BIOMETRICAL, GRAVIMETRICAL AND BIOCHEMICAL DATA IN THREE SUMMER-OLD *CTENOPHARYNGODON IDELLA* SPECIES

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Abstract

The aim of this paper was the biometric study (total length, standard length, the head's length, the maxim height of the body, the circumference and the length of digestive tube), the gravimetric study (body's weight and digestive tube's weight) and the biochemical study (amylase and digestive proteinases activity) for three-summer old Ctenopharyngodon idella representatives, from a systematic arrangement. For biometric and gravimetric analysis were used the classical methods knew in the literature of the field, and the biochemical data were obtained through Métais-Bieth colorimetrical method, respectively, the method with the reactive Folin-Ciocalteu, all the obtained values being subsequently statistically processed and interpreted, calculating a large variety of statistical indices (the average, the error and standard deviation, the variance, the amplitude, the upper and lower limits of confidence intervals, variance coefficient and average's precision coefficient), the correlation and regression relations from a series of character pears (the standard length-body's weight, the standard length-head's length, the standard length-the height, the standard length-the digestive tube's length, the weight of the body-the digestive tube's weight), as well as possible interindividual differences or similarities with Anova test. The obtained results evidences an intense rhythm of development for the individuals of this species, between all the pairs of investigated characters existing positive correlations, the enzymatic activity at digestive tube's level being also extremely underlined.

Key words: grass carp, regression, amylase, proteinases

INTRODUCTION

Cyprinids are species known as valorizing highly various aquatic trophic resources, transforming them into good, highly assimilable meat, with a high content of proteins, vitamins (especially retinol and calcipherol, of considerable importance in preventing rachitism) and mineral salts, which makes it a valuable food for humans, the researches developed in the field evidencing that the proteic substances present in fish meat are more easily digested than those from other types of meat.

The history of the development of the *Ctenopharyngodon idella* species, as well as of the other species belonging to the Chinese complex (*Hypophthalmichthys molitrix*, *Aristichthys nobilis* and *Mylopharyngodon piceus*) begins in the X-XIth centuries, when the Chinese people first introduced this fish-growing in the Iangţî, Amur and Huangho rivers - in culture ponds. In Romania, this fish species was introduced in 1960, from China and former USSR [7].

Ctenopharyngodon idella is a herbivorous fish, characterized by a rapid growth rhythm, an important consumer of aquatic macrophytes; as its food is represented by plants, it may be successfully involved in preventing the development of undesirable aquatic plants in artificial aquatic accumulations, if considering the role it may play in controlling/diminishing both emerse or submerse vegetation masses [5].

The present paper is mainly devoted to the study of some external and internal bodily variables in three summer-old grass carp representatives from the Ţigănaşi Piscicultural Farm, district of Iaşi, starting from the known intense growing rhythm of this species, which may attain sizes between 50 - 90 cm (with a maximum of 150 cm) and a bodily weight of 45 - 50 kg [8].

MATERIALS AND METHOD

The biometric and gravimetric analyses were performed on 70, three summer-old grass carp from the Piscicultural Farm Ţigănaşi, district of Iaşi, on considering the following parameters: total length, standard length, length of the head, maximum bodily height, circumference, bodily weight, length and weight of the digestive tube [9]. All data were statistically processed and interpreted [3; 4], which permitted the calculation of numerous indices (average value, error and standard deviation of the average value, variance, range, confidence interval, coefficient of precision and of variation of the average value).

At the same time, there have been established the correlation and regression relations between a pair series of characters (standard length - bodily weight, standard length - length of the head, standard length - height, standard length of the body - length of the digestive tube, bodily weight - weight of the digestive tube). The regression straight line and the regression equation of the straight line were established, and the regression coefficient - *i.e.*, the extent to which some variable determines the increase of the other variable - was calculated, as well as the determination (R^2) coefficient (factor), known as indicating how much of the percent ratios of the values taken by the dependent variable are determined by the independent variable, and *vice versa* [10; 11].

Biochemical determinations followed the amylasic and proteinasic activity in the median part of the digestive tube in five individuals, three parallel samplings being performed for each of them. In a first stage, the intestinal content was eliminated through scraping, followed by identification of the median part (situated between the esophagus and the duodenum), weighing of the tissue samples, homogenization and extraction of enzymes, and determination of their activity by the colorimetric method, with an iodine solution and, respectively, the Folin-Ciocâlteu reactive [1; 2]. In the end, the results obtained were statistically processed by the unifactorial Anova test, assuming a comparison of the two factors (*calculated F* and *critical F*), one of the two possible hypotheses, namely: the null hypothesis (no correlation observed) and the alternative hypothesis (a correlation may be noticed) being accepted [11].

