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Amphibians of Białystok

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Abstract: The research was carried out on 100 water bodies, from 1998 to 2000. There were 87 water reservoirs located in the area of Białystok, another 13 reservoirs were located in the Białystok surroundings, but outside the administrative boundaries (up to 2.5 km away). Several physical features of the breeding ponds in our study as well as their surroundings were described to determine the urbanization pressure in a given area. The frequency of occurrence of particular amphibian species and their number were determined. In the study area, amphibians belonging to 12 species (with one genetic hybrid) were found. Due to problems identifying "green frogs", they were put into one group for most of analyses. The most frequent amphibians within the administrative boundaries of Białystok were: the "green frogs" (observed in 66.6% of studied water bodies), the common frog (65.5%) and the moor frog (49.4%). These species occurred throughout the entire city. The rarest amphibian species were observed only on the outskirts of Białystok. They were: the crested newt (2.3%) and the natterjack (3.4%). The green toad is considered to be a species less sensitive to urbanization pressure. Paradoxically, it was rarely found in Białystok (9.2%) and only 22.2% of its breeding sites were located in the city centre.

Keywords: amphibians, Białystok, urban populations, breeding ponds

INTRODUCTION

Amphibians are considered to be the group of vertebrates most threatened with extinction. More than 1800 amphibian species are currently endangered on a world scale (IUCN 2007 after Brito 2008). The increase in urbanization is one of the main factors responsible for this situation (Hamer & McDonell 2008). For the purpose of reproduction most amphibians require water. Thus, amphibians of the temperate climate zone are strongly associated with the aquatic environment. Disappearance of amphibian breeding sites is caused by changes in habitats (water pollution, destruction of breeding ponds, and drainage of wetlands). These changes are factors leading to the decline in their population (Amtkjaer 1988, Beebee 1997, Briggs et al. 1998, Vos & Chardon 1998, Godreau et al. 1999). Another very often mentioned factor which negatively influences the number of amphibians, is their mortality on roads. Spring migrations to breeding

ponds often lead to road death (Elżanowski et al. 2009). However, the reasons for the world-wide disappearance of 48% of endangered amphibian species are still unexplained (Stuart after Nystrom et al. 2007, Brito 2008).

There is an increased intensity of unfavourable environmental factors for amphibians in cities which makes urban habitats less uninviting for those animals (Hamer & McDonnell 2008). Many species have relatively low mobility as well as a high fidelity to particular breeding sites. These factors limit their occurrence in urban areas and make natural recolonization almost impossible after the extinction of the local populations (Blaustein et al. 1994).

Studies of batrachofauna were conducted in many Polish cities such us: Poznań (Pawłowski 1993), Kraków (Guzik et al. 1996), Warszawa (Mazgajska 1996, 1998), Białystok (Siwak et al. 2000), Wrocław (Kierzkowski & Ogielska 2001), Chorzów (Sołtysiak 2004), Zielona Góra (Najbar et al. 2005), Lublin (Chobotow & Czarniawski 2007), Olsztyn (Nowakowski et al. 2008) and Gniezno (Adamiak 2008).

The natural environment of Białystok is poorly known. Earlier studies were limited mainly to floristic papers (e.g. Cieluch 2000, Gajko 2000). Little is still known about the fauna of vertebrates (including amphibians) occurring in the city. The batrachofauna of this part of Podlasie was only examined in some areas so far: in the vicinity of Michałowo (Rzepecki 1962), Bielsk Podlaski (Nikonowicz 1969), Dąbrowa Białostocka (Krasowski 1969) and the Narwiański National Park (Sidoruk 2004, 2005).

In recent years, Białystok has developed rapidly. This urban development has caused a continuous increase of anthropopression on habitats occupied by amphibians. It is necessary to gain detailed knowledge about: the places of where amphibians occur, the water bodies they use for breeding as well as an estimation of their numbers at particular sites. Such information will enable future comparative studies to determine the influence of urbanization pressure on local amphibian populations.

The aims of this research were to determine the species composition, frequency of occurrence, and the abundance of amphibian populations breeding in the water bodies of Białystok. The influence of some environmental factors on species diversity observed in breeding ponds, was also analysed.

Study area

Białystok is situated on the western edge of the macroregion of the Białystok Upland, within the North Podlasian Plain, on the banks of the Biała River (Kondracki 1988). Białystok covers an area of 102 km^2. It is characterized by the varied relief. The city is located on Upland built from sand-covered boulder clays, which are crossed by river valleys (Żerański 1997). Almost the entire city lies in the catchment area of the Biała River, which is a left-bank tributary of the Supraśl River. The Supraśl River drains only the northern edge of the city, whereas Horodnianka, which enters directly into the Narew River, drains the southern edge of Białystok. The geological structure and relief support the occurrence of 37 springs in the north-eastern part of the city (Łoszewski 1995).

The region of Białystok is subject to the stronger influence of a continental climate than other parts of Poland. This area is characterized by a shorter vegetation period (180–195 days) and long, snowy winters (snow cover stays 80–87 days). The number of days with temperature below 0° C reaches 50–60, whereas days with ground frost: 110–138. There is not much rainfall and other precipitation. In the last half-century, precipitation oscillated around 594–621 mm annually. The average annual temperature fluctuates between 6.8°C and 8.3°C (Żerański 1997).

In the XVIII century, the area of what is present-day Białystok, still had a predominantly country character. At that time, the city was small and was a background of the manor house neighbouring it. There were fields, meadows, orchards, vineyards, ponds, a zoological garden, forests, scattered farms and country housing estates (Nieciecki 1997). Development of industry, craft and trade in the second half of the XIX century caused the disorganized expansion of the city. After the Second World War, most of the area was occupied by new housing estates and factories (Żerański 1997). Currently, Białystok has about 300 000 inhabitants and is one of the fastest growing cities in Poland.

