CHANGES IN CARABID COMMUNITIES ALONG THE URBANIZATION GRADIENT IN PYONGYANG (NORTH KOREA)

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Abstract. The Carabids were pitfall trapped and individually collected in Pyongyang in 8 sites along the urbanization gradient from city margin to its centre in September – November 1986 and June – July 1990. Altogether 51 species were recorded, representing 14.7% of the species known to occur in Korea. The communities consisted exclusively of middle and small species (up to 20 mm). There was not found any species of the genus *Carabus*. Absence of non-flying species probably also results from very intensive agricultural exploitation of Pyongyang surrounding. Most species belonged to the genera *Amara* and *Harpalus*, characteristic also in Korean conditions for fields and orchards. The humid climate was reflected by the occurrence of several species of the genus *Chlaenius* even in the very city centre. Urbanisation gradient was manifested by decline on number of species, individuals and diversity index and by increase in relative representation of Transpalaearctic species *Dolichus halensis*, *Pseudoophonus tardus* and *Ansisodactylus signatus*. There can be defined some pairs or groups of vicariant species taking the same position in the (peri)urban ecosystems in East Asia and Europe: *Platynus magnus* x Platynus *assimilis*, *Nebria coreica* x *Nebria brecollis*. *Pseudoophonus sinicus* + *P. simplicidens* + *P. coreanus* + *P. jureceki* x *P. calceatus*, *Curtonotus nitens* x *Curtonotus aulicus.* Generally, the rules of forming the carabid communities in urban conditions in both parts of Palaearctis are very similar.

Keywords: Carabids, communities, urban fauna, Pyongyang, North Korea.

Rezumat. Schimbările cenozelor de carabide de-a lungul gradientului de urbanizare la Pyongyang (Coreea de Nord). Carabidele s-au colectat din 8 locuri în Pyongyang situate de-a lungul gradientului de urbanizare de la marginea oraşului până în centru. Colectările s-au făcut în septembrie – noiembrie 1986 şi iunie – iulie 1990. În total s-au găsit 51 specii, ceea ce reprezintă 14,7% specii cunoscute în Coreea. Cenozele au fost compuse exclusiv din specii mici sau medii (până la 20 mm). În oraş şi împrejurimi n-a fost găsită nici o specie a genului *Carabus*. Absenţa speciilor aptere rezultă şi din exploatarea agrară foarte intensivă a împrejurimilor orasului Pyongyang. Majoritatea speciilor au aparţinut genurilor *Amara* şi *Harpalus,* care sunt caracteristice şi în condiţiile nord coreene pentru agrocenoze şi livezi. Clima umedă a fost reflectată de găsirea câtorva specii ale genului *Chlaenius* chiar în centrul oraşului propriu zis. Gradientul urbanizării a provocat scăderea numărului speciilor, indivizilor şi a indicelui de diversitate, precum şi creşterea abundenţei relative a speciilor transpalearctice *Dolichus halensis, Pseudoophonus tardus* şi *Ansisodactylus signatus.* Printre specii pot fi definite mai multe perechi sau grupuri de specii vicariante care iau aceeaşi poziţie în ecosistemele periurbane din Asia răsăriteană şi din Europa: *Platynus magnus* x *P. assimilis*, *Nebria coreica* x *N. brecollis*. *Pseudoophonus sinicus* + *P. simplicidens* + *P. coreanus* + *P. jureceki* x *P. calceatus, Curtonotus nitens* x *C. aulicus.* În general, regulile după care se formează cenozele carabidelor în ambele părţi ale palearcticei sunt foarte similare.

Cuvinte cheie: carabide, cenoze, fauna urbană, Pyongyang, Coreea de Nord.

INTRODUCTION

The urban environment consists of an extraordinarily variable mosaic of habitats. Its includes as ephemeral habitats arising simultaneously in different sites in the city where the initial stages of succession of plant and animal communities can be observed, islands of relatively stabilized ecosystems in densely built-up areas, as well as sometimes even surprisingly well preserved habitats situated at city margins or sometimes projecting deeply into the city interior and acting as biocorridors. Immigration of species from the city surroundings into its interior depends on the biodiversity and state of the nature in the city exterior, course of streets and structure of built-up areas and pattern of greenery mosaic. The ecosystems surviving in the city are subjected to strong anthropogenic influences like chemical, light and noise pollution, pests control, intensive care at greenery in gardens and parks, trampling, recreation and other human activities.

The fauna of urban ecosystems is an objective of many investigations programs (London, Warsaw, Moscow, Budapest, Leipzig, Brno, Bratislava, Madrid) in Europe (KLAUSNITZER, 1990) since mid-1970-s. Within all these projects Carabids were also studied (CZECHOWSKI 1980a, 1980b, 1981; DAVIS, 1978; DUSHENKOV, 1983; HALLER, 2003; KLAUSNITZER & RICHTER, 1980; LIK, 2010; ŠUSTEK, 1979, 1984, 1989; TOPP, 1972) and a lot of data has been collected, which allow certain generalizations. There exists, however, a question to what degree these general conclusions can be extended on urban fauna in other continents, with essentially different species and conditions.

The aim of this study is (1) to establish the structure of Carabid communities in Pyongyang as a big East Asian city, (2) to show differences between the communities in the city interior and exterior and (3) to show to what degree there are general patterns in forming the urban fauna in Central Europe and East Asia.

