MORPHOMERISTIC CHARACTERS AND LENGTH-WEIGHT RELATIONSHIP OF WILD AND CULTURED MOLA CARPLET, *Amblypharyngodon mola* (HAMILTON, 1822)

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The present study was conducted to check the disparity between wild and cultured stock of *Amblypharyngodon mola* using the bio-morphometric data and meristic characteristics such as length-weight relationship (LWR) and relative gut length (RGL). A total of 656 specimens were collected using drag net and cast net for a period of one year from Daya river and about 226 fish individuals were collected from hatchery bred stock of ICAR-CIFA, Bhubaneswar, India. No significant ($P > 0.05$) differences were observed in five meristic and twenty-two morphometric characters of wild and cultured stocks of mola. The estimated regression line showed a better relationship between the total length (TL) to standard length, fork length, pre-dorsal and post-dorsal length, orbit diameter (r^2 value). Further, a negative allometric growth was also noticed in both stocks with the b value of 2.988 and 2.844 with r^2 value of 0.915 and 0.923 in the wild and hatchery bred stocks respectively. Analysed length and weight were highly significant ($P<0.01$). The TL max of 9.1 cm was recorded in present study which is higher than that reported in Fish Base.

INTRODUCTION

Amblypharyngodon mola, vernacularly known as mola carplet in English and mahuradi in Odia (State language of Odisha State of India) is an economically as well as nutritionally enriched small indigenous fish species, having rich content of vitamin A (Baishya *et al.,* 2010; Gupta and Banerjee, 2014; Gogoi and Goswami, 2015; Ahmed *et al.,* 2017) is a potential species for aquaculture and recently used for income generation and protein supplementation. It has gained much attention in the form of mola aquaculture as people look for species diversification and nutritional quality. Recently, mola is being cultured in earthen ponds in India and other countries. The seed for this culture is sourced from natural habitats and ponds where auto spawning of this species takes place. In recent years, due to rampant and over use of agricultural pesticides, the population of mola from natural habitats is depleting very fast. Hence, its propagation and culture has become essential to save this species.

The morphometry and some other biological parameters (gut length, GSI, fecundity etc.) has been studied by earlier workers (Azadi and Mamun, 2004; Hoque and Rahman, 2008; Saha *et al.,* 2009; Naeem *et al.,* 2012; Mondal and Kaviraj, 2013). LWR of mola has been earlier studied and reported by other workers (Hossain *et. al.,* 2006; Suresh *et.al.,* 2007; Baishya, *et al.,* 2010; Gogoi and Goswami, 2014). Further, it has been reported that

geographical location/feature also plays an important role in the LWR of fish (Naeem *et al.,* 2012). It is also believed that length-weight parameters of the same species may vary among different populations/stock due to variations in feeding, reproductive activities, habitat etc. The disparity in stock could be measured by different methods, length and weight relationship is one of the reliable and easiest methods to evaluate or assess a stock. Even it was also used to conserve and manage the fishery resources in a sustainable way. Though many workers have studied the morphology and meristic characters of this species that are either cultured or found in a natural system (lake river, canal, wet land) but they did not compare between any wild and cultured stock. So, the present study was conducted to compare the morphomeristic characters and LWR of mola from two distinct habitats such as river and cultured tanks (hatchery bred stock reared in cemented tanks).

MATERIALS AND METHODS

The present study was conducted to assess the disparities if any that may exist between wild and cultured *A. mola* by adapting morphometric and meristic characteristics, length-weight relationship, and relative gut length. The wild samples were caught from the river Daya in the vicinity of Bhubaneswar city (19.87˚N and 85.55˚E) using gill/cast net for a period from January 2016 to December 2016. Fish were identified (Talwar and Jhingran,1991) and confirmed from FishBase. The cultured fish obtained from hatchery bred stock of *A. mola* from Carp Breeding Unit, ICAR-Central Institute of Freshwater Aquaculture, Bhubaneswar (18˚42" N and 34˚9" E). A total of five meristic and twenty-two morphometric characters (total body length (TBL), fin length (FL), Standard Length (SL), post-dorsal-length (PDL), pre-dorsal length (PDL), head length (HL), post-orbit length (POL), pre-orbital length (POL), orbital diameter (OL), dorsal fin length (DFL), head depth (HD), maximum body depth (MaxBD), minimum body depth (MinBD), anal fin height (AFH), pectoral fin height (PFH), ventral fin height (VFH), pre-ventral fin length (PVF), pre-pectoral fin length (PPFL), distance between pectoral and anal fin (DPA), and distance between ventral and anal fin (DVA) were studied following standard procedures (Rao, 1966; Dwivedi and Menezes, 1974).

