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INVESTIGATION OF LENGTH-WEIGHT RELATIONSHIP AND CONDITION FACTOR OF *Carassius gibelio* RELATED TO WATER QUALITY IN PANTELIMON II LAKE

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Abstract

Length-weight relationship, Fulton's K condition factor and the size structure were assessed for unsexed cyprinid gibel carp, Carassius gibelio (Bloch, 1782) (N= 100) caught from Pantelimon II Lake area - a man-made lake from Colentina River.
Negative allometric growth was estimated for gibel carp in both seasons: TW = 0.0396 x $TL^{2.7583}$ *(N=50, November 2016) and TW = 0.0269 x* $TL^{2.8639}$ *(N=50, May 2017). Condition factor K registered values between 1.44 and 2.38 (cold season), 1.49 and 3.79 (warm season).*
The physico-chemical parameters such as pH, electrical conductivity, total dissolved solids, total hardness, chemical oxygen demand, ammonium nitrogen, nitrite-nitrogen, nitrate nitrogen and phosphorus-phosphate were determined, in order to evaluate the impact of abiotic environmental conditions on fish population. The microbiological examination of water quality was also carried out, to detect the micromycetes which may pose health risk to both human and fish. The presence of Penicillium spp. and some yeast strains were confirmed in water samples from the studied area.
According to all analyzed parameters, the water resource was found to be within the suitable range for well-being of C. gibelio, which is important assuming that local fishermen often catch and eat gibel carp.
To our knowledge, this paper provides first information on length-weight relationship, Fulton's K condition factor and the size structure of Carassius gibelio from Pantelimon II Lake.

***Key words**: gibel carp, length-weight relationship, Pantelimon Lake, water quality.*

INTRODUCTION

The size of specimens and water-quality factors are among the many determinants that influence the population of a fish (Stavrescu-Bedivan et al., 2016).
Pantelimon lakes I and II - man-made lakes, originating in the damming of Colentina River, crossing the Bucharest municipality - have recreational value, being designed for the local tourism and for fishing activities (Petrisor, 2000).
Pantelimon II Lake, along with Cernica Lake, is also used as industrial water supply, in the south-east of Bucharest (Stănescu & Gavriloaie, 2011).
Environmental pollution was noticed in this lentic ecosystem, due to the use of pesticides and the dumping of household wastes by the inhabitants of the adjacent districts (Petrisor, 2000).
According to data obtained from sportive fisherman and other reports, in the ichthyofauna community structure of Pantelimon lakes were noticed before the following species: *Carassius auratus gibelio* (gibel carp), *Carassius carassius* (crucian carp), *Hypophthalichthys nobilis* (bighead carp), *Cyprinus carpio* (common carp), *Alburnus* sp. (bleak), *Pelecus cultratus* (sichel), *Perca fluviatilis* (European perch), *Stizostedion lucioperca* (zander), *Rutilus rutilus* (roach), *Scardinius erythrophtalmus* (rudd), *Rhodeus amarus* (European biterrling), *Lepomis gibossus* (pumpkinseed), *Gobius kessleri* (the Kessler's gudgeon), *Gambusia holbrooki* (mosquitofish), *Ameiurus nebulosus* (brown bullhead) (Petrisor, 2000; Gavriloaie & Chis, 2007; Gavriloaie, 2008; www.pescuitul.ro/; www.rapitori.ro/).
A survey of literature revealed that scarce information is available on growth features of gibel carp *Carassius gibelio* (Bloch, 1782) - an

important cyprinid species for recreational fishing – in Romanian waters. We provided some new data on length-weight relationship and condition factor for *C. gibelio* from few lentic ecosystems in a previous study (Stavrescu-Bedivan et al., 2015).

