

## SEASONAL CHANGES IN ABUNDANCE AND DIVERSITY OF GROUND BEETLES (COLEOPTERA: CARABIDAE) IN TWO NATURAL HABITATS OF THE JAMAICA BAY WILDLIFE REFUGE

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**Abstract.** Spatial and temporal variation in the species composition, seasonal abundance and diversity of ground beetles were studied in two sites: wet meadow (site 1) and shrub thickets (site 2), both located in the Jamaica Bay Wildlife Refuge (Gateway National Recreation Area, New York). Ground beetles (Carabidae) were pitfall-trapped from May to October 2008. A total of 230 individuals of carabids representing 34 species were collected in the vegetative season, 91.2% of which represented autochthonous and 8.8% introduced species. Totals of 210 individuals representing 27 species and 20 beetles representing 11 species were trapped from site 1 and site 2, respectively. Harpalinae was the most abundant subfamily, with a total of 20 species: this subfamily contributed to 77.39% of all caught individuals. *Chlaenius sericeus* (FORSTER, 1771) was the most abundantly collected species from the site 1, and it was mostly trapped in spring and summer. *Calathus opaculus* LECONTE, 1854 was the abundantly species trapped from the site 2. The majority of carabids trapped from the site 1 belonged to species overwintering as adults, but those trapped from the site 2 belonged to species overwintering as larvae. Carabids activity culminated in site 1 in spring-summer, and decline in autumn, but in site 2 activity culminated in spring and autumn. The ratio of female to male in all carabids caught in the traps in both sites was 1.34:1. Species richness, number of specimens and diversity were much higher in site 1.

**Keywords:** Carabidae, diversity, seasonal abundance, sex ratio.

**Rezumat. Dinamica activității sezoniere și diversitatea carabidelor (Coleoptera: Carabidae) în două habitate naturale din Refugiul Natural Jamaica (JBWR).** A fost cercetată compoziția specifică, activitatea sezonieră și diversitatea carabidelor din două habitate naturale: lunca umedă și desiș de arbuști, ambele situate în Refugiul Jamaica (Jamaica Bay Wildlife Refuge (Gateway National Recreation Area, New York)). Carabidele au fost colectate cu ajutorul capcanelor Barber în perioada lunilor mai - octombrie, 2008. În total au fost capturați 230 indivizi, ceea ce reprezintă 34 specii, dintre care 91,2% au constituit specii autohtone (nearctice) și 8,8% specii introduse europene sau eurosiberiene. În lunca umedă, în capcane au fost colectați 210 indivizi ce reprezintă 27 specii, în desișul de arbuști, 20 indivizi ce reprezintă 11 specii. Subfamilia Harpalinae a fost cea mai abundentă, cu un total de 20 specii reprezentând 77,39% total indivizi capturați. În primul habitat *Chlaenius sericeus* (FORSTER, 1771) a fost cea mai abundentă specie și s-a capturat în capcane (în special primăvara și vara), iar în cel de-al doilea habitat, specia cea mai abundentă a fost *Calathus opaculus* LECONTE, 1954. Majoritatea carabidelor colectate în lunca umedă sunt specii ce iernează în stadiul de adult, iar în desișul de arbuști, specii ce iernează în stadiul de larvă. În lunca umedă, vârful de activitate a adulților a fost cea mai mare în perioada de primăvară-vară, cu activitate scăzută în toamnă, în timp ce în desișul de arbuști cea mai intensă activitate a adulților s-a observat primăvara și toamna. Raportul femelelor față de masculi (sex ratio) a tuturor carabidelor capturate în capcanele Barber din ambele habitate a fost 1,34:1. Bogăția specifică, numărul de indivizi și diversitatea, au fost în general mai mari în lunca umedă.

