



TAXONOMIC STUDY ON THE SUPPOSED HYBRIDS OF INDIAN MAJOR CARPS AND CHINESE CARPS IN THE LOCAL MARKETS OF KHULNA, JESSORE AND SATKHIRA DISTRICT, BANGLADESH

Shamima Sultana*, Md. Saifuddin Shah, Alokesh Kumar Ghosh and Joyanta Bir

Fisheries and Marine Resource Technology Discipline, Khulna University, Khulna 9208, Bangladesh

KUS: 16/10: 250316

Manuscript received: March 25, 2016;

Accepted: November 16, 2016

Abstract: The present study deciphers the extent of the activity of heterospecific mixing of gametes and production of hybrids that are available as food fishes in the markets of Khulna, Jessore and Satkhira districts during March to July, 2009. The taxonomic characters of two putative hybrids from 150 samples namely *Catla catla* × *Labeo rohita* and *Labeo rohita* × *Labeo calbasu* were studied and compared with their original species and significant differences were found in most of the meristic characters and morphometric proportions at 5% level of significance. The two hybrids were not found to be intermediate between their original species for most of the characters. *Catla catla* × *Labeo rohita* deflected more toward catla; while *Labeo rohita* × *Labeo calbasu* toward calbasu, however, the hybrid does not have barbel as with calbasu. The results of the study revealed a grave situation of fishes' gene pool mixing in the hatcheries.

Keywords: Taxonomy, putative hybrids, character, catla×rohu, rohu×calbasu

Introduction

The Indian major carps are the natural inhabitants of the perennial river networks of India, Pakistan and Bangladesh, and, enjoy a wide distribution. The Indian major carp species (catla, rohu, mrigal) and chinese carp species (silver carp, grass carp, big head carp, mirror carp, common carp etc.) are considered as best suitable carp species. Once the major carps were the target species, but now the exotic fishes are cultured in ponds and lakes; however, the Indian major carps are much popular and farmers usually select them as rearing species. Hybridization is a method of improving productivity of cultivable species. Fish hybridize relatively easily, and the variety of species crosses and even wider taxonomic combination. There has been a rapid progress in the field of fish hybridization, with the success of induced breeding of fishes through hypophysation. The study of hybridization may be useful in examining patterns of dispersal and biogeography of fish species. Several interspecific and intergeneric hybrids among various Indian major carps were produced for first time by Chaudhuri (1959). However, the work carried out in the field of fish hybridization in India (Chaudhuri, 1959; Alikunhi *et al.*, 1963; Varghese and Sukumaran, 1971 and Chaudhuri, 1973) is rather meager. Altogether six interspecific and 13 intergeneric hybrids have been produced among the four species of Indian major carps belonging to the three genera, viz. *Catla*, *Labeo* and *Cirrhinus*. Accordingly, hybridization work was carried out

Corresponding author: <shamimasultana87@gmail.com>

DOI: <https://doi.org/10.53808/KUS.2016.13.1.1610-L>

between different species of a genus (interspecific) and species of different genera (intergeneric) among the Indian major carps and Indian and Chinese major carps, including the common carp to study whether the hybrids acquired any useful traits from their respective parent species, such as smaller head, wider body and more flesh content as in rohu-catla hybrid, pond breeding habit as in *Cyprinus carpio*, or advantageous feeding habits. (Chaudhuri, 1959 and 1973; Alikunhi and Chaudhuri, 1959; Alikunhi *et al.*, 1963; Hamsa, 1972; Hamsa and Alikunhi, 1971; Varghese and Sukumaran, 1971; Ibrahim *et al.* 1980; Reddy, 1977. These experiments have demonstrated a high level of compatibility among Indian carps for hybridization.