Many semi-natural and natural ecosystems exist near urban environments inside the city limits. Nonetheless, there is still a growing anthropopression. These natural areas occupy 3600 ha (about 32% of the city area), and over a half of these (about 18%) are forest complexes and parks. These local areas maintain natural, valuable plant communities. Particularly important natural environments are those of the Biała River valleys and tributaries, where semi-natural and natural habitats occur. They constitute a mutually connected system of ecological corridors joining the Supraśl valley, Knyszyńska Forest and the catchments area of the Narew River.

In this study 87 water bodies in the city were investigated. About 80% of these waters are situated within the city limits of Białystok. About 20% of the water bodies are in a natural state, whereas the rest have been altered to various degrees.

Material and methods

The studies were conducted in the area of Białystok from March to July, in 1998–2000. The 87 water bodies located within the administrative boundaries of Białystok were investigated. The species composition and abundance of amphibian breeding populations were estimated. Thirteen water bodies located up to 2.5 km from the city limits were also examined (Fig. 1). These outer sites were studied because the rapid development of the city may influence the neighbouring areas. Also, an early monitoring of these sites will enable future comparative studies. Such studies about possible changes in amphibian communities connected with increasing urbanization pressure may eventually be done. Field controls were conducted on average four times at each site throughout the whole study period.

The following methods were applied during field investigations: controls along the shores of the water bodies, catching amphibians with a landing net, and monitoring the voices of anuran mating males.

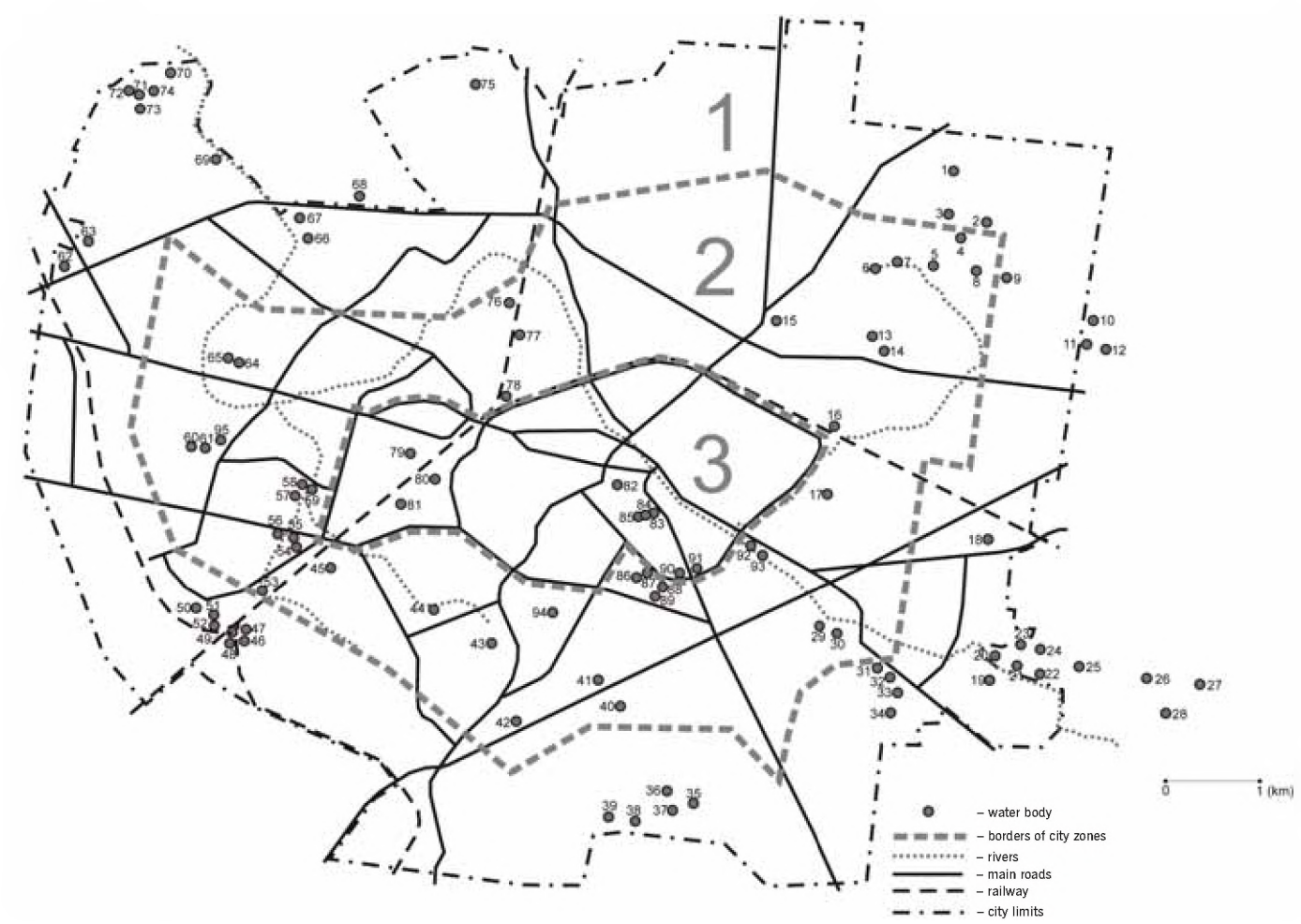

Fig. 1. Location of the studied water bodies within city limits in relation to distinguished city zones.

All caught animals were determined into species. "Green frogs" were determined on the basis of the ratio of metatarsal tubercle length to inner toe length (D.p./ C.int. index) (Berger 2000). In this paper, taxa *Rana esculenta* and *R. lessonae* were pooled into one „green frog" group (*Rana esculenta* complex).

