



Amphibians of Lublin

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Abstract: The occurrence of amphibians in Lublin city (South-East Poland) was studied in the years 1998–2006. At 33 localities, including all water bodies in the Lublin area, 12 taxons of amphibians were found. Common frog *Rana temporaria* was most frequently observed in studied water bodies (84.7% of all locations). The results indicate that the rarest and extremely threatened with extinction species are: crested newt *Triturus cristatus* and common tree frog *Hyla arborea*.

Key words: urban fauna, amphibians

INTRODUCTION

In the last years a lot of studies connected with biodiversity of urban areas have been conducted in Poland (e.g. Barczak & Indykiewicz 1998, Indykiewicz et al. 2001, 2008). The important subjects of these investigations are amphibians – vertebrates extremely sensitive to environmental changes and therefore used as excellent bio indicators that fluctuate very quickly. The main threats for the amphibians in cities are the disappearance of breeding habitats, serious difficulty in seasonal migrations and habitat degradation (Hamer & McDonnell 2008). The aim of this study is to present the results of research on population of amphibians in Lublin – the biggest city in the South-East Poland. Results of the studies presented below can be helpful not only for estimating the condition of amphibian populations, but also as a guide during planning the city development in the areas, where species whose habitat should be protected by law under European directives, occur.

The populations of amphibians of the Lublin Upland were subject of a number of studies conducted firstly in protected areas (Chobotow & Czarniawski 1999, 2001). Batrachofauna of this region includes 13 lowland species: the common newt *Triturus vulgaris* (Linnaeus, 1758), the crested newt *Triturus cristatus* (Laurenti, 1768), the common toad *Bufo bufo* (Linnaeus, 1758), the green toad *Bufo viridis* Laurenti, 1768, the moor frog *Rana arvalis* Nilsson, 1842, the common frog *Rana temporaria* Linnaeus, 1758, the edible frog *Rana kl. esculenta* Linnaeus, 1758, the pool frog *Rana lessonae* Camerano, 1882, the marsh frog *Rana ridibunda* Pallas, 1771, the common tree frog *Hyla arborea* (Linnaeus, 1758), the fire-bellied toad *Bombina bombina* (Linnaeus, 1761), the common spadefoot *Pelobates fuscus* (Laurenti, 1768) and considered as rela-

tively rare the natterjack *Bufo calamita* (Laurenti, 1768) (Głowaciński & Rafiński 2003). In the last years the decrease in populations of crested newts and fire-bellied toad has been observed. It seems that the same process regarding common tree frogs has been occurring in several parts of the Lublin Upland. The adequate data on distribution of “green frogs” population in this area, especially on presence of marsh frog *Rana ridibunda*, are still insufficient.

STUDY AREA

Lublin city is located in the Lublin Upland, on loess hills slit by valleys of three rivers: Bystrzyca, Czechówka and Czerniejówka (51°15' N, 22°35' E). The city is spread at an altitude of 162–233 m, with the area of 147.5 km² (2008) and population around 360 thousands inhabitants. Within the borders of the city forests occupy 1664 ha, agricultural grounds (allotments, orchards, meadows) 1253 ha and green areas (parks, cemeteries) 345 ha.

Despite of favourable geological structure the city has inadequately developed superficial waters. Nevertheless, in the area of agglomeration including city centre, there still exist the relics of semi-natural moist forests, wet meadows with seasonal water pools and fragments of old river beds, which, similarly to artificial pools, make suitable habitat for amphibians existence. Unfortunately, during the city's expansion, old river meanders were destroyed, wet meadows drained and valleys of rivers transformed. In the strict central area of the city wooded grounds are scarce, there are also no water reservoirs.

Water reservoirs of Lublin are generally connected with river valleys. The majority of water bodies of the area (about 80%) were built by men (e.g. Zemborzycki Retention Reservoir, drains, fish ponds). Some of them were transformed to a very significant degree by concreting banks or were located in the submerged areas (unused parts of garden plots). Only few of them have “semi-natural” character, e.g. small seasonal pools surrounded by arable fields in the northern part of the city or short sections of river banks.