Interspecific hybrid of *Labeo rohita* and *Labeo calbasu* grows faster than calbasu and fertile. *L. rohita* - *C. catla* hybrids grow faster than rohu. The meat yield in hybrids is higher than in parents (Chaudhuri, 1971 and 1973). In Bangladesh, mainly nine types of carp hybrids can be found. They are rohu×catla, rohu×calbasu, rohu×mirror carp, rohu×mrigal, catla×mrigal, catla×silver carp, catla×mirror carp, mrigal×mirror carp, bighead×silvercarp. Detailed investigations on important aspects, like taxonomic characters and comparative growth rate, embryonic and larval development in order to evaluate their utility in aquaculture, are very important. The hybrids as a rule should show intermediate characters and the preponderant hybrids that were collected from the market were judged for the morphometric and meristic characters. The present study was conducted to find out the extent of the activity of heterospecific mixing of gametes and production of hybrids that are available as food fishes in the markets of greater Khulna, Jessore and Satkhira district. The results of the research revealed a grave situation of fishes' gene pool mixing in the hatcheries. Unintentional and unplanned heterospecific mixing of gametes is detrimental for the species' gene pool from a genetic viewpoint. This leads to introgression of gene pool and can bring havoc in the population of the cultivable species.

Materials and methods

The present study was carried out on samples collected randomly from the local markets of Khulna, Jessore and Satkhira districts during March to July 2009.

Different types of putative hybrids of Indian major carps and Chinese carps were collected randomly. A total of 150 samples were sampled for taxonomic study. Samples of the putative hybrids (catla×rohu, rohu×calbasu) & single species of catla, rohu and calbasu were collected and were immediately preserved in ice box.

Fifteen morphometric characters viz., the total length (TL), standard length (SL), fork length (FL), height of the body (BHt), head length (HL), length of the upper jaw (LUJ), pre-orbital length (PrOL), eye diameter (EDia), post-orbital length (PsOL), pre dorsal length (PrDL), length of dorsal fin base (LDFBs), height of the dorsal fin (HtD), least depth of caudal peduncle (LtDtCP), length of caudal peduncle (LCP), length of anal fin base (LAFBs), and height of pelvic fin (HtP) was recorded separately following standard methods.

Nineteen meristic characters (countable characters) were counted including scale on, above and below the lateral line, number of fin rays of dorsal, caudal, anal, pectoral and pelvic fins of the fish.

Results

Mainly three types of hybrids were found in the local market of Khulna, Jessore, and Sathkhira districts during the study period. They were putative hybrids of catla and rohu, rohu and calbasu and rohu and mirror carp. Availability of putative hybrids of catla and rohu were more frequent than rohu and calbasu and number of hybrids of rohu and mirror carp was very rare.

Morphometric characters of putative hybrids: Significant differences between catla×rohu putative hybrid, catla and rohu were found at 5% level ($p<0.05$) in several combinations of body proportions (Table 1).

Table 1: Various body proportions of catla×rohu putative hybrid and in the single species of catla and rohu

Proportion Characters	catla (Mean±SD)	catla×rohu (Mean±SD)	rohu (Mean±SD)	p-value
TL:SL	1.32±0.032 ^b	1.35±0.027 ^c	1.27±0.024 ^a	0.000*
FL:SL	1.12±0.017 ^a	1.15±0.013 ^a	1.13±0.094 ^a	0.245
SL:HL	3.23±0.149 ^a	3.47±0.226 ^b	4.04±0.215 ^c	0.000*
SL:PrDL	2.20±0.082 ^a	2.19±0.051 ^a	2.22±0.053 ^a	1.064
SL:HtB	2.73±0.227 ^a	2.80±0.122 ^a	3.32±0.182 ^b	0.000*
HL:PrOL	3.21±0.187 ^{ab}	3.26±0.176 ^b	3.13±0.225 ^a	0.039*
HL:EDia	6.19±0.486 ^b	6.01±0.763 ^b	5.48±0.399 ^a	0.000*
HL:PsOL	1.89±0.858 ^a	1.95±0.287 ^{ab}	2.04±0.172 ^b	0.014*
SL:LDFBs	3.48±0.336 ^a	3.93±0.181 ^b	4.56±0.269 ^c	0.000*
SL:LCP	5.91±0.379 ^a	6.41±0.414 ^b	6.27±0.599 ^b	0.000*
HL:LUJ	6.27±1.164 ^a	7.41±0.891 ^b	7.73±1.225 ^b	0.000*
SL:LtDtCP	6.65±0.421 ^a	6.68±0.415 ^a	7.20±0.559 ^b	0.000*
HtB:LtDtCP	2.45±0.182 ^b	2.39±0.166 ^b	2.17±0.161 ^a	0.000*
LCP:LAFBs	2.13±0.303 ^a	2.01±0.228 ^a	2.10±0.262 ^a	0.171
SL:EDia	20.04±1.933 ^a	20.94±3.796 ^{ab}	22.14±1.925 ^b	0.013*

*significantly different at 5% level of significance

(TL-Total length, SL-Standard length, FL-Fork length, HL-Head length, PrOL- Pre orbital length, EDia-Eye diameter, PsOL-Post orbital length, PrDL-Pre dorsal length, LDFBs-Length of dorsal fin base, LtDtCP-Least depth of caudal peduncle, LCP-Length of caudal peduncle, LAFBs-Length of anal fin base, HtB-Height of the body, LUJ-Length of the upper jaw.)

