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**EFFECT OF CLIMATIC CONDITIONS ON POST-HIBERNATION BODY CONDITION AND REPRODUCTIVE TRAITS OF *BUFO BUFO* FEMALES.** [1]**Nataša Tomašević**, [2]**Dragana Cvetković**, [1]**I. Aleksić**, and [1]**Jelka Crnobrnja-Isailović.** [1]*Department of Evolutionary Biology, Siniša Stanković Institute for Biological Research,* 11060 Belgrade, Serbia; [2]*Faculty of Biology, University of Belgrade,* 11000 Belgrade, Serbia

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Body condition and the climatic factors affecting it have attracted much research interest recently, especially in the context of changing climate and its impact on amphibian populations (R e a d i n g, 2007). One of the causes underlying the decline of some amphibian populations may be global warming (C a r e y and A l e x a n d e r, 2003; P o u n d s et al., 2006), and there is general interest in the biological consequences of occurrence of warmer than average years and mild winters. R e a d i n g and C l a r k e (1995) found that changes in body condition of female *B. bufo* were significantly correlated with temperature variation over on 11-year period. In a still longer-term study (23 years), R e a d i n g (2007) demonstrated clear relationship between increase in mean temperature, body condition decline, and decrease in fecundity.

Among temperate zone anurans, the common toad, *Bufo bufo* (B o r k i n and V e i t h, 1997), has proved a good subject for investigating the relationships between the environmental conditions and variation in body condition and life history traits (K u h n, 1994; R e a d i n g and C l a r k e, 1995; C v e t k o v i ć et al., 2003; R e a d i n g, 2003; S z t a t e c s n y and S c h a b e t s b e r g e r, 2005).

Body condition is a crucial parameter related to survival and reproductive success. In temperate zone amphibians, body reserves are depleted during hibernation and breeding, and rebuilt during the following active period (R e a d i n g and C l a r k e, 1995). Thus, interannual differences in body condition may reflect variation in climatic conditions experienced during the previous year, during hibernation, or immediately after emerging from hibernation.

The aims of the present study (as part of a larger ongoing project) were to examine the interannual variation in post-hibernation body condition in female common toads from the vicinity of Belgrade, Serbia (studied in the period of 2001-2003) and investigate the relationships between body condition, female reproductive traits, and climatic conditions experienced previously.

Adult female *B. bufo* specimens were caught after hibernation (in March), measured from snout to vent (SVL) to the nearest 0.1 mm using a dial caliper, and weighed with an electronic balance to 0.001 g precision.

Different body condition indices (BCI) are available (J a k o b et al., 1996; G r e e n, 2001; R e y e r and B ä t t i g, 2004); here, BCI was calculated as the weight/length ratio according to the formula (K u h n, 1994):

$$BCI = mass/SVL^3 \times 10^6$$

Data on interannual variation in reproductive traits (fecundity and egg size) were obtained from T o m a š e v i ć et al. (2007; unpublished).

To investigate possible effects on body condition, the following climatic data were obtained: mean monthly temperature and precipitation during the previous active period (March – October), during hibernation, and for the month preceding spawning, as well as mean annual temperature and cumulative annual precipitation. Climatic data were obtained from the Republic Hydrometeorological Service of Serbia (RHSS; ECA&D database, K l e i n T a n k et al., 2002).

The posthibernation body condition index varied over the study period (Table 1).

Although this variation did not prove statistically significant (ANOVA, $F=1.98$, $p=0.14$), analysis of contrasts showed that BCI in 2003 was significantly higher ($F=3.99$, $p<0.05$) than values in previous years.

Our earlier study on life history traits (T o m a š e v i ć et al., 2007; unpublished) showed that interannual variation in egg size was highly significant (ANOVA, $F=7.69$, $p<0.01$), contrary to variation in egg number ($p>0.05$). Again, the highest values of mean egg diameter were found in the 2003 sample. In accordance with findings of K u h n (1994) that egg size increased with somatic condition, mean egg diameter in our sample was positively correlated with BCI.

With respect to climatic conditions during the active period, no significant differences in mean monthly temperature were found between years. Mean monthly precipitation was significantly higher in 2001, but no corresponding effect on BCI was observed. This could be explained by previous findings that hot dry summers have stronger impact on BCI decrease than hot wet summers (R e a d i n g and C l a r k e, 1995), while none of the summer seasons in our study was extremely hot and dry.

Table 1. Descriptive statistics for the posthibernation body condition index (BCI) in female *Bufo bufo* and climatic variables for the study period (2000-2003); n – number of individuals, range – minimal and maximal values. Climatic variables: $T_{AP}$, $T_{hib}$, and $T_{mps}$ – mean temperature during the previous active period, during hibernation, and during the month preceding spawning, respectively; $Pr_{AP}$ $Pr_{hib}$ and $Pr_{mps}$ – mean precipitation for the same periods; temperature is given in ºC, precipitation in mm.

| *Body condition index (BCI)* | | | |
|---|---|---|---|
| year | n | mean BCI ± SE | range |
| 2001 | 10 | 146.02 ± 8.28 | 106.07 ± 194.92 |
| 2002 | 15 | 147.04 ± 6.91 | 108.53 ± 191.32 |
| 2003 | 47 | 158.21 ± 3.07 | 112.64 ± 202.80 |

| *Climatic variables* | | | | | | |
|---|---|---|---|---|---|---|
| year | $T_{AP}$ | $T_{hib}$ | $T_{mps}$ | $Pr_{AP}$ | $Pr_{hib}$ | $Pr_{mps}$ |
| 2000/01 | 18.28 | 5.27 | 5.8 | 31.67 | 30.33 | 17.0 |
| 2001/02 | 17.76 | 3.12 | 8.5 | 91.12 | 204.02 | 14.0 |
| 2002/03 | 17.00 | -0.17 | -2.1 | 56.94 | 47.40 | 26.5 |

Toads in such circumstances are likely to enter hibernation in poor condition, since high temperatures combined with low humidity increase the risk of desiccation, affecting their foraging and thus the rebuilding of body reserves.

With respect to winter conditions, it appears that winter temperatures had the strongest impact on BCI. Earlier studies (R y s e r, 1989; R e a d i n g and C l a r k e, 1995) suggested that a mild winter and warm pre-spawning period had a negative effect on the body condition of hibernating anurans, through an elevated metabolic rate and the increase in energy reserve utilization. Thus, toads are more likely to emerge from hibernation in good condition after colder winters.

The results of the present study support this hypothesis. The highest BCI in our sample was in 2003, following a cold winter: mean monthly temperature during hibernation was –0.17ºC, and mean temperature for the month preceding spawning was –2.1ºC, thus showing that mild, relatively warm winters may be more stressful to hibernating amphibians.

The results of this study point to a close relationship between body condition on emergence from hibernation, mean temperatures during winter and the month preceding spawning, and egg size. However, the conclusions must be treated with caution because the insufficient number of studied seasons precluded rigorous statistical testing. The authors of the present study will continue to obtain longer-term data and investigate other effects as well.

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