Figure 1. Sampling points from water and fish from Pantelimon II Lake (map source: Google Earth)

In most studies concerning the growth patterns of a fish species, the length-weight relationships (LWR) play an important role (Stavrescu-Bedivan et al., 2016). Condition factor, used to show the fitness or well-being of an individual fish, represents an indicator reflecting the interactions between biotic and abiotic environmental factors to the physiological condition (Keyombe et al., 2015; Stavrescu-Bedivan et al., 2015).

On the other hand, the importance of monitoring water quality for protection of aquatic life has been documented by numerous authors (Isa et al., 2012; Mitrănescu et al., 2007; Scăeţeanu et al., 2012). In terms of moulds and fungi, several papers have shown the link between biological pollution and the environmental health (Refai et al., 2010; Scăeţeanu et al., 2012).

Since several ecological and physiological factors are more size-depended than age-dependent, length of the fish was considered to be more biologically relevant than age (Kalaycı et al., 2007; Rosli and Isa, 2012; Stavrescu-Bedivan et al., 2016).

For Romanian ichtyofauna there is still a vast paucity of data on length-frequency distribution of gibel carp (Stavrescu-Bedivan et al., 2015).

Considering our ongoing interest concerning evaluation of length-weight relationship for various fish species correlated with water chemical composition, we found proper to: (1) investigate the length-weight relationship, Fulton's condition factor and growth pattern for *Carassius gibelio* sampled in two season (December 2016 and May 2017) from the lentic ecosystem - Lake Pantelimon II; (2) detect the water quality in order to see if gibel carp lives in a friendly environment and if caught in the area could represent a healthy source of food.

MATERIALS AND METHODS

Study area

With a surface of 260 ha, Pantelimon II Lake is located in Ilfov County, in the eastern neighborhood the 2nd sector of Bucharest; most of the lake is outside Bucharest, in Pantelimon city (Sfetcu, 2005).

The fish and water samples, for both chemical and microbiological analysis were collected from the following points (Figure 1) of Pantelimon II Lake: 44°26'39.59"N, 26°12'4.65"E (SP 1 - "La Pod"/"at the bridge" and 44°26'32.22"N, 26°11'52.25"E, respectively (SP 2 - "La Cabană"/"at the cottage") (Figures 2-3).


Figure 2. Sampling point "at the bridge", at the border between Dobroeşti Lake and Pantelimon Lake


Figure 3. Sampling point "at the cottage"

Fish collection and measurements

Overall (December 2016, May 2017), 100 gibel carp were caught from Pantelimon II Lake freshwater ecosystem.

A total number of 50 fish individuals (sex combined) were collected on gillnet in 2016, respectively in 2017. After sampling, *C. gibelio* specimens were transported directly in laboratory for biometric analysis (Figure 4).

Figure 4. Analyzing gibel carp in the laboratory

Each fish individual was measured for total length (TL ± 1 mm) and weighted (TW ± 1 g). The length-weight relationship (LWR) was expressed by using the equation: $TW=aTL^b$, where intercept (coefficient *a*) describes the rate of change of weight with length and slope (coefficient *b*) offers information about isometric or allometric types of growth (Froese, 2006). The relationships between the length and the weight of fish in each sampling campaign were determined through linear regression (Log TW= Log a + b Log TL).

It is known that when $b > 3$, positive allometric pattern of growth is indicated, while low values of b (< 3) suggest negative allometric or hypoallometric growth (Karachle and Stergiou, 2012; Stavrescu-Bedivan et al., 2016). The parameters of LWR and coefficient of determination (r^2) were estimated by the least-square method, using PAST (Paleontological Statistics Software) version 3.04.

Fulton's condition factor (K), used for assessing the degree of well-being of the fish in their habitat (Nehemia et al., 2012) was calculated using the equation: $K=(TW/TL^3)*100$.

Size intervals for total length distribution of *C. gibelio* samples caught in study site were established in accordance with Innal (2012) and Stavrescu-Bedivan et al. (2015).