A total of 882 fish, which comprised of 656 wild and 226 cultured fish were used to establish length-weight relationship. Total length (cm) and total weight (g) were measured using scale and digital electronic weighing balance (Afcoset, ER-2000 A) respectively. The collected data were used to calculate the LWR of the fish by expression $W= aL^b$ (Le Cearn, 1951) whereas, W is the total weight (g), L is the total length(cm), a is the intercept and b is the coefficient of regression (Forese, 2006, Nobile *et al.,* 2015). Based on the estimated LWR equation, weight of the individual fish was predicted. Each individual length assemblage was determined from number of fish sampled in each individual length of *A. mola*. Relative gut length was calculated using the formula: gut length/total body length. All data were analysed using Microsoft office 2010 and SPSS 20. The value of $P<0.05$ has been used to estimate the level of significance.

RESULTS

The summary statistics of the meristic and morphometric characteristics of the wild and cultured mola are presented in Table 1 and 2 respectively. A small variation observed between both the stocks, but it was not statistically significant. Total length had a linear regression relationship for wild and cultured *A. mola* to the fork length (Fig. 1), standard length (Fig. 2), post-dorsal length (Fig. 3), pre-dorsal length (Fig. 4), head length (Fig. 5).

Table 1: Meristic characteristics of wild and cultured *A. mola*

Particulars	Wild			Cultured		
	Range	Mean	Standard deviation	Range	Mean	Standard deviation
No. of lateral line scales	10 - 21	15.45	2.45	11 - 25	18.00	3.92
Pectoral fin rays	12 - 18	14.97	1.46	10 - 18	14.56	2.10
Dorsal fin rays	11 - 22	17.57	2.38	8 - 21	16.21	4.14
Caudal fin rays	6 –23	11.05	4.14	10 - 19	13.20	2.43
Anal fin rays	11 - 18	13.54	1.90	6 - 17	12.90	3.54
Ventral fin rays	14 - 16	15.12	1.02	14 - 17	15.67	1.53