33 water bodies, including virtually all reservoirs in the administrative borders of Lublin agglomeration, were investigated. For detailed description of studied locations – see Appendix 1. The localisation of small, seasonal pools that dry during summer was determined through colour aerial photography (Czarniawski & Gosik 2002).

METHODS

The studies were conducted in years 1998–2006. Water bodies were penetrated regularly each year from the end of February to September. In this period, each pond was examined about 10 times.

Observations were made by searching amphibians along the shoreline of ponds and ditches and counting them together with spawn and tadpoles. Most of the water bodies

were researched entirely, while for rivers and vast reservoirs sections 200 meters of shoreline were observed.

Observations of some species including green toad, common tree frog and fire-bellied toad were based, beside direct observations, on amphibian voices.

The pools were grouped into nine classes according to its location: I – city centre or quarters with dense building; II – quarters with low, dispersed building; III – parks, cemeteries or other green areas, IV – forests; V – protected areas (nature reserves); VI – fallow lands with elements of industrial activity; VII – fallow lands, with insignificant impact of urbanization; VIII – gardens; IX – grounds surrounded by agricultural areas (fields, meadows) (Appendix 1).

The adult amphibians (especially “green frogs”), spawn and tadpoles were identified according to Berger (2000) keys. In order to assess the number of each amphibian species present in water bodies, three classes were distinguished: the 1st class from 1 to 20 individuals, the 2nd class from 21 to 100 individuals and the 3rd class – over hundred of individuals (according to Mazgajska 1998). Table 1 shows the maximum number of mature individuals observed in each location.

RESULTS

During the studies carried out in 33 locations including water reservoirs in the border of Lublin area, twelve species of amphibians (all living in lowland Poland, except natterjack *Bufo calamita* and agile frog *Rana dalmatina* Bonaparte, 1840) were found. The average number of species per water body was 3.70 ± 2.05 (SD). Only in one reservoir (3% of total number of reservoirs) no amphibians were observed (Table 1). The highest numbers of amphibian species (8–10) were found in seasonal water bodies in the NE part of the town in Rudnik district (locations No. 1, 3), but population of amphibians was sparse in this area. Characteristic species of this area are *Bombina bombina* and *Rana lessonae*. The most numerous amphibian populations was found in the SW part of Lublin. It was formed by *Bufo bufo* and *Rana temporaria*.

The most frequently observed species in water reservoirs was *Rana temporaria* (28 –84.7% of all water bodies studied), then *Rana* kl. *esculenta* (26 reservoirs – 78.8%) and *Bufo bufo* (in 54.4% of the reservoirs) (Table 2). The most numerous amphibian species were *Rana* kl. *esculenta* – more than 100 specimens in 16 locations in different parts of Lublin area, *Rana temporaria* (14) and *Triturus vulgaris* (6) (Table 1).

Large populations of “green frogs” were dominated by water frogs. The occurrence of small, isolated populations (up to 20 specimens) of *Rana lessonae* were observed in two isolated places (6.1%), located near south and North-East borders of the city. *Rana ridibunda* was detected only in a concrete clarifier (location No. 19).

Relatively numerous (more than 100 breeding specimens) populations of *Rana arvalis* were monitored in 3 locations (23.1%). Breeding individuals of *Bufo viridis* were detected in 11 water reservoirs, but the average number of individuals oscillated around 10, and only in Botanic Garden ponds (location No 8) it reached 50 specimens.

Table 1. Occurrence and estimated abundance of particular amphibian species in studied water bodies. Classes of abundance: 1: 1–20 individuals, 2: 21–100 individuals, 3: 100< individuals.

