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# ESTIMATION OF GROWTH AND MORTALITY OF SOME COMMERCIAL CYPRINIDS FROM THE DANUBE DELTA

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***Abstract***

*Common carp and Prussian carp are two of the main exploited freshwater fish from the Danube Delta, that`s why obtaining information regarding the stock assessment has great importance for population structure. Our study aimed to investigate the parameters of growth and mortality among these populations. From the result of our study, the correlation between length and weight was W = 0.04×Lt2.70 for common carp and W = 0.10×Lt2.47 for Prussian carp. The calculated parameters for mortality were: total mortality (Z) was 1.74 for Common carp and 2.29 for Prussian carp, the natural (M) was 0.82 for Common carp, respectively 1.03 for Prussian carp, while the rate of exploitation reached a value of 0.53 for common carp and 0.55 for Prussian carp. In conclusion, the study analysed mortality due to natural causes, fishing, and overfishing and concluded that both species are currently being overexploited.*

***Key words****: freshwater fish, inland fishing, Length-Weight ratio, von Bertalanffy's equation.*

## INTRODUCTION

Carp is by far the most representative fish in Romanian fisheries. The carp as a wild species was the basic fishery production in the lower Danube basin. It was and it will remain, at least as goal, the main fish species in Romania (Nicolae et al., 2012; 2018).

The common carp, scientifically known as *Cyprinus carpio* L. 1758, is widely distributed across the globe, inhabiting freshwater, brackish waters, and large lakes with dense vegetation (Kottelat & Freyhof, 2007). The Prussian carp (*Carassius gibelio*) is a freshwater species that can be found in various aquatic habitats ranging from plains to hills. However, it does not thrive well in areas with excessive overgrown vegetation (Gheorghe et al., 2012). In Romania, the common carp and the Prussian carp are one of the most preferred fish by Romanian consumers due to its texture and pleasant flavour (Stroe et al., 2022).

In Romania, over 70%, of inland fishing is represented by fishing in the Danube Delta, even though, in the last years, the Danube Delta fisheries have diminished because of the decline of fish stocks, mostly due to habitat loss to floodplain and impoundments (Năstase et al., 2017).

From one year to another, the average size and structure of fish captured from the Danube Delta changed, decreasing from 1747 tons between 1963 and 1974 to 252 tons in the period 1992 and 2003 to 158 tons (2018-2022) in Gorgova-Uzlina lake-complex (Năvodaru & Cernișencu, 2006).

In the given situation, an investigation was carried out in the Danube Delta's Gorgova-Uzlina Lake complex during the year 2022 in order to determine certain population traits of common carp and Prussian carp, including their distribution of length and weight, the relationship between length and weight, as well as various growth parameters and mortality rates.

## MATERIALS AND METHODS

***Study area, fish sampling***. Specimens of *C. carpio* and *C. gibelio* were sampled in 2022 in the Gorgova-Uzlina Lake complex (Figure 1).

The Gorgova lake complex is situated on the depression of the same name (about 26,000 ha) and includes important lakes such as Gorgova, Isac, Uzlina, Isacel, Cuibeda, Obretinul Mic, Obretinciuc, Potcoava, Gorgovat, Cruglic. This complex is crossed by the Litcov Canal, which is the most important waterway in this part of the Danube Delta.