All breeding sites of amphibians were described according to chosen physical features: the size of the water body, the presence of shallows etc. (see Appendix 1). On the basis of intensity and accumulation of anthropopression factors (human population density, building height and road network), three zones within the administrative boundaries of Bialystok were distinguished. The 1st was the „outskirts" zone. This zone extended 1 km from the city boundaries. Woodlands, agricultural and fallow lands occupy the main part of zone 1. There are also peripheral groups of detached houses, and industrial lands with, for example, a sewage treatment plant and airport. The 2nd was the „intermediate" zone. It also consisted of meadows, small woodlands and fallow lands, often in the neighbourhood or between built-up areas. There are allotments, park areas, quite a lot of detached houses, blocks of flats and large industrial areas here. The 3rd was the "centre" zone, mainly with built-up areas; blocks of flats, detached houses, park areas, wastelands with ruderal flora, and areas in the vicinity of the train station, etc. This zone is characterized by the highest accumulation of the urban factors (Fig. 1). Water bodies were also classified according to what surrounded them: high-density housing (blocks of flats and dense city centre); low and disperse housing; municipal gardens (green areas surrounded with buildings); suburban/urban forests; nature reserves; opened ruderal areas with elements of industrial activity; opened ruderal areas slightly transformed by people; allotment gardens and peat bogs.

In all the studied breeding ponds, the presence or absence of coastal shallows was also described. Water bodies were also divided into classes according to size: 1) < 0.3 ha, 2) 0.3– 1.0 ha, 3) > 1.1 ha. All detailed descriptions of all studied water bodies are presented in Appendix 1.

The populations of the particular amphibian species on each site were characterized according to highest number of individuals observed during a single control. Breeding populations of amphibians were divided into 3 groups according to their number: A – from 1 to 20 individuals, B – from 21 to 100 individuals, C – over 100 individuals (Mazgajska 1996).

The frequency of occurrence of particular amphibian species was determined in the 87 water bodies located in the city. The relation between water body location in one of the three main zones with the number of amphibian species was analysed. This was done to estimate if the increasing intensity of the urbanization factors alter the amphibian species composition. The influence of breeding pond area, and the presence of shallows on amphibian species diversity (expressed as a number of species) were also determined. These analyses were performed using the non-parametric Kruskal-Wallis analysis of variance.

Results

Amphibians bred in 94.3% of the studied water bodies within the administrative boundaries of Białystok, and in 95% of all water bodies, which included those 87 within the city and those 13 located outside the city.

Twelve amphibian species (including a genetic hybrid) were found in Białystok: the crested newt *Triturus cristatus* (Laurenti, 1768), common newt *Triturus vulgaris* (Linnaeus, 1758), fire-bellied toad *Bombina bombina* (Linnaeus, 1761), common spadefoot *Pelobates fuscus* (Laurenti, 1768), common toad *Bufo bufo* (Linnaeus, 1758), green toad *Bufo viridis* (Laurenti, 1768) natterjack *Bufo calamita* (Laurenti, 1768), tree frog *Hyla arborea* (Linnaeus, 1758), common frog *Rana temporaria* (Linnaeus, 1758), moor frog *Rana arvalis* (Nilsson, 1842), the edible frog *Rana esculenta* and pool frog *Rana lessonae*. The occurrence of the pool frog *Rana lessonae* Camerano, 1882 and edible frog *Rana esculenta* Linnaeus, 1758 was confirmed according to D.p./ C.int. index. The voices of mating green frog males, led to the conclusion that marsh frog *Rana ridibunda* Pallas, 1771 not occured in studied ponds.

Water bodies located in the city (N = 87) were used on average, by 3.26 species of amphibians (± 1.97 SD). These figures also take into consideration the water reservoirs where amphibians did not breed. A maximum of 8 amphibian species used one city water body (3 sites) as a breeding place. In 3 other reservoirs, 7 amphibian species were found. In 5 of the water reservoirs, amphibians did not breed at all (Appendix 1). The number of amphibian species differed in relation to water body location ($H = 19.797$, $p = 0.001$). The least number of species was observed in the centre zone (Fig. 2).

The most frequently observed amphibians in Białystok were: "green frogs", the common frog and the moor frog. Less frequently observed were: the common toad and smooth newt (see Appendix 1). The occurrence of all species mentioned above was widespread throughout the city area. Within the city centre, the breeding sites of the common toad, common frog and moor frog, however, were limited to 2 water bodies (Appendix 1). Much less frequently observed were: the fire-bellied toad (occurred in 18.4% of all studied water bodies in the city limits), common spadefoot (26.4%) and tree frog (17.2%). The much less frequently observed species, like the crested newt (2.3%) and natterjack (3.4%) were mainly found on the outskirts of the city (Table 1, Appendix 1).

All 9 water bodies located in the city centre (zone 3), were used by amphibians as breeding sites. From 1 to 2 species bred in every water body of this zone (in one pond it was 4 species). "Green frogs" were the most frequent in zone 3, occurring in 66.6% of the water bodies. The smooth newt, green toad, common toad, common frog and moor frog occasionally used the water bodies in zone 3 for breeding.

It was found, that the size of a water body influences the number of amphibian species, which breed in it ($H = 7.97$, $p = 0.018$). The smallest number of amphibian species breed in water reservoirs with the smallest area (Fig. 3). Shallows in water bodies create suitable places for amphibian reproduction. Thus a considerable increase in the number of amphibian species was observed in water bodies with shallows ($H = 11.91$, $p = 0.0006$) (Fig. 4).

Table 1. Frequency of breeding amphibians' occurrence and their estimated abundance in the studied bodies of water (N = 87) in the city of Białystok.