Water body number	Species												
	<i>Bufo bufo</i>	<i>Bufo viridis</i>	<i>Bombina bombina</i>	<i>Triturus vulgaris</i>	<i>Triturus cristatus</i>	<i>Pelobates fuscus</i>	<i>Hyla arborea</i>	<i>Rana arvalis</i>	<i>Rana temporaria</i>	<i>Rana esculenta</i>	<i>Rana lessonae</i>	<i>Rana ridibunda</i>	“green frogs” complex
1	1	1	2	3		1		3	3	3			3
2	1			2					3	3			3
3	1	1	1	3	1	1		3	3	3	1		3
4	1							3	2				
5	1				1				3	3			3
6	1	1		3			1	1	3				
7													
8	2	2		3		1		2	3	3			3
9	1	1		2	1				2	3			3
10										3			3
11	1	1						1	3	3			3
12								1	3	1			1
13									1	1			1
14	1								1	1			1
15	1	1		3		1			3	3			3
16				1				1	1	1			1
17	1	1						1	3	3			3
18									2	3			3
19									2	3		1	3
20	1							1	1				
21						1			1	1			1
22	1			3					3	3			3
23	1						1	2	3	3	1		3
24				1					1				
25	1								3	2			2
26	3									3			3
27										1			1
28									3				
29		1							2	2			2
30	1	1		1					1	1			1
31		1							2				
32								2		1			1
33				1				1	1	3			3

Table 2. Frequency of breeding amphibians occurrence and their estimated abundance in studied bodies of water in Lublin.

	Species	Number of water bodies (%) used for breeding	Number of water bodies in particular class of abundance (%)		
			1–20	20–100	> 100
1	<i>Triturus cristatus</i>	3 (9.1)	3 (100)		
2	<i>Triturus vulgaris</i>	12 (36.4)	4 (33.3)	2 (16.7)	6 (50)
3	<i>Bombina bombina</i>	2 (6.1)	1 (50)	1 (50)	
4	<i>Pelobates fuscus</i>	5 (15.2)	5 (100)		
5	<i>Bufo bufo</i>	18 (54.4)	16 (90)	1 (5)	1 (5)
6	<i>Bufo viridis</i>	11 (33.3)	10 (91)	1 (9)	
7	<i>Hyla arborea</i>	4 (12.1)	4 (100)		
8	<i>Rana temporaria</i>	28 (84.7)	8 (28.6)	6 (21.4)	14 (50)
9	<i>Rana arvalis</i>	13 (39.4)	7 (53.8)	3 (23.1)	3 (23.1)
10	<i>Rana esculenta</i>	26 (78.8)	8 (30.8)	2 (7.7)	16 (61.5)
11	<i>Rana lessonae</i>	2 (6.1)	2 (100)		
12	<i>Rana ridibunda</i>	1 (3.0)	1 (100)		
10–12	green frogs complex	26 (78.8)	8 (30.8)	2 (7.7)	16 (61.5)

Up to 20 specimens of common spadefoot *Pelobates fuscus* were observed in 5 pools (15.1%).

Smooth newt was detected in 12 pools (36.4%). High numbers of this amphibian (more than 200 breeding specimens), were observed in 3 of them.

Small, isolated populations of *Bombina bombina*, were limited to pools surrounded by agricultural areas still existing in the north-east part of the city (2 locations – 6.1%, about 10 and 30 individuals). Rare and extremely threatened species *Triturus cristatus* and *Hyla arborea* were also detected. As far as crested newt is concerned only few adult individuals were found in 3 locations. One adult specimen of common tree frog was observed in one location while spawn with tadpoles were found in another reservoir. Both pools were located in the southern part of Lublin.

DISCUSSION

The diversity of amphibian fauna in Lublin seems to be higher than in majority of other cities. However, this quantitative result could not be simply compared with the results of other studies conducted in Polish cities (e.g. Mazgajska 1996, 1998), in which the group of “green frogs” was considered as one taxon.

“Brown frogs” were most frequently observed in breeding ponds, especially common frog. It is the most common amphibian in Lublin area. According to Vershinin (1990), Pawlowski (1993), Mazgajska (1996) “brown frogs” do not occur in central part of cities. Also in Lublin, the highest number of these amphibians was observed on city borders. However, they were found in the remnants of semi-natural wet meadows with seasonal water pools that are located in the core of Lublin city. In contrast to Warsaw (Mazgajska 1998), common frog occurred more frequently than moor frog.