**Cuvinte cheie:** Carabidae, diversitate, abundență sezonieră, raportul sexelor.

### INTRODUCTION

The Jamaica Bay Wildlife Refuge (JBWR), a unit of Gateway National Recreation Area, is one of the most important urban wildlife refuges in the USA, and is the largest bird sanctuary in the northeastern United States. Encompassing 3.662 ha it is comprised of diverse habitats including open fields, shrub thickets and developing woodlands, wet meadows and salt marshes, several fresh and brackish water ponds and an open expanse of bays and islands - all located within the limits of New York City. More than 325 species of birds have been recorder here during the last 25 years.

In the Jamaica Bay region there have been observed 69 species of butterflies (Lepidoptera) restricted to one or more habitat types (INGRAHAM et al., 1989), but generally, little is known about the insects of this area. The objectives of this study were to 1) evaluate the seasonal activity patterns of carabids in two habitats (wet meadow, shrub thickets) by using pitfall traps and to examine the factors influencing their peak of activity; 2) investigate the richness and diversity of carabid species during the research period in both sites in each season (Simpson's and Shannon's diversity indices, and equitability); 3) estimate the abundance and population structure of ground beetles in three sampling periods in two different habitats, located in the JBWR.

### MATERIAL AND METHODS

Both study sites were established in the East Pond of JBWR, located on the east side of Cross Bay Boulevard, Queens, NY. The site 1 was a wet meadow. We have chosen this site as an open habitat, consisting of small herbaceous plants with few vertical plant components, predominantly the reed growing along water shores. The soil consists of organic matter, sand, gravel and it was permanently moist. The site 2 was selected as a shrub thicket. This type of habitat was semi-open, consisting of many species of herbaceous plants, bushes and some scarcely growing trees. The

soil was sandy and permanently dry during the growing season. The surface of soil was covered by a thin layer of leaf-litter.

The Carabids were sampled in spring, summer, autumn by using pitfall traps consisting of plastic jars (08 cm diameter by 10 cm deep) buried in the ground even with the surface and filled with a solution of white vinegar (100 ml in each trap). In each habitat type 10 pitfall traps were installed in May, July and October.

The distance between the set traps was 10 m. The traps were exposed for 7 days in each of the above month (May, July, and October). All captured insects from the traps were transported in the laboratory and were washed, counted, separated by sex. Some manually collected individuals were preserved in 70% alcohol for further identification, but many species were kept in the laboratory in order to study their behaviour, life cycle and type of reproduction.

The classification of the Carabidae was taken from LAWRENCE & NEWTON (1995), and ARNETT JR. & THOMAS (2000). The works of ARNETT JR. & THOMAS (2000), DOWNIE & ARNETT JR. (1996), NOONAN (1991), LIEBHERR (1986) and ERWIN (1974) were used as identification key for the majority of species. The Microscope MBS-9 (LOMO) was used for identification of species and separation by sex.

Adults and immature stages of beetles are deposited at the Division Natural Resources GNRA, New York, and at the Jamaica Bay Institute, GNRA, New York.