	Species	Number of water bodies (%) used for breeding	Number of water bodies in particular class of abundance (%)		
			1–20	21–100	> 100
1	*Triturus cristatus*	2 (2.3)	1 (50)	0	1 (50)
2	*Triturus vulgaris*	30 (34.5)	27 (90)	1 (3.3)	2 (6.7)
3	*Bombina bombina*	16 (18.4)	16 (100)	0	0
4	*Pelobates fuscus*	23 (26.4)	21 (91.2)	2 (8.8)	0
5	*Bufo bufo*	30 (34.5)	18 (60)	8 (26.7)	4 (13.3)
6	*Bufo viridis*	8 (9.2)	6 (75)	2 (25)	0
7	*Bufo calamita*	3 (3.4)	3 (100)	0	0
8	*Hyla arborea*	15 (17.2)	12 (80)	2 (13.3)	1 (6.7)
9	*Rana esculenta* complex	58 (66.6)	28 (48.3)	21 (36.2)	9 (15.5)
10	*Rana temporaria*	57 (65.5)	22 (38.6)	20 (35.1)	15 (26.3)
11	*Rana arvalis*	43 (49.4)	20 (46.5)	11 (25.6)	12 (27.9)

Discussion

The results obtained from the areas we studied, indicated that amphibian species composition did not significantly differ compared with the nearby areas of Michałowo (Rzepecki 1962), Bielsk Podlaski (Nikonowicz 1969) and the Narwiański National Park (Hermaniuk et al. 2004). The marsh frog was one species observed in a nearby area, but not within city limits.

In comparison with other cities, Białystok demonstrates a rich amphibian species composition both throughout the entire city as well as in particular water reservoirs. The number of amphibian species detected in Białystok was one of the highest number of all Polish cities. Lublin had an equally high number (12 species) (Chobotow & Czarniawski 2007). The average number of amphibian species – 3.26 per pond observed in Białystok was higher than that shown for Warszawa in 1996 (2.14) and much higher than that shown in one of Warszawa districts (Wawer) in 2007 (only 1.46) (Mazgajska 1996, 2009).

In Białystok the natterjack was rare, and it was not observed at all in Poznań (Pawłowski 1993), Kraków (Guzik et al. 1996), Łódź (Stopczyński 1997), Warszawa (Mazgajska 1996, 2008), Wałbrzych (Bałuka 2000), Wrocław (Ogielska 2000, Kierzkowski & Ogielska 2001), Chorzów (Sołtysiak 2004) and Oława (Majtyka 2006). The natterjack is also a rare species outside urban areas (Głowaciński & Rafiński 2003). Its low frequency in the research area should not only be associated with the influence

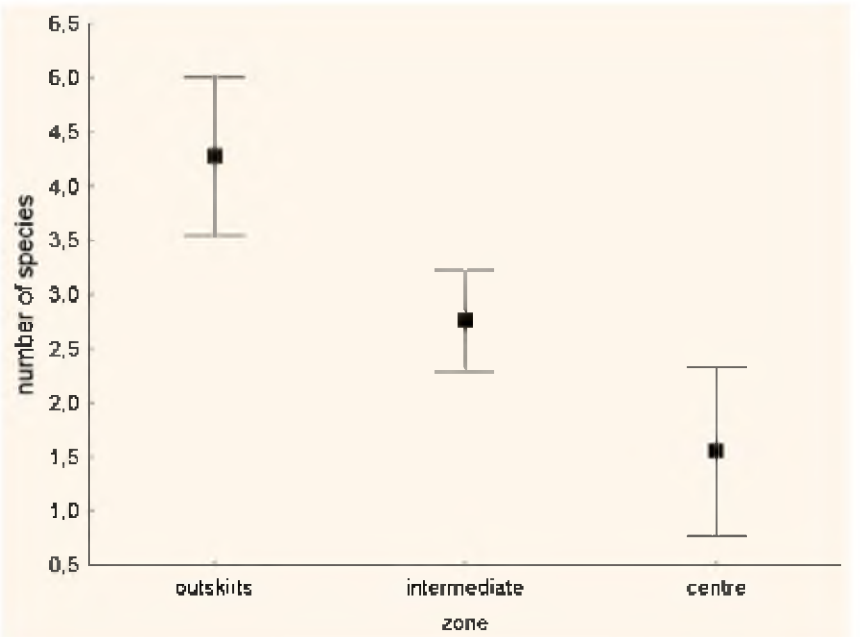

Fig 2. Number of amphibian species (means ± 95% CI) in relation to location of the water bodies studied in an urbanization gradient.

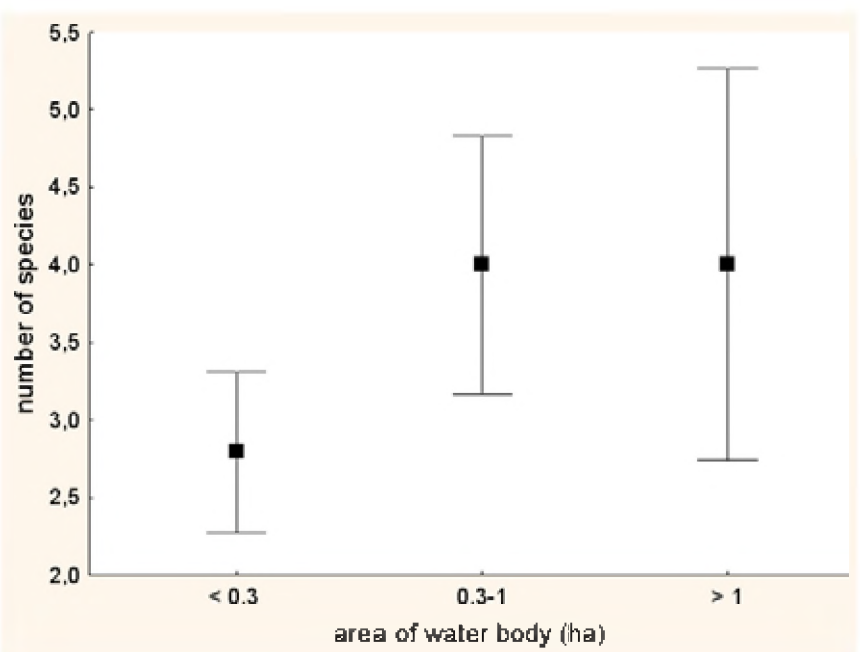

Fig. 3. Number of amphibian species (means ± 95% CI) in relation to the size of the studied water bodies.