Water sampling

For samples collected from the Pantelimon II Lake were determined some physico-chemical parameters, as it follows: pH, electrical conductivity (EC), total dissolved solids (TDS), total hardness (TH), chemical oxygen demand (COD), ammonium nitrogen ($N\text{-}NH_4^+$), nitrite-nitrogen ($N\text{-}NO_2^-$), nitrate nitrogen ($N\text{-}NO_3^-$) and phosphorus-phosphate ($P\text{-}PO_4^{3-}$). Water samples and fish collection were done in the same month of the year (December 2016, May 2017).

Water samples were taken at about 45 cm below surface layer in sterile recipients, both for chemical and microbiological analyses. The microbiological analysis was performed within 4 hours after collection. For chemical analyses, the samples were subsequently stored at 4°C before analysis to minimize physical and chemical changes. These analyses were conducted within 48 hours after collection. All samples were allowed to stay until they reached room temperature before analysis (Stavrescu-Bedivan et al., 2015).

Chemical analysis

The chemical analysis of water samples was performed in the same manner (same methodology and instrumentation) as previously reported (Stavrescu-Bedivan et al., 2015), by using methods similar to those recommended for drinking water (Mănescu et al., 1994). All analyses were performed in triplicate and the reported values represent the mean of results.

Microbiological analysis

The water samples from Pantelimon II Lake were inoculated on Potato-Dextrose-Agar growth medium sterilized at 121°C and 1.2 atmospheres during 15 minutes. The next step was to take 1 mL of suspension from each sample and places it directly on the growth medium in Petri dishes of 90 mm diameter. All samples were then incubated in the dark for 7 days, at 24°C. Identification of the micromycetes according to specialist literature was made with a Krüss Optronic microscope (Manole and Ciocoiu, 2011; Ciocoiu et al., 2015; Stavrescu-Bedivan et al., 2016).

RESULTS AND DISCUSSIONS

Fish growth characteristics

The biological information about growth offers important data regarding the fish well-being and organisms's adaptation to the environment (Stavrescu-Bedivan et al., 2016).

The biometric data for *Carassius gibelio* sampled from Pantelimon II Lake in November 2016 were registered as: TL (min. 18.2 – max. 24.8 cm, with a mean of 21.05 cm); TW (min. 103 - max 273 g, with average of 168.0 g); Log (TW) = 2.758 L Log (TL) - 1.402 (r^2= 0.843, 95% CL of the parameters *a* and *b*); TW = 0.0396 x $TL^{2.7583}$ (Figure 5). Growth type for Gibel carp was determined as negative allometric ($b < 3$). Fulton's condition factor K has a value of 1.90 (min. 1.44 - max. 2.38).

In May 2017, the biometric data were registered as: TL (min. 15.4 - max. 29.3 cm, with a mean of 19.48 cm); TW (min. 72 - max 434 g, with average of 138.92 g); Log (TW) = 2.863 L Log (TL) - 1.570 (r^2= 0.842, 95% CL of the parameters *a* and *b*); TW = 0.0269 x $TL^{2.8639}$ (Figure 6). Growth type for gibel carp sampled in 2017 was estimated also as negative allometric ($b < 3$). Fulton's condition factor K has a value of 1.82 (min. 1.48- max. 3.79).

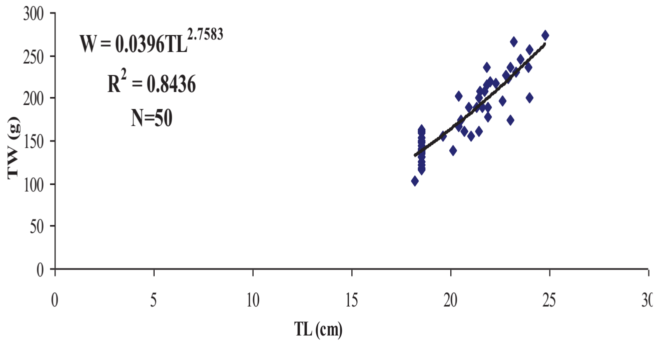

Figure 5. LWR of the gibel carp in Pantelimon II Lake area (November 2016)