MATERIAL AND METHODS

The material was collected during two expeditions to the Democratic People's Republic of Korea (North Korea) undertaken within the collaboration agreements between the Czechoslovak Academy of Sciences and Academy of Sciences of DPRK in September - November 1986 and June - July 1990. The beetles were pitfall-trapped (plastic jars

of 300 ml with 75 mm wide opening filled by formalin) and individually collected at 8 sites. The traps were emptied in 7-10-day intervals, between longer excursions to other parts of the country. In each site 5 traps were installed. In order to maximize the chance to obtain a representative material within a very limited time, the beetles were also collected individually. In the park around the Potogang hotel the sampling was completed by collecting beetles coming in the evening on illuminated entry into the building or to lamps in the parks. Because of a relative limited extent of the whole material, samples collected in individual sites by all methods were pooled.

The study sites (Fig. 1) were selected so that they characterize the urbanization gradient from the surroundings to the city centre and can be easily visited by walking from the hotel and can be hidden or protected from the public.

The Carabids were identified using mainly the works of ANDREWES (1977), HABU (1973, 1978, 1982a, 1982b, 1983, 1984, 1987), JEDLIČKA (1962, 1963, 1965), KÜHNELT (1941), LAFER (1989), LINDROTH (1956), NETOLITZKY (1942-1943), PAWLOWSKI (1974) and UÉNO et al. (1999). The nomenclature was partly up-to-dated according to KRYZHANOVSKIJ et al. (1995).

The dominance of species is characterized by the following scale: eudominant > 10%, dominant 5-10%, subdominant 1-5%, recedent 0.5-1% and subrecedent < 0.5%. The presence of species is characterized as it follows euconstant > 75%, constant 50-75%, accessory 25-50% and accidental < 25%. The Shannon/Weawer index serves to characterize diversity.

The hierarchical classification of the communities was carried out by unweight average linkage methods using the Jaccard's index for presence-absence data and Whiteker's index for the quantitative data. The calculations were done by the program CAP III.

Pyongyang´s environment and specification of individual study sites:

Major part of Pyongyang lays at an altitude of about 30 m, only the surrounding hills reaching about 50-60 m. Its surroundings are mostly deforested and intensively used for agriculture. The forests are preserved only on low hills norther of the city and, from a part, they are transformed into large parks or recreation zones included as islands into the built up zone. They belong to the alliance *Pino koraiensis-Quercion mongolicae* and are strongly affected by cutting-off of lower wooden vegetation as burning wood. In some places traces of digging trenches during the Korean war are also visible and indicate a profound damaging or destroying of them in early 1950-ies. Meadow or pasture vegetation formations in the European sense do not exist there at all.

The city as such was completely built up anew, after the extensive destructions during the Korean war (1950-1953), according to modern urbanistic concepts. Therefore there does not exist any historical densely built-up centre with closed blocks of buildings, typical of European cities. The major part of Pyongyang resembles the big housing estates of Central and East European cities from 1960-1980-s, with isolated prefabricate high blocks, and a considerable portion of public greenery functioning as biocorridors. Just a minor part of the city consists of 3-4-floor houses built up in 1950-s, emergency one-floor living buildings or industrial and logistic complexes. There do not exist residential quarters of family houses surrounded by small gardens, like in European suburbs.

The climate (average temperature 9.8ºC, annual precipitation sum 925 mm) is influenced by cold sea streams and frosty winds from Siberia in winter and is characterized by great differences between winter and summer (Table 1). Winter is long and cold (140 frosty days), with little precipitation. Summer is warm with temperatures reaching 30ºC, but humid, with strong monsoon rains in July and August, when 52% of the annual precipitation falls. Still in September the humidity is very high and dense fogs last about until noon in first two weeks. In late September the weather becomes dry. Transition between the warm growing season and winter is sudden, especially in autumn.

Table 1. Basic climatic parameters in Pyongyang.
Tabel 1. Principalii parametri ai climei oraşului Pyongyang.

Characteristics	Months											
	J	F	M	A	M	J	J	A	S	O	N	D
Average maximum temperature ºC	- 0.8	2.4	8.9	17.1	22.6	26.7	28.6	28.9	24.7	17.2	9.4	1.7
Average temperature ºC	- 10.7	-7.8	-1.8	4.9	10.9	16.5	20.7	20.5	14.3	6.7	- 0.3	-7.2
Average monthly temperature ºC	- 8	- 4.5	2.0	10.0	16.0	21.0	25.0	25.0	20.0	13.0	4.0	5.0
Precipitation sums in mm	12.2	11.0	24.7	49.9	72.2	90.3	275.2	212.8	100.2	39.9	34.9	16.5
Number of frosty days	31	28	25	5	0	0	0	0	0	2	19	30

Due to the official, extremely anthropocentric, Juche ideology, there does not exist the environment and nature protection in the Europeans sense. In 1980-s, the organochlorine pesticides continued to be abundantly used, even to treat the urban greenery on streets.

The geologic substrate is acid, of volcanic origin. The soils are mostly sandy. The abundant water from monsoon rains influences the litter structure in abrupt slopes arranging the pine needles perpendicularly to contour lines.

