THE USE OF EPISODIC POOLS BY AMPHIBIANS IN LOWLAND HABITATS OF SOUTHWESTERN POLAND

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Abstract. Episodic pools are one of the most unstable water habitats. They arise rarely, at least once every few years and last a relatively short period (in principle one vegetative season). They are characterized by a lack of water flora and fauna. Later, a few aquatic organisms inhabit them. Of the 15 amphibian taxa inhabiting Polish lowlands, six anurans use episodic pools for mating and larval development; *Bombina bombina*, *Pelobates fuscus*, *Epidalea* [=Bufo] *calamita*, *Pseudepidalea* [=Bufo] *viridis*, *Hyla arborea*, and *Pelophylax* [=Rana] *esculentus* complex [probably only *Pelophylax* kl. *esculentus*].

Key words: amphibian species assemblages, temporary pools, breeding anurans

INTRODUCTION

The lowland amphibian species living in Poland are characterized by a wide diversity of preferences when choosing breeding pools. Preferences may be influenced by surface area, depth, stage of development of lake or riverside plants and water flora, and finally the periodicity. The tolerance of particular species to the last mentioned factor has been well studied (JUSZCZYK 1987). Particular species are able to breed in temporary pools while others are not.

The temporary pools used by amphibians to breed in are of two types distinguished by CZACHOROWSKI (1993). The first type involves those which are formed and dry each year or so and therefore can be characterized as the periodic. The periodic pools' formation depends on typical periodic weather conditions (melting snow, rainfalls) connected with physical factors (subsoil

permeability, water table, relief). The periodic pools usually have a formed basin possible to recognize when dried out. They are characterized by water flora and fauna adapted to seasonal drying (*Cyanobacteria*, *Bacillariophyceae*, *Mastigota*, *Myosotis*, *Rotifera*, *Branchiopoda*, *Copepoda*, *Musculium* and others) (CZACHOROWSKI 1993, WILLIAMS 2006).

The second type of temporary pools hereinafter referred to as episodic pools are pools formed not periodically but accidentally according to random climate phenomena (intensive and/or long lasting precipitation, flooding) - once every few or more years, and the kind of relief. The episodic pools do not have a formed basin therefore they are just pools. There is also no flora and fauna characteristic for the temporary periodic pools (CZACHOROWSKI 1993, WILLIAMS 2006).

With temporary periodic pools, amphibians are capable of reproducing regularly every year and so they gather round such pools. Also, the food base is large enough to support both the larvae and adults of the species feeding during the breeding season.

Some algae and invertebrate species form large numbers very quickly, just after the pool becomes filled with water. Vascular plants resistant to seasonal drying of the pools quickly pervade when filled with water.

The episodic pools are generally not characterized by any of the features mentioned above. They are formed rarely and so there is no generation continuity of amphibians inhabiting such a pool, amphibians arrive to them by chance the same year they have formed. The food base (animals) seems poor, dormant stages get to such pools accidentally and in small numbers. Regarding flora, the situation seems a bit different. Just after the water fills the pool, there are still terrestrial plants existing throughout the basin. As the terrestrial plants die out, their soft parts decay whilst the hard parts remain. Algae quickly spread in the pools, the spores of which arrive by chance. Over time, the pools become devoid of higher plants with the bottom becoming covered by putrefying plant material. When episodic pools form in fields without vascular plants, the pools remain devoid of higher plants.

The main scope of this paper is to answer the question: which of the lowland amphibian species living in Poland use the episodic pools for breeding and what considerations are connected with it.