“Green frogs” were also commonly observed in water bodies on the whole area of Lublin. It is interesting that in concrete clarifier in the city centre *Rana ridibunda* was found. According to our information there is a possibility, that this small population was created artificially, as a result of setting free the amphibians caught in various areas outside the city and used for didactical or scientific purposes. Actually, the majority of frogs observed in the above mentioned reservoir could be determined as various forms of hybrid *Rana* kl. *esculenta*.

According to the data given by e.g. Juszczyk (1987) and Mazgajska (1996) crested newt, fire-bellied toad and common spadefoot are considered as relatively rare. Neither of these species occurred in the ponds situated in the central area of the city. It is interesting that the only pond in Lublin area where crested newt’s larvae were found, was built by a man. *Triturus cristatus* prefers medium-sized or larger water bodies, similar to the manmade reservoirs. Unfortunately, during research the ponds were completely rebuilt. The absence of natterjack in the Lublin area is similar to the data on this species from other cities (e.g. Mazgajska 1996, 1998, Stopczyński et al. 2004).

Closer to the city centre, the number of species decrease. In the core central area of the city only single individuals of green toad were observed. The nearest water bodies were 1 km away from the amphibian locations (dead specimens) and separated by streets with very high traffic. Green toad has an exceptionally high resistance to drying out (Juszczyk 1987). Moreover, Juszczyk (1987) claims that it is the species most strongly connected with built-up areas. During winter green and common toads are frequent amphibians in garages and cellars of some suburban districts. Large numbers of dead amphibians are indicators of a situation where amphibians have difficulties in reaching places of hibernation as well as breeding ponds.

Although common toad is quite frequently observed in Lublins’ water bodies, the majority of populations were small and isolated. *Bufo bufo* and *Bufo viridis* faces difficulties with reaching hibernation places and breeding ponds. In contrast to situation in Warsaw (Mazgajska 1996), both toads were observed together in a few breeding ponds.

Older records on the presence of common tree frog in the city (in water bodies 10 and 30) were not confirmed during this research. Actually, only in one pool (no. 23) in the south part of Lublin spawn and tadpoles of *Hyla arborea* were found together with few adult specimens.

Pointed by many authors before (Chobotow & Czarniawski 2001, Pabijan & Przy-stalski 2003), the high importance of small water bodies located in agricultural regions of the area used as breeding sites was confirmed. In reservoirs located in NE part of the city and in Uroczyisko Lipnik, where the negative effect of urbanization on amphibian popu-

lations was relatively small, 8–10 species were observed, including common spadefoot and fire-bellied toad considered as rare in urban habitats (Mazgajska 1996, Kierzkowski & Ogielska 2001). The opposite situation was noticed in the complex of strongly contaminated industrial settlers near Sugar Refinery. The reservoirs have surface of approximately 12 ha, and were populated only by few specimens of common and water frogs.

The data on distribution of amphibian populations and condition of water pools presented in this paper was acquired several years ago. Since that time a dozen of new water bodies – e.g. fish ponds have been built, while other were destroyed or exposed to progressing degradation. According to some current observations, it seems that the current condition of Lublin amphibians researched in this paper could give results similar to the data presented by Guzik et. al. (1996) – the quantitative composition of amphibians could be unchanged, but their abundance declining, with some local populations being destroyed.

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STRESZCZENIE

[Płazy Lublina]

Badania nad płazami Lublina przeprowadzone zostały w latach 1998–2006. Wyznaczono 33 stanowiska, położone zarówno w centralnej części aglomeracji miejskiej, jak i na jej obrzeżach, takie jak doliny rzek, stawy, drobne okresowe zbiorniki, zbiorniki przemysłowe itd. Stwierdzono występowanie 12 taksonów płazów oraz oszacowano ilość osobników w poszczególnych populacjach. Za gatunki bardzo rzadkie i zagrożone uznano traszkę grzebieniastą i rzekotkę drzewną. Potwierdzono duże znaczenie drobnych, okresowych zbiorników jako dogodnego miejsca rozrodu płazów.