The following sites (Fig. 1) were studied:

1 and 2– pine-oak forest in shallow glans in small hills near the western margin of Pyongyang, at the road to Nampo, close to the Taedonggang river (Fig 1a). An about 40-50 years old stands of the alliance *Pino koraiensis-Quercion mongolicae* (c.f. KOLBEK et al. 2001), at present with strongly predominant *Pinus koraiensis* and with young

Quercus dentatus and *Q. mongolicae* in undergrowth. Mature oaks were rare in the stand. The bottom of the valleys showed moderately increased humidity. Due to the very similar character of both sites and the reduced distance between them, the material sampled from them was pooled;

3 – little fields of soybean surrounded by grassy plots on the dike of the Taedonggang river (Fig. 1b). The vicinity of the site was completely free of any buildings at the time of investigation, only the vegetable farm existed in the vicinity;

4 – a narrow ruderal grassy site on the Saemaul street (Fig. 1c);

5 – a grassy plot under dispersed trees and shrubs at a dike near the Potogang river (Fig. 1d). A drier site laying about 1 m above the surface of the surrounding Potogang river floodplain;

6 – an alluvial park around Potogang hotel, with high and relatively dense tree vegetation on the Potogang river floodplain (Fig. 1d). The potential vegetation probably belongs to the association *Parthenicisso tricuspidati-Fraxinetum rhynchophyllae* (c.f. KOLBEK et al., 2001). The extent of the park was larger in 1986-1990 than shown in figure 1;

7 – garden of the Hungarian embassy (Fig. 1c), a large grassy plot with high and dispersed trees on a moderate southerly oriented slope;

8 – garden of the Czechoslovak embassy (Fig. 1c) a narrow grassy strip with individual low cedars (*Thuja* sp.) in front of the embassy building. Because of the similar character, low distance and limited material the samples were pooled.

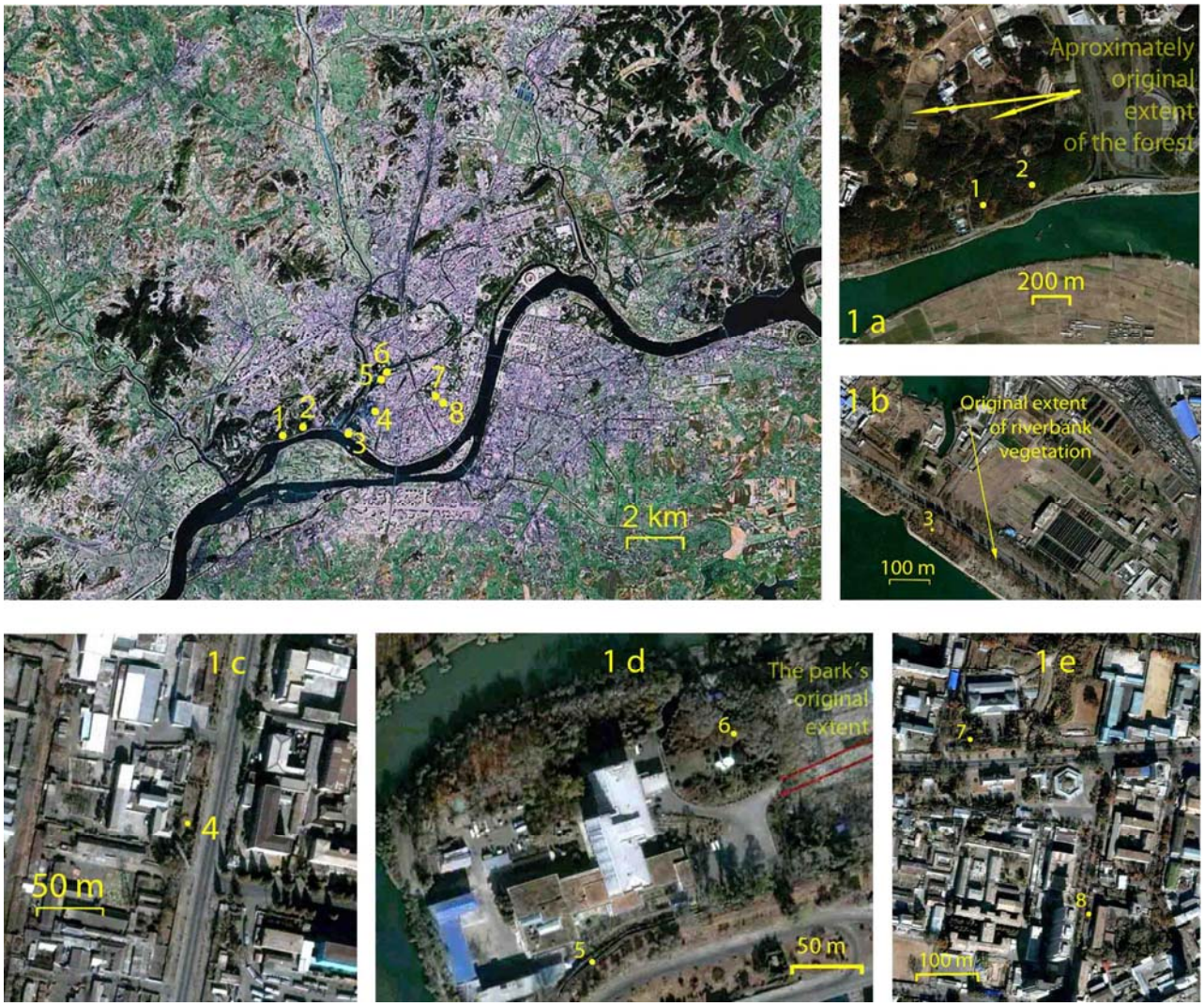

Figure 1. Pyongyang´s surroundings, localization of the study sites in the city and details of immediate vicinity of study sites. The photographs were taken from Google Earth and correspond to the state of 2007. Because of the extensive building activity in last 20 years, the approximate state of vegetation at the time of material collecting is approximately reconstructed by shadowed pictures (details 1a, 1b and 1 d).