The putative hybrids, catla×rohu showed intermediate range with respect to the morphometric ratios, viz; SL:PsOL SL:LDFBs and SL:EDia. In respect of SL:HL, SL:HtB, HL:EDia, SL:LtDtCP and HtB:LtDtCP the hybrids resembled more toward catla. Hybrids deviated more towards rohu in respect of HL:LUJ. The hybrids crossed the range of both original species in respect of TL:SL, SL:LCP and HL:PrOL. The hybrids showed lower range than the range of both original species catla and rohu in respect of SL:PrDL and LCP:LAFBs. Dorsal profile of the putative hybrid catla×rohu was more convex than the

ventral. The putative hybrids had an intermediate range in the number of scale above lateral line, total number of dorsal fin ray, number of branched dorsal fin ray (Table 1).

Significant differences between putative of hybrid rohu×calbasu, rohu and calbasu were found at 5% level ($p<0.05$) in several combinations of body proportion (Table 2).

Table 2: Various body proportions of rohu×calbasu putative hybrid and in the single species of catla and rohu

Proportion Characters	rohu (Mean±SD)	rohu×calbasu (Mean±SD)	calbasu (Mean±SD)	p-value
TL:SL	1.27±0.0247 ^a	1.367±0.0237 ^b	1.37±0.023 ^b	0.000*
FL:SL	1.11±0.016 ^a	1.163±0.021 ^b	1.16±0.022 ^b	0.000*
SL:HL	4.05±0.214 ^a	4.21±0.179 ^b	4.08±0.255 ^a	0.010*
SL:PrDL	2.22±0.053 ^a	2.26±0.065 ^b	2.21±0.051 ^a	0.007*
SL:HtB	3.32±0.182 ^b	2.81±0.180 ^a	2.87±0.259 ^a	0.000*
HL:PrOL	3.13±0.224 ^b	2.87±0.200 ^a	2.81±0.244 ^a	0.000*
HL:EDia	5.47±0.396 ^b	4.90±0.768 ^a	4.79±0.384 ^a	0.000*
HL:PsOL	2.04±0.171 ^a	2.28±0.248 ^b	2.29±0.161 ^b	0.000*
SL:LDFBs	4.56±0.269 ^b	3.69±0.261 ^a	3.72±0.277 ^a	0.000*
HL:LUJ	7.73±1.226 ^b	4.58±0.719 ^a	4.78±0.691 ^a	0.000*
SL:LtDtCP	7.20±0.559 ^a	6.98±0.425 ^a	7.05±0.499 ^a	0.213
HtB:LtDtCP	2.17±0.161 ^a	2.49±0.220 ^b	2.47±0.218 ^b	0.000*
LCP:LAFBs	2.10±.262 ^c	1.71±0.192 ^b	1.50±0.249 ^a	0.000*
SL:EDia	22.15±1.925 ^b	20.63±3.418 ^a	19.50±1.507 ^a	0.000*

*significantly different at 5% level of significance

The rohu×calbasu putative hybrids showed nearly intermediate range in respect of the morphometric ratios SL:EDia, LCP:LAFBs. In respect of TL:SL, SL:FL, HL:PrOL, HL:PsOL, HL: EDia and HtB:LtDtCP the hybrids resembled more toward calbasu. The hybrids crossed the range of both original species in respect of SL:HL, SL:PrDL, HtB:EDia. The hybrids showed lower range than the range of both single species rohu and calbasu in respect of SL:HtB, SL:LDFBs, HL:LUJ. The barbel was absent in putative hybrid rohu×calbasu; while barbel was present in calbasu.

Meristic characters of putative hybrids: Significant differences between catla×rohu putative hybrid and the original species of catla and rohu were found at 5% level of significance ($p<0.05$) in different meristic characters. Number of unbranched pelvic fin ray, number of unbranched caudal fin ray were same for the putative hybrid and catla and rohu (Table 3).

