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Study on Morphological Variation in Iran Grass Carp Stocks

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Abstract: Two stocks of grass carp *Ctenopharyngodon idella* Val were collected from North, Mazandran and South, Khuzestan to compare some morphometric and meristic characters. The Khuzestan stocks were significantly greater in body length, intestine length and number of vertebrae than the Mazandran stocks ($p<0.05$). The body width, depth of Mazandran were higher but gill raker lower than another stock. The Mazandran stock has a smaller head and snout. The Khuzestan grass carp showed low coefficients of variation in almost all morphometric and meristic characters, suggesting homogeneous properties of these stocks while higher variation in Mazandran grass carp stock. It is suggested that the Mazandran and Khuzestan are well established as a strain, but have a common ancestor.

Key words: Morphometric · Meristic · *Ctenopharyngodon idella*

INTRODUCTION

Grass carp is an important in freshwater ponds and reservoirs of Iran. Most submerged weed problems are caused by mixed plant communities and require a general; water bound herbivore, or a number of host-specific organisms to avoid a predominance of resistant plants developing. The grass carp, *Ctenopharyngodon idella* Val. is the most biological candidate to control the water weeds. The grass carp, a freshwater species native to China, have been introduced in more than 100 countries. It was introduced in Europe, Mexico, United States and the temperate zones to improve fish production, but the possibilities for aquatic weed control are more emphasized [1-3].

It was also introduced into Iran, primarily for aquatic weed control purposes, also later was used to improve fish production in polyculture system. From research in various countries it is concluded that the efficiency of the fish for weed control is high, that costs are low and that no severe side-effects are observed.

There are at least several stocks of grass carp that are not known to date. They can not be distinguished by observing morphological characters such as color, scales, eye shape, but they may be distinguish by their head and body forms, or biochemical and molecular analysis. Extensively investigation by using different molecular marker e.g. allozyme, RAPD and microsatellites were used to identify genetic structure of fish [4]

The differences among these Iranian grass carp stocks based on morphological characters are not studied till now and no one has attempted to make a statistical analysis of morphological characteristics of these stocks. This paper presents a study of grass carp collected from North and South to clarify the state of morphological differentiation and variability of Iranian grass carp stocks. The study of differences and variability in morphometric and meristic characters of stocks of grass carp is important in phylogenetically and providing information for subsequent studies on the genetic improvement of stocks.

MATERIALS AND METHODS

Two stocks of grass carp were collected from the respective stock ponds located in North, Mazandran and South, Khuzestan of Iran. The fish were propagated in the two provinces and the larvae of south were transferred to Mazandran at the same farm for common rearing purpose. Samples of fish at different stage of rearing were collected randomly from the stock ponds of two fish farmers

To minimize the effects of the difference in body weight, about one-year-old fish of the same weight were used. In pre-experimental work (Case study) by the author, we found the difference in size of the same weight of two stocks; therefore for more illustration of the differences we fixed the weight and compared other morphological parameters.

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The smallest sample was 20 gram in weight and the largest 565 gram. The fish were transferred to the lab in university alive and kept 24 h in 1000 l tank supplied with fresh running to empted the intestine and extra materials. At the time of biometry, the fish were Anastasias by Ms222 and the morphological parameters were scored.

The morphometric characters measured were: Total and fork length, body depth, body width and intestine length. The relative body depth, body width and intestine length to total length were calculated. Meristic characters counted are: dorsal, ventral, pectoral and anal soft rays, vertebrae, lateral line scales and gill rakers of the first arch. The method of measurements and counts followed by Saanin [5]. The t-test was used to determine significance of the difference of mean values for each characteristic between stocks. The number of characteristics which showed significant differences were recorded for comparison between stocks.

RESULTS

The mean values of weight, length, standard errors and coefficients of variation (%) and other morphometric and meristics for respective stocks were summarized in Table 1 to 4. Out of 14 morphometric and meristic characters, the khozestan stock was different at the 5 % significant level from mazandran in 7 characters.