MATERIAL AND METHODS

The episodic pools have been observed on the Odra left-bank area being also the Oława right bank area, between the town of Oława and the village of Siedlce. Ten episodic pools were used in this study, six formed from precipitation and four from flooding (Fig. 1 and Table 1). All were situated in open areas, mostly fields. These sites were chosen for analysis due to several reasons. Firstly, 13 of the 15 amphibian taxa found in the Polish lowlands are present in the area, the alpine newt *Ichthyosaura* [= *Triturus*] *alpestris* (LAURENTI, 1768)

Figure 1. A map of the study area – Odra River valley, SW Poland . Temporary ponds are numbered 1-10, dotted areas – forests, areas with vertical lines – buildings.

and the agile frog *Rana dalmatina* (FITZINGER, 1839) are the exceptions (JUSZCZYK 1987). Secondly, the area has been monitored by myself for about 11 years, thus previously used breeding sites were well known. Thirdly, the location (the joint valley of the two rivers) is favorable for forming episodic pools. The observations were made in three months, from May to July 2010, once/twice a week only in the daytime. The distances between the permanent breeding sites and the episodic pools where breeding of the particular amphibian species had been found were also analyzed. All data concerning linear distances were taken from the calculations made from the Polish governments Geoportal Project site (<http://www.geoportal.gov.pl/>) .

The year 2010 in that area was abnormally wet. In the winter of 2009/2010, the average precipitation came to about 100% of an average multi-annual total. Due to the long-term low temperatures (the 2009/2010 winter season was said to be very cold), there was a thick snow cover. The total snow cover depth in 2009/2010 in relation to the normal was about 450% (Polish Climate Monitoring

Table 1. Physical parameters and amphibian species assemblage at each episodic pool.

Nr	O	T	A [ha]	D _{max} [cm]	P	Pa	F	Bb	Pf	Pv	Ec	Ha	Pec
1	p	fi	0.24	70	+	m	-	B, t					b
2	p	fi	0.12	60	+	m	-	b					
3	p	fi	0.86	30	+	m	-	b					
4	p	fi	1.18	50	+	l	-	b	T			T	B, T
5	p	fi	0.68	50	+	l	-	B, t	T	B, T		T	b
6	p	fa	0.53	90	+	h	-	B, T					B, T
7	f	s	0.10	40	-	-	+			b, t	T		
8	f	fi	1.25	40	-	l	+	b					b
9	f	fi	6.23	60	-	-	+	B, t		B, t	T		B, t
10	f	fi	2.95	30	-	l	+	b					b

O – origin: p – precipitation, f – flood;

T – type of area where the pool is located: fi – field, fa – fallow, s – sand mine;

A – The surface of each pool was measured using Google Earth (04/06/2010);

D_{max} – maximum depth of the pool;

P – the presences of tall plants growing at or near the pools edge was recorded only as present (+) or absent (-).

Pa – plant coverage of the pool bottom was classified as ‘absent’ if there were no plants, ‘low’ (l) if only a few single plants were present, ‘moderate’ (m) if approximately 50% of the bottom was covered, or ‘high’ (h) if approximately 100% of the bottom was covered.

F – fish: presence/absence

Bb – fire-bellied toad, Pf – common spadefoot, Pv – green toad, Ec – natterjack toad, Ha – common tree frog, Pec – “water frogs”

During a single visit to each pool, the numbers breeding males and the number of tadpoles per 1m² of surface found by the edge of the pool were recorded: B – over 10 males breeding (B) and fewer than 10 (b), over 10 tadpoles (T) and fewer than 10 (t).

Bulletin; winter 2009/2010). Also, the spring was wetter than normal: the average monthly precipitation sum in relation to the normal was about 175-200% (Polish Climate Monitoring Bulletin; spring 2010). Those were the reasons for forming many episodic pools of a precipitation origin. Additionally, there was a flood in that area in May 2010 (County Magazine) that formed episodic pools of a flood origin. It is necessary to divide the episodic pools according to their origin, which influences their ecology. The episodic pools of a precipitation origin were formed soon after the snow melting in March. They were characterized by a spread of green plants on the banks and nearby. There were no typical water animals existing in pools. The episodic pools of a flood origin were formed quite late, in the second part of May, after the Odra flooding. There were no green plants found on the banks because of the earlier flood wave rushing through the land. There were some water organisms found there e.g. fish (*Alburnus*, *Carassius*, *Scardinius*). It is important to mention the fact that the presence of fish in episodic pools does not influence amphibians’ usage as it does in

permanent pools. The shallow, uncovered bottom of the pools with a lack of shelters makes the living conditions very stressful for fish. This probably makes the fish eat less and so their influence over amphibian larvae is decreased.