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Appendix 1. Characteristics of studied water bodies in Lublin. Abbreviations: A – maximal surface of pool in ha (if more than 1 pool – the surface of the biggest); = – length of researched section of bank in km; B – periodicity of pool: + – permanent pond, l – seasonal, emptied in the end of summer, w – seasonal, emptied in spring, C – depth (in m), D – Location – description of surrounding area: I – centre of town or intensive building; II – low, dispersed building; III – parks, cemeteries or other green areas, IV – forests; V – protected areas (nature reserves); VI – ruderal areas with elements of industrial activity; VII – ruderal areas, with insignificant antropopressure; VIII – garden plots; IX – grounds surrounded by agricultural areas (field, meadows); Bank character: N – natural, TE – terraneous embankments, C – concreted.

No	GPS	Description	A	B	C	D	Bank character	Water vegetation
1	51°16'36.82" N, 22°36'11.72" E	Seasonal water pool surrounded by fields	0.06	1	1.5	IX	N, grass, rush	<i>Typha</i> sp., <i>Juncus effusus</i>
2	51°15'41.41" N, 22°36'28.32" E	Drain connected with Bystrzyca river	=0.3	+	0.3	IX	TE, grass	<i>Lemna</i> sp., <i>Ceratophyllum</i> sp.
3	51°16'24.58" N, 22°36'54.98" E	Complex of 3 pools in loess ravine Uroczysko Lipnik	0.25	+/l	0.5–1.5	IX	N, grass, rush	<i>Glyceria plicata</i> , <i>Typha latifolia</i> , <i>Juncus effusus</i> , <i>Heleocharis</i> sp.
4	51°16'8.72" N, 22°37'29.48" E	Post-inundation astatic pool in Bystrzyca valley	0.07	1	0.5	IX	N, grass	-
5	51°16'23.32" N, 22°37'51.53" E	Old river-bed of Bystrzyca river	=0.3	+	1.5	IX	N, grass, shrubs	<i>Lemna</i> sp.
6	51°16'34.49" N, 22°37'24.55" E	Pool	0.1	+	2.0	IX	N, grass, rush	<i>Typha</i> sp., <i>Ceratophyllum</i> sp.
7	51°16'12.11" N, 22°2'30.14" E	Settler in former possession of Communal Institution of Verdure	0.02	+	1.0	VII	C	<i>Typha</i> sp.
8	51°15'38.43" N, 22°30'55.67" E	Ponds in UMCS Botanical Garden, connected with Czechówka river	0.1	+	1.0	III	C/grass	<i>Juncus effusus</i> , <i>Typha latifolia</i> , <i>T. angustifolia</i> , <i>Phragmites communis</i>
9	51°15'33.1" N, 22°30'12.18" E	Water pool in Museum of Lublin County, connected with Czechówka river	0.2	+	1.0	III	TE, grass, rush	<i>Typha</i> sp., <i>Ceratophyllum</i> sp., <i>Elodea canadensis</i>
10	51°15'47.53" N, 22°28'57.53" E	Fish-pond, connected with Czechówka river	0.07	+	1.2	II	TE	<i>Ceratophyllum</i> sp., <i>Elodea canadensis</i>

