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Habitat distribution of the amphibians and reptiles in the city of Plovdiv, Bulgaria

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Abstract: The aim of the current paper is to study the distribution of the amphibians and reptiles in the urban habitats in the city of Plovdiv and the changes in species composition from the periphery to the city center, as well as to classify them according to their level of synantropy. The urban habitats occupied by amphibians were clustered into two main groups: (1) aquatic/semi-aquatic habitats and (2) terrestrial habitats. From the group of aquatic habitats clearly distinguished were the rivers, at about 60 % similarity level as the other aquatic habitats were further divided into two groups: (1) standing ponds and (2) irrigation canals with riparian plant communities. The terrestrial habitats were divided into three groups: (1) inner spaces between buildings, courtyards and the ruderal communities; (2) abandoned lands and vineyards and (3) small and large urban parks and high-fruit orchards. The urban habitats inhabited by reptiles were divided into terrestrial and aquatic, where the semi-aquatic habitats were differentiated from the typical aquatic ones at about 60% faunistic similarity level. The terrestrial habitats were further clustered into two major groups with approximately 27% of faunistic similarity. The distribution of the batracho- and the herpetofauna along urban-rural gradient is analyzed and the recorded species are classified based on their habitat preferences and level of sinantropy.

Keywords: urban habitats, urban-rural gradient, Amphibia, Reptilia, cluster analysis, Hill's numbers.

Introduction

The most serious cause of amphibian and reptile decline in Europe is the loss of habitats (Jellinek et al. 2004, Stuart et al. 2004). Urbanization is recognized to be one of the main factors for habitat loss leading to local biodiversity extinction in urban areas (McKinney 2008). It was also recognized that the negative impact of habitat loss can be ameliorated through adequate management plans (Löfvenhaft et al. 2004). In order to propose efficient management plans in urban areas, local studies should be conducted towards surveying of the ecological needs of amphibians and reptiles. Moreover, species' specific information is needed to emphasize the interspecific differences in the preference for different habitat/landscape elements (Hartel et al. 2007). Furthermore, habitat loss and habitat configuration are one of the most important aspects when studying ecosystems in urban areas (Löfvenhaft et al. 2004).

Currently, habitat-based studies on amphibians and reptiles in urban areas in Europe are scarce (Beebee 1979, Kral et al. 1983, Banks & Laverick 1986, Mann et al. 1991, Chovanec 1994, Scali & Zuffi 1994, Lehtinen et al. 1999, Kühnel & Krone 2003, Ruchin et al. 2003, Ficetola & DeBernardi 2004, Löfvenhaft et al. 2004, Ruchin et al. 2005) and in Bulgaria such studies are largely absent (Milchev 1985). The aim of the current paper is to study the distribution of the amphibians and reptiles in the urban habitats in the city of Plovdiv and the changes in species composition from the periphery to the city center, as well as to classify them according to their level of synantropy.

Material and methods

Study area

Plovdiv municipality is located within the Plovdiv Field in the middle of the Thracian Lowland (South Bulgaria) at 160 m altitude. The city of Plovdiv takes about 53 km² of the Plovdiv municipality and represents an urbanized area with population of 375580 inhabitants (Urban Environment Management Plan of the city of Plovdiv 2009). Study area covers 127 km², calculated from the UTM map of Bulgaria (10x10km). The borders of the research area are identified on the basis of a 1-kilometer UTM grid (10x10km standard quadrants are divided into 100 smaller quadrants of size 1x1 km) (Lerer & Delchev 1978). Thus, the study area includes the administrative boundaries of the city and the surrounding areas, excluding other urban areas (Fig. 1).

Urban habitats

The classification of urban habitats in Plovdiv followed the "Palearctic Habitat Classification" for the habitat types occurring in Bulgaria (Meshinev & Apostolova 2005). For the purposes of the current study, non-populated habitats by amphibians or reptiles were excluded from the study. The identified urban habitat types within the study area are presented with their full names, codes according to the Palearctic Habitat Classification and the abbreviations used by us.