## RESULTS AND DISCUSSIONS

**Species Abundance and Diversity.** Insect populations of the carabids were collected in V, VII and X months of year 2008. In both sites 230 individuals of 34 species were caught. They belong to 16 genera, 12 tribes, and 6 subfamilies (Table 1). The carabids of both sites differed significantly in the abundance and species richness. The total number of beetles caught in the wet meadow comprised 210 individuals, but the number of species is 27. In the shrub thickets the total number of captured beetles comprised only 20 individuals and 11 species. All beetles collected in the spring in both sides comprised 106 individuals, 94 in the summer, and 30 in the autumn, while 27 species were recorded in the spring, 20 in the summer and 12 in the autumn, respectively. The species of the subfamily Harpalinae were the most abundant, with a total of 20 species: this subfamily contributed to 77.39% of all caught individuals. The species occurring in both sites were *Stenolophus infuscatus* (DEJEAN, 1829), *Paratachys pumilus* (DEJEAN, 1831) and *Scarites subterraneus* (FABRICIUS, 1775). *Chlaenius sericeus* was by far the most abundant species, making up 17.39% of the individuals total. *Stenolophus infuscatus* was the next most abundant species overall, with 10.43% of the total individuals. *Chlaenius impunctifrons* SAY, 1823 made up 10.00% of all carabids trapped. The following eight species *Agonum ferreum* (HALDEMAN, 1843), *Agonum melanarium* (DEJEAN 1828), *Omophron labiatum* (FABRICIUS 1801), *Pterostichus caudicalis* (SAY, 1823), *Calathus opaculus* LECONTE, 1854, *Agonum decorum* SAY, 1823, *Poecilus lucublandus* (SAY, 1823), and *Paratachys pumilus* made a total of 3-8% of the total catch; 6 species *Scarites subterraneus*, *Oodes americanus* DEJEAN, 1826, *Oodes amaroides* DEJEAN, 1831, *Dyschirius aeneolus* LECONTE, 1850, *Omophron nitidum* LECONTE, 1848, *Omophron tessellatus* SAY, 1823, represented 1-2%; other 17 trapped species represented less than 1% each.

Of the total carabids found in the JBWR, three species have been introduced to North America from Palaearctis. *Carabus nemoralis* O. F. MULLER species was found in the site 1 in summer and autumn, whereas *Pterostichus melanarius* (ILLIGER, 1798) and *Harpalus rubripes* (DUFTSCHMID, 1812) was found in the site 2 in autumn and in spring, respectively. These species constituted 8.8% of the total number of species collected in the investigation period. The most abundant species in the site 1 were *Chlaenius sericeus* (19.04%), *Chlaenius impunctifrons* (10.95%), *Stenolophus infuscatus* (10.00%), *Agonum ferreum* (9.52%), *Agonum melanarium* (8.57%) and *Omophron labiatum* (8.57%).

In the site 2 *Calathus opaculus* was the most abundant species and comprised 35.00% of total number of carabids caught in this site. *Agonum ferreum* was captured only in spring in 70% of traps, *Paratachys pumilus* was found in 50% of traps, whereas *Agonum melanarium*, *Stenolophus infuscatus* and *Oodes americanus* were collected in 40% of traps.

In the site 1 the average number (mean  $\pm$  SE) of individuals per trap collected were  $4.8 \pm 1.23$  in the spring,  $5.3 \pm 1.62$  in summer and  $2.1 \pm 0.45$  in autumn carabids per week, whereas in the site 2 in spring  $1.5 \pm 0.37$ , in summer  $1.3 \pm 0.28$  and in autumn  $3.0 \pm 1.94$  per week. In both sites the average catches of specimens per 10 traps per day also varied: in site 1 the average catches constitute in spring 14.3 specimens per 10 trap per d., in summer – 13.0, in autumn – 2.7, whereas the average catches in the second site is also lower than in the first site, and constituted in the spring 1.3 specimens per 10 trap per d., in the summer 0.4, and in the autumn 1.7.

In the wet meadow the occurrence of the species *Chlaenius sericeus*, *C. impunctifrons*, *Stenolophus infuscatus* culminated in summer, representing the highly dominant species. This culmination is reflected by higher values of the Simpson index (index of dominance concentration) or, correspondingly, by a decline of Shannon's index. In spring and autumn, the representation of species *Agonum ferreum*, *Chlaenius sericeus*, *Agonum melanarium*, *Omophron labiatum* was more balanced in the reproduction period when the beetles were more active for mating, food and egg laying.

On the contrary, in the shrub thicket the species *Calathus opaculus*, *Stenolophus infuscatus* become dominant in summer and autumn. It was reflected by the increase of the Simpson's index in both seasons and decline of the Shannon's index and equitability.

Table 1. Survey of species, number of individuals and dominance of carabid in wet meadow and shrub thickets between May and October 2008.

Tabel 1. Lista speciilor, numărul indivizilor și dominața carabidelor în rezervația Jamaica Bay Wildlife Refuge în mai-octombrie 2008.

