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MORPHOMETRIC PATTERNS OF CARPS

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ABSTRACT

The production of culture and capture fishery of Indian major carps and Exotic carps coming to a standstill in recent years, even with various technical and managerial inputs, the question over its biodiversity has been ask frequently. The traditional method of morphometric observation along with anatomical and biochemical analysis has been conducted in farme3d reared composite species of Indian major carps and Exotic carps to study its biodiversity. Morphometric measurement in eighteen external characters were analysed with ANOVA ($P < 0.05$) and found significance. Critical analysis of each character by pair-wise comparison gives significant among species in some of characters. Anatomical study with respect to their body length recorded in gill, heart, and kidney gives the general difference in physiological and habitat role played by this organs.

Key words: Carps, morphometry

INTRODUCTION

Indian major carps; Catla (*Catla catla*), Rohu (*Labeo rohita*), Mrigal (*Cirrhinus mrigala*) are the fastest growing fish available for freshwater aquaculture in the country. A fish that grow relatively in short period of time using cheap feed sources is desirable for fish farmer. Exotic species such as common Carp (*Cyprinus carpio*),Grass carp (*Ctenopharyngodon idella*) and Silver carp (*Hypophthalmichthyes molitrix*), which are native to China and also well established in India are also used in polyculture along with Indian Major Carps. Highest production per unit area has been obtained in the polyculture of carps in India. Polyculture or composite culture of carps involving three Indian major carps and three species of exotic carps was developed by research institutes in 1970's has undergone refinement and modification over the years.

Genetic modification occurs inadvertently in a cultured population. Since there is no competition for food and fear for predators, a farmed fish population experiences different kinds of selection regimes unprecedented in natural waters. It becomes domesticated after some generation of breeding and culture, which bring about changes in the gene pool. Changes may also occur in morphology, physiology and/or behaviour of the domesticated fish [1, 2, 3, 4, 5]. The composite or multispecies culture technologies so far developed are based on species manipulation and application of certain management practices. These technology no doubt have boosted the fish culture in several folds. However, at present it is felt that any further improvement in production may not be possible and the researcher gradually realizing the importance of other aspect such as genetic quality and improvement of the candidate species by fully exploiting their hitherto untapped genetic potentials. The various methods available earlier, much before the advent of biochemical and molecular techniques for stock identification or to study the existence of different population in a given species were only the morphometric measurement and meristic counts.

MATERIALS AND METHODS

Measurements of morphometric characters

Various body measurements were carried out according to Munshi and Srivastava (6) with certain modifications.

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.

Head width

It was a straight measurement of the distance between the two eyes.

Height or depth of body

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.

Length of caudal peduncle

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.

Height of caudal peduncle

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.

Length of head excluding snout

It was measured from anterior margin of the orbit to the posterior longest extremity of the opercula.

Post-orbital length

It was measured from the greatest distance from the posterior edge of the orbit to the tip of the operculum.

Snout length

It was measured from the tip of the snout or anterior mid point on the snout or the upper lip to the anterior margin of the orbit or to the front hard margin of the orbit.

Pre-dorsal length

It was measured from the tip of the snout to the origin of the dorsal fin. It was a straight measurement from the mid-point or tip of the upper lip, or the anterior most part of the head to the structural base of the first dorsal fin.

Post-dorsal length

It was a straight line measurement from the structural base of the dorsal fin to the flexure line of the body or the end of the vertebral column or up to the base of the caudal fin.

Height of dorsal fin and anal fin

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.

Length of base of dorsal & anal fin

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.

Measurements of anatomical characteristics

Gill

The two extreme point of the gill raker and the height of the gill filament at the middle and distal were measured.

Heart

The distance from the anterior to the posterior most of the heart was taken as the height and the diameter of both auricle and ventricle were taken as width/breadth.

Kidney

The distance from the anterior to the posterior most of kidney was taken as length and the breadth was measured at the broadest extension in middle. The fork distance was also taken into account.

Collection of fish tissue and their storage

Live six specimen of Indian Major carp (Rohu, Catla, Mrigal) and exotic carp (Grass carp, Silver carp, Common carp) were taken immediately to laboratory and their morphometric measurement were recorded. It was followed by dissection under aseptic condition for the collection of the target tissues by puncturing a sharp scissor over the mid-dorsal part of the head, thus killing the fish. Tissues were collected from four organs viz. muscles (just below the dorsal fin), gills, heart and kidney. Tissues were kept in 1.5 ml eppendorf tubes which were labeled properly in terms of the specimen and the target organs. These eppendorf tubes were immediately frozen at -100 C by keeping in freezer. All tissue samples were transported in ice pack to the Department of Biochemistry laboratory, CBSH, Pantnagar and stored at -200 C till further use.

