TOLERANCE OF LOW TEMPERATURES IN *PELOBATES FUSCUS* EGGS

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ABSTRACT

We experimentally investigated the fraction of hatching eggs as a function of low temperatures in a population of *Pelobates fuscus* situated on the northernmost part of its distribution range. Eggs were not sensitive to the range of temperatures chosen (2°C, 7°C and 9°C, respectively). We speculate that some years' low temperatures in the breeding pond are partly responsible for observed low reproductive output.

INTRODUCTION

Recently a lot of attention has been paid to the decline of amphibians (see for example Balustein and Wake 1990, Wyman 1990, Wake 1991, Elmberg 1993, Blaustein *et al.* 1994). The main part of the declines are doubtlessly real and worrying phenomena, but as Pechman *et al.* (1991) and Blaustein *et al.* (1994) point out separating long term declines from short term fluctuations is crucial for predicting and managing the development of populations. Amphibian populations are known to fluctuate considerably in numbers between years (Jehle *et al.* 1995; Hecnar and M'Closkey 1996), particularly as a response to climatic variability (Duellman and Trueb 1994 and references therein). It would therefore be valuable to investigate each causal factor separately, to get a more fundamental understanding of what lies behind fluctuations and thereby better being able to distinguish between natural variations and general declines.

MATERIALS AND METHODS

We analysed the hatching success of eggs of the Common Spadefoot Toad (*Pelobates fuscus* Laurenti) within a range of prevalent low water temperatures. The population studied is situated on the northern fringe of its distribution range at the Djursland peninsula, Denmark (56°26'N, 10°34'E), and low water temperatures may be a key factor for some years' observed low numbers of froglets.

Three egg bands aged one to two days were collected from a known *P. fuscus* breeding pond. A number of eggs from each of the three bands were incubated in aquaria for 10 days in the laboratory at 2°C, 7°C, and 9°C, respectively. After 10 days the fraction of hatching was evaluated.

The breeding pond was encircled by a drift fence with pit fall traps by the fence at 10m intervals (Dodd and Scott 1994). This way, six males and six females were captured and in pairs put into cages (1.5m x 0.75m plywood with a plastic net serving as a bottom).

The cages were placed at approximately 0.5m depth in the pond. After egg-laying, the egg bands were transferred to smaller cylindrical cages in the pond (0.40m long, diameter 0.08m covered with fine meshed net to allow for passage of water but not eggs or larvae). After hatching, the cages were taken back to the laboratory and the number of larvae as well as the fraction of hatching evaluated. The temperature was measured in the pond occasionally during the experiment (23/4-15/5) close to the cages 10 cm below water surface. Eight measurements were taken before 8 am, whereas fifteen were taken in the afternoon.

RESULTS

The overall fraction of eggs hatched at 2°C, 7°C and 9°C was 0.77, 0.76 and 0.66 respectively (table 1). There was no general relationship between temperature and hatching success. The fraction of eggs hatched was, however, significantly different in the three egg bands (x^2=6.95, df=2, P<0.05); number 3 having a larger fraction of hatching than the other two (0.62, 0.65 and 0.86 respectively, table 1).

Hatching success in the breeding pond was very high. Out of 9707 eggs in six egg bands, 9101 hatched (93.8%). This was significantly higher than hatching success in the laboratory taken as a whole (x^2=18.88, df=1, P<0.01).

Mean values for morning and afternoon temperatures in the pond were 7.8°C and 8.3°C, respectively.

DISCUSSION

There are no trends in the data indicating a temperature dependence of hatching success within the experimental temperature range. Mikulski (1938; in Nöllert 1990) states a survival range of temperatures from 2°C to 26°C for the Spadefoot Toad, which is in accordance with our results. Fog *et al.* (1997), however, states that temperatures below 6°C are critical for survival of embryos of *P. fuscus.*

In the aquaria we used water from the pond from which the eggs originated, in order to simulate development in the field as closely as possible. Contrary to our expectations the fraction of hatched eggs was significantly lower in the aquaria than in the pond. Probably, the eggs in the aquaria suffered from oxygen deficiency since the aquaria were not aerated. Another possible explanation might be that eggs taken to the laboratory were inbred and therefore less viable. This, however, is highly unlikely since the population in question is a fairly large one (approximately 450 adults in 1997), and a source population of the area (Hels, in prep.) showing no other apparent signs of inbreeding, such as a high prevalence of physical abnormalities or unusually low number of eggs in each egg band.

In 1996 when the experiment was conducted, very few metamorphosed froglets of *P. fuscus* left the pond, despite a large number of eggs laid (Hels, in prep.). This was also the case in 1995, where there were periods of low temperatures all through May (Hels, in prep.); whereas in 1994 with a warm spring, many froglets left the pond later that summer (Nielsen and Dige 1995). The number of metamorphs leaving the pond in 1996 was low, although the fraction of eggs hatched in the sample used from the pond in this study was high (93.8%). There was some evidence for density dependent factors (e.g. intraspecific competition among the larvae, cannibalism of the larvae by adults) regulating larval survival of the population in question (Hels, in prep.). Beside the density dependent factors mentioned, temperature acting on larval development could be an important responsible factor for year to year variation in reproductive output. Not only are low temperatures during larval development possibly responsible for a lower fraction of animals metamorphosing, but also for a lower larval growth rate. This makes larvae susceptible to predation for a longer period of time, further reducing the reproductive output (Brodie and Formanowicz 1983, Formanowicz 1986). Temperatures are more often critically low for a species on the northern border of its distribution range than in the central part. Therefore, it is particularly important to consider high mortality rates due to low temperatures in fringe populations.

Table 1: The number of eggs of *Pelobates fuscus* incubated at different temperatures and the numbers hatched

Temperature	Egg band 1		Egg band 2		Egg band 3	
	Total	Hatched	Total	Hatched	Total	Hatched
2°C	59	34	55	35	97	93
7°C	76	48	93	88	96	65
9°C	86	55	65	16	104	97
Total	221	137	213	139	297	255

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