Species	Wet meadow		Shrub thickets	
	N	% Total	N	% Total
<i>Chlaenius sericeus</i> (FORSTER, 1771)	40	19.04	-	-
<i>Stenolophus infuscatus</i> (DEJEAN, 1829)	21	10.00	3	15.00
<i>Chlaenius impunctifrons</i> SAY, 1823	23	10.95	-	-
<i>Agonum ferreum</i> (HALDEMAN, 1843)	20	9.52	-	-
<i>Agonum melanarium</i> DEJEAN, 1828	18	8.57	-	-
<i>Omophron labiatum</i> (FABRICIUS, 1801)	18	8.57	-	-
<i>Pterostichus caudicalis</i> (SAY, 1823)	10	4.76	-	-
<i>Calathus opaculus</i> LECONTE, 1854	-	-	7	35.00
<i>Agonum decorum</i> (SAY, 1823)	9	4.28	-	-
<i>Poecilus lucublandus</i> (SAY, 1823)	8	3.80	-	-
<i>Paratachys pumilus</i> (DEJEAN, 1831)	7	3.33	1	5.00
<i>Scarites subterraneus</i> FABRICIUS, 1775	2	0.95	2	10.00
<i>Oodes americanus</i> DEJEAN, 1826	4	1.90	-	-
<i>Dyschirius aeneolus</i> LECONTE, 1850	4	1.90	-	-
<i>Omophron nitidum</i> LECONTE, 1848	3	1.42	-	-
<i>Omophron tessellatum</i> SAY, 1823	3	1.42	-	-
<i>Oodes amaroides</i> DEJEAN, 1831	3	1.42	-	-
<i>Carabus nemoralis</i> O.F. MÜLLER*	2	0.95	-	-
<i>Nebria lacustris</i> CASEY, 1913	2	0.95	-	-
<i>Calathus gregarius</i> (SAY, 1823)	1	0.47	1	5.00
<i>Clivina striatopunctata</i> DEJEAN, 1831	-	-	1	5.00
<i>Clivina rufa</i> LECONTE, 1857	2	0.95	-	-
<i>Clivina americana</i> DEJEAN, 1831	2	0.95	-	-
<i>Agonum palustre</i> GOULET, 1969	2	0.95	-	-
<i>Amara crassispina</i> LECONTE, 1855	-	-	1	5.00
<i>Chlaenius emarginatus</i> SAY, 1823	2	0.95	-	-
<i>Chlaenius lithophilus</i> SAY, 1823	-	-	1	5.00
<i>Agonum lutulentum</i> (LECONTE, 1854)	-	-	1	5.00
<i>Harpalus rubripes</i> (DUFTSCHMID, 1812)*	-	-	1	5.00
<i>Dyschirius globulosus</i> (SAY, 1823)	1	0.47	-	-
<i>Paratachys proximus</i> (SAY, 1823)	1			5.00
<i>Pterostichus melanarius</i> (ILLIGER, 1798)*	-		1	
<i>Badister transversus</i> CASEY, 1920	1	0.47	-	-
<i>Omophron americanum</i> DEJEAN, 1831	1	0.47	-	-
34	210		20	

**Legend:** \* - a species introduced from the Palearctic (LINDROTH, 1966; KRYZHANOVSKIJ, 1983; KRYZHANOVSKIJ et al., 1995; BOUSQUET & LAROCHELLE, 1993)

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**Sex Ratio.** In the wet meadow females prevailed (59.1%), while in the shrub thickets the males were more abundant (55.0%) (Table 3). The male / females ration varied at different seasons. In spring females predominated

(60.6%), the males representing 39.4% of the catch, in summer females represented 57.3% and males 42.7%, in contrast in autumn males moderately predominated 52.0% over the females 48.0%.

Table 2. Diversity indices and equitability of carabids in both sites during the sampling period (2008).  
Tabel 2. Indicii diversității și echitabilitatea carabidelor din ambele habitate în perioada de colectare (2008).