Most of the ecological characteristics of a big city vary in a directional way from the periphery to the city center, thus forming the so-called "urban-to-rural" gradient (Klausnitzer 1990). Further, the concept of "urban-to-rural" gradient was developed by McDonnel, Picket (1990) and is largely used in urban ecological studies. The main criteria, used to determine the "urban", "suburban" and "rural" zones in the study area was the distance from the city center and the type and density of the residential buildings (urban or rural type). The "urban" zone includes completely the borders of the administrative city center (≈2 km radius from the city center). The "suburban" zone includes the area between the outer border of the urban zone and the administrative borders of the city. The "rural" zone includes the area between the outer borders of the suburban zone and the border of the study area, determined by the UTM grid (Fig. 1).

Survey methods

All identified urban habitats in the city of Plovdiv were surveyed for the presence of amphibians and reptiles in the period March 2007 – October 2009. Several field trips were made and every habitat was visited at least twice. The method used for surveying the herpetofauna was visual and auditory transects (Sutherland 2000). Searches were performed throughout the day and at night.

Amphibians and reptiles were determined visually using the field guides of Arnold, Ovenden (2002) and Biserkov et al. (2007). The classification of the species follows Speybroeck, Crochet (2007). Some specimens were captured by hand (no nets, pit-fall traps or other kind of traps were used), identified by the sounds they make, their eggs or larvae or skin sheds.

Species characteristics

The polytopic/stenotopic dichotomy was defined in the following sense: polytopic species were defined as ecologically tolerant species that occur in more than 5 habitat types, while stenotopic species were ones occurring in less than 5 habitat types.

For the ecological classification of the species according to their level of synantropy the classification of Klausnitzer (1990) was used. According

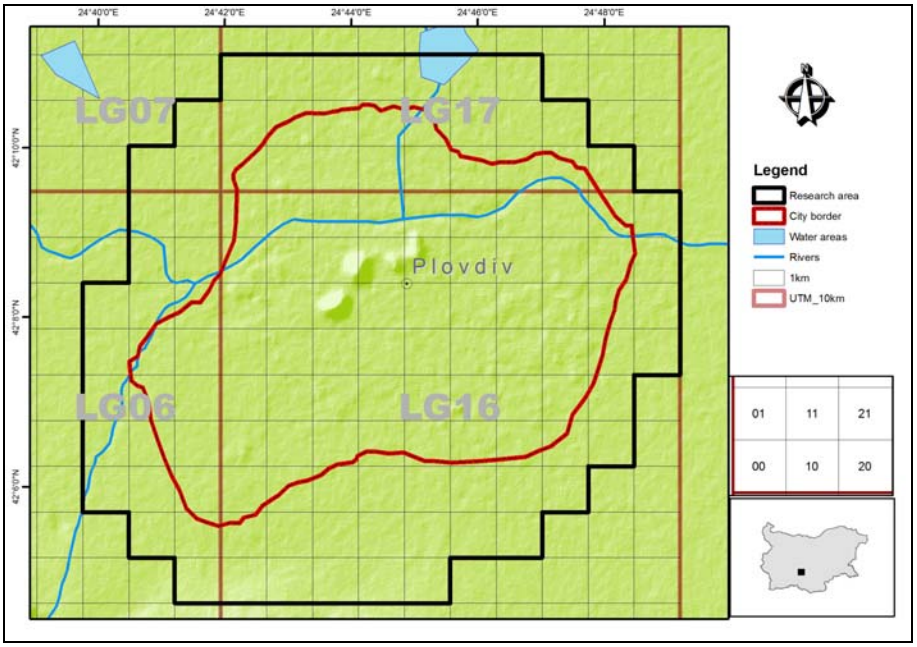

Figure 1. UTM grid of the studied region – the city of Plovdiv and its surroundings. Scale of the UTM quadrants – 1x1 km.

to this classification, there are four ecological groups of animals in subordination to their level of synantropy: *hemerophobes* – species, which avoid urban environment; *hemerodiaphores* – species, which existence doesn't depend on the anthropogenic transformation of the landscape; *hemerophiles* – species, which prefer habitats made by humans and *synanthropes* – species, which are directly connected with habitats made by man and their existence depend on the human activity.

Data analysis

For the species richness estimation of each urban habitat type we used the Hill's Diversity index (Hill's numbers) (Hill 1973): H_0 – number of species; H_1 – Exponential function of the Shannon-Wiener diversity index (exp(H')); H_2 – reciprocal value of the Simpson's diversity index.