Figura 1. Împrejurimile oraşului Pyongyang, poziţia locurilor studiate în oraş şi detaliile împrejurimilor cele mai apropiate ale locurilor. Din cauza activităţilor intensive de construire în zonele respective în ultimii 20 de ani, starea aproximativă a vegetaţiei în timpul colectărilor materialului este reconstruită cu imagini de umbră (detalii 1a, 1b şi 1d).

Generic and specific diversity of Carabids in East Asia and Europe

The Carabid fauna of Korea, in particular of DPRK, is relatively little investigated. KWON & LEE (1986), basing mostly on South Korean data, mention 346 species to occur in the whole peninsula, but in regard to species number occurring in adjacent parts of East Asia or in some European countries with similar climatic conditions and landscape diversity and comparable area (Table 2) these data seem underestimated and the real number of species occurring in Korean can be roughly estimated to 600-700.

The urban fauna always represents a derivate of the fauna of the surrounding landscape, strongly depending on its specific diversity, as well as on the tolerance and dispersal power of individual species. The Carabid fauna of Korea and (Central) Europe represent fauna of opposite site of the Palaearctic subregion. In the southern part of the Korean peninsula, about southerly of 42º N, it is also influenced by elements of the Oriental fauna penetrating from Japan and China, for example the bombardier *Perosophus jesonesis*). In spite of many common features, especially occurrence of some identical genera, there are differences in species diversity of genera distributed in both parts of Palaearctic (Table 3). Whereas the genera *Cicindela, Nebria, Carabus, Poecilus, Pterostichus, Amara* and *Harpalus* are approximately equally represented in both parts of this biogeographic subregion, the genera *Synuchus, Curtonous, Trichotichnus* and *Chlaenius* are richer in East Asian and the genera *Leistus, Ophonus, Dyschirius* and *Trechus* much richer in Europe, some being even absent in Korea. This is an important factor determining the potential pool species being able to survive in urban ecosystems. As shown in table 3, most Carabid species known from Korea are congeners of the species occurring in Europe, but only few Transpalaearctic (e. g. *Carabus granulatus* LINNAEUS 1758*, Dolichus halensis* (SCHALLER 1783)*, Pseudoophonus griseus* (PANZER 1797) or Holarctic species (*Loricera pilicornis* FABRIUS 1775) occur in both country. Most species are East Asian species. Some species are even oriental spreading northwards.

Table 2. Number of Carabid species and genera recorded in Korea, adjacent countries and in some Central European countries according to different authors.
Tabel 2. Numărul speciilor şi al genurilor de Carabidae cunoscute din Coreea, ţările vecine şi din unele ţări Europene după diferiţi autori.

Author	Region	Area in mil. km^2	Species	Genera
LAFER 1989	Russian Far East	7.29	593	84
KRYZHANOVSKIJ et al. 1995	Cisamuria & Maritime Region	2.43	485	92
LAFER 1989	Korea	0.22	171	55
KWON & LEE 1986	Korea	0.22	346	82
UÉNO et al. 1999	Japan	0.38	818	176
JEANNEL 1941-1942	France	0.52	900	118
MAGISTRETTI 1965	Italy	0.30	1189	127
MANDL 1947 and MANDL & SCHÖNMANN 1978	Austria	0. 08	669	78
GEORGIEV & GEORGIEV 1995	Bulgaria	0.11	725	103
HŮRKA 1996	Czechoslovakia	0.13	631	92

Table 3. Comparison of species richness in some major Carabid genera in East Asia and Europe (data taken from authors cited in Table 2).
Tabel 3. Compararea bogăţiei de specii a unor genuri mai mari de Carabidae în Asia răsăriteană şi în Europa (date după autorii citaţi în Tabelul 2).

Genus	Country							
	Cisamuria	Korea	Japan	Italy	France	Austria	Bulgaria	Czechoslovakia
Comparable in both areas								
Cicindela	**9**	**14**	**19**	**15**	**13**	**9**	**16**	**8**
Nebria	**13**	**11**	**15**	**34**	**21**	**18**	**9**	**8**
Carabus	**30**	**33**	**35**	**49**	**45**	**32**	**25**	**30**
Poecilus	**7**	**6**	**3**	**11**	**11**	**8**	**11**	**11**
Pterostichus	**63**	**31**	**72**	**67**	**65**	**56**	**32**	**44**
Bembidion	**49**	**25**	**52**	**123**	**111**	**93**	**86**	**77**
Amara	**43**	**13**	**14**	**64**	**60**	**67**	**50**	**54**
Harpalus + *Pseudophonus*	**48**	**28**	**27**	**61**	**42**	**50**	**54**	**47**
Richer in East Asia								
Synuchus	**10**	**10**	**15**	1	1	1	1	1
Curtonotus	**8**	**6**	**5**	2	2	2	2	2
Trichotichnus	**3**	**5**	**21**	4	2	3	-	2
Chlaenius	**13**	**18**	**27**	14	16	9	14	9
Richer in Europe								
Ophonus	1	–	–	**26**	**31**	**18**	**35**	**19**
Leistus	1	1	5	**17**	**10**	**9**	**6**	**10**
Dyschirius s. l.	12	3	8	**30**	**30**	**29**	**26**	**31**
Trechus	4	–	6	**79**	**59**	**35**	**23**	**20**

Carabid communities in Pyongyang

Altogether 41 Carabid species were found in Pyongyang, representing 12.1% of species known from Korea. Among them only 5 species, i.e. 11.9% also occur in Europe (*Amara majuscula, Anisodactylus signatus, Dolichus halensis, Pseudoophonus griseus* and *Harpalus modestus*), of which three (5.9%) species (*Anisodactylus signatus, Dolichus halensis* and *Pseudoophonus griseus)* were almost always in subdominant or dominant position in the communities. Outside Pyongyang, they occur in Korea, especially in arable land and orchards and also penetrate into moderately disturbed forests. Beside it, unlike Europe, *Dolichus halensis* frequently occurs, together with species of the genus *Chlaenius,* on brook shores in lowlands. In this aspect, habitat preference of the Korean populations strongly differs from the European populations.

