TÜBİTAK

Turkish Journal of Zoology

http://journals.tubitak.gov.tr/zoology/

Short Communication

Turk J Zool
(2015) 39: 182-184
© TÜBİTAK
doi:10.3906/zoo-1310-30

Using body condition index can be an unreliable indicator of fitness: a case of sand lizard *Lacerta agilis* Linnaeus, 1758 (Sauria: Lacertidae)

Krzysztof DUDEK[1,*], Zofia SAJKOWSKA[2], Monika GAWAŁEK[3], Anna EKNER-GRZYB[4]

[1]Department of Zoology, Institute of Zoology, Poznan University of Life Sciences, Poznań, Poland
[2]Laboratory of Biological and Natural Education, Faculty of Biology, Adam Mickiewicz University, Poznań, Poland
[3]Laboratory of Neurobiology, Institute of Zoology, Poznan University of Life Sciences, Poznań, Poland
[4]Department of Behavioural Ecology, Faculty of Biology, Adam Mickiewicz University, Poznań, Poland

Received: 30.10.2013 • **Accepted:** 11.04.2014 • **Published Online:** 02.01.2015 • **Printed:** 30.01.2015

Abstract: In ecological and morphological studies, researchers often use body condition index as a measure of an individual's fitness. Our research shows that body condition index may be an unreliable method for this purpose, because changes in lizards' body proportions are not stable during their lifetime. Results obtained from a Polish population of the sand lizard (*Lacerta agilis*) show that the body length increases faster than the body mass, meaning that the correlation between these 2 parameters is not linear. Herpetologists frequently use the body condition index to compare the fitness of lizards of different ages. Our study demonstrates that this method may not be accurate; in the future, research should strive to develop new ways of measuring lizards' fitness.

Key words: Condition, corpulence, morphology, Lacertidae, sand lizard, *Lacerta agilis*, growth

Corpulence and condition index are important parameters used in animal ecology (Green, 2001). There are many ways of calculating these parameters; most of them include calculating the body mass and proportions between the animal's body parts. An example of a condition index measure would be snout-vent length (SVL) measurement divided by body mass (Bradshaw and De'ath, 1991; Olsson and Shine, 1997; Oppliger and Clobert, 1997; De Fraipont et al., 2000; Pearson, 2000; Meylan et al., 2002). The results of this measurement are sometimes additionally log-transformed to allow further analysis. Olsson (1994) suggests that juvenile sand lizards, *Lacerta agilis* Linnaeus, 1758, invest energy in SVL first, before developing secondary sexual characteristics (for example, color). It is therefore possible to predict changes in a lizard's body proportions during its lifetime. We hypothesize that juvenile lizards invest energy in SVL first and only later increase their body mass. We suggest that older lizards have a higher condition index than younger lizards. To test this hypothesis, we conducted fieldwork on wild-living sand lizards in Poland.

These studies were carried out between April and June from 2008 to 2011, near the town of Odolanów, Poland, 51°34′N, 17°40′E, elevation 110–170 m. Sand lizards were captured using herpetology nets or by hand. Animals were sexed and aged, and assigned to 3 categories: adult, subadult, or juvenile. Categorization was based on SVL (adult >46 mm, subadult 35–46 mm, juvenile <35 mm), because the lizards' length is correlated with their age (Gvozdik, 2000). The snout-vent length was measured to the nearest 0.1 mm using digital calipers. This parameter describes the length between the top of the head and the cloaca chink. Body mass (±0.1 g) was measured with an electronic scale. Lizards were then examined for a different study (Ekner et al., 2011a; Ekner-Grzyb et al., 2013). Each specimen was individually marked with medical cautery units (Ekner et al., 2011b) to ensure that the same lizard was not considered twice in the analyses. After the measurements were taken, the lizards were released in the same place where they had been captured. Lizards were caught using a method that meets Polish legal standards and in accordance with the rules set by the Ethical Commission to Study on Animals (LKE 12/2007).