RESULTS AND DISCUSSION

In the three summer-old *Ctenopharyngodon idella* individuals taken into study, higher values of the main statistical indices (variance, deviation and standard error of the mean value) have been recorded for standard bodily length, length and weight of the intestine, as well as for bodily weight (Table I). The highest variation coefficient (27.248%) was registered for the average weight of the digestive tube, while the total average length records the lowest variation coefficient (5.577%), which indicates some interindividual uniformity.

Table I. Values of the main statistical indices of bodily variables in three summer-old *Ctenopharyngodon idella*

Statistical indices	Bodily variables							
	L (cm)	ls (cm)	lc (cm)	H (cm)	Ci (cm)	G (g)	Ltd (cm)	Gtd (g)
Average	66.6	57.76	13.54	17.86	34.3	3260	128	36
S $\overline{x}$	1.661	1.833	0.382	0.741	1.220	290.43	12.004	4.415
Median	68.5	58.5	13.5	18.3	35	3500	141	36
S (σ)	3.714	4.1	0.856	1.657	2.729	649.422	26.842	9.874
Variance	13.8	16.813	0.732	2.748	7.45	421750	720.5	97.5
Range	8.5	11	2.3	4	6.5	1550	66	24
Minimum	60	51	12.2	15	29.5	2200	90	25
Maximum	68.5	62	14.5	19	36	3750	156	49
Confidence level (95%)	4.612	5.091	1.063	2.058	3.389	806.364	33.328	12.26
SL	71.212	62.851	14.603	19.918	37.689	4066.36	161.328	48.26
IS	61.987	52.668	12.476	15.801	30.91	2453.63	94.671	23.739
VC%	5.577	7.098	6.323	9.281	7.957	19.92	20.97	27.428
m%	2.494	3.174	2.827	4.150	3.558	8.908	9.378	12.266

S $\overline{x}$ = standard error, S (σ) = standard deviation, SL = superior limit, IL = inferior limit, VC% = average variation coefficient, m% = average precision coefficient, L = total length of the body, ls = standard length, lc = length of the head, H = maximum height of the body, Ci = circumference, G = weight, Ltd = digestive tube length, Gtd = digestive tube weight

The data listed in the Table above show that the grass carp population taken into study attains a total average length of the body of 66.6 cm and a weight of 3260 g.

Starting from the average values of standard deviation, there have been calculated the limits of the confidence intervals within which one may find the real mean value of the analyzed individuals. Thus, with a 95% probability (α = 0.05), the three summer-old *Ctenopharyngodon idella* species records a standard average length between 52.668 - 62.851 cm, an average length of the head between 12.476 and 14.603 cm, an average height between 15.801 - 19.918 cm, an average circumference between 30.91 - 37.689 cm and an average bodily weight between 2453.63 and 4066.36 g, all these values agreeing with the existent literature data [8], evidencing a high and variable growing rhythm (400 - 3000 g), depending on the availability of food and also of the populating density (Table I).

Another objective of the present study followed the variation in the length and weight of the digestive tube. The biometric analysis performed showed that the three summer-old grass carps, taken over from the Ţigănaşi population, have an average length of the digestive tube equal to 128 cm, which means an about two times higher values than that of the total average bodily length, the literature of the field [5] indicating for this species a digestive tube exceeding 2-3.5 times the bodily length, which might be due to the active feeding characterizing this species, known as possibly consuming, in 24 hours, a total amount of food equal to its own bodily weight, and even more.

The following stage of the statistical analysis of the biometric and gravimetric data here considered was to establish the correlation and regression relations between the various pairs of characters. Thus, for each pair of variables in part, the Pearson index of parametric correlation was established and its significance was tested. The **calculated** values of **t** were compared to those of the **critical t**, null (no correlation) and alternative (existence of correlation) being settled, while the comparison between the values of the **calculated t** and **critical t** led to the acceptance of one of these hypotheses.