Continued on the next page

No	GPS	Description	A	B	C	D	Bank character	Water vegetation
11	51°14'35.54" N, 22°34'39.97" E	Old river-bed of Bystrzyca river, formed in years 50' of 20th century during correction the bed of the river	0.1	+	2.0	VII	TE, rush	<i>Lemna</i> sp.
12	51°14'2.58" N, 22°33'47.63" E	Small water pools with unstable surfaces situated on the area of old peat-bog, pleasure ground drained in years 2000–2001	0.1	w/l	0.6	III	N, grass	-
13	51°13'58.26" N, 22°33'29.37" E	Complex of industrial settlers situated near Sugar Refinery in Lublin	12	+	1.5	VI	TE	-
14	51°14'58.01" N, 22°34'58.23" E	Allotment gardens in Czechówka valley, founded in 1960' on the area of former "Big Royal Pond". Actually garden-plots are permanently submerged and unused.	5	+	0.5	VIII	N, rush	<i>Typha</i> sp., <i>Phragmites communis</i>
15	51°13'3.96" N, 22°32'25.65" E	Pools connected by drain with Bystrzyca river	0.02	+	1.5	VII	N, grass, rush	<i>Lemna</i> sp., <i>Typha</i> sp., <i>Phragmites communis</i>
16	51°15'18.05" N, 22°9'12.91" E	Astatic pools. The remnant of old marshy meadows with two big water pools and few small flows	0.01	1	0.5	IX	N, grass	<i>Lemna</i> sp., <i>Ceratophyllum</i> sp., <i>Elodea canadensis</i>
17	51°8'51.14" N, 22°28'22.8" E	Complex of fishing ponds situated in alder swamp	3	+	1.5	IV	TE, grass	<i>Lemna</i> sp., <i>Ceratophyllum</i> sp.
18	51°17'6.63" N, 22°34'59.24" E	Pool founded in year 2001	0.05	+	1.5	VI	TE, grass	<i>Lemna</i> sp.
19	51°14'29.03" N, 22°34'27.44" E	Settler, concreted bottom and bank, partially overgrown by ruderal plants, strongly polluted by communal wastes; water turbid, contaminated	0.02	+	0.5	VII	C	-
20	51°13'30.26" N, 22°34'44.5" E	Pools in unused garden-plots near Czerniejówka river	0.01	w/l	0.3	VIII	N	-
21	51°9'50.06" N, 22°30'20.06" E	Pools in old, unused sand excavation	0.01	+	0.3	II	N, ruderal	<i>Typha</i> sp., <i>Juncus effusus</i>

22	51°9'41.5" N, 22°29'43.98" E	Complex of drains on wet meadows, (south from Zemborzycki Retention Reser- voir), total surface of this area about 25 ha	=2	+	0.4	IX	TE, grass	<i>Ceratophyllum</i> sp., <i>Elodea canadensis</i>
23	51°9'15.45" N, 22°30'7.89" E	Complex of old peat excavations on a wet meadow situated in Bystrzyca valley	0.05	+	3.0	IX	N, rush	<i>Typha</i> sp., <i>Phragmites australis</i> , <i>Ceratophyllum sp.</i> , <i>Elodea canadensis</i>
24	51°16'48.95" N, 22°38'29.12" E	Valley of Bystrzyca river	=1	+	0.5–2.5	VI	N/TE	<i>Ceratophyllum</i> sp. <i>Lemna sp.</i> ,
25	51°9'5.81" N, 22°29'7.28" E	Small pools in alder swamp in Bystrzyca valley	0.01	+	1.0	IV	N	<i>Lemna</i> sp.
26	51°9'57.16" N, 22°31'8.29" E	Zemborzycki Retention Reservoir – section of bank near “Rękaw” gulf	=1	+	1.5	IV	N, rush	<i>Ceratophyllum</i> sp., <i>Elodea canadensis</i> , <i>Typha</i> sp.
27	51°15'12.86" N, 22°32'45.08" E	Valley of Czechówka river	=0.1	+	0.5–1.5	VI	TE/N	<i>Ceratophyllum</i> sp., <i>Elodea canadensis</i>
28	51°13'41.21" N, 22°35'28.63" E	Complex of partially dried fish-ponds, used to the end of 90' of last century; now present remnants of rush vegetation	12	w/l	0.3	II	TE/N	<i>Typha</i> sp.
29	51°12'10.31" N, 22°35'28.63" E	Garden-pool	0.01	+	1.0	II	TE	<i>Lemna</i> sp.
30	51°12'49.12" N, 22°39'2.11" E	Seasonal pool	0.06	+/l	1.0	IX	N, <i>Carex</i> sp.	-
31	51°15'28.83" N, 22°31'52.09" E	Submerged garden-plots in Czechówka valley	1	+/l	0.5	VIII	N	-
32	51°14'21.15" N, 22°34'26.8" E	Valley of Czerniejówka river	=0.2	+	0.5–1.0	VI	C/TE	-
33	51°14'30.75" N, 22°34'34.03" E	Valley of Bystrzyca river	=2.5	+	0.5–1.5	VII	TE, grass	-