

Morphometric and Meristic Analysis of Silver Carp (*Hypophthalmichthys molitrix*) from Tanda Dam, District Kohat, Pakistan

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Abstract: A study on the morphometric characters and meristic count of Silver carp (*Hypophthalmichthys molitrix*) was conducted in Tanda Dam Kohat Pakistan during the month of January and February 2015. Meristic count (Six characters) and morphometric character (Nineteen) for each specimen were studied. 20 samples of silver carp were examined for the study of morphometric and meristic count. Some deviations, with regard to a few morphometric and meristic count have been observed. The meristic counts of pectoral fin rays were constant in all three groups, while other parameters of meristic count vary in all the groups. Dorsal fin rays in small group of silver carp were recorded 8, in medium and in large group observed 7 and the number of spines measured in small group was one spine while in medium and large having two spines. Ventral fin rays of small group have 8 rays while in medium and large having 7 with two spines. Anal fin rays of small and medium groups having 12 rays and large group have 13 rays with one spine. Caudal fin ray of small group were ranging from 21-22, medium group were observed from 20-24 and in larger group were ranging from 24-25 without any spines. The morphometric character showed gradual increase in the body length and weight increases. On the basis of meristic and morphometric characteristics, fish is identified as *Hypophthalmichthys molitrix*. Morphometric studies of *Hypophthalmichthys molitrix* in relation to body length showed that there was isometric growth pattern. Finally this study will be useful for taxonomist, fisheries biologist and manager for its sustainable management through correct identification.

Key words: *Hypophthalmichthys molitrix* • Morphometric Measurement • Meristic Count • Tanda Dam

INTRODUCTION

Fishes are one of the most important groups of vertebrates, which benefit human being in various ways. Fish is very important dietary animal protein source in human nutrition [1]. There are more than 186 freshwater fish species described from freshwater bodies of Pakistan. Substantial quantities of commercially important fish are caught from rivers annually. The inland commercially significant native fish fauna comprises about 30 species of which the economically important species are: *Labeo rohita*, *Gibelion catla*, *Cirrhinus mrigala*, *Cirrhinus sreba*, *Channa straita*, *Channa marulius*, *Speratas arwari*, *Wallago attu*, *Rita rita*, *Bagarius bagarius*,

Tenualosa ilisha, *Notopterus notopterus*, *Nemacheilus* spp., *Tor macrolepis*, *Schizothorax* spp. and *Clupisomanaziri* [2]. The most important freshwater culturable fishes of Pakistan are the major Indian carps like Rohu (*Labeo rohita*), Thaila (*Catla catla*) and Mori (*Cirrhinus mrigala*). Some exotic species such as Gulform (*Cyprinus carpio*), Grass carp (*Ctenopharyngodon idella*) and Silver carp (*Hypophthalmichthys molitrix*) are also introduced in Pakistan. In our country, suitable or common combinations of fish for composite fish culture system are *Labeo rohita*, *Catla catla* and *Cirrhinus mrigala*, where as the specific interactions among fish species are important in the sustenance of any polyculture system and much research work has been

done on the culture of these three fish species under different treatments [3]. Asian carp any of several species of fish belonging to the carp family (Cyprinidae) that are native to eastern Asia, particularly China and Russia and naturalized in some American waterways. The grass carp (*Ctenopharyngodon idella*) bighead carp (*Hypophthalmichthys nobilis*) black carp (*Mylopharyngodon piceus*) and silver carp (*Hypophthalmichthys molitrix*), following their accidental introduction into waterways in the United States, are collectively referred to as Asian carp. Bighead and silver carp were considered the most significant threat because of their overconsumption of plankton. The tools for measuring discreteness of same species are the morphometric and meristic study of fish sample. A very advantageous apparatus for research of biology, ecology, physiology, population dynamics and health management is indeed a mathematical data of length-weight relationship gained from investigation of different sexes and sizes from a specific area's meristic and morphometric counts of a sample is very important [4].

Identification of a species plays a key role for the behavioral study. Different methods are used for identification but meristic counts and morphometry are considered as earliest and authentic for the identification of species [5]. A meristic count means anything that can be counted while morphometry is external measurement of an organism [6]. Silver carp (*Hypophthalmichthys molitrix*) is in the family Cyprinidae may also be referred to as flying carp because of their tendency to jump from the water when disturbed. The silver carp was first named Valenciennes. First introduced into the United States in 1973 a fish farmer used silver carp in his Arkansas ponds to control the levels of phytoplankton. By the end of the 1970's some state, federal and private facilities as well as sewage lagoons had been stocked with silver carp. It didn't take long for silver carp to be detected in natural waters [7]. In 1980 individuals were found in natural waters. Silver carp were imported to North America in the 1970s to control algae growth in aquaculture and municipal wastewater treatment facilities. They escaped from captivity soon after their importation. They are considered a highly invasive species [8]. Silver carp are olive green in color on their dorsal side and silver on the ventral side. They have a deep, laterally compressed body and a large head. Their eyes are located near the ventral side, which makes them easily distinguishable from other carp. Both dorsal and anal fins are present, but an adipose fin is lacking. They have 1 to 3 dorsal spines, 1 to 3 anal spines, 6 to 7 soft dorsal rays and 10 to 14 soft anal rays.