To test our hypothesis, we calculated the classical condition index (SVL divided by the body mass) and compared it between sex and age categories. Lizards with tail autotomy were excluded from the study. The effect of age on condition index was tested using multiple regression. In the graph, only the first model of the regression was shown to explain the variance of the results.

* Correspondence: dudeekk@gmail.com

Statistical analysis was performed using SPSS 21.0 PL for Windows.

A total of 273 sand lizards were captured (115 adults, 50 subadults, and 108 juveniles; 65.22 mm and 8.95 g, 39.16 mm and 1.79 g, and 32.02 mm and 1.08 g were the respective means). There were 52 females and 63 males in the adult group.

There was a significant correlation between body mass and body length (Figure 1). The above relationship is best described with an exponential function ($y = 0.180 + 0.057x$; $R^2 = 0.942$); however, a linear function also describes the results well and is included here for the purpose of comparison ($y = -7.301 + 0.242x$, $R^2 = 0.900$). Statistical analysis shows that juvenile lizards have a proportionally longer body and smaller body mass (Figure 2).

Our results support the hypothesis that the development of the lizards' body size is not linear. During their development, lizards first invest in body length and then in body mass.

These results have important methodological implications. We have demonstrated that corpulence or condition indices are not reliable indicators of fitness condition in lizards, especially in an age-diverse population, because individuals of different ages differ significantly in their body proportions. Researchers should be encouraged to estimate the fitness of lizards in an alternative way. Bancila suggested residual index, which uses the residuals from an OLS regression of body mass against 1 or more length measurements, usually after log transformation which is not correlated with SVL, life stage, or season (Bancila et al., 2010). A promising new method is scaled mass index, which standardizes body mass at a fixed value of a linear body measurement based on the scaling relationship between mass and length (Peig and Green, 2009, 2010).

We hope our article will be important for this research field, but we must note that our study is valid for only *L. agilis* and has not been tested for other lizard species.

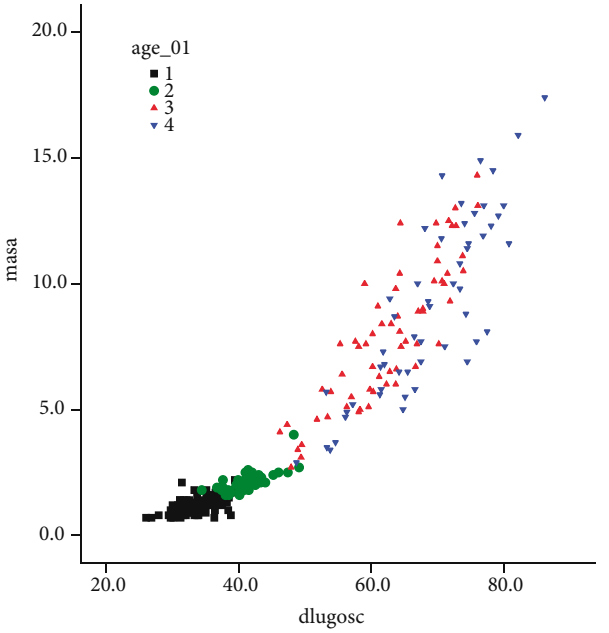

Figure 1. Correlation between lizards' body length and body mass in the 3 age groups.

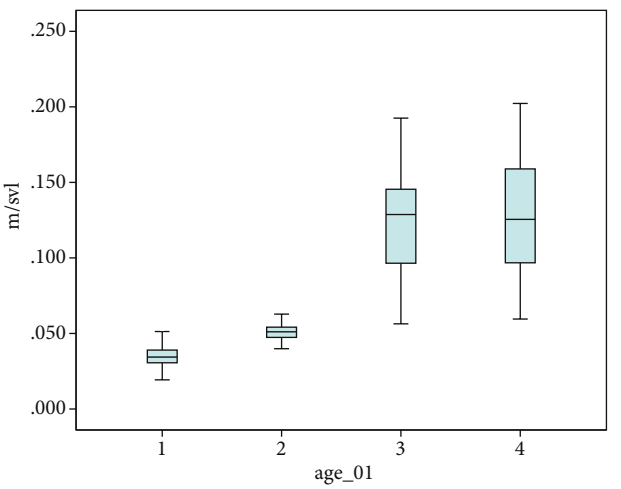

Figure 2. Relation between lizards' condition index in the 3 age groups. There were significant relationships between age groups but not sex groups.