As, each time, the value of **calculated t** was higher than that of **critical t**, positive correlations have been registered between all pairs of variables taken into study. The strongest correlation was evidenced between standard length and bodily weight, the Pearson correlation index taking a value close to its maximum (r = 0.963). According to the regression coefficients calculated for these two characters, the observation was made that, at an 1 cm increase of standard bodily length, bodily weight increases with 152.664 g while, at an 1 g increase of bodily weight, it registers a increase with 0.006 cm of standard bodily length. The determination coefficient (R^2) expresses the fact that, in 92.91% of the cases (Fig.1), the values taken by the dependent variable (in this case, bodily weight) are determined by the values of the independent variable (standard length of the body).
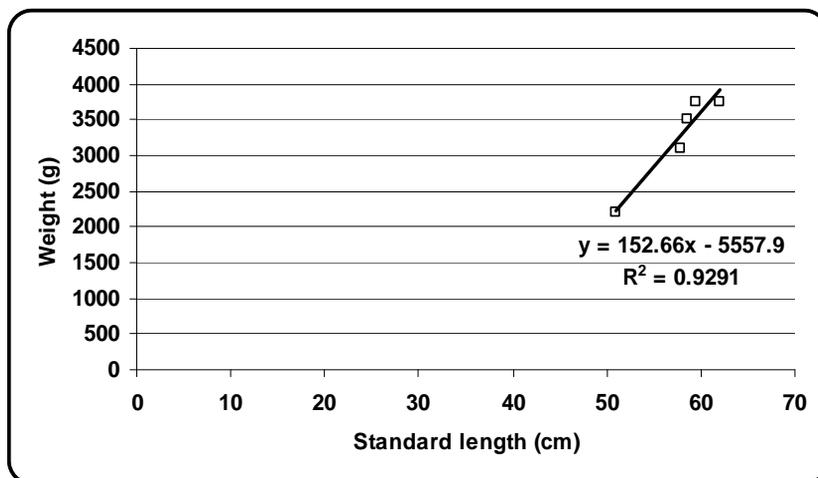

Fig.1. Graphical representation of the regression between standard bodily length and weight in three summer-old *Ctenopharyngodon idella*

As to the correlation between standard length and length of the head, Figure 2 shows that the values attained by the two variables are valid in 83.13% of the cases, the values of the calculated regression coefficients expressing that:
- at an 1 cm increase of bodily standard length, length of the head increases with 0.199 cm;
- at an 1 cm increase of the length of the head, bodily standard length increases with 4.569 cm.

A positive correlation has been also established between standard length and height of the body (r = 0.929), such a type of relation being valid in 86.4% of the cases (Fig.3). According to the regression coefficients calculated for these two characters, there results that:
- at an 1 cm increase of standard length, bodily height increases with 0.375 cm;
- at an 1 cm increase of height, standard bodily length increases with 2.299 cm.
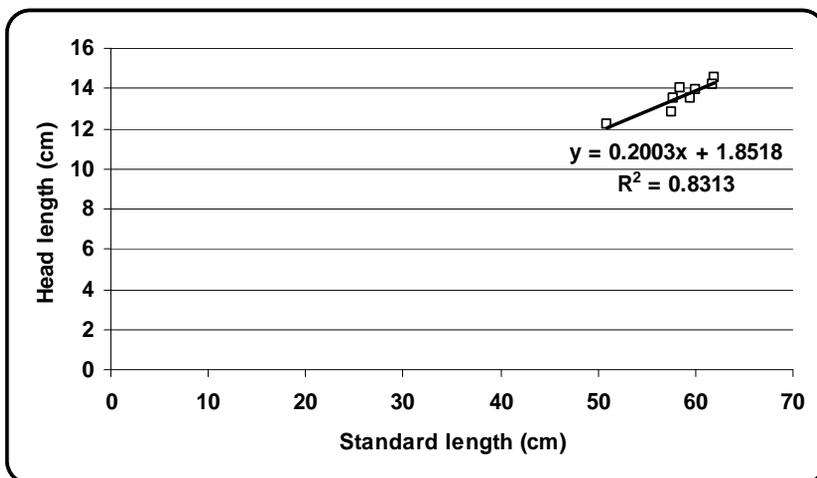

$$y = 0.2003x + 1.8518$$
$$R^2 = 0.8313$$

Fig.2. Graphical representation of the regression between standard bodily length and head length in three summer-old *Ctenopharyngodon idella*
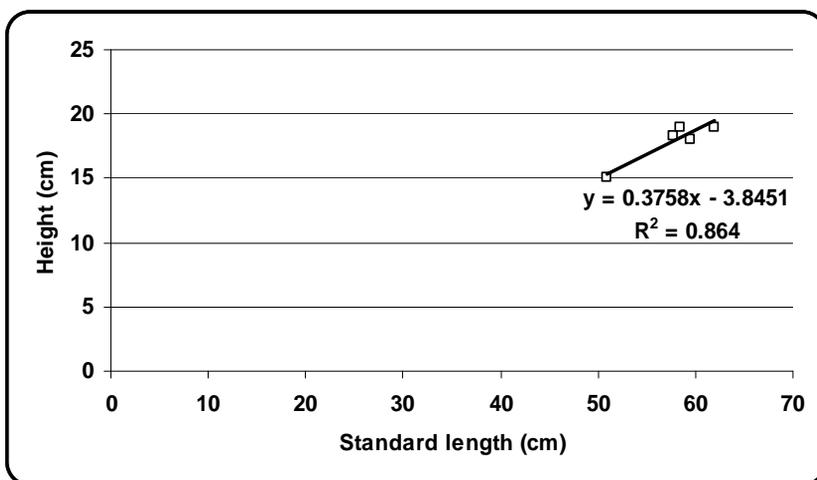