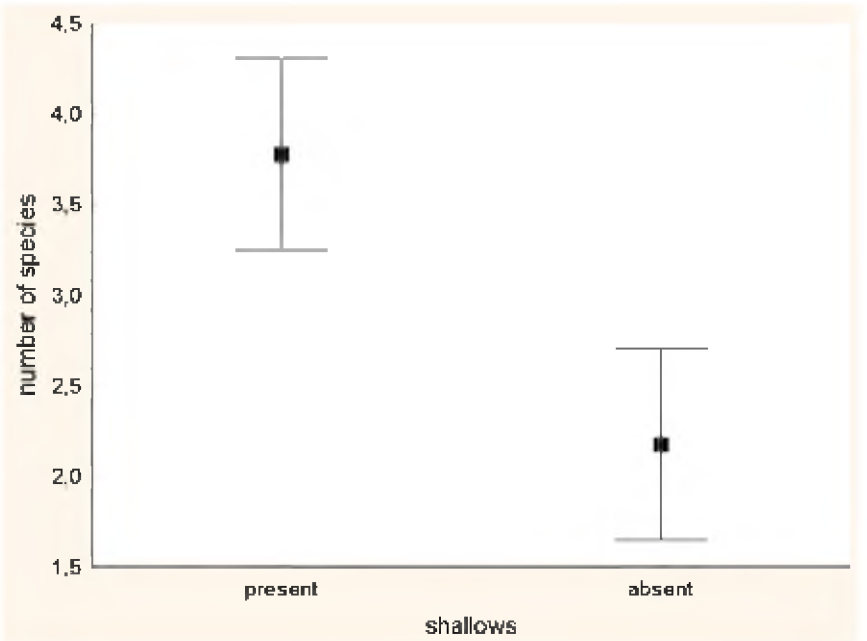

Fig. 4. Number of amphibian species (means ± 95% CI) in relation to the presence/absence of shallows in the studied water bodies.

of urbanization on its populations. The natterjack frequency in the research area was 3.44% within the city and 3.0% in the outside area and 13 reservoirs located up to 2.5 km away from the city.

Similarly, the absence of the marsh frog in the study area is not presumably associated with the particular sensitivity of this species to the urbanization pressure. Its absence in the study area is more a result of its rare and mosaic occurrence in Poland. This is definitely the rarest species belonging to the "green frogs" group in Poland (Głowaciński & Rafiński 2003). The marsh frog was also not found in Kraków (Guzik et al. 1996), Wałbrzych (Bałuka 2000) and Oława (Majtyka 2006). On the other hand, *R. ridibunda* was found in Poznań (Pawłowski 1993), Warszawa (Mazgajska 1996) and Wrocław (Ogielska 2000). The absence of the marsh frog in Białystok, although the city is located in its geographical range (Głowaciński & Rafiński 2003), could be explained by the lack of available habitats preferred by this species. It likes large water bodies such as lakes, fish breeding ponds, old river beds, big clay pits and rivers (Juszczyk 1987, Berger 2000). However, individuals of this species were also not found in the direct neighbourhood of Białystok (Hermaniuk et al. 2004), in spite of the presence of suitable habitats. The closest site of *R. ridibunda* was located about 25 km away from the study area (unpublished data – database of the Institute of Nature Conservation PAN).

In Białystok, there was a high frequency of occurrence in species considered to have an intermediate sensitivity to urbanization pressure, such species were: the common

frog, moor frog, common toad, and the "green frogs". In some cases, there was even a high frequency of occurrence in species considered sensitive to urbanization pressure, e.g. the common spadefood. These high occurrences may indicate that urban factors have a weaker influence on amphibians in Białystok compared to other Polish cities. For example, in Warszawa in 1992–1994, the frequency of the most common species were: 56.6% of all studied water bodies for "green frogs", 18.4% for the common frog, whereas 27.6% for the moor frog. The frequencies of these species in Białystok were: 66.6%, 65.5% and 49.4% respectively. The crested newt, fire-bellied toad, common spadefoot and common tree frog are species considered to be sensitive to urbanization pressure (Mazgajska 1998, 2008). However, in the Białystok study area, they were more frequent than in Warszawa: the common spadefoot – 26.4% (6.6% in Warszawa), and the fire-bellied toad – 18.4% (9.2% in Warszawa). The common tree frog was observed in 17.2% of water bodies studied in Białystok but this species was absent in Warszawa in 1992–1994, but in later studies, however, it was found on a single site (Mazgajska 1998, and own data). Only the frequency of *Triturus cristatus* was similar and very low in both cities – two sites in Białystok and one in Warszawa. Like in other large urban agglomerations, the above mentioned species also occur only in peripheral areas, creating small populations, or they are not found at all (Pawłowski 1993, Guzik et al. 1996, Mazgajska 1996, Stopczyński 1997). On the other hand, in Białystok there were fewer green toads in the dense city centre. Only 22% of all green toads` breeding sites were located in the Białystok centre (zone 3), while in Warszawa it was 47% of all water bodies used by this species (Mazgajska 1996). In Poznań (Pawłowski 1993) *Bufo viridis* breed mainly in the city centre, and only one site was located in the peripheral area.