Habitat	Spring	Summer	Autumn
Wet meadow	D = 0.332 ± 0.004 H' = 3.655 ± 0.193 E = 1.145	D = 0.441 ± 0.007 H' = 3.246 ± 0.192 E = 1.055	D = 0.328 ± 0.003 H' = 2.944 ± 0.438 E = 0.855
Shrub thickets	D = 0.368 ± 0.013 H' = 2.416 ± 0.494 E = 1.660	D = 0.664 ± 0.016 H' = 1.520 ± 0.498 E = 1.320	D = 1.457 ± 0.073 H' = 1.417 ± 0.335 E = 0.401

Legend: D – Simpson’s index; H’ – Shannon’s index; E – equitability.

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More females than males were captured in the site 1 in spring (66.4%) and summer (57.1%), while in autumn the count of females was lower than the males (47.4%). In the site 2 there were more males (66.6%) than females (33.4%) whereas in summer there were more females (60.0%) than males (40.0%), but in autumn there was captured the same count of females and males. The sex ratio of carabids in spring, summer and autumn in both sites is given in Table 4. In both sites the average catches also varied per trap per week. In the site 1, in spring 3.9 ± 0.92 females and 2.6 ± 0.65 males were found per trap per week, in summer 3.2 ± 0.84 females and 3.9 ± 1.11 males, and in autumn 1.28 ± 0.19 females and 1.60 ± 0.54 males. In the site 2 in spring 1.1 ± 0.18 males were collected per trap per week, whereas in summer and autumn the number of males decreased; on the contrary, the number of females in spring and summer were lower, but in autumn 1.5 ± 0.70 females were collected per trap per week.

Table 3. The total catch and sex ratio (in %) of carabids in both habitats in 2008.  
Tabel 3. Sex ratio (in %) și numărul total de carabide capturate în 2008.

Habitat	Σ (Captured individuals)	♂♂	♀♀
Wet meadow	210	40.9	59.1
Shrub thickets	20	55.0	45.0

The female / male ratio in the most abundant species *Chlaenius sericeus*, *Stenolophus infuscatus*, *Chlaenius impunctifrons*, *Agonum ferreum*, *Agonum melanarium*, and *Omophron labiatum* was 1.35:1, 0.90:1, 0.91:1, 1.31:1, 2.00:1, and 2.40:1, respectively. Thus, for the following four species *Chlaenius sericeus*, *Agonum ferreum*, *Agonum melanarium* and *Omophron labiatum* the percentage of females was significantly predominant, while the males predominated in *Stenolophus infuscatus* and *Chlaenius impunctifrons*.

Table 4. The sex ratio (in %) of carabids in both habitats during the growing season of 2008.  
Tabel 4. Sex ratio (in %) al carabidelor capturate din ambele habitate în perioada de vegetație (2008).

Growing season	Wet meadow		shrub thickets	
	♂♂	♀♀	♂♂	♀♀
Spring	33.6	66.4	66.6	33.4
Summer	42.9	57.1	40.0	60.0
Autumn	52.6	47.4	50.0	50.0