RESULTS AND DISCUSSION

I observed the effective breeding (completed metamorphosis) of six amphibian taxa in the episodic pools. They were the anuran species only: fire-bellied toad *Bombina bombina* (LINNAEUS, 1761), common spadefoot *Pelobates fuscus* (LAURENTI, 1768), green toad, *Pseudepidalea* [=Bufo] *viridis* (LAURENTI, 1768), natterjack toad *Epidalea* [=Bufo] *calamita* (LAURENTI, 1768), common tree frog *Hyla arborea* (LINNAEUS, 1758), and water frogs – *Pelophylax* [=Rana] *esculentus* complex. I did not observe the breeding of any other amphibians commonly found in this area: crested newt *Triturus cristatus* (LAURENTI, 1768), common newt *Lissotriton* [=Triturus] *vulgaris* (LINNAEUS, 1758), common toad *Bufo bufo* (LINNAEUS, 1758), moor frog *Rana arvalis* (NILSSON, 1842), or common frog *Rana temporaria* (LINNAEUS, 1758). Probably, only the edible frog *Pelophylax* kl. *esulentus* (LINNAEUS, 1758) used the episodic pools for breeding I did not hear the characteristic voice of the male pool frog *Pelophylax lessonae* (CAMERANO, 1882) or marsh frog *Pelophylax ridibundus* (PALLAS, 1771) at the breeding site, both of which are known to exist in the study area. Among the captured adults, there were no pool or marsh frogs. These observations are roughly consistent with the one by HARTEL *et al.* (2005).

The fire-bellied toad, green toad, and edible frog were breeding in both the episodic pools of a precipitation and flood origin. The common spadefoot and common tree frog were breeding only in the episodic pools of a precipitation origin while the natterjack toad was breeding only in the episodic pools of a flood origin.

The breeding call of the fire-bellied toad was observed in nine episodic pools (they were mostly single males' calls). Breeding chorus were observed in four episodic pools but a large number of tadpoles (about 10 tadpoles per 1 m² water surface, near the banks) were found in only one of them. In the other three pools only single tadpoles were found.

The breeding calls of the edible frog were heard in seven episodic pools, and in three of them, there were at least a few males calling. Tadpoles were also found in three pools, two of which had significant numbers (about 10 tadpoles per 1 m²).

The breeding calls of green toad males were heard in seven episodic pools, and in two of them there were at least a few males calling at the same time. In one of the pools, I noticed a large number of the tadpoles, about 30-40 per 1 m².

The breeding sites of the common spadefoot were found in two episodic pools of a precipitation origin. The breeding sites were only observed on the basis of the presence of tadpoles. In both pools, the density of the tadpoles was significant, 10-15 per 1 m².

The breeding sites of the common tree frog were also noticed only on the basis of the presence of tadpoles in two episodic pools of a precipitation origin (the same pools as that of the common spadefoot). The density of the tadpoles was also significant, up to 20 per 1 m².

The breeding sites of the natterjack toad were found in two episodic pools of a flood origin. I heard up to four males calling in one of the pools while in the other one only tadpoles were found. In both pools, there were about 20-30 tadpoles per 1m².