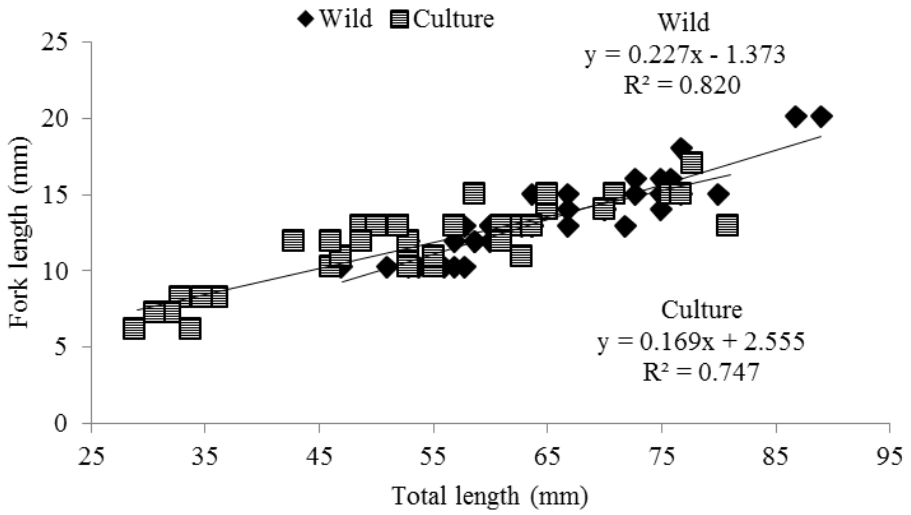

Fig. 1. Relationship between the total length and fork length

Table 2: Morphometric characteristics of wild and cultured *A. mola*

Particulars (in mm)	Wild			Cultured		
	Range	**Mean**	**Standard deviation**	**Range**	**Mean**	**Standard deviation**
Total body length	47 - 89	65.50	9.89	10 - 81	42.81	24.25
Fork length	10 - 64	22.65	17.06	6 - 59	23.00	18.31
Standard length	12 - 69	50.75	10.08	22 - 65	42.00	11.41
Post -dorsal length	28 - 53	39.45	5.87	12 - 47	31.08	8.91
Pre- dorsal length	18 - 38	27.80	4.27	12 - 44	21.59	8.32
Head length	10 - 19	13.68	1.98	6 - 16	10.59	3.25
Post-orbital length	5 – 9	7.20	0.94	3 - 8	5.38	1.85
Pre-orbital length	2 – 5	3.00	0.68	2 - 5	3.05	0.88
Orbital diameter	3 – 6	4.48	0.64	2 - 14	5.89	3.48
Dorsal fin length	8 - 14	11.13	1.68	4 - 13	9.30	2.65
Head depth	7 - 14	10.53	1.84	4 - 14	10.19	2.89
Maximum body depth	11 - 24	15.40	3.14	5 - 20	9.68	4.33
Minimum body depth	3 - 9	6.05	1.32	3 - 7	5.49	1.54
Anal fin height	5 - 10	7.38	1.27	4 - 78	8.38	11.85
Pectoral fin height	7 - 13	9.33	1.46	4 - 11	8.16	1.83
Ventral fin height	5 - 11	7.70	1.20	3 - 9	6.95	1.68
Pre-ventral fin length	13 - 43	27.88	6.07	11 - 34	23.68	6.32
Pre-pectoral fin length	11 - 19	13.73	1.87	5 - 17	12.62	3.10
Pre-anal fin length	24 - 51	35.55	6.20	12 - 45	30.86	8.16
Distance from anal fin to caudal fin base	14 - 36	22.75	7.82	13 - 38	24.14	7.98
Distance between pectoral and anal fin	14 - 35	23.71	4.47	9 - 35	20.35	5.98
Distance between ventral & pectoral fin	8 - 19	13.17	3.27	7 - 18	10.68	2.64