MORPHOMETRICS

The average values of various external morphological characters studied in six of composite species of Indian

major carps; *Rohu* (*Labeo rohita*), Catla (*Catla. catla*), Mrigal (*Chirrhinus mrigala*) and Exotic carps; Grass carp (*Ctenopharyngodon idella*), Silver carp (*Hypophthalmichthys molitrix*), Common carp (*Cyprinus carpio*) from experimental fish farm Pantnagar are shown in Table 1 and 2. A total of 19 morphometric characters were recorded and their relative morphometry were calculated based on the total length of the respective specimen.

Simultaneously, anatomical observations of the above species were recorded in three tissues viz. gill, heart and kidney. Their relative readings were shown in Table 3, 4 and 5 respectively.

Pair-wise comparison of relative morphometric characters shown in Table 2 gives relative significance among most of the morphometric characters studied in six composite species. Even though some of the characters can be identified by simple external ap pearance, critical analysis of some of their characters was also equally necessary.

Equal observations for standard length were observed between L. rohita & C. carpio, C. catla with C. mrigala & C. carpio, and C. mrigala with H. molitrix & C. idella. Similar observation was found for L. rohita & C. idella in case of head length. Similar head widths were observed between L. rohita with C. catla & H. molitrix and C. catla & H. molitrix. Only L. rohita & *C. idella* was observed with similar body depth. Non-significant caudal

Table 1: Average relative length (in cm) of six species taken for morphometric observations.

Sl.	Morphometric characters	Rohu	Catla	Mrigal	S.C	G.C	C.C
1	Standard length	0.79	0.81	0.82	0.83	0.83	0.80
2	Head length	0.20	0.22	0.17	0.24	0.20	0.25
3	Head width	0.13	0.14	0.10	0.13	0.12	0.11
4	Depth of body	0.22	0.27	0.17	0.25	0.22	0.33
5	Length of caudal peduncle	0.21	0.19	0.19	0.17	0.17	0.20
6	Caudal peduncle depth	0.11	0.14	0.11	0.12	0.13	0.14
7	Head length (excluding snout)	0.13	0.15	0.12	0.17	0.13	0.15
8	Post orbital length	0.09	0.12	0.09	0.14	0.10	0.12
9	Snout length	0.07	0.07	0.05	0.07	0.07	0.10
10	Pre-dorsal length	0.38	0.36	0.36	0.45	0.43	0.44
11	Post dorsal length	0.41	0.42	0.44	0.39	0.42	0.37
12	Height of anal fin	0.14	0.17	0.13	0.11	0.13	0.14
13	Height of dorsal fin	0.16	0.17	0.14	0.15	0.14	0.12
14	Length of dorsal base	0.17	0.17	0.17	0.10	0.11	0.30
15	Length of anal base	0.06	0.06	0.06	0.15	0.08	0.12
16	Length of pectoral fin	0.15	0.18	0.14	0.16	0.16	0.15
17	Length of pelvic fin	0.14	0.16	0.15	0.13	0.12	0.15
18	Eye diameter	0.04	0.03	0.03	0.03	0.03	0.04

peduncle lengths were observed between L. rohita and C. carpio, C. catla with C. mrigala & C. carpio, C. mrigala & C. carpio and H. molitrix & C. idella while in the case of caudal peduncle depth L. rohita with C. mrigala & H. molitrix, C. catla & C. carpio and C. mrigala & H. molitrix have non- significant observations.

Similarity in head length (excluding snout) between L. rohita & C. idella and C. catla & C. carpio whereas post-orbital length between L. rohita & C. mrigala and C. catla & C. carpio were observed. L. rohita & C. mrigala was observed with similar snout length. C. mrigala with L. rohita & C. catla, C. carpio with H. molitrix & C. idella and L. rohita with C. catla, H. molitrix & C. idella, C. catla with C. mrigala & C. idella, C. mrigala with C. idella have similar pre-dorsal and post-dorsal length respectively.

Similarities between C. mrigala with L. rohita, C. idella & H. molitrix, C. carpio with L. rohita & C. idella and L. rohita with C. catla, C. mrigala with H. molitrix,

C. idella & C. carpio in the case for pre-dorsal and post dorsal length were observed respectively.

Anal base and dorsal base length were found to have similarities between L. rohita with C. catla & C. mrigala and C. catla with C. mrigala.

Non-significant observations for pectorial fin length and pelvic fin length were observed between H. molitrix with C. idella & C. carpio, C. idella with C. carpio and L. rohita with C. mrigala, H. molitrix & C. carpio, C. catla with C. mrigala & C. carpio, C. mrigala with C. carpio, H. molitrix with C. idella respectively.