The lateral line is approximately 80 to 130 scales in length. The lateral line is complete and curved ventrally with 91-124 small scales. The mouth is large, terminal and somewhat oblique. The first gill arch has more than 100 gill rakers. The rakers are thin, branched and fused into a sponge-like apparatus and specifically adapted to filter phytoplankton [9]. The pharyngeal teeth are in one row (0, 4-4, 0) with striated surface that are long and bluntly rounded. Barbels are absent. Silver carp are also characterized by a smooth ventral keel on the abdomen that runs from the anus to the gill membrane. Silver carp vary considerably in size; most are relatively small (10 to 30 cm), but some can grow as much as 1 m in length and weigh in excess of 60 pounds (27 kg) [11]. Silver carp are filter feeders, feeding primarily on phytoplankton. Using specialized gill rakers covered with a thick matrix of calcified substances, silver carp are able to filter out the very smallest organisms (Ranging in size from 8 to 100 micrometers). However, only a small part of their diet consists of zooplankton and detritus. Silver carp may also eat small arthropods and algae [11]. Silver Carp uses pump feeding and can filter smaller particles than Bighead Carp. In general, adults are phytoplanktivorous, but they are also opportunistic feeders and can consume a variety of zooplankton [12]. In 2007, Silver Carp was added to the list of injurious wildlife under the *Lacey Act* in the United States; Asian carps usually migrate upriver in response to high spring flow, releasing eggs to float downstream into nursery habitats as they develop and hatch after about 35 hours [13]. Asian carp eggs exhibit low densities and are semi buoyant; they require a discernible current that creates turbulence to prevent them from sinking to the bottom. Silver carp are mature after 3 years and are mature enough to breed and will breed until their max age of 10 years old. Spawning occurs anytime between April and September when the temperature is between 18-20 degrees Celsius. They migrate up stream to breed in groups of 15 to 20. They need water with some current so the eggs and larvae can float downstream. Eggs of silver carp reach maturity when they are about 3.2 to 4.7 mm in size. Young enter the larval stage about 68 hours after hatching. During the larval stage, fry are vulnerable and inefficient feeders. After about 5 months, fry have grown to a size of 8 to 12 cm in body length and have become more efficient feeders. Silver carp reach maturity at 4 to 6 years of age, at which point they are capable of reproduction [14]. Silver carp generally reproduce during the spring or summer. Reproduction is primarily cued by increased water temperature. Like other species of carp, silver carp participate in broadcast Spawning. During

spawning, a female releases eggs and males fertilize them within the water column. A single female can carry as many as 2 million eggs [15]. It are frequently seen that in any group of animals' large and small forms differ notably in the relative size of various organs or parts. Morphometrics is the quantitative analysis of organism shape and integral component in evolutionary ecology and developmental studies in Biology. The aim of research work was to find out the morphometrics character of silver carp collected from tanda dam Kohat.

MATERIALS AND METHODS

Study Area: Tanda Dam which is a small dam located in Kohat District, Khyber Pakhtunkhwa Province of Pakistan (Fig. 1). Which forms the Tanda Lake, was designated a Ramsar site on July 23, 1976. The dam is for irrigation purposes, fisheries and picnic. The site comprises a small water storage area in semi-arid hills in the catchments of the Kohat Toi River. Although most of the shoreline is steep, stony and devoid of aquatic vegetation, at the west end there are some areas of gently shelving muddy shores with a small amount of emergent vegetation.

Tanda Dam Reservoir: The reservoir of Tanda Dam (Fig. 1) receives a number of winter and passage migrants including Black Storks, grey herons, egrets, tufted duck, coot too name but a few. It has been named a RAMSAR site, as it's considered an important wetland for passage migrants especially who stop off here. Local wildlife specialists are also trying to encourage Cranes to use this site as they fly over this way and stop over on a nearby river where many are trapped.

Fish Sampling: Samples of Silver Carp were collected from Tanda Dam Kohat during the month of January and February 2014. Twenty samples of specie are collected from Tanda Dam. Sampled silver specimens were carried to laboratory in fresh form and morphologic measurements and meristic counts have been done and data were noted. Measuring and counts have been done on standard methods. The body component measurements were done by scale and weights were determined by digital scale. Relative morphometric measurements (The proportion to fork length) and meristic counts data were set and processed and their Ranges, averages and standard deviations were prepared using SPSS software. In laboratory, 19 morphometric and 6 meristic characters of each fish sample were made in the present study. Morphometric characters including forked



Fig. 1: Map of Tanda Dam

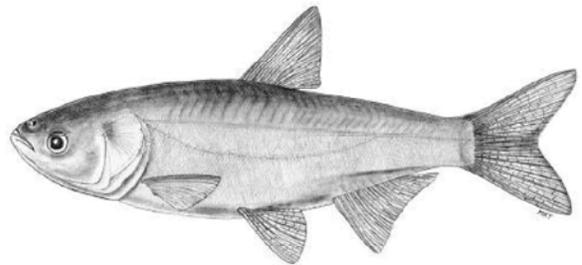


Fig. 2: Silver carp

length (FL), standard length (SL), head length (HL), body depth (d), eye diameter (ed), dorsal-fin height (DFH), dorsal-fin base length (DFL), pectoral-fin height (PFH), pectoral-fin length (PFL), pelvic-fin height (VFH), pelvic-fin length (VFL), anal-fin height (AFH), anal-fin length (AFL), caudal peduncle length (CPL), caudal peduncle depth (CPd). All above morphometric measurements were in centimeters and counts for two dorsal, pectoral, pelvic and anal fin rays and scales were from the both sides of each fish sample.

Silver carp sampling was done from Feb. 2014 to Mar. 2014 in Tanda Dam, Kohat, Pakistan. This sampling was done by the help of commercial fishermen. 20 silver carp fishes of variable size were collected from Tanda dam for present study. The morphometric and meristic characters were analyzed in the laboratory and were done with the help of measuring tray, scales and vernier caliper. Different measurements of both morphometric and meristic characters were taken. All characters were measured in centimeter and weighted on electric balance in gram. The fishes were categorized into three groups i.e. small, medium and large accordingly on the basis of their total length and the acronym of the body parameters to be intended (Figure 2).