Table 3: Meristic characters of catla×rohu putative hybrid and in the single species of catla and rohu

Characters	catla (Mean±SD)	catla×rohu (Mean±SD)	rohu (Mean±SD)	p-value
Scales on lateral line	41.63±0.346 ^c	40.03±0.556 ^a	40.83±0.461 ^b	0.000*
Scale above lateral line	7.13±0.403 ^c	6.90±0.504 ^b	6.57±0.504 ^a	0.000*
Scales below lateral line	5.93±0.254 ^a	5.97±0.320 ^a	6.10±0.548 ^a	0.229
Total number of dorsal fin rays	17.33±10.155 ^c	15.33±0.802 ^b	14.10±0.403 ^a	0.000*
Number of branched dorsal fin ray	14.63±1.326 ^c	13.33±0.802 ^b	12.10±0.403 ^a	0.000*
Number of unbranched dorsal fin ray	2.70±0.651 ^b	2.00±0.000 ^a	2.00±0.000 ^a	0.000*
Total number of pectoral fin ray	15.03±1.033 ^c	15.93±0.828 ^b	14.00±0.830 ^a	0.000*
Number of branched pectoral fin ray	13.77±1.073 ^b	14.93±0.828 ^c	12.03±0.890 ^a	0.000*
Number of unbranched pectoral fin ray	1.27±0.450 ^b	1.00±0.000 ^a	1.97±0.183 ^c	0.000*
Total number of pelvic fin ray	8.97±0.183 ^a	9.00±0.000 ^a	9.00±0.000 ^a	0.372
Number of branched pelvic fin ray	7.97±0.183 ^a	8.00±0.000 ^a	8.00±0.000 ^a	0.372
Number of unbranched pelvic fin ray	1.00±0.000	1.00±0.000	1.00±0.000	--
Total number of caudal fin ray	19.03±0.183 ^b	18.97±0.183 ^b	18.80±0.407 ^a	0.005*
Number of branched caudal fin ray	17.03±0.183 ^b	16.97±0.183 ^b	16.80±0.407 ^a	0.005*
Number of unbranched caudal in ray	2.00±0.000	2.00±0.000	2.00±0.000	--
Number of rudimentary caudal fin ray	7.53±1.137 ^b	8.20±1.324 ^c	5.20±0.997 ^a	0.000*
Total number of anal fin ray	8.17±0.648 ^b	8.00±0.000 ^b	7.00±0.000 ^a	0.000*
Number of branched anal fin ray	6.20±0.887 ^a	6.00±0.000 ^a	6.00±0.000 ^a	0.223
Number of unbranched anal fin ray	1.97±0.556 ^b	2.00±0.000 ^b	1.00±0.000 ^a	0.000*

*significantly different at 5% level of significance

Significant differences between rohu×calbasu putative hybrid, rohu and calbasu were found at 5% level of significance ($p<0.05$) in different meristic characters (Table 4).

Table 4: Meristic characters of rohu×calbasu putative hybrid and single species of rohu and calbasu