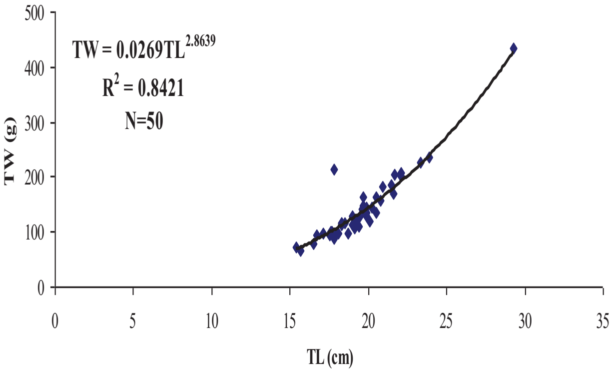

Figure 6. LWR of the gibel carp in Pantelimon II Lake area (May 2017)

The common total length for gibel carp is 20 cm, according to FishBase.

In Pantelimon II Lake area, the total length of most gibel carp (96%) had values between 18.5 and 24 cm, while more than half of these fish specimens (62%) sampled in November 2016 weighted more than 160 grams. Similar length frequency was noticed for *C. gibelio* in a previous report (Stavrescu-Bedivan et al., 2015). For 86% of the fish captured in May 2017, the total body length ranged between 16.5 and 22 cm, and 74% of them weighted between 66 and 150 grams. The results showed that total body length for *C. gibelio* inhabiting Pantelimon II Lake in Ilfov County is included in the normal range of values recorded for this measurement of this species.

Various factors including season, preservation technique, population density, sexual maturity age, length range of captured specimens, habitat, food, environmental conditions affect the parameters of the length-weight relationship (Innal, 2012; Stavrescu-Bedivan et al., 2016). In the present study, the slope *b* was within the expected range of 2.5-3.5 for all the gibel carp analyzed individuals.

Length-weight relationship indicated that populations of *Carassius gibelio* caught in December 2016 from Pantelimon II Lake aquatic ecosystem exhibited a negative allometric growth. Similar data were recorded for the same cyprinid fish sampled in Brăneşti 3 Lake on the River Pasărea, tributary of the Dâmboviţa, Ilfov County (Stavrescu-Bedivan et al., 2015). In a previous study, we noticed that the pattern of negative allometric growth could be attributed to trophic state of the water, assuming the results of the chemical analysis (Stavrescu-Bedivan et al., 2015).

The Fulton's condition of the fish sampled in study area has values between 1.44 and 2.38. Thus, *Carassius gibelio* specimens from Pantelimon II Lake may suggest a better fitness than *C. gibelio* collected from other Romanian water bodies (Stavrescu-Bedivan et al., 2015).

Among the factors responsible for differences in condition factor for the same species in various habitats are included the values of water quality parameters or the effect of increased fishing pressure (Stavrescu-Bedivan et al., 2016).

Water quality

Physico-chemical parameters for water samples collected from Pantelimon II Lake are presented in Table 1.

Table 1. Physico-chemical parameters for water samples from Pantelimon II Lake

Parameters / Results	SP1		SP2	
	2016	2017	2016	2017
pH	6.97	7.26	7.88	8.19
EC (μS/cm)	785	743	562	524
TDS (mg/L)	425 [I]	406 [I]	342 [I]	318[I]
TH (mg $CaCO_3$/L)	28.74	27.94	18.37	16.78
COD (mg O_2/L)	4.84 [I]	3.89 [I]	6.07 [II]	6.35 [II]
N-NH_4^+ (mg N/L)	0.21 [I]	0.31 [I]	0.13 [I]	0.24 [I]
N-NO_2^- (mg N/L)	0.022 [II]	0.021[II]	0.051[III]	0.038 [III]
N-NO_3^- (mg N/L)	1.47 [II]	1.26[II]	0.11 [I]	0.32 [I]
P-PO_4^{3-} (mg P/L)	0.43 [IV]	0.41 [IV]	0.45 [IV]	0.48[IV]