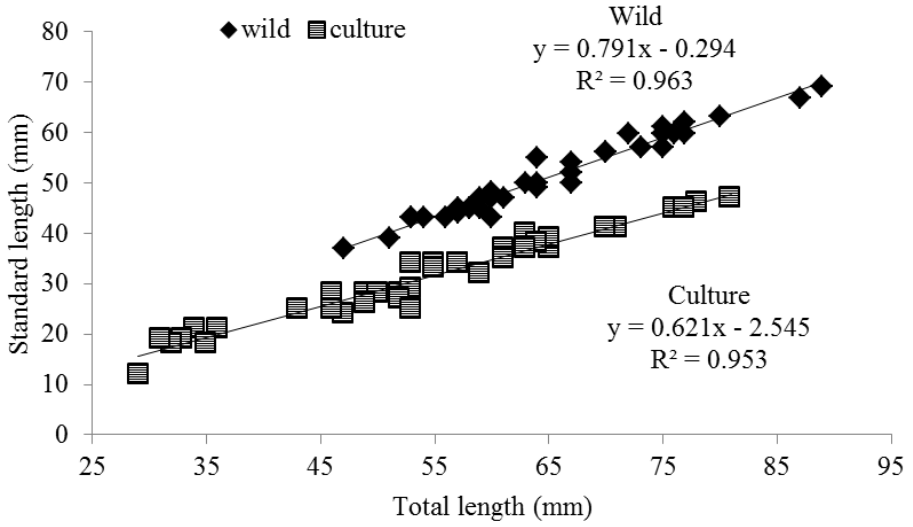

Fig. 2. Relationship between the total length and standard length

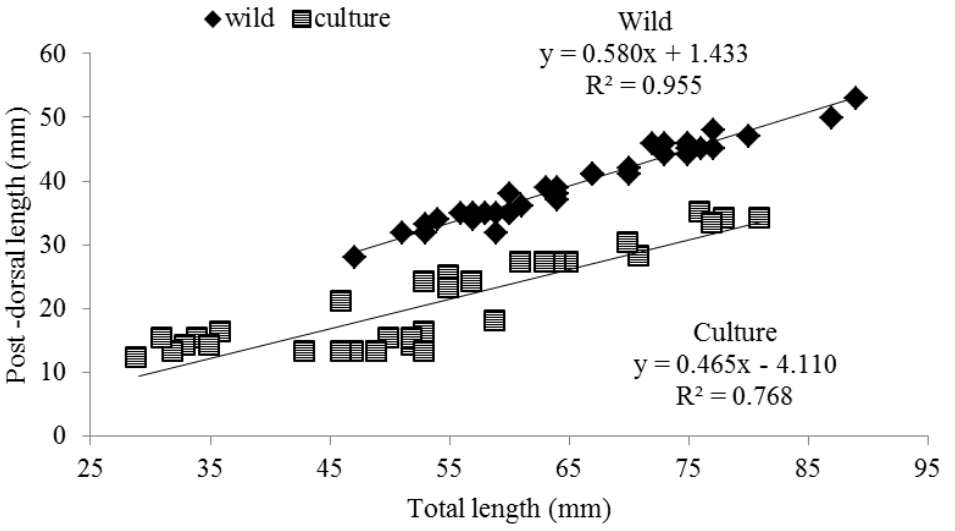

Fig. 3. Relationship between the total length and Post -dorsal length

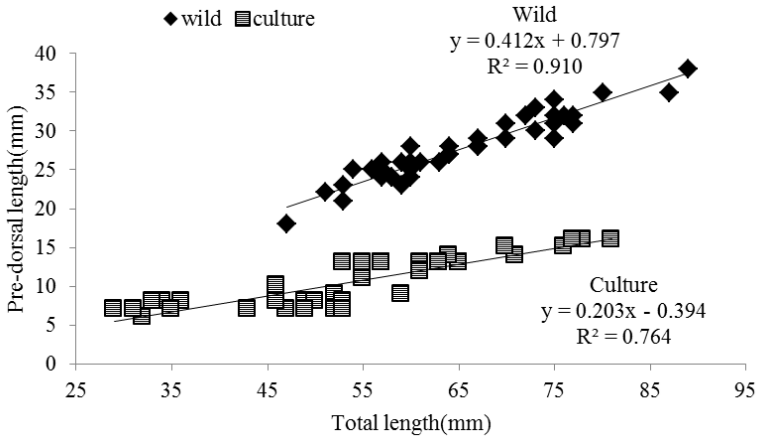

Fig. 4. Relationship between the total length and Pre-dorsal length

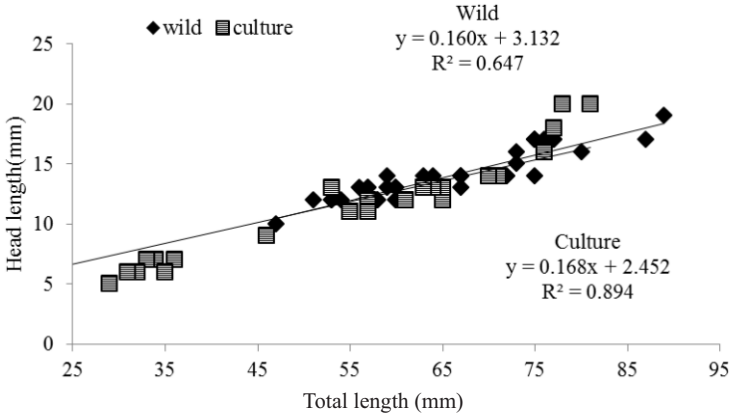

Fig. 5. Relationship between the total length and head length

The detailed information of the sample size, total length range (mm) body weight range (mg), LWR parameters with 95% CI of a and b, and coefficient of determination (r^2) were depicted in Table 3. Overall length-weight relationship of wild mola can be expound by the equation $Y= 0.009X^{2.988}$ ($r^2 = 0.9153$, n= 656) (Fig. 6) and cultured mola can be elucidated by the equation $Y =0.009X^{2.844}$ ($r^2 =0.9234$, n = 226) (Fig. 7), where Y is the predicted individual weight of fish (g), and X is measured total length (mm). The predicated weight of wild (Table 4) and cultured mola (Table 5) as explained by the models which closely coincide with the actual mean weight of group indicating the possibility of future use by researchers and aqua industry.