The community in the forest on city margin consisted of 22 species (Table 4). Two species, *Nebria coreica* SOLSKY, 1787, (30%) and *Pseudoophonus simplicidens* SCHAUBERGER, 1929 (10.5%) were eudominant, four species *Asaphidion semilucidum* (MOTSCHULSKY 1862) (7.3%), *Syntomus pallipes* (DEJEAN, 1825) (7.3%), *Tachys graduatus* (BATES, 1783) (7.3%) were dominant. 10 species were subdominant and 6 species were recedent. The occurrence of *Nebria coreica, Tachys graduatus, Anisodactylus signatus* (PANZER 1797), *Epomis nigricans* (WIEDEMANN, 1821) and *Platynus magnus* (BATES 1873) indicates moderately increased humidity resulting from the accumulation of water in the bottom of a shallow glen. However, the humidity was not high enough to allow a higher representation of *Platynus magnus and Epomis nigricans* or the occurrence of *Chlaenius* species, otherwise very common in Korea. Most species belonged to the genera *Dolichus*, *Amara, Curtonotu, Harpalus* and *Pseudoophonus* and, similarly as their European congeners, are characteristic rather for open landscape than for a forest. The occurrence of *Nebria coreica* strongly resembles the occurrence of *Nebria brevicollis* (FABRICIUS 1792) in some drier (or dried) floodplain forests or urban alluvial parks in Europe. However, its absence in the Potogang park (see bellow) indicates it to be less tolerant. When comparing with other forest localities visited in Korea (ŠUSTEK, 2003), the species of the genus *Carabus* absented here, inclusively the most common species *Carabus sternbergi* ROESCHKE, 1898, which takes a similar position in carabid communities of Korean forest at low altitudes as *Carabus nemoralis* O. F. MULLER 1764 in Europe. Therefore, there absented any large species and the community consisted only of middle sized or small species. Both these features and strong representation of the species of the genera *Amara, Curtonotu, Harpalus* and *Pseudoophonus* (cumulative dominance 34.7%) indicate a considerable degradation of this community.

The community in the Potogang park consisted of 23 species (Table 4). Three species *Dolichus halensis* (SCHALLER 1783) (22.7%), *Platynus magnus* (BATES 1873) (15.9%) *Curtonotus nitens* PUTZEYS 1866 (12.65) were eudominant and three species *Pseudoophonus griseus* (PANZER 1797) (8.4%), *Anisodactylus signatus* (6.7%) and *Harpalus chalceatus* BATES 1881 (5.1%) were dominant. 6 species were subdominant and 9 species recedent. Especially the high dominance of *Platynus magnus* and *Anisodactylus signatus,* the subdominant occurrence of *Agonum bicolor* DEJEAN. 1831, *Patrobus flavipes* MOTSCHULSKI. 1864, *Epomis nigricans*, *Chlaenius inops* CHAUDOIR 1862, *Chlaenius pallipes* GEBLER 1826 and *Chlaenius virgulifer* CHAUDOIR 1879 indicate high soil humidity in the park, whose ground surface lays about 50 cm above water table in the adjacent Potogang river. The occurrence of *Pseudophonus capito* MORAVITZ 1864 in other localities visited in North Korea, also confirms the alluvial character of the park, similarly as the finding of the ripicolous *Perosophus jessoensis* MORAWITZ 1863, an outsdanding representative of the oriental fauna. In contrast, the high dominance of *Dolichus halensis*, *Pseudoophonus griseus, Anisodactylus signatus* and *Harpalus chalcentus,* as well as no presence of six species of the genera *Amara, Harpalus* and *Pseudoophonus* (except for *P. capito*) indicate discontinuous tree canopy and grassy vegetation in the park. *Platynus magnus* evidently takes the same coenotic position in the community as *Platynus assimilis* in Central European floodplain forests and floodplain parks in centres of Brno and Bratislava (ŠUSTEK, 1979, 1984). Similarly*, Pseudoophonus griseus* substitutes here the function of the west Palaearctic *Pseudoophonus rufipes* in degraded forest or floodplain forests and urban parks in Europe (ŠUSTEK, 1989). It is remarkable, that in Europe *Pseudoophonus griseus* is restricted, unlike *Pseudoophonus rufipes,* more or less only on open landscape habitats and does not penetrate the damaged forest or forest like habitats, as it does in Korea. The same shift in habitat preference also occurs in European and East Asian populations of *Dolichus halensis*. Other four localities have, in spite of their different position in the city, similar structure (Table 4). Species number is much lower, fluctuating between 6 and 10. The number of individuals of all species range from 26 to 64. Thus these values represent about half of the respective values in the first two localities. In all of them the dominant species were *Dolichus halensis* (3.8 – 54%) and *Pseudoophonus griseus* (4.0 – 26.4%). In the three localities out of the very centre *Pseudoophonus simplicidens* SCHAUBERGER, 1929 and *Curtonotus nitens* also dominated. In addition, the driest ruderal site is dominated by *Harpalus palidipenis* MORAWITZ, 1870 (15.4%), which also seems to be rather xerophilous in other localities. In the dyke located in the vicinity of the Potogang hotel *Pseudoophonus sinicus* HOPE 1858 was eudominant (32.8%), but it was not recorded at all in the near Potogang park. In the embassy gardens some East Asian species of the genera *Curtonotus, Harpalus* and *Pseudoophonus* disappeared (Table 4). Only *Harpalus palidipenis* preserved here its position (11.9%). At the same time, the Transpalaearctic *Dolichus halensis* (35.71%) and *Pseudoophonus griseus* (23.4%) become highly eudominant. Beside it, there appeared the hygrophilous species *Chlaenius inops* (2.4%) and *Chlaenius virgulifer* CHAUDOIR 1879. Their presence in the embassy gardens, however, does not result from humidity, which is generally higher in Pyongyang than in Central European cities, but more probably from night migrations and attraction on light, similarly as in the European congeners (ŠUSTEK, 1999). *Curtonotus nitens* seems to play a similar zoocoenotic role in urban