Morphometric and Meristic Data: In laboratory, 19 morphometric and 6 meristic characters of each fish sample were made in the present study. Study of morphometric and meristic characters follows the methods

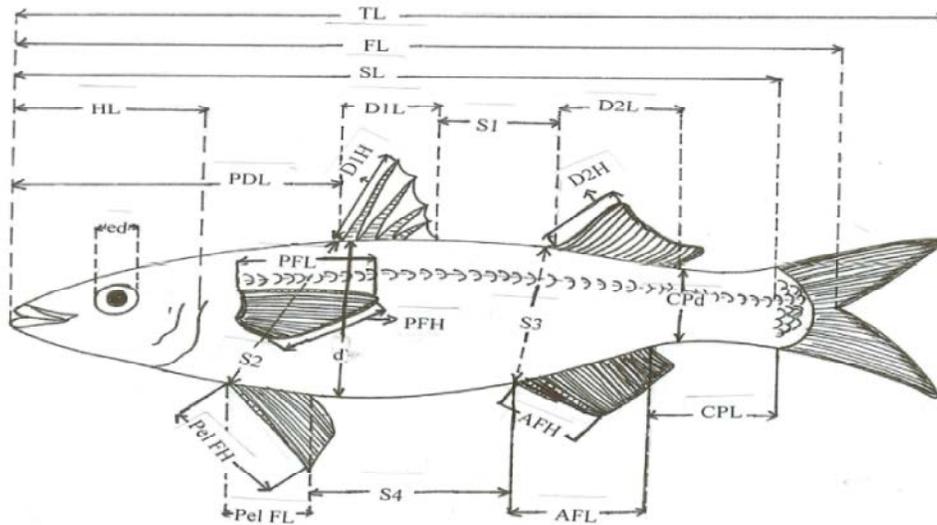


Fig. 3: Measurements of the Different Morphometric and meristic Parameters of Fish

of Gharaei [3] with slight modifications. Morphometric characters including forked length (FL), standard length (SL), head length (HL), body depth (BD), eye diameter (ED), dorsal-fin height (DFH), dorsal-fin base length (DFBL), pectoral-fin height (PFH), pectoral-fin base length (PFBL), pelvic-fin height (PeFH), pelvic-fin base length (PeFBL), anal-fin height (AFH), anal-fin base length (AFBL), dorsal spine length (DSL), anal spine length (ASL), caudal peduncle length (CPL), caudal peduncle depth (CPD). All above morphometric measurements were in centimeters and counts for dorsal, pectoral, pelvic and anal fin rays and scales were from the both sides of each fish sample (Figures 3).

Morphometric Characters: Anal fin base length (AFBL), Anal fin height (AFH), Anal fin spine length (AFSL), Body depth (BD), Caudal fin depth (CFD), Caudal fin length (CFL), Caudal peduncle depth (CPD), Caudal peduncle length (CPL), Dorsal fin base length (DFBL), Dorsal fin height (DFH), Dorsal fin spine length (DFSL), Eye diameter (WD), Fork length (FL), Head length (HL), Pectoral fin base length (PFBL), Pectoral fin height (PFH), Pelvic fin base length (PeFBL), Pelvic fin height (PeFH), Standard length (SL), Total length (TL), Weight of fish (WF).

Meristic Characters: Anal fin rays (AFR), Dorsal fin rays (DFR), Dorsal fin spine (DFS), Lateral line scales (LLS), Pectoral fin rays (PFR), Ventral fin ray (VFR).

Measurements of Morphometric Characters: Each species was identified in the field as well as in laboratory

by using field guide and after identification the fishes were immediately preserved in 10% formaldehyde solution that stored in 70% ethanol for long term preservation.

Total Length: It was measured from the tip of the snout to the tip of the caudal fin, i.e. the greatest distance between the most anterior projecting parts of the head to the posterior most tip of the caudal fin. The measurement was a straight line and should not be taken over the curves of the body.

Standard Length: It was measured from the tip of the snout to the base of the caudal fin. It was straight distance from the anterior most part of the head to the end of the vertebral column/caudal peduncle.

Head Length: It was a straight measurement of the distance from the tip of the mouth or snout to the most distant point on the opercular membrane.

Body Depth: It was measured along the vertical line at the deepest part. It was the vertical measurement from a point on the body of the fish on its back when its height was greatest to a straight line to the ventral most surface or profile. It needs not necessarily to be in the middle of the fish.

Caudal Peduncle Length: It was measured from the posterior base of fin to the base of caudal fin, i.e. from the last point of contact of anal fin posterior to the end of the vertebral column or the flexure line of the body.

Caudal Peduncle Height: It was measured along the vertical line at its narrowest part i.e., the least vertical distance from the dorsal to ventral profile at the narrowest part of the caudal peduncle was a straight measurement.

Dorsal Fin and Anal Fin Height: It was measured from the anterior point junction with the body to the anterior tip of the fin where the other ray did not reach.

Dorsal & Anal Fin Base Length: It was the distance measured in a straight line between the anterior most and posterior most junctions with the body.

Length of Pectoral and Pelvic Fin: It was the distance between the origin and place of insertion into the body to the extreme tip.

Eye Diameter: It was the maximum diameter cover by the eye.

RESULTS AND DISCUSSION

Length of Different Groups of Silver Carp: Size of different groups of silver carp measured in (cm). Small group of fishes were in the range of 35-39 cm, Medium group were measured within range of 39-43 cm and large group were in the range of 43.2-47.