Table 3: Descriptive and length-weight relationship of the *A. mola*

	Length (cm)		Weight (g)		Length-weight relationship parameters							
Source of fish	Min	Max	Min	Max	a value	b value	95% cl of a	95% cl of b	t stat-a	t stat-b	r^2	r value
Daya River	3.4	9.1	0.27	7.69	0.009	2.988	0.007-0.01	2.918-3.057	-74.84	84.10	0.9153	0.9567
Cultured bred	2.10	6.30	0.07	1.78	0.009	2.844	0.008-0.011	2.737-2.952	-53.82	51.98	0.9234	0.9230

a and b are regression coefficient, Multiple r is the correlation coefficient and r square is the coefficient of determination.

Table 4: Length-weight relationship of wild and number of fish sampled for individual length of *A. mola*

Sl no	Length (cm)	Predicted value (Min - Max)	Actual estimated mean value (g)	Sample size (n)
1.	3.4	0.35 (0.27 - 0.27)	0.27	1
2.	3.5	0.38 (0.33 - 0.4)	0.37	2
3.	3.7	0.45 (0.42 - 0.42)	0.42	2
4.	3.9	0.53 (0.47 - 0.84)	0.60	6
5.	4	0.57 (0.46 - 0.63)	0.56	9
6.	4.1	0.61 (0.56 - 1.02)	0.80	6
7.	4.2	0.66 (0.48 - 1.12)	0.78	12
8.	4.3	0.7 (0.53 - 1.19)	0.84	11
9.	4.4	0.75 (0.67 - 1.31)	0.94	11
10.	4.5	0.81 (0.66 - 1.36)	0.86	15
11.	4.6	0.86 (0.73 - 1.24)	0.98	22
12.	4.7	0.92 (0.73 - 1.22)	0.91	20
13.	4.8	0.98 (0.68 - 1.19)	0.98	17
14.	4.9	1.04 (0.72 - 1.12)	0.98	13
15.	5	1.1 (0.76 - 1.25)	1.10	20
16.	5.1	1.17 (0.81 - 1.6)	1.12	14
17.	5.2	1.24 (0.95 - 1.49)	1.21	16
18.	5.3	1.31 (0.84 - 2.19)	1.22	28
19.	5.4	1.39 (1.03 - 2.04)	1.35	9
20.	5.5	1.47 (0.99 - 2.27)	1.40	27
21.	5.6	1.55 (1.14 - 2.35)	1.59	12
22.	5.7	1.63 (1.07 - 2.17)	1.61	23
23.	5.8	1.72 (1.14 - 2.41)	1.57	27
24.	5.9	1.81 (1.22 - 2.09)	1.63	23
25.	6	1.9 (1.21 - 3.29)	1.87	27
26.	6.1	2 (1.48 - 2.76)	2.02	17
27.	6.2	2.1 (1.65 - 2.99)	2.19	32
28.	6.3	2.2 (1.4 - 3.61)	2.17	17