SP - sampling points, where the fish were caught in December 2016 and May 2017: SP1 – "la pod" ("at the bridge"); SP2 – "la cabană" ("at the cottage"). Values between square brackets represent quality classes for surface water according to Order 161/2006

According to literature (Stone et al., 2013), optimal growth of most fish species is favoured by pH values that are within 6.5 and 9.0, values below 6.5 leading to a decrease of reproduction. In the case of analyzed water samples, the results are between 6.97-8.19, these values being within the range recommended by Order 161/2006 (pH=6.5-8.5) and similar with those reported for Cişmigiu Lake, Brăneşti 3 Lake (Stavrescu-Bedivan et al., 2015) and Morii Lake (Stavrescu-Bedivan et al., 2016). Some authors (Alatorre-Jacome et al., 2011) consider that ideal pH for an aquaculture system must be near 7, for most of the fish species the lethal limits being below 5 and above 10. Furthermore, some studies indicate that pH values for lakes range between 7.3 and 9.2 (Tsytsarin, 1988; Nikanorov and Brazhnikova, 2009).

EC is a parameter often used to evaluate TDS, which represent about half of the EC (Stone et al., 2013). Our results for EC were 524-785 μS/cm, within the desirable range for fish culture (60-2000 μS/cm) (Stone et al., 2013). TDS varied between 318-425 mg/L and on the basis of these values the water may be associated with first class of quality for surface waters. The found values were similar with those reported for Morii Lake (Stavrescu-Bedivan et al., 2016). Anyway, it has been reported that TDS levels vary in different waters depending upon the season, location or other factors (Dastagir et al., 2014).

The water hardness is associated with the presence of dissolved polyvalent metallic cations, the main contribution being made by calcium and magnesium. TH (as mg $CaCO_3$/L) is a parameter of water for fish culture and it is desirable to be found in the range 50-150 mg/L, but values greater than 20 mg/L are considered to be acceptable (Stone et al., 2013). For SP2 sampling point, the TH values in 2016 and 2017 were below 20 mg $CaCO_3$/L, meanwhile for SP1, it have been found values close to 30 mg $CaCO_3$/L.

COD is a parameter that indicates water pollution and is expressed as amount of oxygen that oxidizes organic species. Clean water usually has COD between 2-4 mg/L (Cohl et al., 2014). Water samples collected from SP1 present COD values that allow associating the water to first class quality, meanwhile the COD values for SP2 sampling point are higher and allow framing to second class of quality for analyzed water samples.

Nitrogen species and phosphates are nutrients for different microorganisms and aquatic plants but in certain circumstances are unwanted due of their possible effects as inhibiting water aeration, which can lead to death of various aquatic species.

Found ammonium nitrogen levels indicate that water from SP1 and SP2 during both sampling campaigns may be categorised to first class of quality for surface waters. The found values for Pantelimon II Lake are much lower than those reported for Morii Lake (Stavrescu-Bedivan et al., 2016). Some studies (Yang et al., 2011) indicated that the increase in ammonia concentration in lake water may cause toxicity to aquatic organisms. However, toxicity of ammonia to fish varies with fish species, age or other quality parameters (Latha and Lipton, 2007; Stone et al., 2013).

Nitrite nitrogen concentrations found after analysis ranges between 0.021-0.051 mg/L, similar with those reported for Cişmigiu Lake (Stavrescu-Bedivan et al., 2015) but lower than those reported for Brăneşti 3 Lake (Stavrescu-Bedivan et al., 2015) and Morii Lake (Stavrescu-Bedivan et al., 2016). The main danger associated with high nitrite nitrogen levels is represented by the hypoxia due to the methemoglobin formation in fish blood ("brown blood disease") (Durborow et al., 1997). Some studies (Buttner, 1993) evidenced that levels of 0.5 mg/L nitrite have reduced growth and adversely affected fish. Notwithstanding, nitrite toxicity to fish varies significantly with fish species, some of them being more sensitive (trout), while others are very resistant (mouth bass and bluegill sunfish) (Stone et al., 2013).

