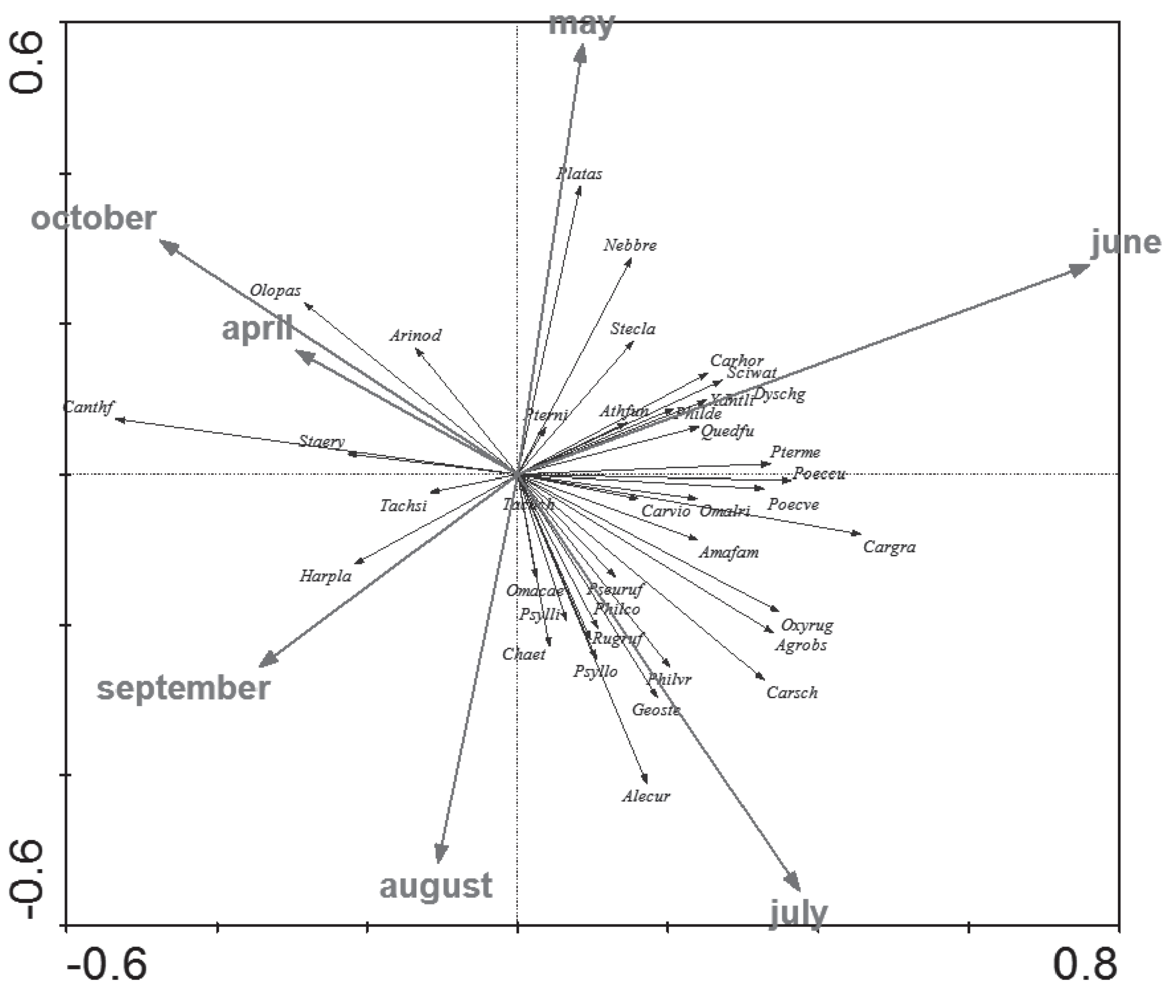

Fig. 2. Ordination beetle species after selected months. Abbreviations of species see Fig. 1.