29.	6.4	2.31 (1.78 - 2.91)	2.37	14
30.	6.5	2.42 (1.71 - 2.65)	2.29	20
31.	6.6	2.53 (2.42 - 3.17)	2.67	15
32.	6.7	2.65 (1.7 - 2.87)	2.50	23
33.	6.8	2.77 (2.28 - 3.25)	2.87	16
34.	6.9	2.89 (2.09 - 3.18)	2.77	18
35.	7	3.02 (2.15 - 3.3)	2.78	9
36.	7.1	3.15 (2.21 - 3.32)	2.90	11
37.	7.2	3.28 (2.35 - 3.66)	3.16	7
38.	7.3	3.42 (3.13 - 3.9)	3.59	7
39.	7.4	3.56 (3.53 - 3.78)	3.66	2
40.	7.5	3.71 (3.28 - 4.91)	4.00	6
41.	7.6	3.86 (3.7 - 5.45)	4.45	6
42.	7.7	4.01 (3.55 - 4.84)	4.44	6
43.	7.8	4.17 (3 - 5.4)	4.43	9
44.	7.9	4.33 (4.26 - 5.88)	5.24	13
45.	8	4.49 (5.6 - 5.88)	5.76	3
46.	8.1	4.66 (3.06 - 5.76)	4.83	5
47.	8.2	4.84 (5.61 - 6.73)	6.07	5
48.	8.3	5.02 (5.45 - 5.97)	5.75	3
49.	8.4	5.2 (3.78 - 3.78)	3.78	1
50.	8.5	5.39 (5.93 - 6.97)	6.30	7
51.	8.6	5.58 (5.89 - 7.7)	6.49	3
52.	8.7	5.77 (6.78 - 6.78)	6.78	2
53.	8.8	5.98 (7.07 - 7.07)	7.07	1
54.	8.9	6.18 (6.98 - 7.09)	7.03	3
55.	9	6.39 (5.04 - 5.04)	5.04	1
56.	9.1	6.6 (6.12 - 6.12)	6.12	1

Table 5: Length-weight relationship of cultured fish and number of fish sampled for each individual length of *A. mola*

Sl no	Length (cm)	Predicted value (Min - Max)	Actual estimated mean value	Sample size (n)
1.	2.1	0.08 (0.07 - 0.07)	0.07	1
2.	2.4	0.12 (0.11 - 0.11)	0.11	1
3.	3.6	0.37 (0.33 - 0.39)	0.36	2
4.	3.7	0.39 (0.4 - 0.49)	0.44	2
5.	3.8	0.43 (0.46 - 0.46)	0.46	1
6.	3.9	0.46 (0.45 - 0.57)	0.52	3
7.	4	0.49 (0.43 - 0.44)	0.43	3
8.	4.1	0.53 (0.58 - 0.58)	0.58	1
9.	4.2	0.57 (0.48 - 0.61)	0.54	2
10.	4.3	0.61 (0.54 - 0.68)	0.61	7
11.	4.4	0.65 (0.56 - 0.76)	0.65	16
12.	4.5	0.69 (0.61 - 0.83)	0.71	12
13.	4.6	0.73 (0.62 - 0.86)	0.73	18
14.	4.7	0.78 (0.67 - 0.94)	0.77	25
15.	4.8	0.83 (0.71– 10)	0.83	21
16.	4.9	0.88 (0.77 - 1.13)	0.9	22
17.	5	0.93 (0.8 - 1.19)	0.92	18
18.	5.1	0.98 (0.85 - 1.17)	0.97	13
19.	5.2	1.04 (0.91 - 1.25)	1.1	10
20.	5.3	1.1 (0.99 - 1.45)	1.12	12
21.	5.4	1.16 (1.03 - 1.49)	1.17	11
22.	5.5	1.22 (1.07 - 1.42)	1.16	8
23.	5.6	1.28 (1.28 - 1.56)	1.42	2
24.	5.7	1.35 (1.43 - 1.47)	1.45	2
25.	5.8	1.42 (1.3 - 1.42)	1.37	3
26.	5.9	1.49 (1.36 - 1.6)	1.48	2
27.	6	1.56 (1.58 - 1.78)	1.66	3
28.	6.1	1.64 (1.49 - 1.49)	1.49	1
29.	6.2	1.71 (1.54 - 1.58)	1.56	2
30.	6.3	1.79 (1.75 - 1.77)	1.76	2