Weight of Different Groups of Silver Carp: Small group fish's weight in (gm) was ranging from 430-650. Medium group fishes weight ranging from 650-804 and large group fish's weight ranging from 804-1000.

Range of Body Length (cm) and Body Weight (g): The body size of different group of silver carp measured in (cm). Small group fishes were ranging from 35-39 and was having mean value of 36.700 while body weight in (g) was ranging from 430-650 with mean value 505.60, body size of medium fishes was ranging from 39-43 and was having mean value of 41.038 while body weight in (g) was ranging from 650-804 with mean value 734.00, body size of large group fishes was ranging from 43.2-47 with mean value of 45.100 while body weight in (g) was ranging from 804-1000 with mean value of 947.14.

Morphometric Character of Silver Carp

Anal Fin Base Length: Anal fin base length mean, median and standard deviation is expressed as centimeter of standard length of small 4.6600, 4.5000, 0.4722; medium 5.8875, 5.9000, 0.0991 and large 6.2429, 6.500, 0.5533 respectively.

Table 1: Length of different groups of silver carp

Groups	Length (cm)
Small	35-39
Medium	39-43
Large	43.2-47

Table 2: Weight of different groups of silver carp

Group	Weight (gm)
Small	430-650
Medium	650-804
Large	804-1000

Table 3: Range of body length (cm) and body weight (g) of silver carp (*Hypophthalmichthys molitrix*)

	Body Length (cm)		Body Weight(g)	
	Mean	Range	Mean	Range
Group I	36.700	35-39	505.60	430-650
Group II	41.038	39-43	734.00	650-804
Group III	45.100	43.2-47	947.14	800-1000

Anal Fin Height: Anal fin height mean, median and standard deviation is expressed as centimeter of standard length of small 3.5200, 3.5000, 0.3564; medium 4.2875, 4.4000, 0.2295 and large 4.7857, 5.00, 0.3436 respectively.

Body Depth: Body depth mean, median and standard deviation is expressed as centimeter of standard length of small 9.6000, 9.5000, 0.2236; medium 10.925, 11.000, 0.7086 and large 11.743, 11.500, 1.0228 respectively.

Caudal Fin Length: Caudal fin length mean, median and standard deviation is expressed as centimeter of standard length of small 4.3400, 4.4000, 0.2408; medium 4.7625, 4.8000, 0.2387 and large 5.4429, 5.5000, 0.3359 respectively.

Caudal Fin Height: Caudal fin height mean, median and standard deviation is expressed as centimeter of standard length of small 7.5600, 7.5000, 0.5550; medium 8.5500, 8.5500, 0.2563 and large 9.0714, 8.8000, 0.6264 respectively.

Caudal Peduncle Length: Caudle peduncle length mean, median and standard deviation is expressed as centimeter of standard length of small 11.060, 11.500, 0.9839; medium 13.500, 13.500, 0.8452 and large 15.786, 16.000, 0.8591 respectively.

Caudal Peduncle Height: Caudal peduncle height mean, median and standard deviation is expressed as centimeter of standard length of small 3.5200, 3.6000, 0.5020; medium 4.1875, 4.1000, 0.2232 and large 4.6857, 5.0000, 0.4562 respectively.

Dorsal Fin Base Length: Dorsal fin base length mean, median and standard deviation is expressed as centimeter of standard length of small 3.0400, 3.00, 0.0894; medium 3.4500, 3.5000, 0.2390 and large 4.0429, 3.8000, 0.5255 respectively.

Dorsal Fin Height: Dorsal fin height mean, median and standard deviation is expressed as centimeter of standard length of small 5.5400, 5.5000, 0.3647; medium 6.4875, 6.5000, 0.2532 and large 7.1000, 7.0000, 0.2944 respectively.

Eye Diameter: Eye diameter mean, median and standard deviation is expressed as centimeter of standard length of small 1.5800, 1.5000, 0.1789; medium 1.6875, 1.7000, 0.1246 and large 1.7429, 1.8000, 0.1272 respectively.

Fork Length: Fork length mean, median and standard deviation is expressed as centimeter of standard length of small 32.000, 31.500, 1.4577; medium 36.212, 35.250, 1.9504 and large 40.571, 40.500, 1.7423 respectively.

Head Length: Head length mean, median and standard deviation is expressed as centimeter of standard length of small 8.0000, 7.5000, 0.8660; medium 9.2375, 9.4500, 0.5927 and large 10.100, 10.000, 0.5354 respectively.

Pectoral Fin Length: Pectoral fin length mean, median and standard deviation is expressed as centimeter of standard length of small 1.9800, 2.0000, 0.3564; medium 2.6500, 2.5000, 0.8552 and large 2.2429, 2.2000, 0.2573 respectively.

Pectoral Fin Height: Pectoral fin height mean, median and standard deviation is expressed as centimeter of standard length of small 5.5800, 5.5000, 0.2490; medium 6.8500, 6.7000, 0.3546 and large 7.7143, 7.8000, 0.4100 respectively.

Standard Length: Standard length mean, median and standard deviation is expressed as centimeter of standard length of small 30.000, 29.500, 1.1726; medium 33.438, 33.100, 1.1401 and large 36.843, 37.000, 1.1297 respectively.

Total Length: Total length mean, median and standard deviation is expressed as centimeter of standard length of small 36.700, 36.500, 1.4832; medium 41.038, 40.900, 1.2212 and large 45.100, 45.000, 1.2530 respectively.

Ventral Fin Length: Ventral fin length mean, median and standard deviation is expressed as centimeter of standard length of small 1.2600, 1.2000, 0.1949; medium 1.6250, 1.4000, 0.4621 and large 1.3714, 1.4000, 0.1380 respectively.