In Białystok "brown frogs" were also occasionally found in the city centre. On the other hand, in the centre of Warszawa and Poznań "brown frogs" did not occur at all (Pawłowski 1993, Mazgajska 1996). In Kraków, single individuals of "brown frogs" were only observed in the city centre (Guzik et al. 1996). The occurrence of "brown frogs" within the centre of Białystok is probably possible due to the favourable topology. Białystok offers "brown frogs" a network of watercourses and forests as well as bushes and meadows penetrating deeply into the city. The Białystok topology may be the reason this city has weaker urbanization pressure than several previously examined Polish cities. Therefore amphibian species such as the common frog and common toad considered to be medium sensitive to the urbanization pressure, are able to exist in Białystok`s dense centre (zone 3) (Mazgajska 1996).

However, in general in water bodies located in the city centre (zone 3, Fig. 1), significantly less amphibian species were observed in the breeding sites compared to the sites of the peripheral areas. Similar results were obtained in Warszawa (Mazgajska 1996) which confirms the thesis that intensified urbanization pressure alters amphibian species richness. Such negative changes in amphibian communities could be especially connected with transformations of water bodies used for breeding (e.g. disappearance of shallows – see Fig. 4). In various water bodies management activities made in urban habitats, amphibian requirements should be taken into consideration, and this may help to prevent such negative changes in populations of those vertebrates.

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Streszczenie

[Płazy Białegostoku]

W latach 1998–2000 przeprowadzono badania batrachofauny 100 zbiorników wodnych. Z tej liczby 87 zbiorników położonych było na terenie Białegostoku, zaś 13 w jego najbliższych okolicach, poza granicami administracyjnymi (do 2,5 km od nich). Zbiorniki rozrodcze płazów opisano biorąc pod uwagę wybrane cechy fizyczne oraz ich otoczenie w celu określenia presji urbanizacyjnej na danym obszarze.

Określono frekwencję występowania poszczególnych gatunków płazów oraz ich liczebność. Ogółem na obszarze badań stwierdzono 12 gatunków płazów (w tym jednego mieszańca hybrydogenetycznego). Z uwagi na problemy z oznaczeniem żab zielonych, do większości analiz wyników połączono je w jedną grupę. Najwyższą frekwencję w granicach administracyjnych Białegostoku wykazały: żaby zielone (66,6%), żaba trawna (65,5 %) i żaba moczarowa (49,4%). Są to gatunki, które występują na terenie całego miasta. Do najrzadszych gatunków płazów, obserwowanych tylko na peryferiach Białegostoku, zaliczyć można: traszkę grzebieniastą (2,3%) i ropuchę paskówkę (3,4%). Uważana za gatunek odporny na presję urbanizacyjną ropucha zielona również wykazała stosunkowo niską frekwencję (9,2%), a jedynie 22,2% wszystkich jej stanowisk rozrodczych znajdowało się w centrum miasta.

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Appendix 1. Characteristics of the studied water bodies in Białystok with data on occurrence and abundance of amphibian species. No – water body number according to Fig. 1. Sit (situation): M – within city limits, P – outside the city; Loc. (description of surrounding area): I – concentrated housing, II – dispersed housing, III – city parks, IV – forests, V – nature reserve, VI – open ruderal areas with industrial activity, VII – open ruderal areas slightly modified by human activity, VIII – garden allotments, IX – peat bogs; Area: 1 – < 0.3 ha, 2 – 0.3–1.0 ha, 3 1.1–2.0 ha, 4 – > 2 ha; Sh – shallows: 1 – absent, 2 – present; Zone: 1– outskirts of town, 2 – intermediate zone, 3 – city center; Amphibian species: *Tc – Triturus cristatus*, *Tv – Triturus vulgaris*, *Bo – Bombina bombina*, *Pf – Pelobates fuscus*, *Bb – Bufo bufo*, *Bv – Bufo viridis*, *Bc – Bufo calamita*, *Ha – Hyla arborea*, *Rec – Rana esculenta* complex, *Rt – Rana temporaria*, *Ra – Rana arvalis*. Abundance: A – 1–20, B – 21–100, C – >100.

Description of water bodies								Amphibian species and their abundance										
No	Place	Sit	Coordinates	Loc	Area	Sh	Zone	*Tc*	*Tv*	*Bo*	*Pf*	*Bb*	*Bv*	*Bc*	*Ha*	*Rec*	*Rt*	*Ra*
1	Wiślana Street	M	53°09'52" N; 23°13'02" E	II	1	2	1					A				B	C	
2	Kluka Street	M	53°09'33" N; 23°13'15" E	VII	1	2	1				A			A	A	A		
3	Kolonia Bagnówka	M	53°09'40" N; 23°12'56" E	VII	1	2	1		A		A	A				A	B	B
4	Kolonia Bagnówka	M	53°09'30" N; 23°13'00" E	VII	1	1	2					B			A	A	A	
5	Kolonia Bagnówka	M	53°09'21" N; 23°12'45" E	VII	1	2	2				A	A				B	C	C
6	Chętnika Street	M	53°09'14" N; 23°12'13" E	VII	1	1	2									B	B	
7	Chętnika Street	M	53°09'16" N; 23°12'24" E	VII	1	2	2										A	
8	Kluka Street	M	53°09'13" N; 23°13'11" E	VII	1	1	2										B	B
9	Kluka Street	M	53°09'13" N; 23°13'15" E	VII	1	2	1			A	B				A		C	C
10	Sowlany	P	53°08'53" N; 23°14'13" E	VII	1	2	1		A						B	B	B	B
11	Sowlany	P	53°08'46" N; 23°14'17" E	VII	1	2	1		A						B	B	C	C