Shannon-Weiner Diversity index is calculated by the following formula (Magguran 1988):

$$H' = -\sum_{i=1}^{S} (p_i \ln p_i),$$

where S - the number of species, p_i - the relative abundance of each species, calculated as the proportion of individuals of a given species to the total number of individuals in the community.

The reciprocal value of the Simpson's Diversity index is calculated by the following formula (Magguran 1988):

$$S = \frac{1}{\sum p_i^2},$$

where S – Simpson's Diversity index; p_i – proportion of species i.

For the estimation of the similarity of the species richness between the urban, suburban and rural zones the Sørensen similarity index was used (Sørensen 1948):

$$QS = \frac{2C}{A+B},$$

where A and B are the number of species in samples A and B, respectively, and C is the number of species shared by the two samples.

The classification of the habitat types was based on the similarity of their species composition (presence/absence data) and the cluster analysis was performed using the Bray-Curtis index and group average linking. Bray-Curtis index is calculated by the following formula (Bray & Curtis 1957):

$$BC_{ij} = \frac{S_i - S_j + 2C_{ij}}{S_i + S_j},$$

where C_{ij} is the sum of minimum abundances of the various species (abundance at the site where the species is the rarest). S_i and S_j are the total number of specimens captured at both sites.

The Hill's numbers estimation and the cluster analysis were performed with the software "BioDiversity Pro" (McAleece et al. 1997).

Results and Discussion

Table 1 lists the identified types of urban habitats in the city of Plovdiv, the abbreviations used in the current study and their codes, according to the Palearctic Habitat Classification.

On Table 2 we present the habitat distribution of the amphibians and reptiles in Plovdiv, their composition in the three urban zones (urban, suburban, rural), and their ecological characteristics according to the habitat selectivity and level of synantropy. Six species of amphibians (*Bufo bufo, Epidalea viridis, Pelobates syriacus, Hyla arborea, Rana dalmatina* and *Pelophylax ridibundus*) were found in total of 15 types of urban habitats and eight species of reptiles (*Mediodactylus kotschyi, Lacerta viridis, Lacerta trilineata, Podarcis tauricus, Emys orbicularis, Natrix natrix, Natrix tessellata* and *Dolichophis caspius*) were recorded in 24 types of urban habitats.

Comparative analysis of the urban habitats based on qualitative faunistic similarity

The cluster analysis of the urban habitats occupied by amphibians based on presence/absence data resulted in grouping into two main clusters: aquatic and semi-aquatic habitats and terrestrial habitats with faunistic similarity of about 15% (Fig. 2). From the aquatic and semi-aquatic habitats clearly distinguished were the rivers and streams (Vrp) at 60% similarity level. The rivers and streams frequently hold predatory fish. To coexist with predators, special adaptations in amphibians are required such as behavioral avoidance using chemical cues, toxic compounds and phenotypic changes in the body. These adaptations are efficient only if the aquatic

habitat is complex enough to allow amphibians using them as refugia (Hartel et al. 2007).

Table 1. Types of urban habitats identified in the city of Plovdiv.

Abbreviation	Habitat name	Code
Aquatic and semi-aquatic habitats		
Vpsv	Constant standing, freshwater ponds	22.1
Vvsv	Temporary standing, freshwater ponds	22.2
Vrp	Rivers and streams	24.1
Vnk	Irrigation canals	89.2
PVkvf	Riparian willow formations	44.1
PVktf	Riparian reed formations	53.6
PVzk	Floodplain crops (rice fields)	82.4
Terrestrial habitats		
Ssts	Dry artificial grasslands	81.1
Svts	Wet artificial grasslands	81.2
Sesnh	European communities of low dry bushes	31.2
Sbh	Barbed bushes	31.7
Snik	Continuous intensive crops	82.1
Szks	Cereals with field margins (strips) of natural vegetation	82.2
Shog	Bush orchards (vines)	83.2
Svog	High orchards	83.1
Sgp	Large urban parks	85.1
Smpg	Small urban parks and gardens	85.2
Sg	Gardens and courtyards	85.3
Svpmb	Inner spaces between buildings	85.4
Siz	Abandoned lands	87.1
Srs	Ruderal communities	87.2
Svgss	Internal bare rock slopes	62.4
Sjsg	Residential buildings (urban type)	86.1
Sjss	Residential buildings (rural type)	86.2
Ssiz	Old industrial areas	86.4

