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Morphometric Study of Fresh Water Bighead Carp *Aristichthys nobilis* from Pakistan in Relation to Body Size

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Abstract: Eighty one Farmed Bighead *Aristichthys nobilis* of different body size ranging 8.80- 47.81 cm total length and 6.86-1766.0 g body weight were used for the analysis of morphometric variable of head length, head width, dorsal fin length, body girth, body depth, tail length and width in relation to total length and body weight of the fish to investigate allometric growth. It was observed that all these relations showed very high correlations. Slopes of the log transformed data were used to compare with an isometric slope, it was found that all the parameters examined showed isometric growth in relation to either total length or body weight, growth in weight is almost proportional to the cube of its length, the values of the slope which is not consistent with cube law. Regression parameters were found to be highly significant.

Key words: *Aristichthys nobilis*, length-weight relationship, condition factor and predictive equations

INTRODUCTION

The big-head carp, *Aristichthys nobilis* is one of the important Cyprinids cultivated in the Indo-pacific region. Like silver carp in shape, belongs to the same subfamily, *Hypophthalmichthys*. This species too originated in the large river of Asia, which flow in to the pacific ocean[1-2]. Big-head carp is the natural inhabitant of the river systems Yangtze, Kwangsi, Kwangteeng and West river of South and Central China and the species has been transported into many countries in recent years[3].

The rapid growth, planktophagic food and controlled reproduction of the big-head attracted the fish culturists in many countries to regard this fish as potential candidate for efficient and profitable fish culture[2]. The big-head was imported by Fisheries Department, Punjab from China in 1989 and was kept at Fish Hatchery Islamabad since then[4].

In view of the importance of this specie, there is an urgent need to study its biology and growth performance in warm water aquaculture system of Pakistan. For present study eighty-one farmed *Aristichthys nobilis* of various sizes were sampled to study the parameters of morphometry and condition factor.

The growth in animal is considered in terms of increase in volume. The volume is represented by weight, which is related to the cube of linear dimension. It is therefor, true that a relationship exists between length (linear dimension) and weight in animal[5]. Measurement of growth as length quantify axial growth, measurement as weight quantify growth in bulk. These two categories of growth are highly correlated[6]. A fish can change its weight without changing in length or vice versa. The relationship between weight and length for fish of a given population can be analysed either by measuring weight and length of the same fish throughout their life or of a sample of fish taken at a particular time[6].The relationship between weight (W) and length (L) typically takes the allometric form: $W=aL^b$, or in the linear form: Log W=Log a+b Log L, where a and b are constants estimated by regression analysis. If fish retains the same shape it grows isometrically and the length exponent b has the value b=3.0, a value significantly larger or smaller than b=3.0 shows allometric growth[7,8]. A value less than b=3.0 shows that the fish becomes lighter for its length and if greater than b=3.0, indicates that the fish becomes heavier for its length as it grows.

The weight-length relationship provides an opportunity to calculate an index commonly used by fisheries biologists to compare the condition factor or well being of a fish[7]. This index is condition factor, (K) $K=100 \times W/L^3$. Fish with a high value of K are heavy for its length, while fish with a low K value are lighter[9].

Several studies on length-weight relationship have been carried out in other parts of the world on various fish species[10-14]. The present topic has long been neglected in

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Pakistan as even then only a few studies have been reported[15-23]. The present study is the first attempt of length-weight, condition factor and allometry of an introduced exotic fish *Aristichthys nobilis*, one of the important fish widely used for food.

MATERIAL AND METHODS

Eighty one Farmed Bighead carp *Aristichthys nobilis* of different body sizes ranging from 8.80-47.81 cm total length and 6.86-1766 g body weight were sampled from Fish Seed Hatchery, Islamabad and Fateh Jang Nursury during the month of December, 1998. Fish were selected at random and caught using a hand net. They were transported live to the laboratory in plastic containers. Fishes were killed with a blow on the head, blotted dry and body length measurement were made by using wooden measuring tray to nearest 0.1 cm and weighed to nearest 0.01 g on an electronic digital balance. Condition factor was calculated using a formula $K=100 \times W/L^3$ following the method of Weatherley and Gill[24] and Wootton[25].

Statistical analysis, including regression analysis and calculation of correlation was carried out by using a computer package Lotus 1-2-3. Zar[26].

RESULTS AND DISCUSSION

The relationship between wet body weight (W) and total length (L) is exponential having the general form $Y=aX^b$, (Fig. 1), or $W=aL^b$. Whereas, Y is independent and X is dependent variable, a is intercept and b is power. When the data is transformed in logarithmic form (Fig. 2) a linear relationship is obtained with a high correlation coefficient ($r=0.996$; $p<0.001$), having the general form.