Morphometric Characters: The average relative body depth and body width of Mazandran grass carp were greater than those of the Khozestan and showed a difference at the 5 % significant level, when the size of fish was 16.8 cm and more than 50g. The Kozestan grass carp had the highest average relative snout length when compared to Mazandran stocks. The value was significantly different at the size of 16.8 cm. The relative intestine lengths for Khozestan were large at all the sampling stages but at the size of 22.6 cm it was significantly different from Mazandran stocks (Table 1). The coefficients of variation for the Mazandran grass carp stocks were large in most of the characters.

Meristic Characters: The highest average vertebral number was found in Kozestan grass carp (40±0.2), than Mazandran stocks (39±0.4, Table 2. These vertebral counts were significantly higher when the fish were at 50 g (31.3cm). The average number of gill rakers for two stocks was also different (Table 3). The highest average gill rakers number was found in Kozestan grass carp (15.9±0.3), than Mazandran stocks (15.2±0.4). The mean counts of lateral line scales varied from 40.1 (Kozestan) to 40.5 (Mazandran). The least mean count of ventral soft rays was from Mazandran, stock, however, the Khozestan stock showed the least mean count of anal soft rays.

Table 1: Mophometrics characters of Mazandran grass carp stocks

Value	Weight(g)	Total Length	Fork Length	Body Depth	Body width	Head Length	Snout	Intestine Length
Mean	21.07	12.74*	11.30*	2.44	1.34	2.26	0.90	27.12
Sd	0.59	0.63	0.60	0.07	0.08	0.14	0.02	0.91
C.V(%)	2.82	4.96	5.31	2.96	6.32	6.16	2.07	3.36
Mean	35.00	14.25*	12.49*	3.51	1.95	2.78	1.04	28.36
Sd	0.93	0.73	0.78	0.35	0.12	0.19	0.09	0.65
C.V(%)	2.65	5.09	6.27	10.09	6.35	6.69	8.84	2.30
Mean	53.00	16.86*	15.66*	3.77*	2.33	3.21	1.31*	31.20
Sd	2.94	0.46	0.52	0.23	0.12	0.11	0.02	0.69
C.V(%)	5.55	2.70	3.33	6.19	5.31	3.45	1.57	2.21
Mean	79.56	18.59*	16.05*	3.93*	2.60*	3.42	1.26*	31.07
Sd	6.41	0.82	1.17	0.22	0.20	0.24	0.07	4.42
C.V(%)	8.06	4.41	7.31	5.55	7.50	6.94	5.29	14.24
Mean	125.80	22.62*	20.09*	4.67*	3.11*	3.70	1.38*	45.20*
Sd	3.71	0.29	0.74	0.08	0.13	0.09	0.13	0.79
C.V(%)	2.95	1.26	3.71	1.69	4.15	2.34	9.46	1.75
Mean	160.93	24.27*	22.0*	5.3*	3.7*	4.73*	1.6	4.73
Sd	13.26	1.44	0.78	0.33	0.92	0.22	0.12	0.22
C.V(%)	8.24	5.92	3.5	6.2	24.9	4.63	7.5	4.6
Mean	502.40	33.18*	29.41*	6.77*	4.25	6.07	2.15*	48.53*
Sd	50.86	1.21	1.43	0.27	0.23	0.27	0.17	9.94
C.V(%)	10.12	3.66	4.85	4.06	5.32	4.47	8.04	20.48