**Seasonal changes in activity of Carabids.** The analysis of dynamics of carabids in the study sites has shown that the carabids activity was seasonal. In the site 1 the variations in the activity of adults in spring and summer were very similar. In the spring spring-summer breeders (*Agonum ferreum*, *Chlaenius sericeus*, *A. melanarium* and *Omophron labiatum*) predominated, comprised 60.0% of all individuals, while in summer, the species *Chlaenius sericeus*, *Chlaenius impunctifrons*, *Stenolophus infuscatus*, comprised 59% predominated. Three species *Chlaenius sericeus*, *Chlaenius impunctifrons* and *Omophron labiatum* were active in this site throughout the growing season. *Chlaenius sericeus* was captured in 70% of traps in spring, in 80% in the summer, and in 20% of traps in autumn; the second wide-spread species *Chlaenius impunctifrons*, occurred in spring in 10%, in summer in 70% and in autumn in 40% of traps; the third species *Omophron labiatum* in the spring was captured in 20% of traps, in the summer in 10%, and in autumn in 30% of traps. Six species, *Omophron nitidum*, *Clivina americana*, *Scarites subterraneus*, *Agonum decorum*, *Pterostichus caudicalis* and *Pterostichus lucublandus* were active in spring and summer; three species, *Omophron tessellatus*, *Carabus nemoralis*, and *Stenolophus infuscatus* were active in spring and autumn or in summer and autumn; 13 species, *Nebria lacustris*, *Clivina rufa*, *Dyschirius globulosus*, *Dyschirius aeneolus*, *Paratachys pumilus*, *Badister transversus*, *Chlaenius emarginatus*, *Chlaenius lithophilus*, *Oodes americanus*, *Oodes amaroides*, *Agonum ferreum*, *Agonum palustre*, *Agonum melanarium* were active either in spring, in summer or in autumn. The activity of adults in the site 2 peaked in autumn due a high dominance of *Calathus opaculus*, comprising more 35.0% of

all individuals. This species was active in spring and autumn. *Scarites subterraneus* and *Stenolophus infuscatus* were active in spring and summer. *Scarites subterraneus* was found in 10% of traps in both seasons, whereas *Stenolophus infuscatus* occurred in both season in 20% of traps.

Altogether 34 carabid species belonging to 16 genera were recorded, but this number is lower than the actual number of carabids species in the study area. The majority of the collected species are native and widely distributed in North America. There are significant differences in abundance, species richness and diversity indices of Carabids communities between both sites. The site 1 was located near water and had permanently moist soil. Thus it offers more suitable conditions for hydrophilous carabids like *Chlaenius sericeus*, *Stenolophus infuscatus*, *Chlaenius impunctifrons*, *Agonum ferreum*, *Agonum melanarium*, *Omophron labiatus*, *Pterostichus caudicalis* best characterized the site 1 (Table 1). Other less common species of the genera *Agonum* BONELLI, 1810; *Poecilus* BONELLI, 1810; *Paratachys* CASEY, 1918; *Oodes* BONELLI, 1810; *Dyschirius* BONELLI, 1810 and *Omophron* LATREILLE, 1802 were restricted in this site (4-9 specimens). They occurred in spring and summer and they may be also taken as characteristic species for this site. The higher values of Shannon's index in all growing seasons in this site could be related also to the suitable hydrologic conditions and simultaneous occurrence of several hydrophilous species. The value of this index decreased here from spring to autumn (Table 2). Laboratory rearing and field observations of most recorded carabids species (Neculiseanu, unpublished data) showed than to be spring-summer breeders, overwintering as adults, starting to be active in early April. In early May the males were more active than females, in looking for mating. Copulation of some species was observed in May at different time of the night and sometimes also by day on the ground surface. Our survey (Neculiseanu, unpublished data) showed that the first copulations of *Chlaenius sericeus*, *Agonum decorum*, *Poecilus lucublandus*, *Pterostichus caudicalis*, and *Scarites subterraneus* species occurred on September 05.09.08, 05.11.08, 05.07.08, 05.12.08, and 05.10.08, respectively. After first mating females became very active for food and egg laying. So, at the end of May, when pitfall traps were installed in site 1, more females than males were collected (63 ♀♀ and 37 ♂♂). The females continue to be active during the entire reproductive period until early August. Thus, in the summer, when the traps were installed (the end of July) also more females than males (52 ♀♀ and 39 ♂♂) were collected. After this period, the activity of females decreased until autumn. So in autumn sample (traps installed in the first half of October), approximately the number of females and males was almost equal (9 ♀♀ and 10 ♂♂). Thus, we observed asynchronous seasonal activity of males and females; in spring and summer the females predominated in wet meadow, but in the autumn, after the reproduction period, both sexes occurred in the equal proportion. The site 2 (dry habitat) dramatically differed from the first habitat and the number of individuals, species, and the average number of catches of individuals per trap per week and per 10 traps per day was lower than site 1 during the research period. The low humidity in this habitat caused these beetles to become less active and, probably, to enter into aestivation.