The other aquatic habitats were divided further into two groups at about 70% similarity – constant and temporary standing ponds and rice fields (Vpsv, Vvsv, PVzk) and irrigation canals with the riparian plant communities (Vnk, PVkfv, PVktf). In the temporary ponds, where the predation risk is generally low (Sheffer et al. 2006), intra- and interspecific larval competition interactions with other abiotic and biotic conditions strongly influence the growth rate, larval period, body size at metamorphosis and survival (Wilbur 1997). Amphibians adapted for successful reproduction in temporary ponds are known as rapid colonizers of the available ponds, multiple breeding through the year, rapid larval growth rates and flexible larval development (Laurila & Kujasalo 1999, Loman 1999, Merila et al. 2000).

On the other hand, urban terrestrial habitats, inhabited by amphibians were divided into three groups; the first two of them (about 40% of faunistic similarity) were the group of the inner spaces between buildings, courtyards and the ruderal communities (Srs, Svpmb, Sg) and the abandoned lands (Siz) and vineyards (Shog). The third cluster of the terrestrial habitats was composed by the small and large urban parks and high-fruit orchards (Svog, Sgp, Smpg) with close faunistic similarity to the aquatic and semi-aquatic habitats. This can be explained by the fact that most of the orchards are located along irrigation canals, and within the city parks, there are temporary standing ponds used for the breeding by some amphibians. The large part of the active season of the postreproductive explosive breeder amphibians is spent in terrestrial habitats around the ponds. Moreover, the terrestrial habitats are important dispersion areas for juveniles (important for the regional maintenance of amphibian species and communities) and hibernation habitats (such as inner spaces between the buildings and interior courtyards) for some species. Due to the life cycle characteristics and the spatial heterogenity of the habitats required to complete it, amphibians are especially sensitive to the habitat loss and fragmentation (Hartel et al. 2007).

The urban habitats inhabited by reptiles in Plovdiv were divided into terrestrial and aquatic and semi-aquatic with faunistic similarity of 1-2% (Fig. 3). Although only three species of the recorded reptiles are typical aquatic species (*Emys orbicularis, Natrix natrix* and *Natrix tessellata*), some terrestrial species of reptiles such as *Lacerta viridis* and *Dolichophis caspius* inhabited moist habitats near ponds and rivers and irrigation canals. Therefore, semi-aquatic habitats (PVktf, PVkvf) were differentiated from the typical aquatic ones (Vpsv, Vrp, Vnk, PVzk) at about 60% faunistic similarity.

Urban terrestrial habitats that are inhabited by reptiles were divided into two major groups at approximately 27%

Table 2. Habitat distribution of the amphibians and reptiles in the city of Plovdiv.
Legend: habitat's names and abbreviations are given in Table 1.

Species	Urban habitats																							
	Vpsv	Vvsv	Vrp	Vnk	PVkvf	PVktf	PVzk	Ssts	Svts	Sesnh	Sbh	Snik	Szks	Shog	Svog	Sgp	Smpg	Sg	Svpmb	Siz	Srs	Svgss	Sjsg	Sjss	Ssiz
AMPHIBIA																									
Bufo bufo	+	+	-	-	-	-	+	-	-	-	-	-	-	+	-	-	-	-	-	+	-	-	-	-	-
Epidalea viridis	-	+	-	-	-	-	+	-	-	-	-	-	-	-	-	+	+	+	+	+	+	-	-	-	-
Pelobates syriacus	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hyla arborea	+	+	+	+	+	+	+	-	-	-	-	-	-	-	+	+	+	-	-	-	-	-	-	-	-
Rana dalmatina	-	+	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pelophylax ridibundus	+	+	+	+	+	+	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
REPTILIA																									
Mediodactylus kotschyi	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	+	+	+	+	-	-	+	+	+	+
Lacerta viridis	-	-	-	-	-	-	-	+	+	+	+	+	+	+	+	+	+	-	-	+	+	-	-	-	-
Lacerta trilineata	-	-	-	-	-	-	-	+	-	+	+	-	-	-	-	-	-	-	-	+	+	-	-	-	-
Podarcis tauricus	-	-	-	-	-	-	-	+	-	+	+	+	+	-	-	+	+	-	+	+	+	-	-	-	-
Emys orbicularis	+	-	+	+	+	+	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Natrix natrix	+	-	+	+	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Natrix tessellata	+	-	+	+	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Dolichophis caspius	-	-	-	-	+	-	-	-	-	-	-	-	+	-	-	+	-	-	-	+	-	-	-	-	-

