

Body mass-related modifications involved in starvation at pumpkinseed *Lepomis gibbosus* (Linnaeus, 1758) (Teleostei, Centrarchidae)

¹Laurențiu Burlacu, ¹Cătălina F. Radu, ¹Nicolae Crăciun, ¹Tiberiu Sahlean, ²Ionel-Claudiu Gavriloaie, and ³Cecilia Bucur

¹Department of Animal Biology, Faculty of Biology, University of Bucharest, Romania, EU; ²S.C. ICPE Bistrița S.A. (Research and Development Institute on Technologies and Equipments for Environment Protection), Bistrița, Romania, EU; ³Research and Development Pisciculture Center, Nucet-Dâmbovița, Romania, EU. Corresponding author: L. Burlacu, laurentiuburlacu@yahoo.com

Abstract. The authors analyze the modifications observed on a population of pumpkinseed (*Lepomis gibbosus* (Linnaeus, 1758)) after a 60 days period of exposure to starvation and attempt to correlate the obtained results to other body-related characteristics, either linearly-measured (such as length, volume and density) or weight-related, in order to achieve an estimation of a weight-loss allowance for the species of interest, that may be interpreted, if of a low daily value, as an advantage in the invasion process.

Key words: *Lepomis gibbosus*, pumpkinseed, weight-loss rate, starvation.

Resume. Les auteurs analysent les modifications observees dans une population de pumpkinseed (*Lepomis gibbosus* (Linnaeus, 1758)) après une exposition au sous-alimentation pour 60 journees et tentent de coreler les resultats avec autres caracteristiques relatifs au corps, soit elles mesuree liniarment (comme longueur, volume et densitee corporelle) ou dependents au poids, pour estimer la rate du perte en poids pour l'espece d'interet; cette rate, si elle a une valeur quotidienne basse, peut etre interpretee comme un avantage pour l'espece dans le process d'invasion.

Mots-clés: *Lepomis gibbosus*, pumpkinseed, rate de perte en poids, sous-alimentation.

Rezumat. Autorii analizează modificările observate în urma expunerii pentru 60 zile la condiții de înfometare a unei populații de biban-soare (*Lepomis gibbosus* (Linnaeus, 1758)) și încearcă să coreleze rezultatele obținute cu alte caracteristici, fie acestea măsurate liniar (ca lungimea, volumul sau densitatea corporală) fie dependente de greutate, pentru a obține o estimare a ratei de pierdere în greutate pentru specia de interes, care poate fi interpretată, în cazul unei valori zilnice scăzute, drept un avantaj în procesul de invazie.

Cuvinte cheie: *Lepomis gibbosus*, biban-soare, rată de pierdere în greutate, înfometare.

Introduction. Motivations for the necessity of studying the biology of foreign/invasive species are well-known: the goal is to understand the mechanisms which facilitate the extension of the species areal - including features which promote the invader's capacity to adapt to various ecosystems, higher physiological tolerance to different factors/negative situations, higher resilience or an increased capacity to exploit a certain niche (depending on size, trophic status, reproduction period, exposure to predators or pathogens).

Most of these mechanisms have been thoroughly studied by Moyle & Marchetti 2006 in terms of invasive species profiling, especially in which concerns behavioral factors, parental care, propagule pressure, prior invasion success etc. Little is known on the impact of factors related to nutrition and growth.

Hypothetically, a lower rate of biomass loss, as a consequence of insufficient available food or other negative factors - calculated by means of difference in initial (higher) and final (lower) weight values, after starvation exposure, divided by number of

days the experiment was carried, eventually expressed under a percent form, Fulton (K) condition factor, relative weight (W_r), volume, body density – offers the advantage of being able to keep a survival-allowing body condition on a longer period of time, under starvation conditions. This would constitute an important advantage in terms of invasion potential.

Lepomis gibbosus (Linnaeus, 1758) is native to the eastern North American area from New Brunswick (Canada) to the Florida peninsula (USA) (Scott & Grossman 1973). In Europe, it has been introduced to many regions and river systems (Welcomme 1988). The species has been reported in 2002 in Denmark (Jensen 2002) and in 2005 in Norway (Sterud & Jorgensen 2006).