$$y = 0.3758x - 3.8451$$
$$R^2 = 0.864$$

Fig.3. Graphical representation of the regression between standard length and bodily height in three summer-old *Ctenopharyngodon idella*

The value of the Pearson correlation index between bodily standard length and length of the digestive tube was established at 0.485, the calculated regression coefficients showing that, at an 1 cm increase of bodily standard length, the length of the digestive tube increases with 3.176 cm, while an 1 cm increase in length of the finally one results a 0.074 cm increase of bodily standard length. The determination factor showed that the two variables are reciprocally determining one another in approximately 60% of the cases (Fig.4).
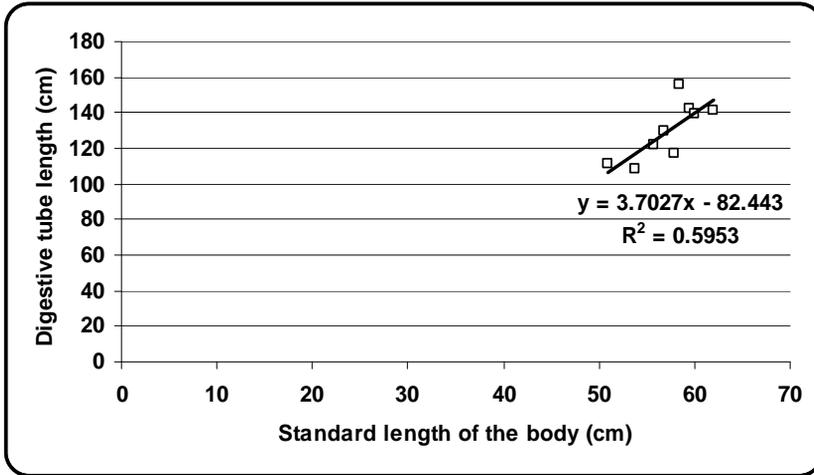

Fig.4. Graphical representation of the regression between standard length of the body and digestive tube length in three summer-old *Ctenopharyngodon idella*

Figure 5 evidences a statistically significant correlation (r = 0.808) between bodily weight and weight of the digestive tube, which is valid in 69.27% of the cases, the regression coefficients estimating that, at an 1 g increase of bodily weight, the weight of the digestive tube increases with 0.012 g, while an 1 g increase of the latter brings about an increase of bodily weight of 53.205 g.
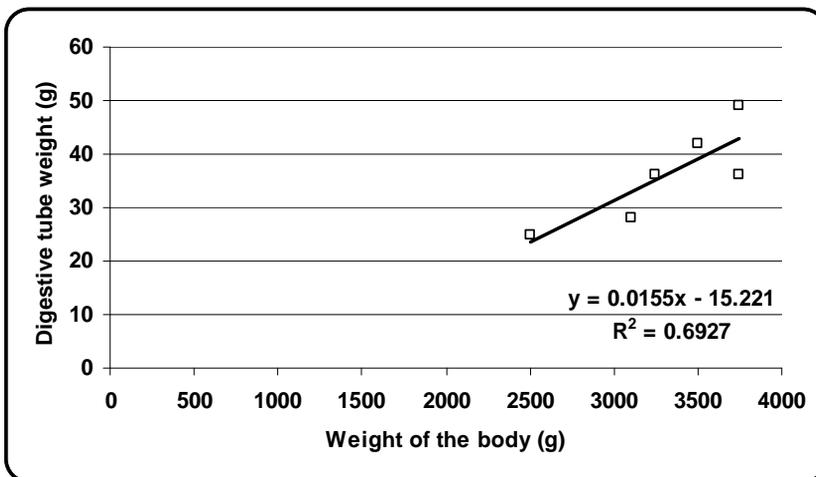

Fig.5. Graphical representation of the regression between weight of the body and digestive tube weight in three summer-old *Ctenopharyngodon idella*

The following objective of the present investigation was the activity of some intestinal enzymes involved in the metabolism of polyglucides and proteins, the nature of the food employed determining, to a certain extent, differentiation of digestive enzymes. Fish nutrition has only recently drawn the attention of specialists as a distinct discipline, until middle of the XXth century, the investigations being exclusively devoted to the anatomy of the digestive tube, some aspects on the physiology of digestion and the nutritive spectrum in some fish species from the natural environment and in very few cultured species. Beginning with the 1960, study on the nutrition requirements of fish has been considerably extended, nowadays nutrition being viewed as a domain of maximum importance, with noteworthy achievements, along with genetics, reproduction and pathology [6].