Maximum gill area as shown in fig. 4.1 was observed
in C. catla followed by C. mrigala, C. carpio and C. idella whereas relatively low observation was seen in L. rohita and H. molitrix.

Maximum relative heart size as shown in fig. 4.2 was observed in L. rohita followed by C. idella, C. carpio, C. mrigala, C. catla and H. molitrix respectively.

Maximum relative kidney area as shown in fig. 4.3 was observed C. idella followed by C. carpio, C. catla, H. molitrix, L. rohita and C. mrigala.

Table 2: Pair-wise comparison of relative morphometric characters of all six species
* Significance at 5% (N.B. Serial number 1 to 18 denotes the 18 relative external morphometric characters)

Sl.	Pair-wise comparisons															CD at 5%
	R-C	R-M	R-SC	R-GC	R-CC	C-M	C-SC	C-GC	C-CC	M-SC	M-GC	M-CC	SC-GC	SC-CC	GC-CC	
1	0.018*	0.026*	0.041*	0.041*	0.011	0.007	0.023*	0.023*	0.0075	0.015	0.015*	0.015*	0.0005	0.030*	0.031*	0.015
2	0.027*	0.026*	0.044*	0.007	0.054*	0.053*	0.017*	0.019*	0.027*	0.070*	0.033*	0.080*	0.036*	0.010*	0.046*	0.009
3	0.004	0.033*	0.0001	0.009*	0.019*	0.036*	0.004	0.013*	0.023*	0.033*	0.023*	0.013*	0.010*	0.019*	0.010*	0.005
4	0.053*	0.040*	0.038*	0.001	0.116*	0.093*	0.015*	0.051*	0.063*	0.078*	0.042*	0.156*	0.037*	0.077*	0.114*	0.010
5	0.018*	0.023*	0.037*	0.044*	0.009	0.005	0.020*	0.026*	0.008	0.014*	0.021*	0.014	0.0067	0.028*	0.035*	0.012
6	0.022*	0.003	0.004	0.014*	0.022*	0.025*	0.019*	0.008*	0.0003	0.0064	0.017*	0.025*	0.010*	0.018*	0.008*	0.007
7	0.020*	0.010*	0.044*	0.003	0.022*	0.031*	0.024*	0.017*	0.0014	0.054*	0.013*	0.032*	0.041*	0.022*	0.019*	0.008
8	0.025*	0.005	0.050*	0.009*	0.024*	0.030*	0.025*	0.016*	0.0015	0.056*	0.014*	0.029*	0.042*	0.027*	0.015*	0.005
9	0.006*	0.015	0.001*	0.005*	0.029*	0.022*	0.007*	0.0015	0.022*	0.015*	0.020*	0.044*	0.005*	0.029*	0.024*	0.003
10	0.017*	0.015	0.068*	0.052*	0.056*	0.002	0.085*	0.069*	0.073*	0.083*	0.067*	0.071*	0.017*	0.0119	0.005	0.016
11	0.011	0.033*	0.015	0.015	0.042*	0.022	0.026*	0.0035	0.053*	0.048*	0.018	0.075*	0.029*	0.028*	0.057*	0.022
12	0.024*	0.014	0.033*	0.015*	0.006	0.038*	0.057*	0.039*	0.031*	0.019*	0.001	0.0072	0.018*	0.026*	0.008	0.014
13	0.004	0.019*	0.013*	0.026*	0.042*	0.023*	0.017*	0.030*	0.046*	0.0065	0.006	0.0224	0.013*	0.029*	0.016*	0.010
14	0.006	0.001	0.272*	0.060*	0.131*	0.0056	0.069*	0.053*	0.137*	0.074*	0.059*	0.132*	0.015*	0.206*	0.191*	0.006
15	0.002	0.002	0.085*	0.016*	0.055*	0.0002	0.087*	0.017*	0.057*	0.087*	0.017*	0.057*	0.069*	0.030*	0.040*	0.004
16	0.030*	0.006*	0.012*	0.010*	0.006*	0.036*	0.018*	0.020*	0.024*	0.018*	0.017*	0.012*	0.0015	0.0057	0.004	0.006
17	0.022*	0.009	0.014	0.020*	0.013	0.005	0.036*	0.042*	0.008	0.022*	0.029*	0.0046	0.0063	0.027*	0.033*	0.014
18	0.005*	0.005*	0.006*	0.006*	0.002	0.0002	0.0015	0.001	0.007*	0.0013	0.0006	0.007*	0.0007	0.008*	0.008*	0.003

Table 3 : Relative gill morphometry (in cm)