12	Sowlany	P	53°08'45" N; 23°14'19" E	VII	1	2	1								A	A	A	
13	Harnasiów Street	M	53°08'49" N; 23°12'06" E	II	1	2	2									A	A	
14	Fredry Street	M	53°08'47" N; 23°12'11" E	II	2	2	2					A				A	A	
15	Wschodnia Street	M	53°08'56" N; 23°11'13" E	I	2	1	2									B		
16	Towarowa Street	M	53°08'10" N; 23°11'51" E	VI	2	2	2									B	B	B
17	Wołyńska Street	M	53°07'44" N; 23°11'33" E	VII	2	2	2				A				A			A
18	Baranowicka Street	M	53°07'30" N; 23°13'14" E	VII	2	2	1		A	A	A				A	A	C	C
19	Dojlidzkie Ponds (Plażowy)	M	53°06'26" N; 23°13'44" E	VII	4	2	1					A				B	A	
20	Dojlidzkie Ponds	P	53°06'46" N; 23°13'18" E	VII	4	2	1			B	B	B				C		C
21	Dojlidzkie Ponds	P	53°06'41" N; 23°13'34" E	VII	4	2	1				A	A			A	B		A
22	Dojlidzkie Ponds	P	53°06'38" N; 23°13'46" E	VII	4	2	1			A		A			A	B		A
23	Dojlidzkie Ponds	P	53°06'46" N; 23°13'34" E	VII	4	2	1			A		A			A	B		A
24	Dojlidzkie Ponds	P	53°06'44" N; 23°13'48" E	VII	3	2	1			C	B	A			B	C	C	C
25	Dojlidzkie Ponds	P	53°06'44" N; 23°14'03" E	VII	4	2	1		A	C	C	C	A		C	C	C	C
26	Dojlidzkie Ponds	P	53°06'36" N; 23°14'47" E	VII	3	2	1			C			A	A	C	B		

Continued on the next page

Description of water bodies								Amphibian species and their abundance										
No	Place	Sit	Coordinates	Loc	Area	Sh	Zone	*Tc*	*Tv*	*Bo*	*Pf*	*Bb*	*Bv*	*Bc*	*Ha*	*Rec*	*Rt*	*Ra*
27	Dojlidzkie Ponds	P	53°06'32" N; 23°15'18" E	VII	3	2	1			B			B	A	A	A		
28	Dojlidzkie Ponds	P	53°06'22" N; 23°14'57" E	VII	4	2	1			A					A	C	A	B
29	Plywood factory	M	53°06'57" N; 23°11'44" E	VI	4	2	2				B	A				C	B	B
30	Plywood factory	M	53°06'53" N; 23°11'53" E	VI	3	2	2					A				C		A
31	Dojlidy Park	M	53°06'38" N; 23°12'24" E	III	2	1	1				A	B				B	A	A
32	Dojlidy Park	M	53°06'36" N; 23°12'25" E	III	2	1	1					B				B	A	A
33	Dojlidy Park	M	53°06'34" N; 23°12'24" E	III	3	1	1					C			A	C		
34	Dojlidy Brewery	M	53°06'23" N; 23°12'24" E	VI	3	2	1			A		C			A	C	C	C
35	Krywlany	M	53°05'51" N; 23°10'30" E	VII	1	2	1	A	A	A	A	A					B	B
36	Krywlany	M	53°05'53" N; 23°10'24" E	VII	1	2	1		A		A						A	
37	Krywlany	M	53°05'49" N; 23°10'28" E	VII	1	2	1		A	A	A	A			A	A	A	
38	Solnicki Forest	M	53°05'37" N; 23°10'00" E	IV	2	2	1				A	A				A	C	C
39	Solnicki Forest	M	53°05'35" N; 23°09'52" E	IV	2	2	1		A		A	A				A	C	C
40	airport	M	53°06'17" N; 23°09'49" E	VII	1	1	2					A			A		A	
41	Letniska Street	M	53°06'33" N; 23°09'36" E	VII	1	2	2										A	A

42	Stadium „Hetman”	M	53°06’15” N; 23°08’51” E	VI	2	1	2						A			A		A
43	Kręta Street	M	53°06’45” N; 23°08’28” E	I	1	2	2											A
44	Bema Street	M	53°07’01” N; 23°08’06” E	VIII	2	2	2						A			A		
45	Octowa Street	M	53°07’15” N; 23°07’01” E	VI	3	2	2		A		A	A				C	B	C
46*	Starosielce Street	M	53°06’45” N; 23°06’19” E	VI	2	2	1		A	A		B				B	A	A
47	Starosielce Street	M	53°06’52” N; 23°06’16” E	VI	1	2	1		A	A							A	A
48	Railway tracks – direction Warszawa	M	53°06’49” N; 23°06’10” E	VII	1	2	1		A	A					A	A		B
49	Railway tracks – direction Warszawa	M	53°06’52” N; 23°06’08” E	VII	1	2	1		A								A	A
50*	Niepodległości Street	M	53°07’00” N; 23°05’49” E	VII	1	2	1			A	A		A	A			A	
51	Lawendowa Street	M	53°06’58” N; 23°06’04” E	VII	1	2	1			A	A							A
52	Lawendowa Street (przy torach)	M	53°06’56” N; 23°06’06” E	VII	2	2	1		A	A	A	A		A		A	A	A
53	Lniana Street	M	53°07’06” N; 23°06’22” E	VII	1	2	2									A	B	A
54	Hetmańska Street	M	53°07’23” N; 23°06’48” E	VII	1	2	2		A		A					A		A
55	Popiełuszki Street	M	53°07’28” N; 23°06’38” E	IX	2	2	2		A	A	A					B	C	C
56	Popiełuszki Street	M	53°07’29” N; 23°06’32” E	IX	2	2	2		A		A					A	C	C
57	Marczukowska Street	M	53°07’43” N; 23°06’44” E	VII	1	2	2					A					B	