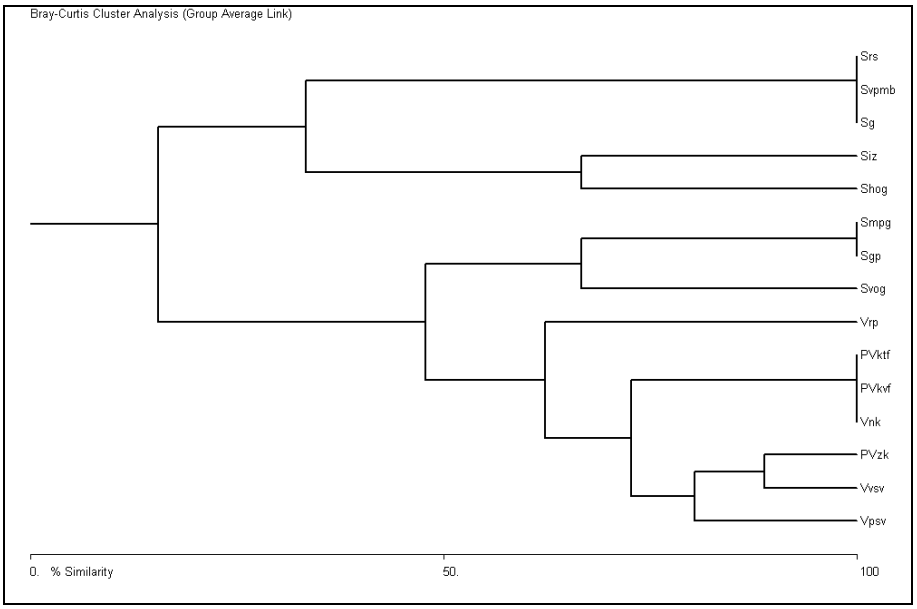

Figure 2. Classification of the urban habitats in the city of Plovdiv based on presence-absence similarity of amphibians (index of Bray-Curtis). *Legend:* habitat's names and abbreviations are given in Table 1.

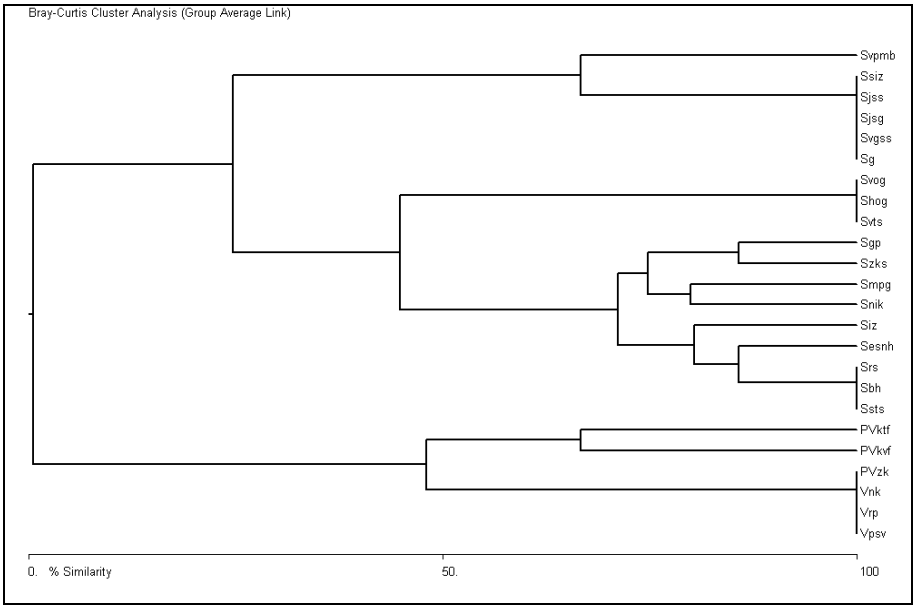

Figure 3. Classification of the urban habitat in the city of Plovdiv based on presence-absence similarity of reptiles (index of Bray-Curtis). *Legend:* habitat's names and abbreviations are given in Table 1.