Table 2: Meristics characters of Mazandran grass carp stocks

Value	Weight(g)	Vertebrae	Gill rakers	Scales on lateral line	Number of soft ray on fin			
					Dorsal	Ventral	Pectoral	Anal
Mean	21.07	39.11	15.56	40.56	8.22	8.11	15.11	8.11
Sd	0.59	0.93	1.13	2.24	1.20	0.93	1.05	0.78
C.V(%)	2.82	2.37	7.27	5.53	14.62	11.44	6.98	9.64
Mean	35.00	39.13	15.38*	39.75	8.00	8.00	15.00	7.88
Sd	0.93	0.83	1.19	0.71	0.53	0.93	0.76	0.83
C.V(%)	2.65	2.13	7.73	1.78	6.68	11.57	5.04	10.60
Mean	53.00	39.60	15.60*	40.40	8.00	8.10	15.00	8.10
Sd	2.94	0.52	0.84	2.17	0.82	0.88	0.94	0.88
C.V(%)	5.55	1.30	5.41	5.37	10.21	10.81	6.29	10.81
Mean	79.56	39.53	15.53*	40.40	8.00	7.87	15.07	8.07
Sd	6.41	0.52	1.06	1.96	0.76	0.99	1.10	0.96
C.V(%)	8.06	1.31	6.82	4.84	9.45	12.59	7.30	11.92
Mean	125.80	39.50	16.00*	39.60	8.10	8.00	15.10	8.20
Sd	3.71	0.53	0.67	1.51	0.74	0.47	0.99	0.79
C.V(%)	2.95	1.33	4.17	3.80	9.11	5.89	6.59	9.62
Mean	160.93	39.47	14.80*	40.67*	7.93	8.20	15.13	8.13
Sd	13.26	0.52	1.15	2.02	1.16	1.08	1.36	0.83
C.V(%)	8.24	1.31	7.75	4.98	14.66	13.20	8.96	10.25
Mean	502.40	39.40	15.80*	42.40	8.07	7.93	15.13	8.07
Sd	50.86	0.83	1.01	1.59	0.70	0.88	0.99	1.03
C.V(%)	10.12	2.10	6.42	3.76	8.72	11.14	6.54	12.80

Table 3: Mophometrics characters of Khozestan grass carp stocks

Value	Weight(g)	Total Length	Fork Length	Body Depth	Body width	Head Length	Snout	Intestine Length
Mean	20.69	13.34	11.87	2.38	1.29	2.34	0.92	27.83
Sd	0.66	0.55	0.47	0.06	0.03	0.09	0.01	0.75
C.V(%)	3.17	4.09	3.95	2.61	2.02	4.00	1.19	2.71
Mean	35.38	15.44	13.56	3.12	1.82	2.82	1.13	28.88
Sd	1.60	0.78	0.83	0.36	0.16	0.14	0.09	0.65
C.V(%)	4.52	5.05	6.13	11.41	8.76	4.98	7.86	2.23
Mean	53.62	17.52	16.07	3.47	2.22	3.09	1.35	32.21
Sd	2.87	0.62	0.05	0.28	0.09	0.31	0.04	1.29
C.V(%)	5.36	3.52	0.31	8.09	4.21	10.03	3.11	4.00
Mean	76.88	19.19	17.06	3.74	2.44	3.40	1.34	32.93
Sd	5.50	0.64	1.06	0.16	0.15	0.18	0.10	3.01
C.V(%)	7.15	3.32	6.19	4.33	5.97	5.41	7.20	9.16
Mean	123.50	23.20	20.68	4.60	2.98	3.68	1.54	46.10
Sd	2.51	0.52	0.41	0.05	0.13	0.07	0.16	0.88
C.V(%)	2.03	2.23	2.00	1.01	4.33	1.82	10.37	1.90
Mean	164.27	25.53	22.3	5.1	3.5	4.37	1.7	48.87
Sd	14.66	1.30	0.48	0.13	0.2	0.14	0.09	2.13
C.V(%)	8.92	5.10	2.1	2.5	6	3.31	5.3	4.37
Mean	508.67	34.33	31.19	6.57	4.15	6.21	2.29	56.40
Sd	51.94	1.72	2.22	0.21	0.19	0.08	0.21	10.73
C.V(%)	10.21	5.02	7.13	3.12	4.64	1.34	9.10	19.03