The lower values of Shannon index in all vegetative season in the site 2 could be also related with very harsh climatic conditions. The decrease of diversity indexes of this site was observed in the same order as in the site 1: spring → summer → autumn (Table 2). This site attracted more the summer-autumn breeders. *Calathus opaculus*, *C. gregarina*, *Harpalus rubripes* and other species belonging to *Clivina*, *Amara*, *Paratachys* are species well adapted to dry conditions, that is why they were captured in the sampling period. It is most likely that other factors also affected the carabid populations in their habitats. The adults and larvae of most species of *Agonum* (BONELLI, 1810; *Carabus* LINNAEUS, 1758; *Chlaenius* BONELLI, 1810; *Calathus* BONELLI, 1810; *Omophron* LATREILLE, 1802; *Clivina* LATREILLE, 1802; *Nebria* LATREILLE, 1806; *Pterostichus* BONELLI, 1810; *Poecilus*; *Scarites* FABRICIUS, 1775; *Stenolophus* DEJEAN, 1821; *Paratachys* consume different type of food, but prefer arthropods, especially insects and their immature stages. These species, which comprise more than 90% of all captured carabids have the potential to be important predators in their habitats.

**Invasive carabids in research habitats.** Occurrence of three non-native carabid species, *Carabus nemoralis*, *Pterostichus melanarius* and *Harpalus rubripes* introduced from the Palaearctis were recorded in our study. These species constituted 8.8% of the total number of species recorded by us. No of them exceeded 1% of the total caught individuals. *Carabus nemoralis* occurred in the site 1 in summer and autumn. This species is a monovoltine, summer-autumn breeder, overwinters as larva and adult (HÜRKA, 1973), prefer the mixed broad-leaved forests (GEORGII, 1986; NECULISEANU & MATALIN, 2000; NECULISEANU, 2003a), but sometimes occur in the urban habitats, with abundant tree vegetation (KRYZHANOVSKIJ, 1983). Some authors showed that *Carabus nemoralis* is abundantly found in both open and closed habitats (HÜRKA, 1973; ZELAZNA & BLAZEJEVICH-ZAWADZINSKA, 2005). This Eurosiberian species distributed in Europe (West, Central, Eastern), in the Urals (Southern), easterly of the Urals it is known in West Siberia (Southern) and Tian-Shan (northern) (KRYZHANOVSKIJ, 1983; KRYZHANOVSKIJ et al. 1995; ZELAZNA & BLAZEJEVICH-ZAWADZINSKA, 2005). In North America this species has been found in city gardens and open woods (DOWNIE & ARNETT, 1996), and is distributed in 13 states of USA (DOWNIE & ARNETT, 1996) and in 33 geographical entities of Mexico (BOUSQUET & LAROCHELLE, 1993). The other introduced species *Pterostichus melanarius* was caught in the site 2 in autumn. This eurytopic species overwinters as larva, seldom as adult (LINDROTH, 1992; HÜRKA, 1975; TOMLIN, 1975; BOUSQUET, 1999; NECULISEANU, 2003a). Some authors consider it to prefer open habitats and to be well adapted to arable land (KRYZHANOVSKIJ, 1983; SHELTON et al. 1983; DESENDER & ALDERWEIRELDT, 1988 et al.). Many authors also found this species in forests (GEORGII, 1986; VARVARA & ZUGRAVU, 2004) and gardens (GOULET et al., 2004; ZELAZNA & BLAZEJEVICH-ZAWADZINSKA, 2005). Other authors showed that this species is caught either from agricultural habitats or from forests (MEDVEDEV & SHAPIRO, 1957; NECULISEANU, 1991; 2003b; NECULISEANU &