Ordination of beetle species after number of tress and human impact on the surrounding landscape

Ordination of beetle species by PCA (Fig. 3) indicates the evidential effect of human impact on the beetle communities in studied plantations. The characteristic for plots with the increased man impact is the absence of stenotopic species (e.g.

quency of ubiquitous beetle species (Group E) was the highest (about 90 %) on the plot 3 and 5. The reason of this fact is the intensively managed surroundings of the plot 3 and dry soils with shallow horizont in the plot 5. The frequency of these eurytopic species is relatively the same (50 – 70 %) in other plots. The lowest frequency of ubiquitous species and highest frequency of anthropotolerant spe-

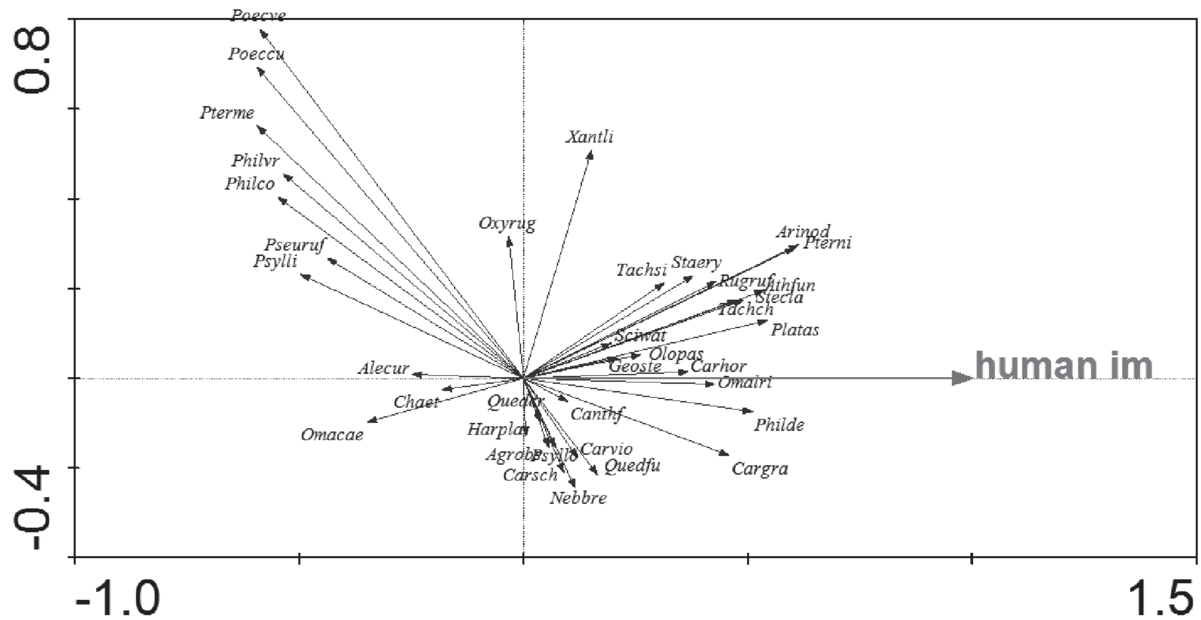

Fig. 3. Ordination of beetle species by PCA (activity of species is increasing in the direction of arrow). The abbreviations of species see Fig. 1.