Table 4: Meristics characters of Khozestan grass carp stocks

Value	Weight(g)	Vertebrae	Gill rakers	Scales on lateral line	Number of soft ray on fin			
					Dorsal	Ventral	Pectoral	Anal
Mean	20.69	39.78	15.89	39.67	8.00	8.00	15.00	7.78
Sd	0.66	0.44	0.93	1.66	0.71	0.50	1.00	0.97
C.V(%)	3.17	1.11	5.84	4.18	8.84	6.25	6.67	12.49
Mean	35.38	39.88	15.38	39.50	8.13	8.13	15.13	8.00
Sd	1.60	0.35	0.74	0.53	0.64	0.64	0.64	0.76
C.V(%)	4.52	0.89	4.84	1.35	7.89	7.89	4.24	9.45
Mean	53.62	40.50	15.92	40.25	8.08	8.17	15.17	8.17
Sd	2.87	1.17	0.90	1.06	0.67	0.58	0.72	0.39
C.V(%)	5.36	2.88	5.66	2.62	8.27	7.07	4.73	4.77
Mean	76.88	39.86	15.93	40.00	8.14	8.14	15.14	8.07
Sd	5.50	0.35	0.80	1.28	0.94	0.64	0.68	0.65
C.V(%)	7.15	0.88	5.01	3.20	11.56	7.86	4.46	8.11
Mean	123.50	40.10	16.20	39.40	8.10	8.10	14.90	8.10
Sd	2.51	0.74	0.92	0.52	0.88	0.88	0.74	0.74
C.V(%)	2.03	1.84	5.67	1.31	10.81	10.81	4.95	9.11
Mean	164.27	39.87	15.73	40.13	8.07	8.13	15.20	8.07
Sd	14.66	0.35	0.80	1.13	0.70	0.74	0.68	0.46
C.V(%)	8.92	0.88	5.08	2.80	8.72	9.14	4.45	5.67
Mean	508.67	40.13	16.13	41.60	8.13	8.07	15.07	8.00
Sd	51.94	0.99	0.99	0.91	0.52	0.70	0.46	0.76
C.V(%)	10.21	2.47	6.14	2.19	6.35	8.72	3.04	9.45

There were no significant differences in the mean counts of dorsal, ventral, pectoral and anal soft rays, among those two stocks (P>0.05). Kozestan was smaller in the coefficients of variation than compared to the Mazandran stocks for all of the meristic counts examined (Table 4).

DISCUSSION

The Mazandran grass carp are characterized based on the morphological characters; by a relatively small head and round body shape. The Khozestan grass carp wise verse has larger snout and elongated body form. The statistical analysis for the two stocks examined in this study supports the validity of stocks characterized by the morphological differences analyzed by t-test. There are at least seven characteristics which are different between two stocks at the 5 % significant level. The differences are quite detectible when the fish are over 50 g or at size of larger than 16 cm. For precise comparing the stocks, the fish should be at mature stage. At mature stage the fish are completed in all morphological characters. In the present study the fish at 16 cm size showed their differences in morphometric and meristics characters.

Based on the available data, the ancestor of mazandran grass carp was brought from Romania and from there, spread to other districts as well as to Khozestan, therefore due to presence of smaller number of brood stocks in Khozestan, the present state in morphological differentiation may have been caused by selection pressure on morphological traits being preferred by fish farmers. Also it is not so far that the genetic differentiation may have been caused by the random genetic drift genes which are due to selection pressure

Body depth, body width and head length are three important characters in considering common carp culture. Deep and wide body and relatively small head are the most preferred characteristics by the fish farmer, because these characteristics are related to the edible part of fish [6].

These three characters were significantly higher in mazandran grass carp. This is maybe due to the fish has been selected for its great body depth and high growth rate, or the presence of higher variety compare to Khozestan stocks.

The Khozestan stocks showed the significantly greater in relative intestine length. The intestine length may determine the effectiveness of nutrient absorption,

because the longer the intestine, the larger its surface area for nutrient absorption [6]. The difference in intestine length may be affected by genetic or/and environmental factors.