The regression coefficient b has a value almost equal to b=3.0. The regression equation of body Weight (w) on Total Length (TL) is presented:

$$\text{Log } W=-2.403+3.320 \log TL \ (r=0.995) \ (r^2=0.992)$$

Condition factor k when plotted against total length and wet body weight, shows an increasing trend with increasing length or weight. The regression parameters of condition factor (k) on wet body weight (w) and Total Length (TL) are presented:

$$K=0.978+0.0003 \ TL \ (r=0.789) \ (r^2=0.624)$$
$$K=0.712+0.0151 \ W \ (r=0.766) \ (r^2=0.587)$$

When the data of Head Length (HL), Head Width (HW), Pectoral Fin Length (PFL), Dorsal Fin Length (DFL), Body Depth (BD), Body Girth (BG), Tail Length (TL) and Tail Width (TW) was plotted against total length and wet body weight, these relationships were found to be highly significant, though in all these cases log transformed data generated high correlation coefficient (Table 1 and 2).

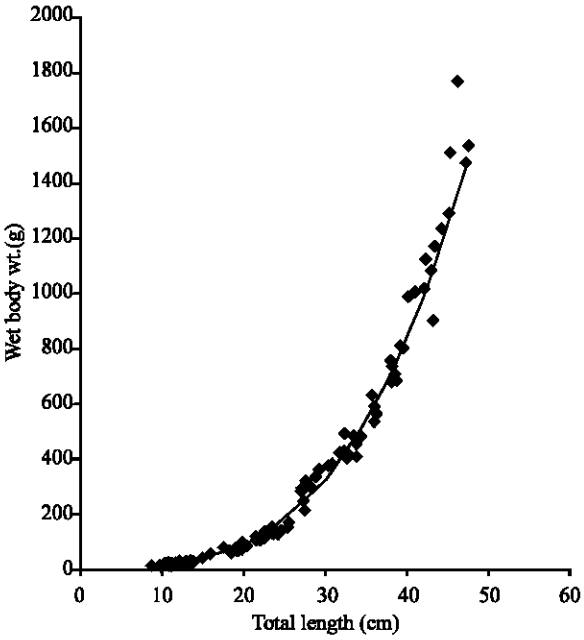

Fig. 1: Relationship between total length (cm) and wet body weight (g) in *Aristichthys nobilis*

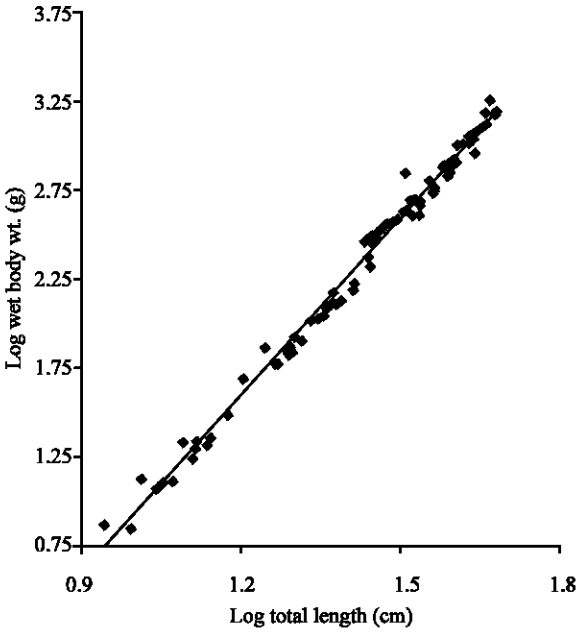

Fig. 2: Relationship between log total length (cm) and log wet body weight (g) in *Aristichthys nobilis*

Table 1: The regression parameters of various body parts in relation to Total Length (TL) and wet body weight (w) of *Aristichthys nobilis*

Regression equation	No. of observation (N)	Correlation coefficient (R)	Proportion of for by variance accounted the regression (R_2)
HL = -0.138+0.299 TL	81	0.982***	0.966
HW = 0.205+0.241 TL	81	0.789***	0.623
PFL = 0.776+0.227 TL	81	0.974***	0.950
DFL = 0.524+0.152 TL	81	0.937***	0.879
BD = -1.111+0.329 TL	81	0.980***	0.962
BG = -2.222+0.658 TL	81	0.980***	0.962
TL = 0.968+0.118 TL	81	0.733***	0.538
TW = 0.346+0.349 TL	81	0.952***	0.907
HL = 5.470+0.006 W	81	0.897***	0.805
HW = 4.521+0.006 W	81	0.786***	0.618
PFL = 3.361+0.005 W	81	0.941***	0.886
DFL = 3.506+0.003 W	81	0.781***	0.611
BD = 4.898+0.007 W	81	0.940***	0.885
BG = 9.796+0.150 W	81	0.940***	0.885
TL = 3.190+0.002 W	81	0.664***	0.441
TW = 6.837+0.008 W	81	0.882***	0.77

Head Length (HL), Head Width (HW), Pectoral Fin Length (PFL), Dorsal Fin Length (DFL), Body Depth (BD), Body Girth (BG), Tail Length (TL), Tail Width (TW), *** $p<0.001$

Research on different fish species collected from commercial as well as from natural waters show that there is a tendency for their regression coefficient (b) in the relation $W=aL^b$ to be close to or greater than b=3.0. Thus growth in many cases tends to be isometric[22] since b=3.0 for isometric growth[6]. In the present study value of b=3.32 which is significantly higher than b=3.0, showing that increase in weight was higher as compared to the cube of its length. Regression parameters were found to be highly significant (Table 3).