The pool with a large number of fire-bellied toad tadpoles was the one of a precipitation origin (pool No. 6, Table 1). This was the only episodic pool among all the ones analyzed being characterized by many tall hard parts of green plants and bushes flooded by water. The fire-bellied toad uses parts of the plants as a substrate for laying eggs (JUSZCZYK 1987). Therefore, the presence of a large number of tadpoles was caused by a wide availability of substrate for the females to lay their eggs. Moreover, the presence of the thicket of bushes gives the breeding adults great protection, this species very seldom breeds in water with an open surface. It is best proven by the fact that only few calling males and single tadpoles were found in the other three pools. Those pools were devoid of water plants and only weak corn shoots were found near the banks. These observations are consistent with those presented by MADEJ (1973). According to this author, the adults make land migrations "...sometimes long-distant...". The presence of single males giving breeding calls in the five episodic pools is connected with such migrations. The longest distance between the permanent breeding site of the fire-bellied toad and the episodic pool where the voices were heard (pool No. 1, Fig. 1) is about 1820m. Therefore, such a distance was covered by the adult specimens during one vegetation season. It seems that the fire-bellied toad did not cover the distance because between the permanent breeding site and the furthest of the episodic pools used for breeding, there were four other episodic pools (of a precipitation origin), each 300-400 m away from one another (Fig. 1). Passive transport, such as floating downstream in the rivers, was not possible. Both the Odra and Oława flow to the north, whereas the fire-bellied toads' migration was in the opposite direction. The episodic pools with fire-bellied toads were of a wide diversity in regards to their surface areas: (0.30-5.32 ha). The complete lack of fire-bellied toads was found in just one pool (No. 7, Table 1). The pool was characterized by ecological conditions different from the other analyzed pools, it was a small (0.07 ha surface) episodic pool of a precipitation origin located in a small sand mine, empty of higher plants. It was located not far (about 170m) from the place this species was predominantly found. Therefore, with regards to the above, such a pool is ignored by the fire-bellied toad.

The largest number of edible frog tadpoles were found in two episodic pools of a precipitation origin. The pools differed in ecological conditions. In one of them (No. 6), there were many tall, hard parts of green plants and bushes while the bottom of the other one was almost completely barren. They also

differed in their surface areas. However, the plants growing on their banks and nearby were of the same type (corn). In the pool where just a few tadpoles were found, there were no plants growing around the edges. Although the maximum depth of the pool was 60 cm, it was mostly much more shallow, about 10-20 cm. The depth of the two previously mentioned pools were much more equal. According to the foregoing, the edible frog chooses pools with plants growing at least nearby for its breeding and prefers deeper pools. However, they do not need well developed water plants. I found just single adult specimens in the other four pools which were the result of land migrations. According to BERGER (2000), the edible frog has one with the strongest urges for migration among all Polish green frogs. Additionally, according to JUSZCZYK (1987), the distance of such migrations is up to 2500 m in a straight line. I personally noticed an equal distance between the observed permanent breeding pools and the episodic pools where adult specimens were found. In the three pools, there were no adult specimens of water frogs found. In two of them (No. 2 and 3), adult specimens could probably be found, at least during a short period of time, because the pools are located among the ones, where such frogs were found. The lack of any water frogs in pool No.7 can be explained by the fact of ignoring such pools (Table 1) by the adults, as happens in the case of the fire-bellied toad.

The green toad tadpoles were found in three episodic pools. The pools were characterized by an almost complete lack of water plants' vegetation. The greatest number of tadpoles were found in pool No. 5. On the northern bank of the pool, near the field path, where there was a large pile of rubble. Pool No. 4 of similar conditions, but without a rubble, was not used by the green toad in the breeding season. The green toad prefers rubble areas (JUSZCZYK 1987), which explains the choice of pool No.5. In the other two pools I observed much smaller numbers of tadpoles. It is not easy to explain the fact that green toads did not breed in the other pools. The distance between the permanent breeding sites to the episodic pool used for breeding is about 1000m, which is less than the distance this toad is able to cover during a single vegetation season because this species has the strongest urge to migrate among all Polish amphibians (JUSZCZYK 1987). The results of these observations indicate their preferences, not their actual migrating skills.

