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Short note

Body Condition of the European Pond Turtle (Emys orbicularis) and the Balkan Pond Turtle (Mauremys rivulata) from Silistar River (SE Bulgaria)

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Abstract. Fulton's condition factor and the scaled mass index of the European Pond Turtle (*Emys orbicularis*) and the Balkan Pond Turtle (*Mauremys rivulata*) populations from Silistar RIver in "Strandzha" Nature Park were calculated and compared. *E. orbicularis* shows greater values of both indices, than *M. rivulata*.

Key words: *Emys orbicularis*, *Mauremys rivulata*, body condition.

Introduction

Body condition is a major concept in ecology considered in many studies, and a variety of non-destructive methods are often used to estimate the condition of individuals based on the relationship between the mass and the length of the body. There is currently no consensus among ecologists about the most appropriate body condition index (BCI) method, and most authors usually tend to apply a method used previously by their peers (Peig & Green, 2010).

Condition indices are used to quantify individual health and they are often used in addition to ecological studies (Stevenson & Woods Jr., 2006). In a previous study on the populations of the European Pond Turtle - *Emys orbicularis* (Linnaeus, 1758) and the Balkan Pond Turtle - *Mauremys rivulata* (Valenciennes, 1833) in "Strandzha" Nature Park (Mollov et al., 2021) we presented new data on the ecological properties of the above-mentioned species of aquatic turtles. In our stidy we used a BCI defined in the sense of Willemsen & Hailey (2002), where the $\log_{10}$ actual weight of the individual is devided the expected weight of the individual as a function of size. The expected weight of the individuals was obtained according to the modified ellipsoid volume formula (after Loehr et al., 2004).

In the current short note a different aproach for calculating the BCI is applied, based on weight and length of the body.

Material and Methods

For the estimating the body condition of the two species of aquaic turtles we used two separate approaches, based on weight and length of the body.

Fulton's condition factor (CF)

Originally developed for fish this is probably the most frequently used metric, for calculating individual fitness (Fulton 1904; Stevenson & Woods Jr., 2006). *CF* is computed as body mass divided by the

cube of body length. In the current study we used a multiplier of 10^4. The calculation of CF assumes isometric growth (isometry in which shape and body composition does not change with size) because length is raised to the 3rd power. This is a fair approximation for many species, including Emys orbicularis (Zuffi et al., 2017).

Scaled mass index (SMI)

The scaled mass index was calculated as an index of body condition following Peig & Green (2009; 2010) and is calculated with the following formula:

$$SMI_i = M_i * \left(\frac{L_0}{L_i}\right)^{b_{SMA}},$$

where: SMI - scaled mass index (the predicted body mass for individual i when the linear body measure is standardized to L_0); M_i - the mass (body weight) of the individual i, measured in grams (g); L_i - straight carapace length, measured with a caliper (with an accuracy of 0.1 mm), L_0 - the arithmetic mean value for L for the study population; b_{SMA} - the scaling exponent, that is, the slope of a standardised major axis (SMA) regression (also know as RMA or reduced major axis regression) of the length relationship. The scaling exponent b_{SMA} was calculated using ln-transformed data by dividing the slope from the RMA regression by the Pearson's correlation coefficient r, using the "RMA" v.1.21 software (Bohonak & van der Linde 2004).

The data were analyzed by descriptive statistics. Comparison of CF and SMI between the two aquatic turtle species was done using the Mann-Whitney U-test, where differences with $p<0.05$ [α=5%] were considered statistically significant. All statistical analises (except for the RMA regression) were performed using the PAST v.4.0 software (Hammer et al., 2001).

Results and Discussion

Details of the morphometric variables measured in both studied species species of aquatic turtles from Silistar River are presented in Table 1.

Table 1. Straight carapace length (L, mm), body weight (M, g), Fulton's condition factor (CF), scaled mass index (SMI) and standard deviations (SD), and details of the scaling exponents used to calculate the SMI in the two studied species of freshwater turtles. The regression coefficients for standardised major axis regressions of M on L (b_{SMA}) and the 95% confidence intervals are also shown. Mean length shown was used as L_0, when calculating the SMI.

Species	n	L ± SD	M ± SD	CF ± SD	SMI ± SD	b_{SMA}	b_{SMA} (CI 95%)
Emys orbicularis	14	120.60 ± 20.87	303.0 ± 134.37	1.62 ± 0.16	284.01 ± 26.12	2.871	2.50 - 3.08
Mauremys rivulata	16	129.23 ± 32.05	318.12 ± 226.05	1.26 ± 0.20	222.89 ± 37.21	3.235	2.71 - 3.47

As mentioned before the Fulton's condition factor assumption is growth to be isometric, since the length is raised to the 3rd power. This seems to be true for *Mauremys rivulata*, since the b_{SMA} value is 3.235, and somewhat true for *Emys orbicularis* as the b_{SMA} value is very close to 3, namely 2.871 and all confidence intervals for b_{SMA} were below around 3 as well (Table 1).

E. orbicularis shows a statistically significant higher values of the *CF* (U=17.0, z=3.93, p=0.0001) and *SMI* index (U=18.00, z=3.98, p=0.00002) than *M. rivulata* in Silistar River.

These results could be used in future studies on the body condition of the native aquatic turtles in Bulgaria.

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