of faunistic similarity. The first group included residential buildings, inner spaces between buildings, courtyards, inner open rocky slopes and old industrial areas (Sg, Svgss, Sjsg, Sjss, Ssiz, Svpmb), which were mainly inhabited, and some exclusively by the Kotshy's gecko (*Mediodactylus kotschyi*). The second group was divided into three subgroups. The first of them (approximately 46% similarity) includes orchards and wet grasslands (Svog, Shog, Svts), inhabited mainly by the green lizard (*Lacerta viridis*). The second group of higher faunistic similarity (around 65%) consists urban parks and agricultural areas (Sgp, Szks, Smpg, Snik), which apparently provide similar environmental conditions for certain species such as *Lacerta viridis* and *Dolichophis caspius*. The third group has a higher faunistic similarity (around 77%), and includes abandoned lands, grasslands and barbed bushes (Siz, Sesnh, Srs, Sbh, Ssts), which are preferred by the Balkan Wall lizard (*Podarcis tauricus*) and the Striped lizard (*Lacerta trilineata*). From all identified urban habitats the reptiles were absent only in temporary standing freshwater ponds (Vvsv).

Those landscape elements that are not used as habitats but may play a major role in determining the success of movements (migrations) of some amphibians and reptiles, represent the "*matrix*" (Kindlmann et al. 2005). A matrix with high permeability assures good movement conditions, which are high quality and safe areas (corridors). Human made structures such as roads, railroads, fences, intensively treated agricultural lands etc. may cause severe mortality of

the individuals crossing them and for many species represent an impermeable matrix (Hein et al. 2004). Due to this fact amphibian and reptile populations may decline because of either the loss of critical habitats (these may be the reproduction, summer and/or hibernation habitats) or the loss of connectivity between the critical habitats (Hartel et al. 2007).

Species richness in the urban habitats

For the amphibians, the most species-rich habitat is "temporary standing, freshwater ponds" (Vvsv) with 5 species and the highest indices of diversity (Table 3, Fig. 4). This is expected considering that this type of ponds are used for the breeding of all identified species of amphibians and is the most common type of water basin in the city. At the same time this is the most vulnerable urban habitat type and conservation measures should be applied to preserve temporary ponds in urban areas. Subsequent habitats are the permanent standing freshwater ponds (Vpsv, PVzk) and rivers and streams (Vrp). Riparian and terrestrial urban habitat types were significantly poorer in species.

Table 3. Diversity indices (Hill numbers) of the studied urban habitats (sorted descending with the species richness). [H_0 – number of species; H_1 – Exponential function of the Shannon-Wiener diversity index (exp(H')); H_2 – reciprocal value of the Simpson's diversity index. Habitat's names and abbreviations are given in Table 1.]

Urban habitats	H_0	H_1	H_2
AMPHIBIA			
Vvsv	5	14.709	0.125
Vrp	4	10.660	0.083
PVzk	4	10.660	0.045
Vpsv	3	7.039	0.333
Vnk	2	3.922	0.071
PVkvf	2	3.922	0.063
PVktf	2	3.922	0.056
Sgp	2	3.922	0.038
Smgp	2	3.922	0.036
Siz	2	3.922	0.031
Shog	1	1.143	0.043
Svog	1	1.143	0.042
Sg	1	1.143	0.034
Svpmb	1	1.143	0.033
Srs	1	1.143	0.030
REPTILIA			
Sesnh	4	10.660	0.043
Sgp	4	10.660	0.027
Siz	4	10.660	0.021
Vpsv	3	7.039	0.333
Vrp	3	7.039	0.167
Vnk	3	7.039	0.111
PVzk	3	7.039	0.067
Ssts	3	7.039	0.056
Sbh	3	7.039	0.038
Szks	3	7.039	0.032
Smpg	3	7.039	0.025
Srs	3	7.039	0.020
PVkvf	2	3.922	0.091
Snik	2	3.922	0.036
Svpmb	2	3.922	0.023
PVktf	1	1.443	0.083
Svts	1	1.443	0.053
Shog	1	1.443	0.031
Svog	1	1.443	0.030
Sg	1	1.443	0.024
Svgss	1	1.443	0.020
Sjsg	1	1.443	0.019
Sjss	1	1.443	0.019
Ssiz	1	1.443	0.019

Unlike the amphibians, the reptiles had the highest species richness in terrestrial habitats: "dry European communities of low bushes" (Sesnh); "large urban parks" (Sgp) and "abandoned lands" (Siz), followed by the aquatic and semi-aquatic habitats (Table 3, Fig. 4). With the lowest species richness only one species recorded per habitat were: "gardens and courtyards" (Sg); "internal bare rock slopes" (Svgss); "residential buildings (urban and rural type) (Sjsg, Sjss) and "old industrial areas" (Ssiz), occupied only by the Kotschyi's gecko (*Mediodactylus kotschyi*).