MATALIN, 2000). *Pterostichus melanarius* (eurosiberian species) is distributed in Europe, Caucasus region (Major, Minor, Central), the Eastern part of the Urals namely West Siberia (Northern, Middle, Southern), over the Plains of Kazakhstan, Altai-Sayan Mt. Land and Middle Siberia (KRYZHANOVSKIJ, 1965; 1983; FREUDE et al., 1976; KRYZHANOVSKIJ et al., 1995; ZELAZNA & BLAZEJEVICH-ZAWADZINSKA, 2005). Its introduction was first recorded in North America in 1926 in Nova Scotia (LINDROTH, 1966). Now it is known in 13 states of USA (DOWNIE & ARNETT, 1996), in America North of Mexico is distributed in 26 geographical entities. *Pterostichus melanarius* has a wider distribution in North America, especially in the northern states and Canada. (BOUSQUET & LAROCHELLE, 1993). Non-native *Harpalus rubripes* was also collected in the site 2, mostly in spring. It is a mixophagous summer-autumn breeder, overwintering as larva and adult (BRIGGS, 1965; NECULISEANU, 2003). Some authors (KRYZHANOVSKIJ, 1965; ZELAZNA & BLAZEJEVICH-ZAWADZINSKA, 2005; LER, 1989) consider it to prefer open habitats and other authors found it also in the forest glade. This species has Palearctic distribution, reaching from Europe, Anatolia, Caucasus, Siberia, Kazakhstan, Central Asian Mountains, China (Ganshu) to the South of Primorie and the North Sakhalin (LER, 1989; KRYZHANOVSKIJ et al., 1995; ZELAZNA & BLAZEJEVICH-ZAWADZINSKA, 2005). *Harpalus rubripes* has a more restricted distribution in the North America than other two introduced species. It was first recorded in North America in New Hampshire by BELL & DAVIDSON (1987), and in Connecticut by KRINSKY & OLIVER (1988). BOUSQUET & LAROCHELLE (1993) showed that this species occurs in America, North of Mexico in Connecticut, New Hampshire and Rhode Island. Our data confirm its distribution also in New York.

### CONCLUSIONS

1. In both sites 34 carabid species (230 individuals) belonging to 16 genera, 14 tribes, and 6 subfamilies were recorded from May to October 2008. Autochthonous species represented 91.2% of all species. *Carabus nemoralis*, *Pterostichus melanarius* and *Harpalus rubripes*, introduced from Palaearctis, constituted 8.8% of all species. Harpalinae was the most abundant and richest in species subfamily, comprising 77.39% of all species. The majority of ground beetles species recorded in the site 1 were spring-summer breeders, overwintering as adults, but the species from the site 2 with summer-autumn breeders, overwintering as larvae.

2. Activity of Carabids in the site 1 was greater in spring and summer, and declined in autumn. At that time the activity of spring-summer breeders *Chlaenius sericeus*, *Stenolophus infuscatus*, *Chlaenius impunctifrons*, *Agonum ferreum*, *Agonum melanarium* and *Omophron labiatum* culminated. They comprised about 60.0% of all individuals captured specimens. In the site 2 a greater activity was in spring and autumn, with activity declining in summer. This peak of activity of adults was due to a high dominance species *Calathus opaculus*, which comprised more 40.0% of all individuals.

3. There are significant differences in diversity of carabids in both study lots. The higher values of Shannon's index in all vegetative seasons could be related to good climatic conditions in the site 1 and value of this index decreased here from spring to autumn (3.655, 3.246, 2.944). This index had lower values in all vegetative seasons in the site 2 with harsh climatic conditions but the value of this diversity index also decreases in the same order as in the site 1 from spring to autumn (2.416, 1.520, 1.417). The Simpson's index in the site 1 had the highest value in summer (0.441), but in the shrub thickets this index had the highest value in autumn (1.457).

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