Among meristic characters, the number of vertebrae, gill rakers and scale patterns is known to be related with growth rate [6]. Vertebral count of grass carp ranged from 39.4 to 40 and gill rakers from 15.2 to 15.9 for Mazandran and Khozestan stocks respectively.

The meristic characters are greatly affected by genetic factors, so that it was suggested that some meristic counts could be used as indicators for the selection of grass carp with a genetically faster growth rate. Higher count of two meristics characters in Khozestan stocks probably is due to selection program, but in other hand the relatively high variation of body shapes and meristic counts, will support the idea that Mazandran stocks are more preferred for selection purpose because there is a general tendency that the phenotypic variance of the non-selected population is relatively larger than that of cultured stocks exposed to intensive selection. The larger phenotypic variance probably includes larger genetic variance, so that the stocks with a high phenotypic variation may have a potential to give a larger selection response in subsequent generations [6].

The low variation in all characteristics of Khozestan stocks has probably been caused by intensive selection and suggests that this stock is well established as strains suitable for culture. On the other hand, the low variation of the majority of characters in this stock may be due to loss of genetic variation caused by a long period of inbreeding and a small number of spawners. More information is necessary to illustrate this question.

There are very few available article discussed the morphological variation of different stocks of grass carp, but recently molecular study are study to illustrate the variation between native grass carp wild domesticated or geographical difference. Analysis of genetic variation in grass carp (*Ctenopharyngodon idella*) from native and colonized regions using ISSR markers have been reported [7]. In this paper, inter simple sequence repeat (ISSR) markers were used to evaluate genetic variation within and among grass carp populations sampled from its native (China) and colonized habitats (USA, Hungary and Japan). The highest genetic diversity was observed in the Yangtze River population, whereas the lowest diversity was found in the Tone River population (Japan). Compared with colonized populations, the native populations possess approximately twice genetic diversity. The AMOVA analysis showed a relatively high level of genetic variation within populations. Significant genetic differences were revealed both among the native populations and between pooled native and colonized populations. On another study, High genetic diversity and substantial population differentiation in grass carp (*Ctenopharyngodon idella*) revealed by microsatellite analysis [8]. All wild and cultured populations in China showed high allelic (A = 6–13.7; Ar = 6.00–8.23) and gene diversity (Ho = 0.71–0.79 and He = 0.71–0.82), while the cultured population located in Malaysia showed low genetic diversity (A = 6.4; Ar = 3.89, Ho = 0.48, He = 0.55). Both AMOVA and Fst analysis revealed significant population structuring. It is very striking that the cultured populations were significantly differentiated from wild populations and contained high genetic diversity.

Also studies have been conducted to investigate the population genetic structure of grass carp *Ctenopharyngodon idella* using mitochondrial techniques in the Yangtze River, China [9]. They studied three locations in the river. The analysis of molecular variance and the fixation index revealed insignificant genetic difference between samples from different locations. The molecular investigation reviled clearly the presence of difference between stocks specially those of origin and native with hatchery managed stocks.

The morphological differences between the stocks and the coefficients of variation within stocks examined in this study are the pre-steps of genetic study of grass carp in Iran. For genetic improvement of grass carp and to estimate the heritability in quantitative traits, as well as the performance traits of stocks we may precisely examined each character of grass carp, under the same environmental conditions. The water temperature and type of feeding may be regard as two main factors in growth rate of grass carp. The type and composition of feed in the pond is an important factor in quality and survival rate of fish during rearing in the pond [10].

The information about genetic diversity and population structure of grass carp obtained in the present study would supply a basis for future genetic improvement through selective breeding.

CONCLUSION

The statistical analysis of morphological characteristics of two grass carp stocks showed differences. Each of these two stocks has several advantages suitable in aquaculture. The results illustrated that for genetic improvement of grass carp, the structure of population and genetic characteristics of stock showed be consider.

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