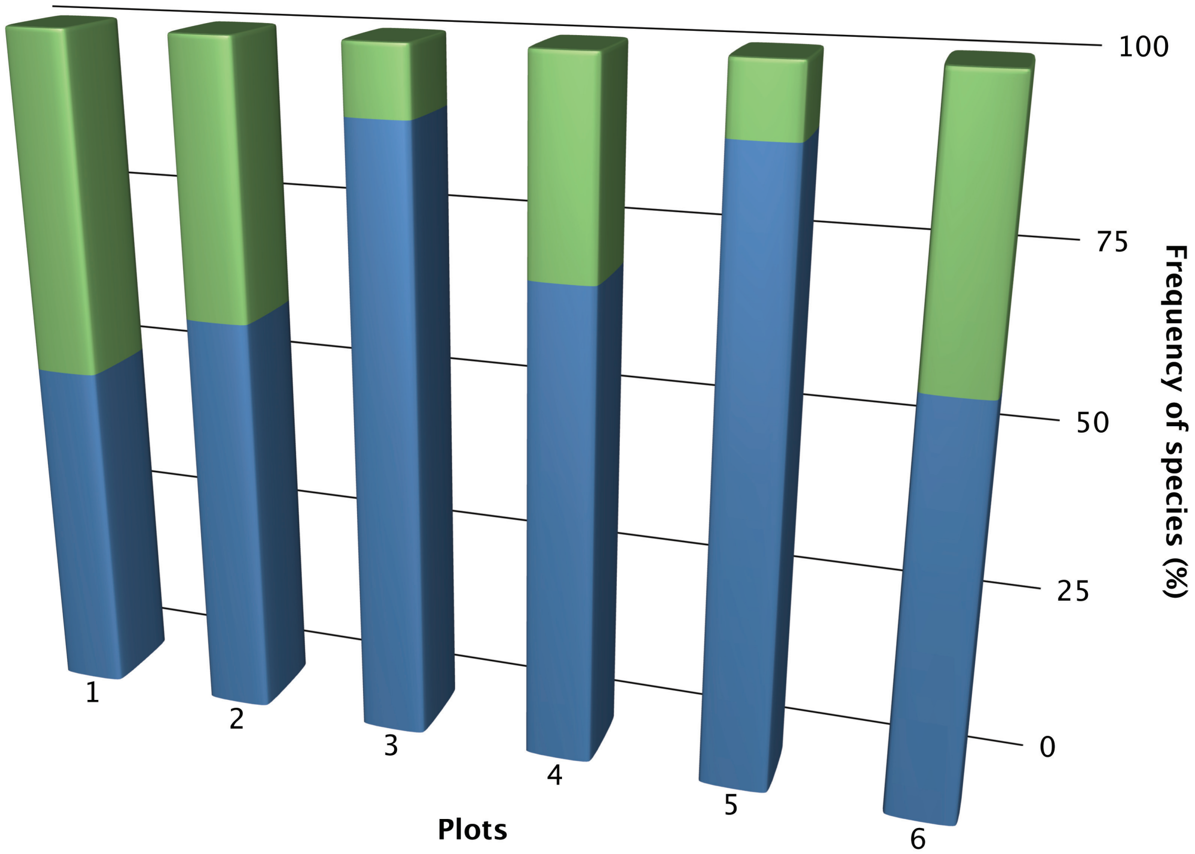

Fig. 4. The effect of man activities on ecological structures of epigeic beetle comunities (R2 – relic species of the second order, upper part of column, E – ubiquitous species, botoom part of column) in studied experimental plots on energy biomass tree plots (1-6).

cies was found on the plot 1. This is caused by the microclimatic and soil conditions of wold, which is very suitable for soil and epigeic invertebrates. The short distance of plantations 2 and 6 to forests or pond is the reason of the higher frequency of anthropotolerant beetle species.

Migration possibilities of selected model species

The success in reaching of original biotope (plantations 3 or 4) by labelled carabid and staphylinid species was very low. The distance 100 m was crossed by 2 males and 1 female of *Carabus granulatus granulatus* and 1 female of *Carabus violaceus violaceus*. The small specimens of carabid beetle *Platynus assimilis* and staphylinid beetle *Philonthus decorus* were not recaptured.

Discussion

The diversity of arthropods and ground beetle especially was studied in plantations of energy biomass plants in England (Semere & Slater, 2007). It was found that the diversity of ground beetles and butterflies was higher in miscanthus plantations than in the surrounding fields of reed canary-grass. It was assumed, that plantations of miscanthus can serve as a biocentrum for beneficial arthropods in simple agricultural landscape. This result were supported by our study on poplar, willow and alder plantations.

The number of epigeic beetle species differs after our results. The microclimatic characteristics (e.g. soil moisture) has the main effect on the surface irregularity (the presence of litter) on tree plantations (Boháč et al., 2005). It is known that small elevations formed by plants and their rests by the forceless management in agricultural biotopes play the positive role as the shelter for epigeic beetles (Luff, 1966; Sotherton, 1985; Boháč et al., 2005). All mentioned characteristics create optimal condition for mesophilous carabid and staphylinid species which were found in bio-energy plantations of trees (e.g. staphylinids *Olophrum assimile, Acidota cruentata*). These species settle wet seminatural habitats (wet forests, springs, peat bogs, shores of ponds and streams).