Characters	rohu (Mean±SD)	rohu×calbasu (Mean±SD)	calbasu (Mean±SD)	p-value
Scales on lateral line	40.83±0.461 ^a	41.20±0.664 ^b	41.33±0.884 ^b	0.018*
Scale above lateral line	6.57±0.504 ^a	7.50±0.509 ^b	7.60±0.621 ^b	0.000*
Scales below lateral line	6.10±0.548 ^a	6.17±0.379 ^a	6.13±0.346 ^a	0.838
Total number of dorsal fin rays	14.13±0.434 ^a	16.53±1.008 ^b	16.63±1.066 ^b	0.000*
Number of branched dorsal fin ray	12.13±0.434 ^a	14.53±1.008 ^b	14.63±1.066 ^b	0.000*
Number of unbranched dorsal fin ray	2.00±0.000	2.00±0.000	2.00±0.000	--
Total number of pectoral fin ray	14.00±0.830 ^a	15.50±0.682 ^b	16.20±1.031 ^c	0.000*
Number of branched pectoral fin ray	12.03±0.890 ^a	14.50±0.682 ^b	14.67±1.184 ^b	0.000*
Number of unbranched pectoral fin ray	1.97±0.183 ^c	1.00±0.000 ^a	1.53±0.507 ^b	0.000*
Total number of pelvic fin ray	9.00±0.000	9.00±0.000	9.00±0.000	--
Number of branched pelvic fin ray	8.00±0.000	8.00±0.000	8.00±0.000	--
Number of unbranched pelvic fin ray	1.00±0.000	1.00±0.000	1.00±0.000	--
Total number of anal fin ray	7.00±0.000 ^a	8.00±0.000 ^b	8.07±0.365 ^b	0.000*
Number of branched anal fin ray	6.00±0.000 ^a	6.00±0.000 ^a	6.30±0.535 ^b	0.000*
Number of unbranched anal fin ray	1.00±0.000 ^a	2.00±0.000 ^c	1.77±0.430 ^b	0.000*
Total number of caudal fin ray	18.80±0.407 ^a	18.63±0.669 ^a	18.63±0.490 ^a	0.380
Number of branched caudal fin ray	16.80±0.407 ^a	16.63±0.669 ^a	16.63±0.490 ^a	0.380
Number of unbranched caudal in ray	2.00±0.000	2.00±0.000	2.00±0.000	--
Number of rudimentary caudal fin ray	5.20±0.997 ^a	8.00±1.050 ^b	8.60±1.303 ^c	0.000*

*significantly different at 5% level of significance

No meristic characters of putative hybrids was found to show intermediate range; while there was no difference in the number of unbranched caudal fin ray, total number of pelvic fin ray, number of unbranched pelvic fin ray and number of branched pelvic fin ray between putative hybrids rohu×calbasu and the original species rohu and calbasu. They resembled calbasu in respect of the number of scales on lateral line, scales above lateral line, number of total and branched dorsal fin ray, number of rudimentary caudal fin ray, number of total anal fin ray, number of total and branched pectoral fin ray. The hybrids crossed the range of both original species in respect of scales below the lateral line. The hybrids showed lower range than the range of both original species in respect of number of unbranched pectoral fin ray. Number of unbranched dorsal and caudal fin ray, number of total, branched and unbranched pelvic fin ray were same for putative hybrids, catla and rohu. There was no difference between rohu and putative hybrids in respect of number of branched anal fin ray. There was no difference between calbasu and putative hybrids in respect of number of total and branched caudal fin ray.

Discussion

Incidence of hybridization was found to be very high especially for catla×rohu putative hybrid than rohu×calbasu; others were quite rare in the study region. Comparison of the taxonomic characters of putative hybrid, namely catla×rohu and rohu×calbasu with their

original species, catla and rohu, rohu and calbasu, revealed that the hybrids were not intermediate between the two original species with respect to most taxonomic characters. Reddy and Varghese (1980a) reported that the putative hybrid, namely catla×rohu had D. 17-18, 3/ (14-15), P.18, V. 9, A. 8, C. 19, L1 42-43, and L.tr. 7.5/9.5. The present study showed D. 14-16, 2/ (12-14), P. 14-17, V. 9, A. 8, C. 18-19, L1 39-41, and L.tr. 5.97/6.90. The two original species, catla and rohu, showed difference in the number of scale above lateral line, total number of dorsal fin ray, number of branched dorsal fin ray and the putative hybrids of catla×rohu exhibited intermediate range in respect of these characters. However, the hybrids exhibited greater resemblance with catla in respect of the number of scales below lateral line, total number of anal fin ray, total number of caudal fin ray and number of branched caudal fin ray, while they were closer to rohu in respect of number of unbranched dorsal fin ray, number of branched anal fin ray, total number of pelvic fin ray, number of branched pelvic fin ray and number of unbranched caudal fin ray. The hybrids crossed the range of both the original species in respect of number of unbranched anal fin ray, number of rudimentary caudal fin ray, total number of pectoral fin ray, number of branched pectoral fin ray and showed lower range than the range of both the single species in respect of number of scales on the lateral line and number of unbranched pectoral fin ray. Desai and Rao (1970) found that in a natural hybrid of catla-rohu, the number of dorsal fin rays was intermediate between that of two parental species, where as the number of pectoral fin rays was same as in catla. According to Natarajan *et al.* (1976), the catla-rohu hybrid recorded from Rihand reservoir in Uttar Pradesh showed intermediate range in meristic counts in respect of dorsal fin rays and pectoral fin rays. They have also observed that in respect of anal fin rays, the hybrids resembled neither parents, showing counts much below the anal fin rays counts of the parents. In the present study, the hybrids also showed intermediate range in respect of number of total dorsal fin ray, number of branched dorsal fin ray, while the number of total pectoral fin ray, number of branched pectoral fin ray were higher and number of unbranched pectoral fin were lower than both the original species. These results agree with the findings of Tripathi *et al.* (1974). However, number of unbranched pelvic and caudal fin ray counts was found to be the same as in the parental species.