Ventral Fin Height: Ventral fin height mean, median and standard deviation is expressed as centimeter of standard length of small 4.4400, 4.5000, 0.3782; medium 5.6500, 5.5000, 0.9914 and large 6.0833, 6.0000, 0.2041 respectively.

Weight of Preserved Specimen: Weight of preserved specimen mean, median and standard deviation is expressed as centimeter of standard length of small 505.60, 480.00, 84.657; medium 734.00, 719.00, 52.208 and large 947.14, 980.00, 74.546 respectively.

Range of Morphometric Character of Silver Carp (*Hypophthalmichthys molitrix*)

Small Group

Morphometry: The result obtained from morphometric measurement of silver carp are presented in table and summarized below.

Anal Fin Length: The mean value of anal fin base expressed in centimeter of standard length was 4.6600 with the range of 4.4-5.5.

Anal Fin Height: The mean value of anal fin height expressed in centimeter of standard length was 3.5200 with the range of 3-4.

Body Depth: The mean value of body depth expressed in centimeter of standard length was 9.6000 with a range of 9.5-10

Caudal Fin Length: The mean value of caudal fin length expressed in centimeter of standard length was 4.3400 with a range of 4-4.6.

Caudal Fin Height: The mean value of caudal fin height expressed in centimeter of standard length was 7.5600 with a range of 6.7-8.1.

Caudal Peduncle Height: The mean value of height of caudal peduncle expressed in centimeter of standard length was 3.5200 with a range of 3-4.

Caudal Peduncle Length: The mean value of length of caudal peduncle expressed in centimeter of standard length was 11.060 with a range of 10-12.

Dorsal Fin Length: The mean value of dorsal fin length expressed in centimeter of standard length was 3.0400 with range of 3-3.2.

Table 4: Statistical analysis of morphometric characters in different length groups of silver carp fish (*Hypophthalmichthys molitrix*) from the Tanda dam of Kohat District

Measurement (cm)	Length Group 1			Length Group 2			Length Group 3		
	Mean	Median	Standard Deviation	Mean	Median	Standard Deviation	Mean	Median	Standard Deviation
AFL	4.6600	4.5000	0.4722	5.8875	5.9000	0.0991	6.2429	6.5000	0.5533
AFH	3.5200	3.5000	0.3564	4.2875	4.4000	0.2295	4.7857	5.0000	0.3436
BD	9.6000	9.5000	0.2236	10.925	11.000	0.7086	11.743	11.500	1.0228
CFL	4.3400	4.4000	0.2408	4.7625	4.8000	0.2387	5.4429	5.5000	0.3359
CFH	7.5600	7.5000	0.5550	8.5500	8.5500	0.2563	9.0714	8.8000	0.6264
CPL	11.060	11.500	0.9839	13.500	13.500	0.8452	15.786	16.000	0.8591
CPH	3.5200	3.6000	0.5020	4.1875	4.1000	0.2232	4.6857	5.0000	0.4562
DFL	3.0400	3.0000	0.0894	3.4500	3.5000	0.2390	4.0429	3.8000	0.5255
DFH	5.5400	5.5000	0.3647	6.4875	6.5000	0.2532	7.1000	7.0000	0.2944
ED	1.5800	1.5000	0.1789	1.6875	1.7000	0.1246	1.7429	1.8000	0.1272
FL	32.000	31.500	1.4577	36.212	35.250	1.9504	40.571	40.500	1.7423
HL	8.0000	7.5000	0.8660	9.2375	9.4500	0.5927	10.100	10.000	0.5354
PFL	1.9800	2.0000	0.3564	2.6500	2.5000	0.8552	2.2429	2.2000	0.2573
PFH	5.5800	5.5000	0.2490	6.8500	6.7000	0.3546	7.7143	7.8000	0.4100
SL	30.000	29.500	1.1726	33.438	33.100	1.1401	36.843	37.000	1.1297
TL	36.700	36.500	1.4832	41.038	40.900	1.2212	45.100	45.000	1.2530
VFL	1.2600	1.2000	0.1949	1.6250	1.4000	0.4621	1.3714	1.4000	0.1380
VFH	4.4400	4.5000	0.3782	5.6500	5.5000	0.9914	6.0833	6.0000	0.2041
WPS	505.60	480.00	84.657	734.00	719.00	52.208	947.14	980.00	74.546

Table 5: Range of morphometric character of silver carp *Hypophthalmichthys molitrix*

Measurement	Mean (Length Group I)	Range	Mean (length Group II)	Range	Mean (Length Group III)	Range
AFL	4.6600	4.4-5.5	5.8875	5.7-6	6.2429	5.3-7
AFH	3.5200	3-4	4.2875	3.9-4.5	4.7857	4.3-5.2
BD	9.6000	9.5-10	10.925	9.5-10	11.743	10.5-13
CFL	4.3400	4-4.6	4.7625	4-4.6	5.4429	5-5.9
CFH	7.5600	6.7-8.1	8.5500	6.7-8.1	9.0714	8.5-10
CPL	11.060	3-4	13.500	10-12	15.786	14.5-17
CPH	3.5200	3-4	4.1875	3-4	4.6857	3.8-5
DFL	3.0400	3-3.2	3.4500	3-3.2	4.0429	3.5-3.8
DFH	5.5400	5-6	6.4875	5-6	7.1000	6.7-7.5
ED	1.5800	1.5-1.9	1.6875	1.5-1.9	1.7429	1.5-1.8
FL	32.000	31-34.5	36.212	34.2-39	40.571	37.5-43
HL	8.0000	7.5-8	9.2375	8-10	10.100	9.5-11
PFL	1.9800	1.5-2.5	2.6500	1.7-3.7	2.2429	1.9-2.5
PFH	5.5800	5.4-6	6.8500	6.5-7.5	7.7143	7-8.2
SL	30.000	29.5-32	33.438	32.5-36	36.843	34.7-38
TL	36.700	35-39	41.038	39-43	45.100	43.2-47
VFL	1.2600	1-1.5	1.6250	1.2-2.5	1.3714	1.2-1.5
VFH	4.4400	4-5	5.6500	4.4-7	6.0833	6-6.5
WPS	505.60	430-650	734.00	650-804	947.14	800-1000

Dorsal Fin Height: The mean value of dorsal fin height expressed in centimeter of standard length was 5.5400 with a range of 5-6.