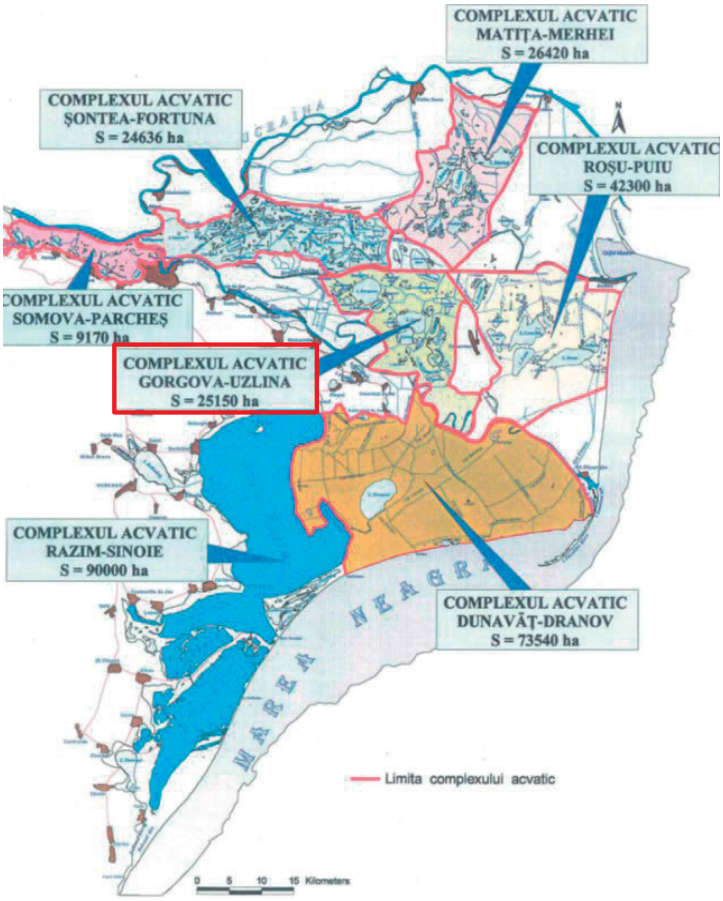


Figure 1. Map of the natural lakes from the Danube Delta (Photo after Năvodaru, 2008)

402 specimens, including 182 Prussian carp and 220 common carp were randomly sampled from commercial catches beginning in April till October 2022. Using an ichtyometer, we measured the fish height (H, cm), total length ($L_T$, in cm), and fork length ($L_F$, in cm). The body weight was determined with an electronic scale.

***The growth and mortality parameters estimation***. For data analysis, we used the average values of the length and body weight of classes. For the determination of the fish growth, we used the Von Bertalanffy equation (Gayanilo et al., 2005). Using the curve analysis of the length converted catch (Ricker, 1975) from the FISAT II software, we estimated the natural mortality (M) at the annual average water temperature of 14°C. Fishing mortality (F) was calculated with the formula described by Pauly (1984): F=Z-M (where: Z represents the total mortality and M – is the natural mortality). The exploitation level (E) was calculated with the formula: E=F/Z (Gulland, 1971). Information regarding the condition of fish stocks can be obtained through the exploitation ratio. Fish stocks with exploitation ratio values less than 0.5 are considered to be easily exploitable, while those with ratios between 0.5 and 1 are heavily exploited.

***Total length-weight (TL-W) correlations***, were determined after Ricker (1975), taking into consideration the total length and body weight of all the measured fish. The equations resulted as follows: $W = a \times L_T^b$ (W - the individual weight of fish; $L_T$ - the total length, a-the intercept; b -the slope of the regression. Ricker, 1975 states that values of the slope "b" under the value of 3 indicate isometric growth (when different parts of an organism grow at the same rate relative to each other), while a value of "b" higher than 3 indicates an allometric growth (when different parts of an organism grow at different rates relative to each other).

***Data analysis***. To analyse the length-frequency data, the data were grouped into intervals of 3 m using Microsoft Excel 2019 and the software package FiSAT II.

## RESULTS AND DISCUSSIONS

Understanding fish population dynamics (i.e., how mortality, growth, and exploitation rate) is mandatory for knowledge of fisheries management.

In the Table 1 are presented the average values of the f of the carp and Prussian carp population from the Gorgova-Uzlina complex from the year 2022.

Table 1. Biometric parameters for common carp and Prussian carp (Gorgova-Uzlina area, 2022)

| Fish species | Statistical parameters, limits | W (g) | LT (cm) | LF (cm) | H (cm) |
|---|---|---|---|---|---|
| *C. carpio* | Mean±Sdev | 2209.98±1276.79 | 52.78-9.96 | 45.51±8.68 | 14.56-2.31 |
| | Min-max | 650-7500 | 40-82 | 25-71 | 10-23 |
| *C. gibelio* | Mean±Sdev | 604.81±262.26 | 31.56±5.51 | 25.64±3.98 | 11.02±1.54 |
| | Min-max. | 200-1400 | 21-50 | 17.5-34 | 8-17 |

Note: W - body weight; LT - total length; LF - fork length; H - height

The average total length of common carp was determined to be 52.78 ± 9.96 cm, with a range of 40 cm to 82 cm, while the total length for Prussian carp was found between 21 and 50 cm, with an average value of 31.56 ± 5.51 cm.

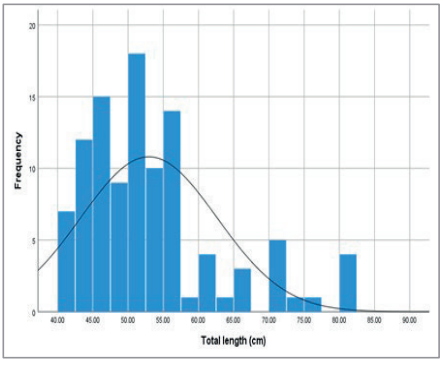


Figure 2. Distribution of total length-frequency for common carp population from Gorgova-Uzlina lake complex, during the year 2022

The overall histograms present a higher frequency at a total length range from 47.2 to 54.4 cm for common carp (Figure 2), while Prussian carp present a higher frequency at a total length range from 29.2 to 33.3 cm LT (Figure 3).