Perhaps from the terrestrial urban habitats the most vulnerable are the abandoned lands, which are rapidly being overbuilt. They are essential for the existence of most of the reptile species in the city and important for the dispersal and migrations for the amphibians in the post-breeding periods.

"Urban-to-rural" composition and ecological classification of the batracho- and herpetofauna

Both the batracho- and the herpetofauna showed a similar distribution pattern along the urban-to-rural gradient (Table 4). In both cases a decrease of the species richness is observed from the periphery to the city center. The Sørensen similarity index confirmed this distribution pattern, showing highest similarity between the suburban and the rural zones and slightly lower similarity between the urban and the suburban zones. The similarity between the urban and rural zone showed the lowest values.

According to the Klausnitzer's classification from the amphibians there were no species that could be classified as "synanthropes". One species (*Epidalea viridis*) is considered "hemerophyle", because it occurs mainly in the urban and suburban zones of the city and is well ecologically adapted and occurs in wide variety of habitats (polytopic species). Two species (*Hyla arborea* and *Pelophylax ridibundus*) are also considered as polytopic and they occur in all three zones, which make them "hemerodiaphores". Three species (*Bufo bufo, Pelobates syriacus* and *Rana dalmatina*) were recorded only from the rural and suburban zones in very few habitat types (stenotopes) and are considered as "hemerophobes".

From the reptiles one species (*Mediodactylus kotschyi*) showed characteristics of a typical synantrope and polytopic species, inhabiting wide variety of urban habitat types, some inhabitable for any other reptilian species. There were no reptilian species recorded which can be classified as "hemerophyles". Four species (*Lacerta viridis, Podarcis tauricus, Emys orbicularis* and *Dolichophis caspius*) were recorded from all three zones in the city and occurred in wide range of urban habitats (except for *D. caspius,* which has more specific habitat preferences and is a stenotopic species), which makes them "hemerodiaphores". Three species (*Lacerta trilineata, Natrix natrix* and *Natrix tessellata*) were absent from the urban zone and occur in few urban habitat types (stenotopic species) and are considered to be "hemerophobic".

Conclusions

1. Six species of amphibians were found in total of 15 types of urban habitats and eight species of reptiles were recorded in 24 types of urban habitats.

Table 4. "Urban-to-rural" composition and ecological classification of the amphibians and reptiles in the city of Plovdiv.

Species	Zone			Sørensen similarity index (S)			Ecological classification	Level of synantropy
	Urban	Suburban	Rural	Urban/Suburban	Suburban/Rural	Urban/Rural		
AMPHIBIA								
Bufo bufo	-	+	+	75.00	80.00	50.00	Stenotopic	Hemerophobic
Epidalea viridis	+	+	-				Polytopic	Hemerophylic
Pelobates syriacus	-	+	+				Stenotopic	Hemerophobic
Hyla arborea	+	+	+				Polytopic	Hemerodiaphoric
Rana dalmatina	-	-	+				Stenotopic	Hemerophobic
Pelophylax ridibundus	+	+	+				Polytopic	Hemerodiaphoric
REPTILIA								
Mediodactylus kotschyi	+	+	-	76.92	93.33	66.67	Polytopic	Synanthropic
Lacerta viridis	+	+	+				Polytopic	Hemerodiaphoric
Lacerta trilineata	-	+	+				Stenotopic	Hemerophobic
Podarcis tauricus	+	+	+				Polytopic	Hemerodiaphoric
Emys orbicularis	+	+	+				Polytopic	Hemerodiaphoric
Natrix natrix	-	+	+				Stenotopic	Hemerophobic
Natrix tessellata	-	+	+				Stenotopic	Hemerophobic
Dolichophis caspius	+	+	+				Stenotopic	Hemerodiaphoric