Acknowledgments

We would like to thank Professor Piotr Tryjanowski for his help with statistics and to native speaker Sara Owczarczak-Garstecka for language correction. This work was supported by grants NN 304 381 338 from the Ministry of Science and Higher Education of Poland and PARENT-BRIDGE Programme: Support for Women Foundation for Polish Science.

References

Bancila RI, Hartel T, Plaiasu R, Smets J, Cogalniceanu D (2010). Comparing three body condition indices in amphibians: a case study of yellow-bellied toad *Bombina variegata*. Amphibia-Reptilia 31: 558–562.

Bradshaw SD, De'ath G (1991). Variation in condition indexes due to climatic and seasonal factors in an Australian desert lizard, *Amphibolurus-nuchalis*. Aust J Zool 39: 373–385.

De Fraipont M, Clobert J, John-Alder H, Meylan S (2000). Increased pre-natal maternal corticosterone promotes philopatry of offspring in common lizards *Lacerta vivipara*. Journal Anim Ecol 69: 404–413.

Ekner A, Sajkowska Z, Dudek K, Tryjanowski P (2011b). Medical cautery units as a permanent and non-invasive method of marking lizards. Acta Herpetol 6: 229–236.

Ekner A, Dudek K, Sajkowska Z, Majlathova V, Majlath I, Tryjanowski P (2011a). Anaplasmataceae and *Borrelia burgdorferi* sensu lato in the sand lizard *Lacerta agilis* and co-infection of these bacteria in hosted *Ixodes ricinus* ticks. Parasites & Vectors 4: 182.

Ekner-Grzyb A, Sajkowska Z, Dudek K, Gawałek M, Skórka P, Tryjanowski P (2013). Locomotor performance of sand lizards (*Lacerta agilis*): effects of predatory pressure and parasite load. Acta Ethol 16: 173–179.

Green AJ (2001). Mass/length residuals: measures of body condition or generators of spurious results? Ecology 82: 1473–1483.

Gvozdik L (2000). Seasonal activity, sex ratio, and abundance in a population of *Lacerta agilis* Linnaeus, 1758 from the Czech Republic. Herpetozoa 13: 165–169.

Meylan S, Belliure J, Clobert J, de Fraipont M (2002). Stress and body condition as prenatal and postnatal determinants of dispersal in the common lizard (*Lacerta vivipara*). Horm Behav 42: 319–326.

Olsson M (1994). Why are sand lizard males (*Lacerta agilis*) not equally green? Behav Ecol Sociobiol 35: 169–173.

Olsson M, Shine R (1997). The seasonal timing of oviposition in sand lizards (*Lacerta agilis*): why early clutches are better. J Evol Biol 10: 369–381.

Oppliger A, Clobert J (1997). Reduced tail regeneration in the common lizard, *Lacerta vivipara*, parasitized by blood parasites. Funct Ecol 11: 652–655.

Pearson AR (2000). Body condition of a Puerto Rican anole, *Anolis gundlachi*: effect of a malaria parasite and weather variation. J Herpetol 34: 489–491.

Peig J, Green AJ (2009). New perspectives for estimating body condition from mass/length data: the scaled mass index as an alternative method. Oikos 118: 1883–1891.

Peig J, Green AJ (2010). The paradigm of body condition: a critical reappraisal of current methods based on mass and length. Funct Ecol 24: 1323–1332.