Eye Diameter: The mean value of eye diameter expressed in centimeter of head length was 1.5800 with range of 1.5-1.9.

Fork Length: The mean value of fork length is expressed in centimeter of standard length were 32.000 with range of 31-34.5.

Head Length: The mean value of head length expressed in percentage of standard length was 8.0000 with a range of 7.5-8.

Pectoral Fin Length: The mean value of pectoral fin length is expressed in centimeter of standard length was 1.9800 with a range of 1.5-2.5.

Pectoral Fin Height: The mean value of pectoral fin height is expressed in centimeter of standard length were 5.5800 with a range of 5.4-6.

Standard Length: The mean of standard length is expressed in centimeter were 30.000 with range of 29.5-32.

Total Length: The mean value of total length is expressed in centimeter of standard length were 36.700 with range of 35-39.

Ventral Fin Length: The mean value of ventral fin length is expressed in centimeter of standard length was 1.2600 with range of 1-1.5.

Ventral Fin Height: The mean value of ventral fin height is expressed in centimeter of standard length were 4.4400 with a range of 4-5.

Weight of Preserved Specimen: The mean value of weight of preserved specimen is expressed in grams was 505.60 grams with range of 430-650 grams.

Medium Group

Morphometry: The result obtained from morphometric measurement of silver carp are presented in Table 4 and 5 and summarized below.

Anal Fin Length: The mean value of anal fin length expressed in centimeter of standard length was 5.8875 with the range of 5.7-6.

Anal Fin Height: The mean value of anal fin height expressed in centimeter of standard length was 4.2875 with a range of 3.9-4.5.

Body Depth: The mean value of body depth expressed in centimeter of standard length was 10.925 with a range of 10-11.9.

Caudal Fin Length: The mean value of caudal fin length expressed in centimeter of standard length was 4.7625 with a range of 4.5-5.

Caudal Fin Height: The mean value of caudal fin height expressed in centimeter of standard length was 8.5500 with a range of 8-8.8.

Caudal Peduncle Length: The mean value of caudal peduncle length was expressed in centimeter of standard length were 13.500 with a range of 12-15.

Caudal Peduncle Height: The mean value of caudal peduncle height was expressed in centimeter of standard length were 4.1875 with a range of 4-4.5.

Dorsal Fin Length: The mean value of dorsal fin length expressed in centimeter of standard length was 3.4500 with the range of 3-3.7.

Dorsal Fin Height: The mean value of dorsal fin height obtained in centimeter of standard length was 6.4875 with a range of 6.2-7.

Eye Diameter: The mean value of eye diameter expressed in centimeter of head length was 1.6875 with range of 1.5-1.9.

Fork Length: The mean value of fork length is expressed in centimeter of standard length were 36.212 with range of 34.2-39.

Head Length: The mean value of head length expressed in centimeter of standard length was 9.2375 with a range of 8-10.

Pectoral Fin Length: The mean value of pectoral fin length is expressed as centimeter of standard length was 2.6500 with a range of 1.7-3.7.

Pectoral Fin Height: The mean value of pectoral fin height is expressed in centimeter of standard length were 6.8500 with a range of 6.5-7.5.

Standard Length: The mean of standard length is expressed in centimeter were 33.438 with range of 32.5-36.

Total Length: The mean value of total length is expressed in centimeter of standard length were 41.038 with the range of 39-43.

Ventral Fin Length: The mean value of ventral fin length is expressed in centimeter of standard length was 1.6250 with range of 1.2-2.5.

Ventral Fin Height: The mean value of ventral fin height is expressed in centimeter of standard length were 5.6500 with a range of 4.4-7.

Weight of Preserved Specimen: The mean value of weight of preserved specimen is expressed in grams of standard length were 734.00 with the range of 650-804.

Large Group

Morphometry: The result obtained from morphometric measurement of silver carp are presented in table 4, 5 and summarized above.

Anal Fin Length: The mean value of anal fin base expressed of standard length was 6.2429 with the range of 5.3-7.

Anal Fin Height: The mean value of anal fin height expressed in centimeter of standard length was 4.7857 with a range of 4.3-5.2.

Body Depth: The mean value of body depth expressed in centimeter of standard length was 11.743 with a range of 10.5-13.

Caudal Fin Length: The mean value of caudal fin length expressed in centimeter of standard length was 5.4429 with a range of 5-5.9.

Caudal Fin Height: The mean value of caudal fin height expressed in centimeter of standard length was 9.0714 with a range of 8.5-10.

Caudal Peduncle Length: The mean value caudal peduncle length expressed in centimeter of standard length was 15.786 with a range of 14.5-17.

Caudal Peduncle Height: The mean value of caudal peduncle height expressed in centimeter of standard length was 4.6857 with a range of 3.8-5.

Dorsal Fin Length: The mean value of dorsal fin length expressed in centimeter of standard length was 4.0429 with a range of 3.5-3.8.