Species	**Length of gill raker**	**Height of gill filament**		**Area**	**Relativity**
		Mid	**Distal**		
Rohu	2.7	1.6	1	3.16	0.107119
Catla	7	2.5	1	9.75	0.270833
Mrigal	2.9	1.8	0.8	3.41	0.142083
S.C	5.8	0.8	0.9	3.22	0.091477
G.C	4	1.7	0.3	3.7	0.132143
C.C	5	1.5	0.6	4.35	0.140323

Table 4: Relative heart morphometry (in cm)

Species	Heart			Area	Relativity
	Total length	Auricle	Ventricle		
Rohu	2.3	1.5	0.8	2.3	0.077966
Catla	2	1.3	1	2.3	0.063889
Mrigal	1.1	0.95	0.75	1.7	0.070833
S.C	2	0.85	0.95	1.8	0.051136
G.C	1.85	1.1	0.9	2	0.071429
C.C	1.75	1.45	0.75	2.2	0.070968

Table 5: Relative kidney morphometry (in cm)

Species	Kidney		Fork distance	Area	Relativity
	Length	Breadth			
Rohu	13	2.5	1.8	4.3	0.145763
Catla	12.5	4.2	1.5	5.7	0.158333
Mrigal	11.5	1.2	0.9	2.1	0.0875
S.C	10.5	3.2	2.2	5.4	0.153409
G.C	12	2.9	1.9	4.8	0.171429
C.C	9	3.8	1.5	5.3	0.170968

DISCUSSION

The examination of both morphological characters and allozyme/isozyme characters are especially desirable as two perspectives with which to test phylogenetic hypotheses [7]. The analysis of morphological characters which include the multivariate analysis of external anatomical characteristics [8] as well as the study of scales and otholiths have been used as a means of stock identification for many years. Pandey and Nautiyal [9] attempted to evaluate some meristic and morphometric characters of taxonomic significance in differentiating S. richardsonii (Gray) and S. plogiostomus (Heckle) and revealed fin length as characters of diagnostic significance ($P<0.05$) between the two species. Under present investigation subjecting morphological and anatomical parameters to ANOVA (single factor) and their relativity it has been found to have the level of significance in all the morphometric characters. Thus, a critical analysis of the morphometric characters by pair-wise comparison was conducted and the level of significant difference between the species was observed in some characters. Hauser et al., [10] reported significant morphological and genetic variation of African dupied (Limnothrissa miodon) population using nested ANOVA. As the current investigation was undergone in order to observe the diversity between the population of six composite species of Indian major carp and Exotic carp which belong to different genus even though of the same family, the significant difference in their morphometry was evident.

The composite species of Indian major carp and Exotic carp forms the backbone of Indian aquaculture, even though the later was brought to India which now has been well adapted to the local conditions and forms an integral part of the freshwater genetic diversity. But

it has been seen recently that the aquaculture production come to a standstill and simultaneously capture fishery of these species are also declining at a faster rate. This may be due to the fact that the breeding programme in most of the hatchery uses limited stock and there is little or no precaution for the genetic variability of the brooders. The wanton destruction of both adult and juvenile fish, ecological degradation, impact of river valley projects, pollution, introduction of competitive and fast growing exotics are some of the causes in natural fisheries.

Knowledge of genetic variability in past have been proven fruitful to fishery managers in identifying discrete breeding populations. Besides, estimation of stock mixtured, indicating problems in fish culture, recognizing and quantifying hybrid populations as well as providing insights into conservation problems may be tackled by molecular technique using protein(s). Keeping in view of the above aspects an attempt was made to employ protein/isozyme analysis as effective means of studying genetic diversity in this composite fish species.

Fish sample were collected from Instructional fish farm Pantnagar, College of Fisheries Science and their morphometric characters were recorded. Gradient SDS-PAGE of denatured proteins and native-PAGE for isozymic pattern of gill, muscle, heart and kidney were carried out to observe their diversity.

The salient observations of the study are summarized below.

The relative morphometric studies conducted in eighteen external characters analyzed by ANOVA (at 5%) shows significant difference and their critical difference were evaluated which shows significant differences in some specific behaviour, characters, habits and habitats.

The relative anatomy of the target organs except muscle was also studied in which some species has better result than the others due to their difference in physiological behaviour.

Thus, it is concluded that the species investigated being of the same family possess very close relationship with respect to the morphology and protein/isozyme pattern and open up further research in the field of population genetics, cytogenetics, molecular genetics, recombinant DNA technology, aquaculture genetics etc. And it is suggested to investigate more number of enzymes and their polymorphic loci along with DNA based markers with large number of sample size for better understanding and sustainable utilization of the genetic diversity of this economically important contents.

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