The catla×rohu putative hybrid showed intermediate range in respect of the ratios, standard length:post orbital length, standard length:length of the base of dorsal fin, and standard length:eye diameter; while standard length:head length, standard length:height of the body, head length:eye diameter, standard length:least depth of caudal peduncle and height of the body:least depth of caudal peduncle the putative hybrids resemble more of catla. From these ratios it could be inferred that the body and head of catla×rohu putative hybrid resembled catla, not same as catla but both are higher than rohu. Dorsal profile of the putative hybrid catla×rohu was more convex than the ventral. The result in some extent agreed with the findings of Chaudhuri (1973), Natarajan *et al.* (1976) and Reddy and

Varghese (1980a). Chaudhuri (1973) stated that in catla-rohu F₂ hybrids, the head was smaller than that of catla (but the ratio is more toward catla) and body broader than that of rohu. Natarajan *et al.* (1976) also found that the catla×rohu hybrid had a general appearance of catla having head conspicuously smaller than catla, but body deeper than rohu. Reddy and Varghese (1980) stated that in catla×rohu / rohu×catla hybrid dorsal profile more convex than the ventral. Paulsen (1995) found that large eyes as indicators of reduced growth. In his study, the ratio between standard length and eye diameter show nearly intermediate range. In the present study, the ratio between standard length of fish and least depth of caudal peduncle was less in the hybrids as compared to the single species of rohu. This showed that the caudal peduncle was broader in the hybrids as catla than rohu. It stated that the hybrids cross the range of both original species in respect of ratio, total length:standard length, that means hybrid had lower standard length than the both the original species.

Putative hybrids (rohu×calbasu) in the present study showed nearly intermediate range with respect to morphometric ratios, standard length:eye diameter and length of caudal peduncle:length of anal fin base. In respect of total length:standard length, standard length:fork length; head length:preorbital length, head length:post orbital length, head length: eye diameter, the hybrids resemble more of calbasu. The putative hybrids crossed the range of both single species in respect of the ratios, standard length:head length, standard length: pre dorsal length while showed lower range than the range of both original species in respect of standard length: body height, standard length:length of dorsal fin base and head length:length of upper jaw. The barble was absent in putative hybrid (rohu×calbasu) and rohu; while barble was present in calbasu. It was seen that rohu×calbasu hybrid had a general appearance of calbasu while barble was absent. So it does not full fill the major goal of hybridization. The references mentioned in the foregoing are based on the studies conducted hybrids produced experimentally and reared under closed and control conditions. The present study was based on hybrid samples collected from markets and were presumed to be produced from the large number of hatcheries established in the greater Khulna, Jessore and Satkhira. Thus the variations observed in the taxonomic features are likely. The principal concerns are for the negative impact of the activity of unplanned heterospecific mixing of the gametes that can bring introgression in the gene pool of the relevant species. The presence of even a few numbers of hybrids among the lot of other pure species (Indian major carps) may be detrimental to the genetic quality in the long run.

Conclusion

The incidence of hybridization was very frequent especially between catla and rohu than between rohu and calbasu; other types of crosses were quite rare. In the present study most of the morphometric and meristic characters showed significant differences between putative hybrids and their single species. But the characters that are actually desired in the hybrids were found almost absent in the putative hybrids except in few cases. Most of the characters of putative hybrids were not found in intermediate range and some were found deflected more toward the original species which actually not desirable in aquaculture. But few characters were positive in that regard. Unplanned heterospecific mixing of gametes is

detrimental, for it can bring introgression of gene pool of the concerned species and bring havoc in the natural gene pool of cultivable species. So, unplanned hybridization should be stopped. Modern technique of genetic variation should be applied for correct and faster taxonomic identification of the hybrids.