According to FAO (1997), it was introduced in Germany in 1881. In 1877 it was introduced from Canada into France (Arnold 1990). In the United Kingdom it was deliberately released into ponds as an ornamental fish (Copp et al 2002), while in Poland an established population has been reported on the lower Oder (Heese & Przybyszewski 1985).

Introductions have been reported from the Iberian Peninsula (Sostoa et al 1987) to Eastern and Central Europe (Welcomme 1988; de Groot 1985), including Romania (Welcomme 1988) and the Black Sea region (Economidis et al 1981).

In most cases, the releases are thought to be deliberate, by aquarists, to populate ponds as a decorative species; another possibility could be unintentional introductions, along with imports of carp fry (Tandon 1976).

Material and method. The experiment was conducted on eleven specimens of *Lepomis gibbosus* (L., 1758), acquired from Research and Development Pisciculture Center, Nucet - Dâmbovița, Romania in November, 2008. The pumpkinseed were kept for 60 days, (from November 15, 2008 to January 13, 2009) in a 50,000cm³ (50x25x40) plastic tank, provided with a Resun SP – 1100L internal Power Filter, indoors, at a constant temperature of 22 – 24 Celsius degrees. During this period of time, they were not fed at all. They were measured at the beginning and at the end of this period.

Measurements. Length and height (in centimeters) data were obtained by means of calibrated photography: every fish was individually photographed next to a standard, using a Panasonic DMC – L10 camera; weight (in grams) was measured using a Kern EMB 220 – I balance with a 0.1g differential; also, every specimen's physical volume (in cube centimeters) was determined by displacement of a measured body of water in a graded cylinder; two cylinders were used, both U cm³ at 20° Celsius, a larger one, graded up to 250 cm³, with a difference between two consecutive gradations of 2 cm³, and a smaller one, graded up to 100 cm³, with a difference between two consecutive gradations of 1 cm³; depending on the size of each individual measured, we opted for the most suitable of the two.

Body condition factors and indices. Considering the fact that body fat is less dense than other body structures, we employed body density as an index of fat-loss, signaled by increased density; correlations with obtained data were attempted, but the small number of specimens did not allow relevant associations. Calculations focused on obtaining a weight and weight-related loss-rate, expressed in "per diem" modifications, both as values and in percent from initial value form.

Data processing. The photographs were processed with specially designed measurement software, Impor Meranie, obtained from Mr. Istvan Falka. All obtained data were introduced into table sheets and processed in Microsoft Excel 2003 with an XLSTAT patch.

Results and discussion. Initial calculations showed an average daily loss in weight of 0.016 g/day (with a minimum of 0.001g and a maximum of 0.058 g); there could not be traced any relevant correlation between length or initial weight of the specimens and the weight-loss rate. In percents, the pumpkinseed fish loses around 0.24% of weight per day, in starvation conditions, with a minimum of 0.036% and a maximum of 0.59% (see Table 1).

Table 1

Observed initial and final weight and weight related values

<i>Nr</i>	<i>W initial</i>	<i>W final</i>	<i>delta W</i>	<i>W loss/day</i>	<i>percentual daily weight loss</i>
1	1.8	1.5	0.3	0.005	0.277777778
2	11.4	10.7	0.7	0.011666667	0.102339181
3	6.7	5.8	0.9	0.015	0.223880597
4	2	1.9	0.1	0.001666667	0.083333333
5	6.8	5.7	1.1	0.018333333	0.269607843
6	4.4	3.7	0.7	0.011666667	0.265151515
7	7	4.5	2.5	0.041666667	0.595238095
8	3.7	3.3	0.4	0.006666667	0.18018018
9	14.8	11.3	3.5	0.058333333	0.394144144
10	6	5.2	0.8	0.013333333	0.222222222
11	4.6	4.5	0.1	0.001666667	0.036231884
ave	6.290909	5.281818	1.009091	0.016818182	0.240918798
min	1.8	1.5	0.1	0.001666667	0.036231884
max	14.8	11.3	3.5	0.058333333	0.595238095

A significant correlation has been found between the daily percentual weight loss and the difference between the initial and the final *Wr* (relative mass). Initial relative mass was expressed as the ratio between the calculated mass (by means of length-weight regression) and the observed mass of each individual. Final relative mass represented the substitution of the initial observed mass with the final (post-starvation observed) mass (Table 2).