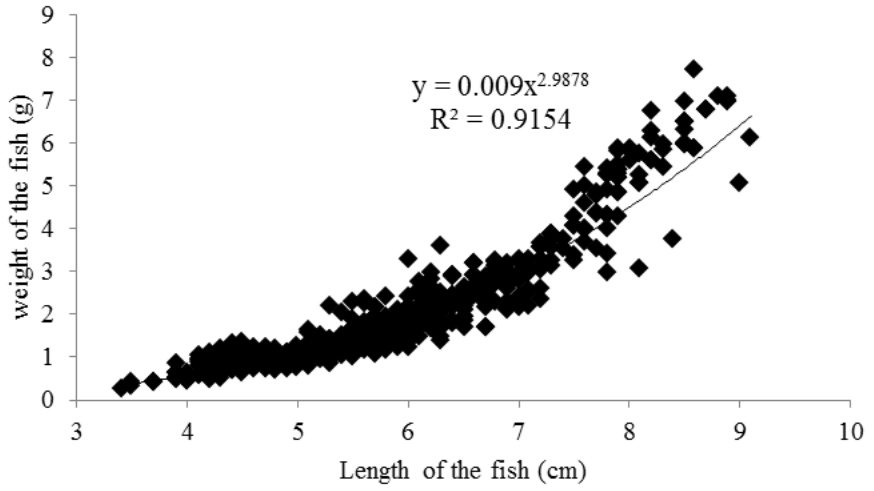

Fig. 6. Length and weight relationship of the wild *A. mola* (n=656)

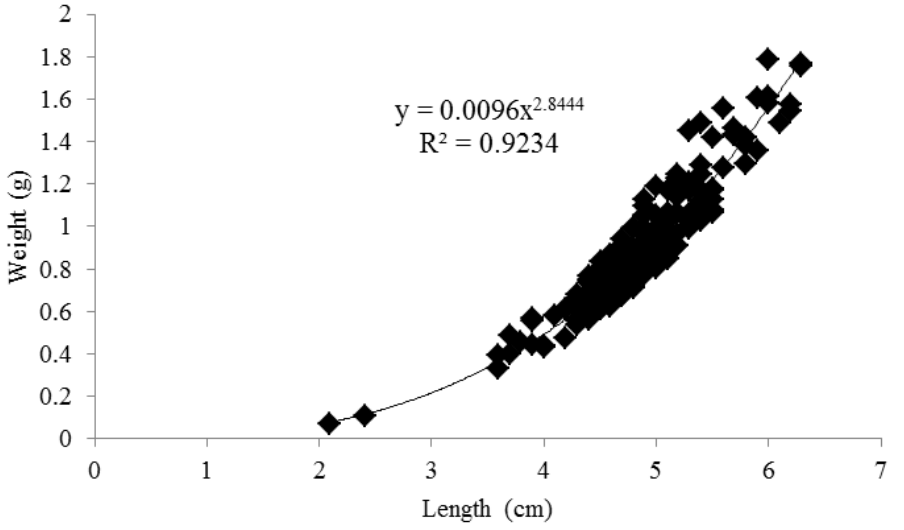

Fig. 7. Length and weight relationship of the cultured *A. mol*a (n=226)

Cultured mola had slender body than wild which evidenced from the average body weight. And, wild stock had greater female population (1:2.33; M: F ratio) than that of the cultured population (1:1.86; M: F ratio). The body and gut length are illustrated in Fig 8 that showed that there was no significant (P>0.05) difference observed between wild and cultured stock. There was high positive correlation observed between body weight and gut length of both stocks.