communities of Carabids as the related congener *Curtonotus aulicus* (PANZER 1797) in Europe, but is obviously more anthropotolerant and adaptive.

The relationships between the studied communities are clearly reflected by hierarchic classification based on presence absence data (Fig. 2). The rich-in-species communities from the forests and Potogang park form one cluster at dissimilarity level 0.56 and the poor communities from city centre form a separate cluster at dissimilarity level 0.58, in which the communities with predominance of more xerophilous species from the Soybean field and ruderal site form a closed cluster. The communities from the embassies' gardens separate from them due to presence of two species of the genus *Chlaenius*. The community from the dike separates from them furthermore due to exclusive occurrence of *Pseudoophonus sinicus.*

Even more realistically are the relationships between the communities reflected by the classification according to the abundance of species (Fig. 3). The community from the forests is separated from other communities due to the predominance of *Nebria coreica.* The communities from Potogang park, soybean field and embassies' gardens are linked together due to similar proportion and higher abundance of *Dolichus halensis, Pseudoophonus griseus* and *Harpalus palidipennis* and lower abundance of *Curtonotus nitens*. On the contrary, the high abundance of *Curtonotus nitens* causes separation of the communities from the ruderal and dike, in spite of the significant difference in the occurrence of *Pseudoophonus sinicus* in the dike.

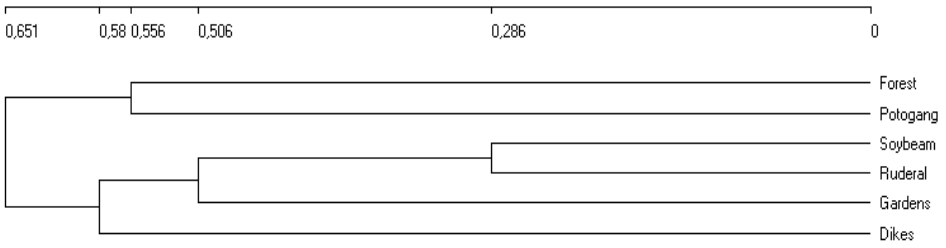

Figure 2. Classification of Carabid communities at six sites in Pyongyang according absence-presence data.
Figura 2. Clasificarea cenozelor de carabide din şase localităţi din Pyongyang pe baza prezenţei şi absenţei de specii.

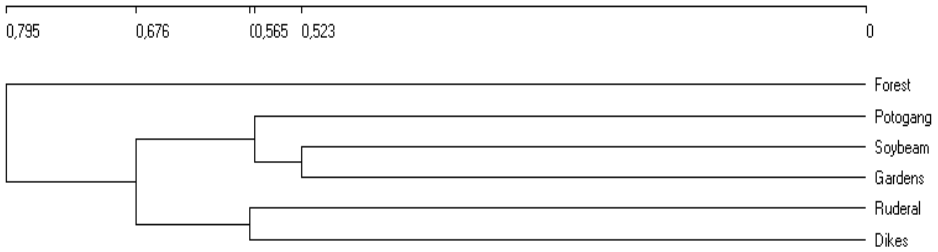

Figure 3. Classification of Carabid communities at six sites in Pyongyang according the abundance of species.
Figura 3. Clasificarea cenozelor de carabide din şase localităţi din Pyongyang pe bază abundenţei de specii.

All communities are characterized by a high diversity and equitability. In the pine forest and Potogang park the Shannon's index reached values of 3.78 and 3.67 bits, while in other localities in city centre it ranged from 2.08 to 2.51. Equitability fluctuated in all localities in narrow limits of 0.67 - 0.86. The high equitability was characteristic also for the most stressed and poor communities in Central European cities (ŠUSTEK, 1984). The high values of Shannon's diversity index in the pine forest and Potogang park are very unusual in Central European cities. Such values correspond only to the richest communities in natural floodplain forests. The reason why the index was so high in both localities results probably from the higher richness of the genus *Pseudoophonus* and similar adaptability of its species, among which all occur at least in one of the studied localities.

All species presented in the Table 4 are able to fly. It increases their ability to penetrate into city centre.

Only two species, the Transpalaearctic *Dolichus halensis* and *Pseudoophonus griseus* were recorded in all localities (Table 4) and three autochthonous species *Curtonotus nitens, Pseudoophonus simplicidens* and *Harpalus pallidipennis* were also euconstant being present on 83.3% of the localities. Four autochthonous species (*Harpalus chalcentus, Pseudooophonus tridens, Harpalus tinculus* and *Amara lucidissima* LAFER, 1987) were constant, being found at three localities. Most of them belonged in the majority of the localities to the dominant species. Thus these 9 species can be considered as the best adapted to the urban ecosystem in East Asia.