Condition factor (K) shows an increasing trend with increasing length and weight in the present study. The condition factor may vary with increasing length when average weight of fish does not increase in direct proportion to the cube of its length[27]. Therefore when b=3.0, K remains constant, if however the weight increase more rapidly than cube of length, the K would increase with increase in length. When weight increases less than the cube of length, K would tend to decrease with the growth of the fish[17].

The specie under study *Aristichthys nobilis* is growing faster with increasing size and violating the cube law and leads to the conclusion that the hatchery conditions are much suitable for its rearing and stocking and achieved positive allometric growth as compared to earlier study[4]. It can be concluded that this species has been well adapted in aquatic environment of Pakistan after its introduction from China.On the basis of the conclusion this species is favorably recommended for culture to the fish farming community in Pakistan.

During growth changes in size bring about changes in shape and body proportions. Allometric exponents on log-log scale relating body weight to the length of body parts is b=0.33 and body length to length of body parts b=1.0 representing isometric growth relationship[28]. In this study values of b of various relationships as given in table-II show that they are not significantly different from b=1.0 Therefore in these cases growth is isometric. The same is true for value of b when compared with isometric slope of b=0.33 are not significantly different (Table 2).

It is therefore concluded that the parameters used increase isometrically with increasing body weight and total length. The reason for isometric growth of head length, head width, pectoral fin length, dorsal find length, body depth, body girth, tail length and tail width is due to proportionate growth of theseparameters in this species maintaining symmetrical form.

Table 2: The regression parameters of various body parts in relation to Total Length (TL) and wet body Weight (W) of *Aristichthys nobilis*

Regresstion equation	No. of observation (N)	Correlation coefficient (R)	Proportion of variance accounted for by the regretion (R_2)	SE(b)	t-value when compared with b=1.00 or b= 0.33
Log HL = -0.555+1.015 Log TL	81	0.988***	0.978	0.0167	0.898^{NS}
Log HW = -0.615+0.998 Log TL	81	0.857***	0.736	0.0672	-0.029^{NS}
Log PFL = -0.844+1.095 Log TL	81	0.979***	0.959	0.0252	3.769***
Log DFL = -0.709+0.959 Log TL	81	0.933***	0.871	0.0414	-0.990^{NS}
Log BD = -0.727+1.126 Log TL	81	0.985***	0.972	0.0213	5.915***
Log BG = -0.426+1.126 Log TL	81	0.985***	0.972	0.0213	5.915***
Log TL = -0.541+0.87 Log TL	81	0.885***	0.784	0.0476	-4.044***
Log TW = -0.380+0.956 Log TL	81	0.965***	0.933	0.0287	-1.522^{NS}
Log HL = 0.186+0.303 Log W	81	0.983***	0.968	0.0061	-4.409***
Log HW = 0.116+0.296 Log W	81	0.849***	0.722	0.0206	-1.626^{NS}
Log PFL = -0.045+0.327 Log W	81	0.976***	0.953	0.0081	-0.308^{NS}
Log DFL = 0.002+0.281 Log W	81	0.913***	0.834	0.0141	-3.432***
Log BD = 0.083+0.340 Log W	81	0.993***	0.988	0.0041	2.585**
Log BG = 0.385 +0.340 Log W	81	0.993***	0.988	0.0041	2.585**
Log TL = 0.058+0.236 Log W	81	0.864***	0.748	0.0154	-6.071***
Log TW = 0.309+0.289 Log W	81	0.973***	0.948	0.0075	-5.440***

Head Length (HL), Head Width (HW), Pectoral Fin Length (PFL), Dorsal Fin Length (DFL), Body Depth (BD), Body Girth (BG), Tail Length (TL), Tail Width (TW) ***$p < 0.001$, **$p < 0.01^{NS}$ $p> 0.05$

Table 3: Length- weight relationship for different fish spectes from different localities

Fish species	Slope (b)	Reference
Labeo rohita (Immature)	3.06	[18]
Cirrhinus mrigala	3.02	[29]
Oncorhynchus mykiss	2.98	[22]
Oncorhynchus mykiss	3.12	[20]
Aristichthys nobilis	2.80	[4]
Oreochromis nilotica (Males and Females)	2.99	[19]
Oreochromis nilotica (Males)	3.10	[21]
Cyprinus carpio	3.17	[23]
Aristichthys nobilis	3.32	Present study

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