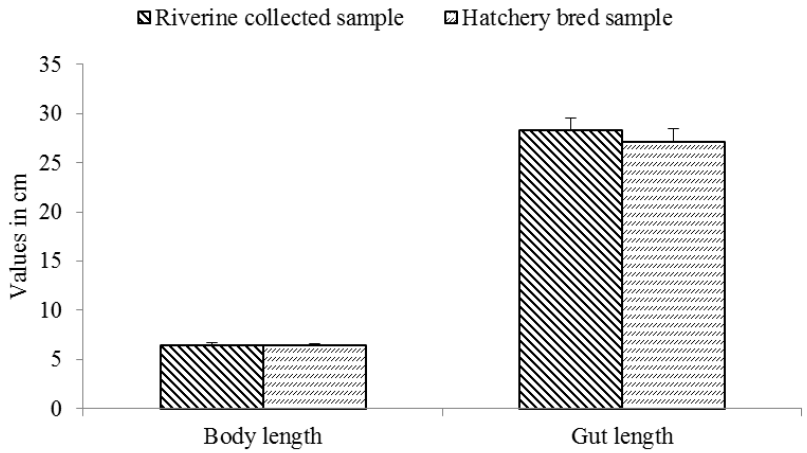

Fig. 8. Body length and gut length of *Amblypharyngodon mola*

DISCUSSION

The present study compared the morphomeristic characteristics and length-weight relationship (LWR) of wild collected and cultured *A. mola.* Both of these parameters are used to find out intra species variations between different populations. These phonetic characters are emerged from genotype, environmental factors and natural selection (Dobzansky, 1970; Fowler, 1970). Here, in our study, we found that the mean body length (65.50mm) was higher in wild sample than cultured (42.8mm). Variation in total length between two stocks may be due to the effect of Jordan's rule (Increase in body parts or sized with increase in latitude between the same species of different stocks). Fish are keen to environmental variations than any other vertebrates (Stearns, 1983; Allendorf *et al.,* 1987; Wimberger, 1992). In our study, we used classical dimension method to study the meristic count of mola, which is one of the most trusted methods (Straus and Bond, 1990, Park *et al.,* 2001, 2004, 2007). In the present study, total length had a linear relationship with standard length, fork length, pre-dorsal length post -dorsal length head length, and eye diameter of *A. mola*. Similarly, linear relationship was found between total length and different morphometric parameters of Catfish (Tiwari and Qureshi, 2003). Meristic characters of fish are determinant which indicated that meristic characters remain unchanged with length of the fish (Talwar and Jhingran, 1992; De-Silva and Liyanage, 2009; Renjini and Bijoy Nandan, 2011). Similarly,

no difference was recorded intra population of *Tor putitora* (Langer *et al.,* 2013), *Liza parsia* (Renjini and Nandan, 2011) and *Barilius bendelisis* (Hazharika, 2011). Similarly, linear relationship was found between the total length and different morphometric parameters of Catfish (Tiwari and Qureshi, 2003). Contrary, there was a significant difference observed between morphometric characters male and female of *A. mola* (Gogoi and Umesh, 2015).

Length-weight relationship (LWR) is easiest method to measure weight of the fish in field with use of length. Highest r^2 was observed in wild and cultured stock which indicates small dispersion of the data and very good prediction. The average value of a (0.005 to 0.01) and b (2.5 to 3.5) were within expected range (Froese, 2006). In the present study, cultured and wild mola had elongated bodies rather than thicker body, resulted in b value was less than 3 (negative allometric growth). The cultured fish had lesser b value (2.844) as compared to the wild fish (2.988). Sarkar *et al.,* (2013) studied the LWR of *A. mola* from the river of Ganga main channel, Gomti and Rapti and found a lower b value of 1.92, 1.82 and 1.91 respectively. Similarly, Devi and Das, (2017) also found a lower b value of 2.595 for wetland reared mola in Assam. This indicated that b value varies between place to place even persistence of similar kind of environment. It mainly influenced by the trophic base, shape, fatness (Carlender, 1977; Froese, 2006; Nobile *et al.,* 2015), age of the fish, season, and food (Yin, 1995; Xie *et al.,* 2018). Based on the LWR, the weight of each individual length was slightly dispersed from the mean length though, were within the minimum and maximum range. However, the maximum length of 9.1 cm was recorded in present study which higher the report of those who presented in FishBase. RGL changed according to the developmental life stage of fish (Hossain *et al.,* 1990; Bhuiyan and Islam, 1991; Lawal *et al.,* 2012; Koundal *et al.,* 2013). RGL of wild collected *A. mola* had 4.35-fold higher than the total length of fish, whereas 4.21-fold noticed in cultured stock.

CONCLUSION

The study shows that there is no significant difference occurs in basic morphology and gut morphology of *A. mola* between wild and cultured stocks. LWR plays a significant role in fisheries management particularly of which fish do not have standard culture practice. In this study, we aimed to assess the culture suitability of the *A. mola* and the difference in growth of wild and cultured fish. It showed that no considerable difference between the wild and cultured environment. Despite, data presented in this study increase baseline information on LWR of *A. mola* would be beneficial for fish biologist for conservation of biodiversity, and aquaculturists for the better management of fishery resources. The recorded maximum (9.1cm) length here would update the online FishBase.

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