Nitrate nitrogen levels are much lower in SP2 sampling point in comparison with SP1, where found values framed the analyzed water in second class of quality for surface waters. According to literature (Stone et al., 2013), nitrate is relatively non-toxic to fish and does not represent a health hazard, excepting levels higher than 90 mg/L nitrate nitrogen.

In surface waters, inorganic phosphorus is encountered as phosphate (PO_4^{3-}) and is bound to living or dead particulate matter. The level of phosphorus reported for surface waters usually range between 0.005-0.5 mg P/L (Stone et al., 2013). The concentration found in analyzed samples is slightly above 0.4 mg P/L, this being the criteria to classify the subjected surface water to fourth class of quality.

In SP 1, the fungal population from Pantelimon II Lake was represented by some yeast strains and *Penicillium* spp. fungus (December, 2016). In SP 2, leek, opaque, white-creamy, dense and milky-colored yeast colonies have been identified. Chromophoric colonies have also been isolated, which, through the released pigment, stained the culture medium in yellow (May 2017) (Figure 7).

In a previous study (Stavrescu-Bedivan et al., 2016), we mentioned that microbial pollution in the aquatic environment could be accumulated in the tissues of fish, but further investigations are needed in order to establish a link between the water load in fungus and quality and fish wellbeing.

CONCLUSIONS

As literature survey evidenced the lack of information regarding length-weight relationship and type of fish growth related to water quality for Pantelimon II Lake, our study was focused on this subject and provided the conclusions presented below.

The length-weight equations determined for gibel carp captured from this environment indicated a negative allometric type of growth, which means that fish increase in length rather than in body thickness.

Mycological analysis indicated the presence of yeast and *Penicillium* spp. fungus in the water samples taken from the studied ecosystem. Also, the chemical analysis highlighted the presence of nitrite nitrogen content and the presence of high levels of phosphorus in surface waters, which classifies the lake's waters in II and III-IV quality classes respectively. However, the values were lower compared with other lakes studied before, indicating a possible increased confidence when it comes to fish life quality and fish consumption.

These results could be useful references for future comparative studies about biometric data of *Carassius gibelio* from Romanian related to the features of freshwater ecosystems.

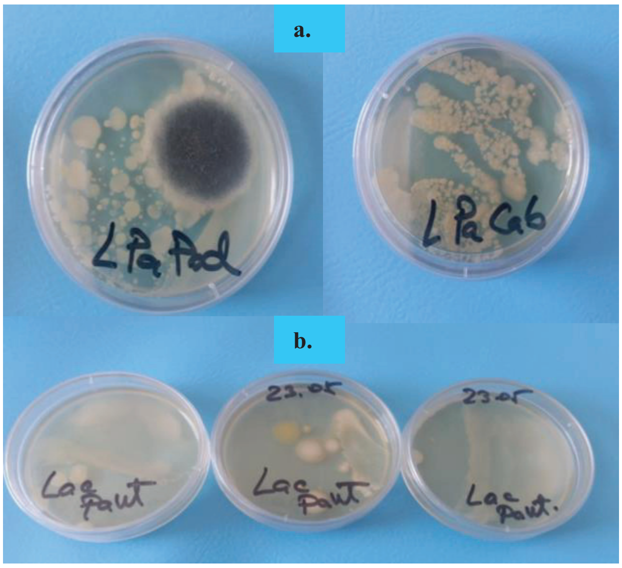

Figure 7. Microbiota identified in water sampling points from Pantelimon II Lake: a. *Penicillium* spp. and yeasts colonies (SP1, December 2016); b. chromophoric yeasts (SP2, May 2017)

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