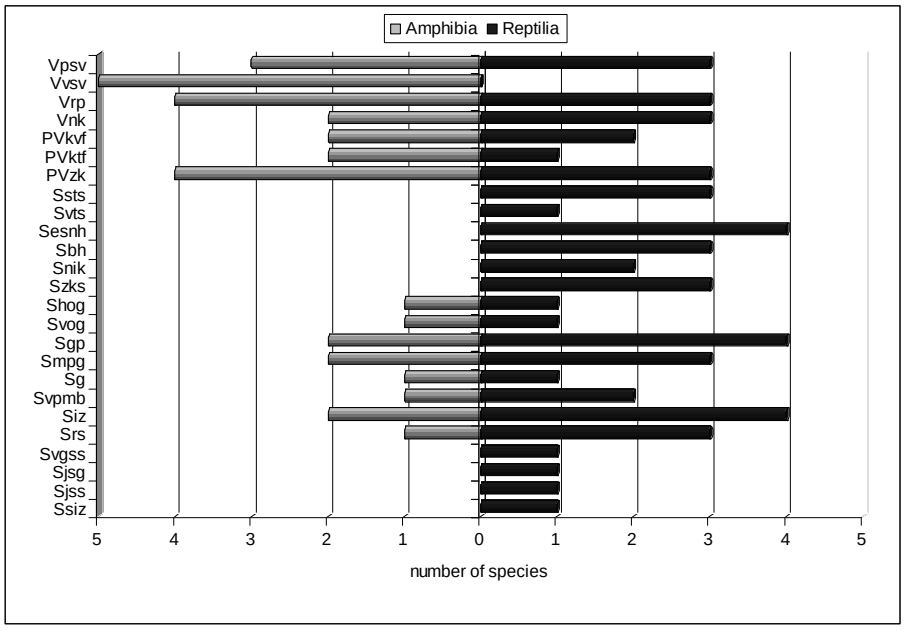

Figure 4. Number of species of amphibians and reptiles in the studied urban habitats. *Legend:* habitat's names and abbreviations are given in Table 1.

2. The cluster analysis of the urban habitats occupied by amphibians resulted in two main clusters: (1) aquatic and semi-aquatic habitats and (2) terrestrial habitats. From the aquatic and semi-aquatic habitats clearly distinguished are the rivers and streams, as the other aquatic habitats were divided into two groups: (1) constant and temporary standing ponds and rice fields and (2) irrigation canals with the riparian plant communities. The urban terrestrial habitats, inhabited by amphibians were divided into three groups: (1) inner spaces between buildings, courtyards and the ruderal communities; (2) abandoned lands and vineyards, and (3) small and large urban parks and high-fruit orchards.

3. The urban habitats inhabited by reptiles were divided into terrestrial and aquatic/semi-aquatic, where the semi-aquatic habitats were differentiated from the typical aquatic ones at about 60% faunistic similarity. Urban terrestrial habitats inhabited by reptiles were divided into two major groups: (1) residential buildings, inner spaces between buildings, courtyards, inner open rocky slopes and old industrial areas (2) orchards, wet grasslands, urban parks, agricultural areas, abandoned lands, grasslands and barbed bushes.

4. For the amphibians, the most species-rich habitat is "temporary standing, freshwater ponds" and for the reptiles – "dry European communities of low bushes"; "large urban parks" and the "abandoned lands", followed by the aquatic

and semi-aquatic habitats. We strongly recommend for the future development of the management plan of the city to be included measures for conserving temporary ponds and abandoned lands to some extend, which will play important conservation role for the amphibians and reptiles in Plovdiv.

5. Both the batracho- and the herpetofauna showed a decreasing distribution pattern (concerning number of species) from the periphery to the city center. The "suburban" and the "rural" zones show the biggest faunistic similarity and slightly lower similarity between the "urban" and the "suburban" zones.

6. In the city of Plovdiv, there are no amphibian species that could be classified as "synanthropes". One species is considered as "hemerophyle", two species as "hemerodiaphores" and three species as "hemerophobes". From the reptiles one species (*Mediodactylus kotschyi*) shows characteristics of typical synantrope. There are no reptiles which can be classified as "hemerophyles". Four species are considered "hemerodiaphores" and three species are considered to be "hemerophobic".

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