References

- Alikunhi, K.H. and Chaudhuri, H., 1959. Preliminary observations on hybridization of the common carp (*Cyprinus carpio*) with Indian carps. *Proceedings of the Indian Science Congress*, 3: 46-47
- Alikunhi, K.H.; Sukumaran, K. K. and Parameswaran, S., 1963. Induced spawning of Chinese carps, *Ctenopharyngodon idellus* and *Hypophthalmichthys molitrix* in ponds at Cuttack, India. *Proceeding Indo-Pacific Fishery Commission*, 10(2): 181–204
- Chaudhuri, H., 1959. Experiments on hybridization of Indian carps. *Proceedings of the Indian Science Congress*, 46(4): 20–21
- Chaudhuri, H., 1971. Fish hybridization in Asia with special reference to India. Lectures, Seminar/Study tour in the USSR, on “Genetic Selection and Hybridization of cultivated fishes”. 19 April–29 May 1968. Food & Agricultural Organization Representative (TA), 2926: 151–159
- Chaudhuri, H., 1973. Fertility of hybrids of Indian carps and preliminary studies on the F2 generations of carp hybrids. *Journal of the Inland Fisheries Society of India*, 5: 195–200
- Desai, V.R. and Rao, K.J., 1970. On the occurrence of natural hybrid of catla-rohu in Madhya Pradesh. *Journal of the Zoological Society of India*, 22 (1 & 2): 35–40
- Hamsa, N., 1972. *Studies on some cyprinid hybrids*. Ph.D. Thesis, Bombay University, Bombay
- Hamsa, N. and Alikunhi, K.H., 1971. Preliminary studies on upgrading *Cirrhinus reba* by hybridization. *Journal of the Indian Fisheries Association*, 1(1): 68–73
- Hussain, M.G.; Barman, B.K.; Das, T.K.; Islam, M.; Khan, M.I.; Shah, M.S.; Mair, G.C.; Bart, A.; Islam, M.N.; Mia, M.Y. and Sharia, S., 2002. Workshop on “Strategies for Genetic Management and Improvement”. Discussion Groups, Aquaculture and Fish Genetics Research Program, DFID.112pp
- Ibrahim, K.H.; Kowtal, G.V. and Gupta, S.D., 1980. Embryonic and larval development among *Catla catla* (Hamilton) x *Hypophthalmichthys molitrix* (Valenciennes) hybrid. *Journal of the Inland Fisheries Society of India*, 12(2): 69–73
- Natarajan, A.V.; Desai, V.R. and Mishra, D.N., 1976. On the natural occurrence of the intergeneric catla-rohu hybrid in Rihand (Uttar Pradesh) with an account of its potential role in reservoir fisheries development in India. *Journal of the Inland Fisheries Society of India*, 8: 83–90
- Penman, D.J.; Mair, G.C.; McAndrew B.J.; Hussain, M.G.; Basavaraju and Tuan, S.P.A., 2002. Genetic management of non-indigenous carps for low input aquaculture systems in Asia. *Aquaculture News*, 19: 19-22

- Sultana S., Shah M.S., Ghosh A.K. and Bir J. 2016. Taxonomic study on the supposed hybrids of Indian major carps and Chinese carps in the local markets of Khulna, Jessore and Satkhira district, Bangladesh. *Khulna University Studies* Volume 13 (1) : 55-64
- Paulsen, H., 1995. *Large eyes as indicators of reduced growth rate*. Danish Institute for fisheries research project: 150-157
- Reddy, P.K., 1977. *Studies on taxonomic characters and growth of catla-rohu and rohu-catla hybrids*. M.F.Sc. Thesis, University of Agricultural Science, Bangalore. 136pp
- Reddy, P.K., and Varghese, T.J., 1980. On the taxonomic characters of two major carp hybrids, catla-rohu and rohu-catla. *Proceedings of the Indian Academy of Sciences*, 89(5): 419–429
- Tripathi, S.D.; Sinha, N.K. and Sharof, R.K., 1974. Hybrid carp from Adartal Lake, Jabalpur. *Jabalpur Nehru Krishi Vishwavidyalaya Research Journal*, 8(3): 165–169
- Varghese, T.J. and Sukumaran, K.K., 1971. Notes on hypophysation of catla-rohu hybrid. *Annual Day Souvenir*, CIFE, Bombay: 16–17