In Central European cities and in Madrid (ŠUSTEK, 1981, 1984, 1989), a clear tendency to increase of representation of species with large areas of distribution toward city centres was observed. This phenomenon can be explained so that the species which have occupied a larger area must be more euryecious, adaptable and mobile than the species limited to small areas or strict endemics. Thus, they have just those properties, which are inevitable to penetrate and survive in unfavourable conditions of large cities. This phenomenon is evidently valid also in Pyongyang, were the proportion of qualitative and quantitative representation of the Transpalaearctic species strongly increases in the localities in Pyongyang centre, proportionally to increasing urbanization (Fig. 4).

DISCUSSIONS AND CONCLUSIONS

The urban fauna of Carabids in East Asia and Europe has the following common features:

1. decline or absence of wingless species;
2. absence of large species (above 20 mm);
3. tendency to autodominace of 1 – 2 species in medium disturbed communities;
4. number of species on medium disturbed communities ranges from 20 to 30, while in the most influenced communities in the city centre moves around 10;
5. with the increase of disturbance degree it also increases the representation of species with extensive areas of geographic distribution;
6. increased urbanization pressure leads to considerable convergence of community structure in localities in very city centre and to selection of a narrow spectre of species being able to survive in such conditions.

The Carabid communities in the urban environment in East Asia show the following specific features:

1. much higher sensitivity of the Carabus species to urbanization. *Carabus sternbergi* ROESCHKE, 1898, the most frequent species in Korea and an ecological vicariant of *Carabus nemoralis* in the forests at low altitudes (ŠUSTEK 2003), is absent even in wider surroundings of Pyongyang. Its absence can result from higher degree of disturbance in the past and from isolation of remnants of forests stands. The cultivation of rice in a considerable portion of landscape can also play an important role, because the long-term flooding of rice fields acts as a strong barrier and, as matter of fact, eliminates populations of any terrestrial animal from large surfaces. Thus, just extremely few Carabids can survive on narrow and often repaired embankments separating individual tables of rice. Absence of the *Carabus* species in the forests located in the surroundings of Pyongyang is surprising from the view point of the generally high humidity in North Korea, which approximates humidity in Central European mountains, at altitudes above 1500 m, with positive climatic water balance (ŠKVARENINA et al., 2002). In Central Europe in such conditions the high humidity allows the Carabids behaving at lower altitudes as stenotopic forest species to inhabit successfully also the non-forest habitats (ŠUSTEK, 2006). Similarly in Bratislava, where several large seminatural forest islands were included into the intravilan, the *Carabus* species continue to survive in large parks.
2. due to much more humid climate the strongly hydrophilous and ripicolous species of the genus *Chlaenius* also occur in the very city centre.

Table 4. Survey of Carabids occurring at six sites in Pyongyang and their abundance (CE – species occurring also in Central Europe, presence in %).
Tabel 4. Lista carabidelor în şase localităţi în oraşul Pyongyang şi abundenţa lor (CE - specie răspândită şi în Europa centrală, prezenţă în %).

Species	CE	Site								
		Forest	Potogang	Soybeam	Ruderal	Dikes	Gardens	Sum	%	P %
Dolichus halensis (SCHALLER, 1783)	X	4	27	27	1	5	15	79	18.59	100.00
Curtonotus nitens PUTZEYS, 1866		4	15	6	10	15		50	11.76	83.33
Pseudoophonus griseus (PANZER, 1797)	X	7	10	2	4	6	11	40	9.41	100.00
Nebria coreica SOLSKY, 1875		38						38	8.94	16.67
Pseudoophonus simplicidens SCHAUBERGER, 1929		13	2	10	6	4		35	8.24	83.33
Platynus magnus (BATES, 1873)		2	19					21	4.94	33.33
Pseudoophonus sinicus HOPE, 1858						21		21	4.94	16.67
Harpalus pallidipennis MORAWITZ, 1870		3	5	2	4		5	19	4.47	83.33
Anisodactylus signatus (PANZER, 1797)	X	2	8					10	2.35	33.33
Asaphidion semilucidum (MOTSCHULSKY, 1862)		9						9	2.12	16.67
Harpalus chalcentus BATES, 1881		1	6			2		9	2.12	50.00
Pseudooophonus tridens MORAWITZ. 1862			3			3	3	9	2.12	50.00
Syntomus pallipes (DEJEAN, 1825)		9						9	2.12	16.67
Tachys graduatus (BATES, 1783)		9						9	2.12	16.67
Curtonotus giganteus (MOTSCHULSKY, 1844)		5						5	1.18	16.67
Chlaenius inops CHAUDOIR, 1862			4				1	5	1.18	33.33
Pseudoophonus jureceki JEDLIČKA. 1934						5		5	1.18	16.67
Amara pseudosimplicidens LAFER, 1987		4						4	0.94	16.67
Bembidion moravitzi CSIKI, 1928		4						4	0.94	16.67
Chlaenius micans (FABRICIUS, 1972)							4	4	0.94	16.67
Chlaenius virgulifer CHAUDOIR, 1879			3				1	4	0.94	33.33
Pseudophonus capito MORAVITZ, 1864			4					4	0.94	16.67
Harpalus tinculus BATES, 1876		1		1			1	3	0.71	50.00
Amara lucidissima LAFER, 1987		2	1			1		3	0.71	50.00
Amara majuscula (CHAUDOIR, 1850)	X	1	1					2	0.47	33.33