Beetles species related to fungi were found exclusively in plantations closed to forests (e.g. staphylinids *Mycetoporus erichsonanus, Geostiba circellaris*). Even some typical forest species (e.g. *Pterostichus oblongopunctatus* and *Philonthus decorus*) maintained relatively large populations in studied plantations. They seems to be more flexible than other forest species and may quickly occupy new biotopes similar to forest.

The absence of the second higher activity in the autumn is typical for man affected biotopes (Holland, 2002).

The migration possibilities of ground beetles and staphylinid beetles is relatively great (Tischler, 1977; Boháč, 1999; May, 2005). The likelikehood of recapture of small species is lesser than for the great one on the other site (Boháč et al., 2004). It was the reason that only great species of ground beetles were recaptured in our study.

We can conclude, that the plantations of energy biomass trees have the high biodiversity of epigeic and hemiedaphic beetles. The communities of beetles differs markedly from other in agricultural landscape by the higher frequenfy of more sensitive anthropotolerant species. The frequency of ubiquitous species is clearly lower than in agricultural landscape. The character of surrounding landscape and the intensity of the man effect on the landscape affetcs the structure of beetle communities. There were no found statistically evidential effect of the number of trees in plantations on beetle communities.

Acknowledgement

The research presented here was supported by the the Research Intention of the Ministery of Education and Youth of the CR No. MŠMT 2B06131.

REFERENCES

Boháč J. 1999: Staphylinid beetles as bioindicators. Agriculture, Ecology and Environment, **74**: 357-372.

Boháč J. 2003. The effect of environmental factors on communities of carabid and staphylinid beetles (Coleoptera: Carabidae, Staphylinidae). in: Frouz, J., Šourková, M., Frouzová, J. (eds.): Soil physical properties and their interactions with soil organisms and roots of plants, Institute of Soil Biology AS CR, České Budějovice: 113-118.

Boháč J., Frouz J. & Syrovátka O. 2005. Carabids and staphylinids in seminatural and drained peat meadows. Ekológia (Bratislava), **24**: 292-303.

Boháč J., Hanousková I. & Matějka K. 2004. Effects of habitat fragmentation due transportation impact with different intensity on epigeic beetle communities in cultural landscape. Ekológia (Bratislava), **24**: 35-46.

Braak C. J. F. & Šmilauer P. 1998. CANOCO Release 4. Reference manual and user`s guide to Canoco for Windows: Software for Canonical Community Ordination. Microcomputer Power, Ithaca, NY.

Holland J. M. (ed.) 2002. The agroecology of carabid beetles. Intercept Ltd., Andover, 356 pp.

Hůrka K., Veselý J. & Farkač J. 1996. Using of carabid beetles for bioindication of the environmental quality (in Czech). Klapalekiana, **32**: 15-26.

Luff M. L. 1966. The abundanse and diversity of beetle fauna of grass tussocks. Journal of Applied Ecology, **35**: 189-208.

New T. R. 2005. Invertebrate conservation and agriculotural ecosystems. Cambridge University Press, Cambridge, New York, Melbourne, Madrid, Cape Town, Singapore, Sao Paolo: 354 pp.

Semere T. & Slater F. M. 2007. Invertebrate populations in miscanthus (*Miscasnthus x giganteus*) and reed canary-grass (*Phalaris arundinacea*) fields. Biomass & Bioenergy, **31**: 30-39.

Semere T. & Slater F. M. 2007a. Ground flora, small mammal and bird species diversity in miscanthus (*Miscanthus x giganteus*) and reed canary-grass (*Phalaris arundinacea*) fields. Biomass & Bioenergy, **31**: 20-29.

Sotherton N. W. 1985. The distribution and abundance of predatory Coleoptera overwintering in field boundaries. Appl. Biol., **106***:* 17-21.

Šustek Z. 1994. Impact of water management on carabid community (Insecta, Coleoptera) in a Central European floodplain forest. Quad. Staz. Ecol. Civ. Mus. St. Nat. Ferrara, **6**: 293-313.

Thiele H. U. 1977. Carabid beetles in their environments. Springer Verlag, Berlin, Heidelberg, New York, 369 pp.

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Received: 24.11.2007
Accepted: 14.12.2007
Printed: 28.10.2008