Also, significant correlation was observed between differences in initial and final *K* (Fulton condition factor) and daily percentual weight loss (Table 2).

Table 2

Individual values for percentual daily weight loss and differences between initial and final relative mass (*Wr*)

<i>Nr</i>	<i>percentual daily weight loss</i>	ΔW_r	ΔK
1	0.27	0.26	-0.01
2	0.10	0.15	0.05
3	0.22	0.21	-0.01
4	0.08	0.08	0.000877
5	0.26	0.28	0.01
6	0.26	0.03	-0.23
7	0.59	0.49	-0.10
8	0.18	0.01	-0.16
9	0.39	0.35	-0.03
10	0.22	0.20	-0.01
11	0.03	0.05	0.01
ave	0.24	0.19	-0.04
min	0.03	0.01	-0.23
max	0.59	0.49	0.05

No significant correlation was observed between volume and volume-related calculations (body density), pointing to the fact that all modifications depending on linear dimensions (length, volume, density) do not involve in the condition modification derived from the process of starvation, in opposition to other weight-related indices.

Conclusions

- Condition modification as a result of starvation processes is primarily a function of weight and other weight related calculations;
- There is no traceable relation between condition modification as a result of starvation and linear dimensions such as length, volume or body density;
- An average rate of 0.01 g per day seems to be a sufficiently slow weight-loss rate for the species of interest, in order to allow long starvation periods and still maintain a survival body condition; in this respect it would point to interesting data to compare weight loss rates for other alien/invasive species, to establish a "weight-loss allowance" rate for these species and also compare such obtained results to similar calculations for indigenous freshwater fish species;
- Weight-loss rate does not seem to be related to length or other length correlated dimensions/measurements (such as age, for example) or initial weight of the specimens, but it seems to have a certain relation with the body condition of the individual (calculated either as K or W_r) prior to exposure to starvation.

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Received: 19 January 2009. Accepted: 26 January 2009. Published: 30 January 2009.

Authors:

Laurențiu Burlacu, University of Bucharest, Faculty of Biology, Department of Animal Biology, Splaiul Independenței 91-95, Bucharest 050095, Romania, EU, e-mail: laurentiuburlacu@yahoo.com

Cătălina Floriana Radu, University of Bucharest, Faculty of Biology, Department of Animal Biology, Splaiul Independenței 91-95, Bucharest 050095, Romania, EU, e-mail: the1onlynewt@yahoo.com

Nicolae Crăciun, University of Bucharest, Faculty of Biology, Department of Animal Biology, Splaiul Independenței 91-95, Bucharest 050095, Romania, EU, e-mail: nicolae.craciun@yahoo.com

Tiberiu Sahlean, University of Bucharest, Faculty of Biology, Department of Animal Biology, Splaiul Independenței 91-95, Bucharest 050095, Romania, EU, e-mail: tiberiu.sahlean@gmail.com

Ionel-Claudiu Gavriloaie, S.C. ICPE Bistrița S.A. - Research and Development Institute on Technologies and Equipments for Environment Protection, Romania, Bistrița, Parcului street, no 7, 420035, e-mail: cgavriloaie@icpebn.ro

Cecilia Bucur, Research and Development Pisciculture Center, Romania, Dâmbovița County, Nucet 137335, e-mail: bucurcecilia@yahoo.com

How to cite this article:

Burlacu L., Radu C. F., Crăciun N., Sahlean T., Gavriloaie I.-C., Bucur C., 2009 Body mass-related modifications involved in starvation at pumpkinseed *Lepomis gibbosus* (Linnaeus, 1758) (Teleostei, Centrarchidae).

AACL Bioflux 2(1):57-61.

Printed version: ISSN 1844-8143

Online version: ISSN 1844-9166 available at: <http://www.bioflux.com.ro/docs/2009.2.57-61.pdf>

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