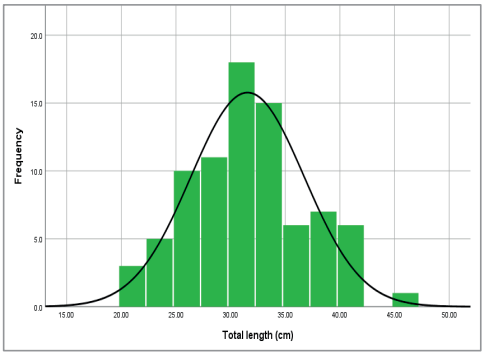


Figure 3. Distribution of length-frequency of Prussian carp population from Gorgova-Uzlina lake complex, during the year 2022

The Lt-W relation was calculated as follows: $W=0.04\times Lt^{2.70}$ ($r^2=0.95$) for common carp (Figure 4), and $W=0.10\times Lt^{2.48}$ ($r^2=0.92$) for Prussian carp, respectively (Figure 5).

The regression coefficient "b" showed negative allometric growth, for both species (b=2.70 for common carp, and b=2.48 for Prussian carp respectively). The value of "b" for the common carp is close to values reported by Gheorghe et al. (2011) (b=2.84), for the period 2006-2009 in the northern part of Brăila Natural Park (Fundu Mare Island, Cravia, and Calia branch).

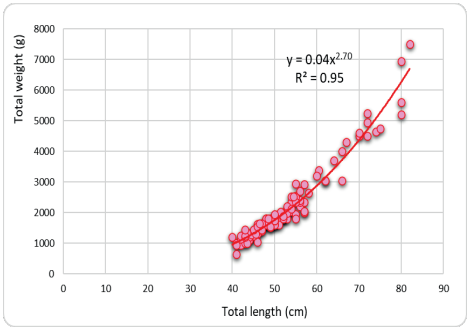


Figure 4. Total length-Weight correlations for common carp (Gorgova-Uzlina lake complex, the year 2022)

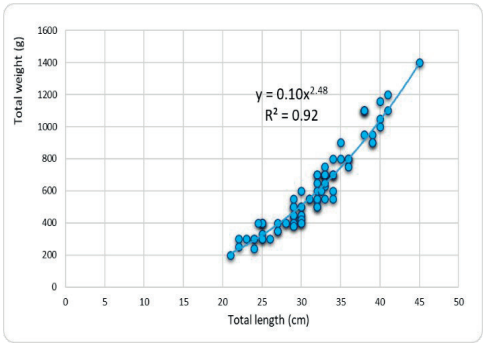


Figure 5. Total length-Weight correlations for Prussian carp (Gorgova-Uzlina Lake complex, the year 2022)

For Prussian carp, fished in the Danube River, between Brăila (km 170) and Gropeni (km 196) during the period 2006-2009, Gheorghe et al., 2012, reported a higher value of "b" (b=2.86). Generally, the values of the "b" coefficient is affected by several factors, such as: sex, age, physiological conditions, food availability, life span, or growth increments (Sinovčić, 2000).

*Growth parameters*. Estimates of population parameters are essential for understanding the biological characteristics of fish species (Camargo et al., 2015; Talet et al., 2019). In this context, length frequency data and growth curves were plotted with the help of FISAT II for each specie (Table 2).

The asymptotic length ($L\infty$) and the growth rate coefficient (k) determined by the direct-fit of length frequency (ELEFAN I) was 70.35 cm, and 0.71 year$^{-1}$ for common carp, while for Prussian carp, the $L\infty$ and k were estimated as 47.25 cm and 0.85 year$^{-1}$.

Hypothetical age ($t_0$) was predicted as -0.71/year for carp, respectively -0.85/year for Prussian carp, which gave the Von Bertalanffy growth equations: Lt = 70.35 (1-exp [-0.71(t+0.49)]) for common carp, respectively Lt = 47.25 (1-exp [-0.85(t+0.50)]) for Prussian carp.