Continued on the next page

Description of water bodies								Amphibian species and their abundance										
No	Place	Sit	Coordinates	Loc	Area	Sh	Zone	*Tc*	*Tv*	*Bo*	*Pf*	*Bb*	*Bv*	*Bc*	*Ha*	*Rec*	*Rt*	*Ra*
58	Marczukowska Street	M	53°07'47" N; 23°06'47" E	VII	2	2	2									B	C	B
59	Marczukowska Street	M	53°07'46" N; 23°06'52" E	VII	2	1	2					B				B	A	A
60	Niska Street	M	53°07'58" N; 23°05'53" E	VII	2	2	2		A			C				C	C	C
61	Niska Street	M	53°08'00" N; 23°05'54" E	VII	2	2	2		A			C				C	B	
62	Kleeberga Street	M	53°09'10" N; 23°04'26" E	VI	1	1	1			A						B	B	A
63	Tkacka Street	M	53°09'20" N; 23°04'41" E	VI	1	2	1										B	B
64	Kołłątaja Street	M	53°08'33" N; 23°06'05" E	VII	1	2	2										A	A
65	Kołłątaja Street	M	53°08'35" N; 23°06'03" E	VII	1	1	2		A			A				A		
66	Gajowa Street	M	53°09'26" N; 23°06'47" E	VII	1	2	1									A	B	B
67	Maczka Street	M	53°09'34" N; 23°06'40" E	VII	1	1	1									A	C	
68	Lodowa Street	P	53°09'36" N; 23°07'22" E	II	1	1	1									B	C	
69	Kleeberga Street (Auchan)	M	53°09'51" N; 23°06'04" E	VI	2	2	1					B				A		
70	Produkcyjna Street	M	53°10'28" N; 23°05'36" E	VII	1	2	1			A					A	B	B	
71	Produkcyjna Street (sewage treatment plant)	M	53°10'22" N; 23°05'06" E	VI	1	2	1		A						A	C	C	C
72	Produkcyjna Street	M	53°10'23" N; 23°05'05" E	VI	1	1	1		A							B	B	

73	Produkcyjna Street (sewage treatment plant)	M	53°10'18" N; 23°05'14" E	VI	2	2	1		A		A	B	B		B	B	B	B
74	Produkcyjna Street (sewage treatment plant)	M	53°10'24" N; 23°05'17" E	VI	1	2	1		A	A					B	C	B	
75*	Antoniuk Forest	M	53°10'32" N; 23°08'20" E	IV	1	2	1	C	C		A	A			C	B	C	C
76	Railway tracks – direction Sokółka	M	53°09'03" N; 23°08'45" E	VIII	1	2	2		A								B	
77	Railway tracks – direction Sokółka	M	53°08'43" N; 23°08'44" E	VI	1	1	2										A	
78	Railway tracks – direction Sokółka	M	53°08'24" N; 23°08'38" E	VI	1	1	2		B	A								
79	Prowiantowa Street	M	53°08'00" N; 23°07'46" E	VI	1	1	3		C									
80	Stołeczna Street / railway tracks	M	53°07'49" N; 23°08'01" E	VI	1	2	3		A									
81	Lokomotive shed Białystok	M	53°07'38" N; 23°07'42" E	VI	2	1	3						A					
82	Moat at Branicki palace	M	53°07'46" N; 23°09'44" E	III	2	1	3									A		
83	Fountain "Przy Praczkach"	M	53°07'40" N; 23°10'07" E	III	1	1	3									A		
84	Pond in "Planty" park	M	53°07'38" N; 23°10'03" E	III	1	1	3									A		
85	Fountain in "Planty" park	M	53°07'36" N; 23°09'59" E	III	1	2	3						B			A		
86	Pond in zoo "Akcent"	M	53°07'14" N; 23°09'59" E	III	2	1	2						A			A		
87	Ditch in zoo "Akcent"	M	53°07'14" N; 23°10'02" E	VIII	1	1	2										A	A

Continued on the next page

Description of water bodies								Amphibian species and their abundance										
No	Place	Sit	Coordinates	Loc	Area	Sh	Zone	*Tc*	*Tv*	*Bo*	*Pf*	*Bb*	*Bv*	*Bc*	*Ha*	*Rec*	*Rt*	*Ra*
88	Przemysłowa Street	M	53°07'11" N; 23°10'09" E	VIII	2	2	2		A		A					B	B	B
89	Zwierzyniecka Street	M	53°07'06" N; 23°10'05" E	VIII	1	1	2		A							A	A	
90	Podleśna/ Mickiewicza Streets	M	53°07'14" N; 23°10'20" E	I	3	2	3					A				A	A	A
91	Miłosza Street	M	53°07'16" N; 23°10'32" E	I	3	2	3									A		A
92	Branickiego Street / Biała River	M	53°07'25" N; 23°11'00" E	VII	2	2	2		A							B		
93	Branickiego Street / Biala River	M	53°07'23" N; 23°11'05" E	VII	1	2	2										C	
94*	Świerkowa Street	M	53°07'02" N; 23°09'08" E	VI	1	2	2						A					
95*	Sikorskiego Street	M	53°08'00" N; 23°05'58" E	VII	1	1	2					B				B	B	
96	Towarowa Street	M	53°08'16" N; 23°11'50" E	VI	1	2	2											
97	Railway tracks – direction Sokółka	M	53°08'45" N; 23°08'36" E	VI	1	1	2											
98	Kolonia Bagnówka	M	53°09'38" N; 23°12'33" E	VII	1	1	1											
99	Dojlidy Brewery	M	53°06'30" N; 23°12'24" E	VI	1	1	1											
100	Dojlidy Brewery	M	53°06'31" N; 23°12'20" E	VI	1	2	1											