Dorsal Fin Height: The mean value of dorsal fin height expressed in centimeter of standard length was 7.1000 with a range of 6.7-7.5.

Eye Diameter: The mean value of eye diameter expressed in centimeter of head length was 1.7429 with range of 1.5-1.8.

Fork Length: The mean value of fork length is expressed in centimeter of standard length were 40.571 with range of 37.5-43.

Head Length: The mean value of head length expressed in centimeter of standard length was 10.100 with a range of 9.5-11.

Pectoral Fin Length: The mean value of pectoral fin length is expressed in centimeter of standard length were 2.2429 with a range of 1.9-2.5.

Table 6: Meristic characters of Silver carp (*Hypophthalmichthys molitrix*)

Meristic Character	Length group I	Length group II	Length group III
Lateral line scales	124-129	103-128	113-117
Dorsal fin rays	I+8	II+7	II+7
Pectoral fin rays	I+16	I+16	I+16
Ventral fin rays	8	I+7	I+7
Anal fin rays	I+12	I+12	I+13
Caudal fin rays	21-22	20-24	24-25

Pectoral Fin Height: The mean value of pectoral fin height is expressed in centimeter of standard length were 7.7143 with a range of 7-8.2.

Standard Length: The mean of standard length is expressed in centimeter was 36.843 with range of 34.7-38.

Total Length: The mean value of total length is expressed in centimeter of standard length were 45.100 with a range of 43-47.

Ventral Fin Length: The mean value of ventral fin length is expressed in centimeter of standard length was 1.3714 with range of 1.2-1.5.

Ventral Fin Height: The mean value of ventral fin height is expressed in centimeter of standard length were 6.0833 with a range of 6-6.5.

Weight of Preserved Specimen: The mean value of weight of preserved specimen is expressed grams of standard length were 947.14 with a range of 800-1000.

Meristic Characters of Silver Carp (*Hypophthalmichthys molitrix*): Meristic character of silver carp recorded in number, out of which lateral line scales of small group were ranging from 124-129, in medium group were ranging from 103-128 and in large group were ranging from 113-117 in number. Dorsal fin rays in small group of silver carp were recorded 8, in medium and in large group observed 7 and the number of spines measured in small group was one spine while in medium and large having two spines. 16 Pectoral fin rays are present in all groups of species with one spine. Ventral fin rays of small group have 8 rays while in medium and large having 7 with two spines. Anal fin rays of small and medium groups having 12 rays and large group have 13 rays with one spine. Caudal fin ray of small group were ranging from 21-22, medium group were observed from 20-24 and in larger group were ranging from 24-25 without any spines. All of the above finding shows that in some aspects silver carp showed similarities

while in some count they showed variation in all group of fishes, such variation are due to difference in growth rate, size and age of the fishes.

DISCUSSION

Silver carp (*Hypophthalmichthys molitrix*) is a species of freshwater cyprinid fish. It is cultivated in China, from different pounds more silver carp were produced worldwide in aquaculture than any other species. Silver carp transported in Pakistan through connected water ways with china. The most common reason for importation from china was that silver carp more frequently used in aquaculture. Apart from this silver carp also enhance wild fisheries department of Pakistan. Silver carp reaches an average length of 60 to 100 cm with a maximum of 140 cm and about 45 kg weight Wikipedia [16]. In our present study which focus on morphometric and meristic count of this fish because there was no previous work done on these aspect from Tanda Dam Kohat. Fishes can quickly adapt themselves by changing necessary morphometrics because they show great sensitivity to environmental fluctuations. It is distinguished that in response to differences in environmental conditions the morphological characters can show high flexibility, these environmental conditions includes temperature and food abundance. In general, fish make obvious variations in morphological traits both between and within populations than any other vertebrates in the world and they were more vulnerable to environmentally induced morphological variations. They have adopted very high phenotypic plasticity. By modifying their behavior and physiology these are the environmental changes to which they adapt quickly. These modifications which were adopted by the fish ultimately change their morphology [17]. A total of 20 specimens of silver carp of different size and weights were studied for morphometric and meristic studies. 19 morphometric and 6 meristic characters. Examination of both morphometric and meristic character were useful for the identification and phylogenetic analysis of silver carp in Pakistan. Morphometric character of different body regions and different body size were most useful for identification and classification. Our main purpose of the study was to determine morphometric and meristic haracter which include multivariate analysis of external anatomical characteristics of silver carp. Among morphometric characteristics the length of different body parameters increases with the increase in body length and age. On the basis of body length we had divided our

experimental species into three groups that was small, medium and large. All the morphometric parameters are considered to the best discriminative characters for the correct identification and classification of silver carp in Khyber Pakhtunkhwa Pakistan. Growth of all morphometric parameters was found to be linear fashion in relation to the increase in total length. The meristic count including LLS, AFR, DFR, PFR, VFR and CFR were counted and are presented in table 4 and 5 Since all the parameters are not constant in all the length groups of fish with different body length. Some are constant and some show deviation it means that some meristic counts are independent of body length [18]. Though several methods have been used for the identification of fish, but morphometric and meristic characters were considered as most primitive and authentic methods that had been mostly used in fish biology to calculate the discreteness and relations between various taxonomic categories. However meristic data have more advantages over morphometric data, because most meristic counts can be easily measured from live fish without killing it. In present study meristic counts of pectoral fin rays in all specimens having different length remained same, while dorsal and pelvic fin ray vary in number in all specimen and anal fin ray, caudal fin ray and lateral line scales were not same in different fishes of different length and size. So some meristic counts were independent of body size and few were dependent of body size. while there was no variation in few meristic counts with increase in body length. Among meristic counts pectoral fin rays were 16 and were constant in all specimens, dorsal and pelvic/ventral fin rays were 7-8 in number whereas anal fin rays, caudal fin rays and lateral line scales were` 12-13, 21-25 and 103-129. Lateral line has more scales in small groups than in large groups.