Table 2. Von Bertalanffy growth equation parameters for *Cyprinus carpio* and *Carassius gibelio* species at the Gorgova-Uzlina, during the year 2022

| Fish species | Asymptotic length | Growth rate coefficient of Von Bertalanffy | Hypothetical age | Total mortality | Natural mortality | Fishing mortality | Exploitation rate |
|---|---|---|---|---|---|---|---|
| Common carp | 70.35 | 0.71 | -0.49 | 1.74 | 0.82 | 0.92 | 0.53 |
| Prussian carp | 47.25 | 0.85 | -0.50 | 2.29 | 1.03 | 1.26 | 0.55 |

The values of the asymptotic length and the growth coefficient obtained for the Prussian carp were found to be lower than those reported in other studies.

Gheorghe et al., 2012 reported an asymptotic length of 39.38, for Prussian carp fishing in the Danube River, Braila (km 170) - Gropeni (km 196). However, the values are similar to those reported at www.fishbase.org, from other parts of Romania country (Danube Delta at Puiu-Roşu, 47.8 cm, Somova - 40 cm, Isacova 45.7 cm).

It is generally assumed that the differences between the values of $L\infty$ and K can be influenced by factors such as population size, environmental conditions, and species density, as noted by Adams (1980).

Thus, these factors may be related to the observed variances.

***Mortality coefficients and exploitation ratio***. The rate of natural mortality (M) for the common carp was predicted to be 0.82 year$^{-1}$ using Pauly`s (1980) equation, at a mean temperature of 14°C. Using the length-converted catch curve (Figure 6) we determined a total mortality of 1.74 year$^{-1}$, while the fishing mortality was predicted to be 0.92 year$^{-1}$, and the exploitation ratio (E) was approximated to 0.53 year$^{-1}$.

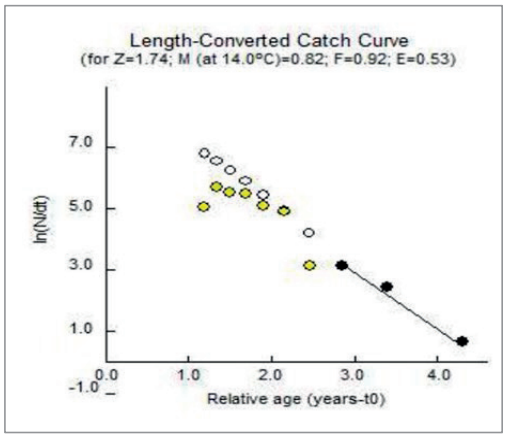


Figure 6. Length converted catch curve of common carp (lake complex Gorgova-Uzlina, 2022)

For Prussian carp, the natural mortality was predicted to be 1.03 year$^{-1}$, while the total mortality is Z=1.74 year$^{-1}$. The fishing mortality registered a value of 1.26 year$^{-1}$, and the exploitation rate recorded a value of 0.55 year$^{-1}$ (Figure 7). In our study, the mortalities due to natural and environmental causes (M) registered lower values than those caused by fishing, for both species, but higher in comparison with those registered in 2011 and 2012 by Gheorghe et al.

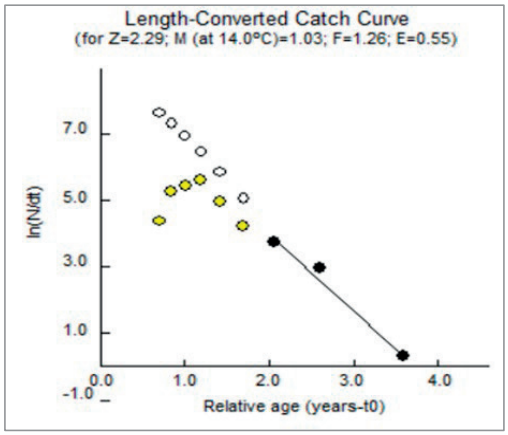


Figure 7. Length converted catch curve of Prussian carp (lake complex Gorgova-Uzlina, 2022)

According to Pauly (1983), high values of natural mortality and fishing mortality can indicate an overfished condition. Also, from the results of the exploitation rate, it appears that the stocks of common carp and Prussian carp populations are overexploited (E=0.53 for common carp and E=0.55 for Prussian carp). Therefore, according to the affirmation of Gulland, 1971, an exploitation rate bigger than 0.5 is a statement for an overfished stock, we can conclude that the common carp and Prussian carp populations are overexploited in this area of the Danube Delta.

## CONCLUSIONS

The aim of the present study was to collect new data regarding the growth and mortality of common carp and Prussian carp, from the Gorgova-Uzlina Lake complex.

The growth rate of fish has significant implications for their ecological dynamics, including factors such as susceptibility to predation and timing of sexual maturation, as well as their participation in fisheries.