The common spadefoot's breeding was only observed in episodic pools of a precipitation origin. The breeding period of this amphibian ends in May, therefore the episodic pools of a flood origin must have been formed too late to be used. The longest distance between the permanent breeding site from the episodic pool used for breeding was about 750 m. The observed distance was similar to that described by BLAB and VOGEL (1999).

The common tree frog's tadpoles were found in the same episodic pools as the common spadefoot's breeding sites. The absence of tadpoles in the episodic pools of a flood origin can be explained by the fact that there were no vascular plants growing on or near the banks. The absence of tadpoles in episodic pools 1-3 could be due to their location, the longer banks adjoin the

road, or by the distance which is too long for the frogs to cover during a single vegetation period. The common tree frog will breed in pools which are devoid of any water plants provided that there are some plants growing close to the water (e.g. corn in this case). The longest distance between a permanent breeding site from the episodic pool used for breeding was about 1350m, which is half of the distance described by BLAB and VOGEL (1999).

Natterjack toad breeding was only observed in episodic pools of a flood origin (No. 7 and 2). The two pools were very different from each other in regards to surface area, they were the biggest and the smallest ones among the ten pools observed. The episodic pools of a precipitation origin were characterized by well developed bank plants and the corn growing further in the middle. According to my observations, natterjack toads avoid pools with well developed bank plants. It prefers pools either devoid of bank plants or with plants that are not too tall nor grow densely (primary succession stage). The longest distance between the permanent breeding site from the episodic pool used for breeding by the natterjack toad was about 2200m.

The breeding of other amphibian species inhabiting this area has not been observed. The absence of the common newt and crested newt was noticeable. This is probably caused by its weak locomotory ability compared to auras. The nearest breeding pools of the crested newt and the common newt were located about 300 m from the episodic pools of a flood origin and 540 m from the episodic pools of a precipitation origin. According to the foregoing, the distances are too long for the newt to cover during a single vegetation period. The common toad and the brown frogs have their breeding time in early spring (KOWALEWSKI 1979, JUSZCZYK 1987). Therefore, the episodic pools of a flood origin could not have been used as they were formed in May. Adult specimens of the common toad remain close to the particular pools where they were born (JUSZCZYK 1987), it is mostly noticeable with females. A single vegetation period is too short for the pool to be inhabited by even a few adult males. This seems to be the main cause of the common toad's absence in the episodic pools even though the ecological conditions were met. The moor frog prefers larger pools provided that there are some secluded spots suitable for breeding. There are no such microhabitats in the episodic pools of a precipitation origin and therefore, there are no proper conditions for breeding. The common frog prefers small pools that heat up in a short time. All the analyzed pools of a precipitation origin were of a larger surface area and therefore, it took longer for the water to be heated up after ice melting, causing the absence of the common frog in such pools.

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EPIZODYCZNE ZBIORNIKI WODNE A PŁAZY

STRESZCZENIE

Zbiorniki epizodyczne są jednymi z najmniej stabilnych środowisk wodnych. Powstają rzadko, raz na kilka lat i trwają krótko, w zasadzie 1 sezon wegetacyjny. Charakteryzują się brakiem lub bardzo słabo wykształconymi fito- i zoocenozami wodnymi. Spośród 15 taksonów płazów zamieszkujących polskie nizinny, 6 wykazuje zbiorniki epizodyczne na godowiska, osiągając sukces rozrodczy (przeobrażenie kijanek). Są to wyłącznie płazy bezogonowe – kumak nizinny *Bombina orientalis* (LINNAEUS, 1761), grzebiuszka ziemna *Pelobates fuscus* (LAURENTI, 1768), ropucha paskówka *Epidalea calamita* (LAURENTI, 1768), ropucha zielona *Pseudepidalea viridis* (LAURENTI, 1768), rzekotka drzewna *Hyla arborea* (LINNAEUS, 1758) i żaby zielone *Pelophylax esculentus* complex [prawdopodobnie tylko żaba wodna *Pelophylax kl. esculentus* (LINNAEUS, 1758)].

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