Bradycellus curtulus (MOTSCHULSKY, 1860)		2						2	0.47	16.67
Epomis nigricans (WIEDEMANN, 1821)		1	1					2	0.47	33.33
Harpalus modestus DEJEAN, 1829	X	2						2	0.47	16.67
Chlaenius pallipes GEBLER, 1826				1			1	2	0.47	33.33
Patrobus flavipes MOTSCHULSKI, 1864			2					2	0.47	16.67
Pseudoophonus coreanus (TSCHITSCHERINE, 1895)			2					2	0.47	16.67
Pseudoophonus eous TSCHITSCHERIN, 1902						2		2	0.47	16.67
Agonum bicolor DEJEAN, 1831			1					1	0.24	16.67
Amara magnicollis TSCHITSCHERIN, 1894					1			1	0.24	16.67
Amara mikae LAFER (1987)			1					1	0.24	16.67
Amara sinuaticollis MORAWITZ, 1862			1					1	0.24	16.67
Bradycellus plutenkoi LAFER, 1989			1					1	0.24	16.67
Cymindis daimio BATES, 1873		1						1	0.24	16.67
Harpalus bungii CHAUDOIR, 1844				1				1	0.24	16.67
Oxycentrus argutoroides BATES, 1873			1					1	0.24	16.67
Perosophus jessoensis MORAWITZ, 1863			1					1	0.24	16.67
Number of individuals		124	119	50	26	64	42	425		
Number of species		22	23	8	6	10	9	42		
Shannon's diversity H´		3.78	3.67	2.08	2.21	2.30	2.51			
Equitability E		0.82	0.81	0.67	0.86	0.84	0.79			

In the communities ecological vicariation of Asian and European species can be observed. In the communities of floodplain urban park we mention the pair *Platynus magnus* and *Platynus assimilis.* In the fields and urban ruderals, four Asian species, *Pseudoophonus sinicus, P. simplicidens, P. coreanus* and *P. jureceki* play an analogous role as their European congener *P. calceatus* and Asian *Curtonotus nitens* is vicariant for European *Curtonotus aulicus.* A similar pair of vicariant species is represented, to a certain degree, by the endemic *Nebria coreica* and European *Nebria brevicollis.* Both species can be found in forests or some urban parks in places with slightly increased humidity. However, they considerably differ in their body size, *Nebria brevicollis* being more than twice as large as *N. coreica*.

In spite of a limited time for the executed studies, it is obvious that the urban fauna of Carabids in both opposite parts of the Palaearctic is subjected to the same rules of forming. As shown on the example of the species of genera *Harpalus* and *Pseudoophonus* the appurtenance of a species to a genus and subgenus can have a considerable predictive value about ecological requirements of ecologically little known species. On the other hand, examples of *Dolichus halensis* and *Pseudoophonus griseus* show that considerable shifts in habitat preference and coenotic role of a species can occur in opposite parts of its extensive area of geographical distribution.

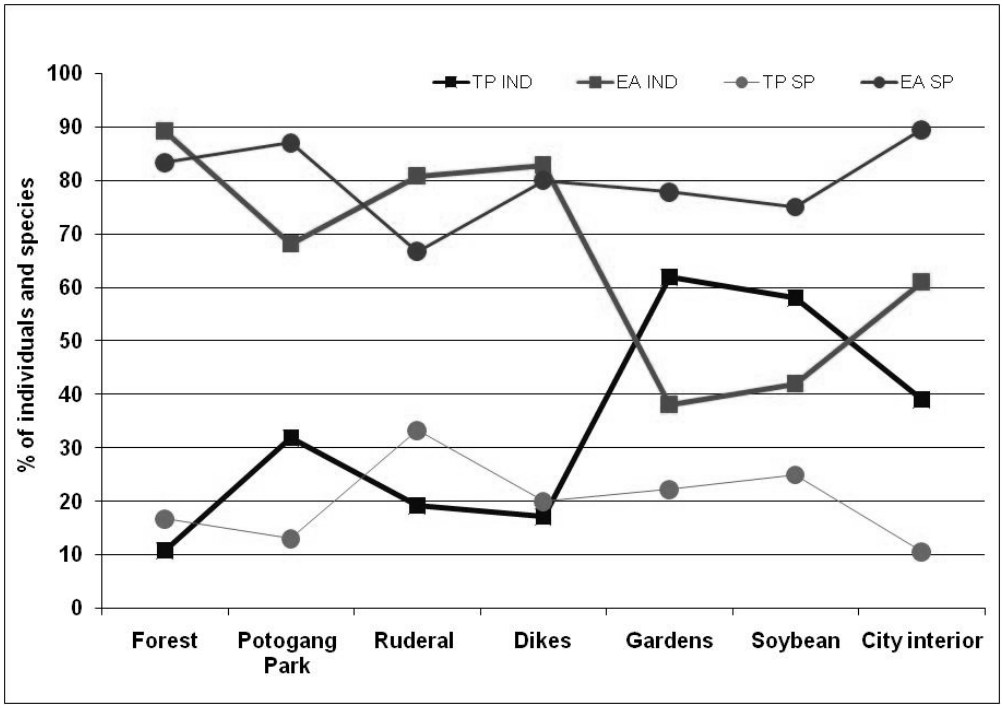

Figura 4. Changes in the proportion of the number of species (SP) and individuals (IND) of East Asian (EA) and Transpalaearctic (TP) species along the urbanization gradient in Pyongyang.
Figura 4. Schimbări proporționale ale numărului de specii (SP) şi de indivizi (IND) ale speciilor asiatice răsăritene (EA) şi transpalearctice (TP) de-a lungul gradientului de urbanizare în Pyongyang.

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