As a result of our study, it can be established that the total length of carp fishes' ranges between 40-82 cm and of the Prussian carp between 21-50 cm.

In terms of correlations between the total length-weight, we observed negative allometric growth patterns for both species.

Also, the study analysed mortality due to natural causes, fishing, and overfishing and concluded that both species are currently being overexploited.

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## REFERENCES

Adams, P. B. (1980). Life history Pattern in marine fishes and their consequences for fisheries management. *Fishery Bulletin, 78*(1), 1-12.

Camargo, M., Giarrizzo, T., & Isaac, V. J. (2015). Population and biological parameters of selected fish species from the middle Xingu River, Amazon Basin. *Brazilian Journal of Biology*, *75*(3 Suppl 1), 112-124.

Gayanilo, Jr., F. C., Sparre, P., & Pauly, D. (2005). FAO-ICLARM stock assessment tools II. Revised version. User's guide. *FAO computerized information series. Fisheries*, *8*, 1-126.

Gheorghe, D. C., Răzlog, G. P., Cristea, V., & Enache, I. (2011). The growth characteristics of common carp (*Cyprinus carpio*) in the northern part of the Small

Island of Brăila Natural Park. *AACL Bioflux*, *4*(2), 154-158.

Gheorghe, D. C., Nica, A., Cristea, V., & Răzlog, G. P. (2012). Growth and mortality estamation parameters for the Prusian carp (Carassius gibelio, Bloch, 1782) population from Danube River (km 170-196). *UASVM Iaşi, Lucrări Ştiinţifice - Seria Zootehnie*, *57*(17), 164-169.

Gulland, J. A. (1971). Ecological aspects of fishery research. *Advances in ecological research*, *7*, 115-176.

Kottelat, M., & Freyhof, J. (2007). *Handbook of European freshwater fishes*. Cornol, CH: Publications Kottelat Publishing House.

Năstase, A., Oţel, V., & Năvodaru, I. (2017). Ecological status of fish fauna in arms of the Danube Delta (Danube Delta Biosphere Reserve, Romania) at the beginning of the third Millennium. *Acta Zoologica Bulgarica*, *69*(3), 349-360.

Năvodaru, I. (2008). *Estimation of fish and fishery stocks*. Constanța, RO: Dobrogea Publishing House.

Năvodaru, I., & Cernișencu, I. (2006). Study offisheries from riverine Danube Delta: Gorgova-Uzlina and Sontea-Furtuna lake-complexes. *Scientific Annals of the Danube Delta Institute, 12*, 177-180.

Nicolae, C. G., Grosu, H., Costache, M., Diniță, G., Marin, M., & Niță, V. (2012). Study concerning the heritability estimation for some bioeconomic and ecoeconomic characters in Ropsa carp breed. *Scientific Papers, Series D. Animal Science*, *LV*, 316-319.

Nicolae, C. G., Rotar, M., Marin, M. P., Pogurschi, E., Bahaciu, G., & Udroiu, A. (2018). Research on the evolution of the meat production characters and the correlations among them in Ineu crap breed. *Scientific Papers. Series D. Animal Science*, *LXI*(2), 256-259.

Pauly, D. (1980). On the interrelationships between natural mortality, growth parameters, and mean environmental temperature in 175 fish stocks. *ICES Journal of Marine Science*, *39*(2), 175-192.

Pauly, D. (1983). Some simple methods for assessment of tropical fish stocks. *FAO Fisheries & Aquaculture - Technical papers*, *234*, 1-52.

Ricker, W. E. (1975). Computation and interpretation of biological statistics of fish populations. *Bulletin of the Fisheries Research Board of Canada*, *191*, 1-382.

Sinovčić, G. (2000). Anchovy, *Engraulis encrasicolus* (Linnaeus, 1758): biology, population dynamics and fisheries case study. *Acta Adriatica*, *41*(1), 3-53.

Stroe, M. D., Crețu, M., Ibănescu, D.C., Stanciu, S.S., & Patriche, N. (2022). Estimation of growth parameters and mortality rate for common carp and Prussian carp from Danube Delta *Scientific Papers. Series D. Animal Science*, *LXV*(2), 432-436.

Talet, L. B., & Talet, A. B. Age, Growth and Mortality of the Common Carp (*Cyprinus carpio)* Population in Merdja Sidi Abed Dam, Algeria. *Omni-Akuatika Journal of Fisheries and marine Research, 15*(1), 39-46.

www.fishbase.org, accessed online February, 15, 2023.