Our present study latter could helpful to the students of fisheries, fisheries biologist and taxonomist for the correct identification and classification of silver carp exist in various location of Pakistan.

CONCLUSION

Silver carp (*Hypophthalmichthys molitrix*) is a species of family cyprinidae and as also known to be a flying carp due to its ability of jumping when disturbed. It is important culturable fish that's why it is important in aquaculture. We had collected the samples of our specie silver carp from Tanda Dam, which is located in district Kohat Khyber Pakhtunkhwa, Pakistan and samples were collected by the help of local fisherman through net.

We worked on the morphometry and meristic counts of silver carp. For our research work we use 20 samples of silver carp and divided them into three groups on the basis of their size that were small, medium and large. We determined morphometric and meristic characters in addition to measure the mean, median and standard deviation of these three groups distinctly. The present study will help to recognize the morphometric of different variants in relation to identification. Identification of specie is authentic step of research work. As we know that morphometric studies are important to understand the taxonomy but also essential to know about variation related to their habit and habitat among the variants of the species. Finally we are hopeful that our research work will help other student to identify silver carp.

REFERENCES

1. De Grandchamp, K.L., J.E. Garvey and L.A. Csoboth, 2007. "Linking adult reproduction and larval density of invasive carp in a large river" Transaction of the American Fisheries Society, 136: 1327-1334.
2. Sahu, P.K., J.K. Jena, P.C. Das, S. Mondal and R. Das, 2007. "Production performance of *Labeo calbasu* (Hamilton) in polyculture with three Indian major carps *Catla catla* (Hamilton), *Labeo rohita* (Hamilton) and *Cirrhinus mrigala* (Hamilton) with provisions of fertilizers, feed and periphytic substrate as varied inputs", Aquaculture, 262: 333-339.
3. Gharaei, 2012. "Morphometric and meristic studies of snow trout *schizothorax zarudnyi* (Nikolskii, 1897) as a threatened endemic fish", World Journal of Fish and Marine Sciences, 4: 426-429.
4. Kolar, 2005. "Bigheaded Carps", Biological Synopsis and Environmental Risk Assessment, American Fisheries Society, Bethesda, MD.
5. Kolar, C.S., D.C. Chapman, W.R. Courtenay Jr., C.M. Housel, J.D. Williams and Jennings, 2007. "Bigheaded Carps", a biological synopsis and environmental risk assessment. Special Publication, American Fisheries Society, 33 Bethesda. Maryland, 204.
6. Conover, G., R. Simmonds and M. Whalen, 2007. "Management and Control Plan for Bighead, Black, Grass and Silver Carps in the United States", Aquatic Nuisance Species Task Force, Washington, D.C, 223.
7. Calkins, H.A., 2010. "Linking Silver Carp habitat selection to phytoplankton consumption in the Mississippi River" Southern Illinois University, Carbondale, Illinois, M.Sc Thesis.
8. Garvey, J.E., M. Hill, S.J. Tripp and H.A. Calkins, 2009. "Fish passage in the upper Mississippi River system" Fisheries and Illinois Aquaculture Center, Department of Zoology, Southern Illinois University, Carbondale IL, 62901. 88.
9. Cooke, S.L. and Hill, 2010. "Can filter-feeding Asian carp invade the Laurentian Great Lakes", A bioenergetic modeling exercise. Freshwater Biology, 55: 2138-2152.
10. Xie, S., Z. Li, S. Xie, H. Wang and Murphy, 2007. "Fisheries of the Yangtze River show immediate impacts of the Three Gorges Dam", Fisheries, 32: 343-344.
11. Yi, B., Z. Liang, Z. Yu, R. Lin and M. He, 2006. "A study of the early development of Grass Carp, Black Carp, Silver Carp and Bighead Carp in the Yangtze River China" In Early development of four cyprinids native to the Yangtze River, China.
12. Chen, J., P. Xie, D. Zhang, Z. Ke and H. Yang, 2006. "In situ studies on the bioaccumulation of microcystins in the phytoplanktivorous Silver Carp (*Hypophthalmichthys molitrix*) stocked in Lake Taihu with dense toxic Microcystis Blooms" Aquaculture, 261: 1026-1038.
13. Zhang, J., M. Zhang, L. Shan and Z. Fang, 2007. "Microwave-vacuum heating parameters for processing savory crisp Bighead Carp (*Hypophthalmichthys nobilis*) slices", Journal of Food Engineering, 79: 885-891.
14. Ke, Z., X. Ping and L. Guo, 2008. "In situ study on effect of food competition on diet shifts and growth of Silver and Bighead Carps in large biomaniplulation fish pens in Meiliang Bay, Lake Taihu", Journal of Applied Ichthyology, 24: 263-268.
15. Hansen, February 9, 2010. Great Lakes Fishery Commission, House Committee on Hansen, M.J., 2010. "The Asian carp threat to the Great Lakes" Statement of Dr. Michael Transportation and Infrastructure, Subcommittee on Water Resources & Environment.
16. Sampson, S.J., J.H. Chick and M.A. Pegg, 2009. "Diet overlap among two Asian carp and three native fishes in backwater lakes on the Illinois and Mississippi rivers" Biological Invasions, 11: 483-496.
17. Nayman, 1965. "Growth and ecology of fish population", Journal of Animal Ecology, 20: 201-219.
18. Talwar, P.K. and A.G. Jigman, 1992. "Inland fishes of India", International Journal of Plant and Animal Sciences, 3: 19-24.