Generally, the fish growing ratio is an index that may record significant variations, among the environmental factors that may influence it in a most direct manner the first position being occupied by the availability of food. In the natural growing systems, this availability is related to the trophic biomass occurring in the ecosystem while, in aquaculture, the physiological requirements of food are met on the basis of the artificial fodder administered.

As to intestinal amylase, it registers - in the grass carp - an average activity equal to 0.5292 mg starch/30 min., while proteinases attain a value of 0.9942 nmoles Tyr/min.x ml (Fig.6).
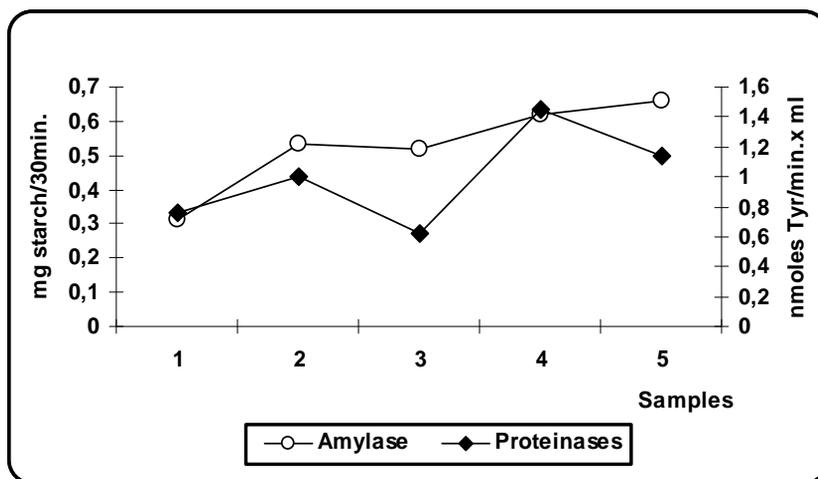

Fig.6. Amylasic and proteinasic activity from the digestive tube in three summer-old *Ctenopharyngodon idella*

Statistical processing of the experimental data made use of the unifactorial Anova test, permitting to calculate the square sums, the value of the factor, as well as its critical value (Tables II - III). In a subsequent stage, there have been established the null (no differences) and alternative (differences being observed) hypotheses of the test, while comparison between *calculated F* and *critical F* led to the acceptance of one of the two hypotheses.

Table II. Calculated and critical values of the factors of intestinal amylase activity in three summer-old *Ctenopharyngodon idella*

Source of variation	SS	g. l.	$\overline{SS}$	p	Calculated F	Critical F
Internal	15.262	1	15.262	0.008	12.122	5.317
External	10.072	8	1.259			
Total	25.334	9				

SS = squares sum, g. l. = degree of freedom, $\overline{SS}$ = mean squares sum, p = probability

Table III. Calculated and critical values of the factors of intestinal proteinasic activity in three summer-old *Ctenopharyngodon idella*

Source of variation	SS	g. l.	$\overline{SS}$	p	Calculated F	Critical F
Internal	10.057	1	10.057	0.023	7.719	5.317
External	10.422	8	1.302			
Total	20.48	9				

SS = squares sum, g. l. = degree of freedom, $\overline{SS}$ = mean squares sum, p = probability

Having in view that, in both cases, the value of ***calculated F*** (of 12.122 and 7.719, respectively) is higher than that of ***critical F*** (5.317), the accepted alternative hypothesis was the one according to which statistically significant differences do exist in the interindividual amylasic and proteinasic activity, in close correlation with the specificity and alimentary behavior of each individual in part.

CONCLUSIONS

The results of the investigations led to the following conclusions:

- All bodily variables under study oscillate between the normal limits cited in the literature for this development stage, which is closely correlated with the abundance of aquatic macrophytes.

- Analysis of the five pairs of variables permitted to evidence some positive correlation relations, the values of *calculated t* being, each time, higher than those of *critical t*, the most intense relation being noticed between standard length and bodily weight.

- In the median part of the digestive tube there has been put into evidence both amylasic and proteinasic activity, the obtained values being closely correlated, on one side, with the feeding regime of this species and, on the other, with the biochemical role of each enzyme.

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