Khulna University Studies **Volume 11 (1&2) and 12(1&2): ??-?? : December 2013**

LIFE SCIENCE

TAXONOMY AND SOME ASPECTS OF BIOLOGY OF *Punitus sarana* AND *Punitus gonionotus*

Shikder Saiful Islam*, Md. Saifuddin Shah, Md. Lifat Rahi, Priyanka Biswas, Md. Rashedul Islam and Joyanta Bir

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

KUS: 12/20-060612

Manuscript received: June 06, 2012 Accepted: Fbruary 20, 2013

Abstract: The shar punti, *Puntius sarana* is a small indigenous and native species of Bangladesh. In the present times because of large scale degradation of habitats and for many of the natural and anthropogenic activities the species has been reduced drastically and considered as an endangered species. On the other hand, *Puntius gonionotus* has been introduced in Bangladesh from Thailand and considered as an important aquaculture species. The samples of *P. sarana* and *P. gonionotus* were collected from *Kumar* River in Faridpur district and from local markets in Khulna city. Paired sample t-test and multiple comparisons were made for some important characteristic proportions and other biological aspects such as hepatosomatic index, dressing percentage and condition factor were calculated for both the species. Some identifying characteristic proportion were found as; head length: eye diameter = 1:3.48 (*P. sarana*) and 1:3.435 (*P. gonionotus*), standard length: head length = 1:3.94 (*P. sarana*) and 1:3.96 (*P. gonionotus*), caudal peduncle length 13.25% in case of *Puntius sarana* and 14.17% in case of *P. gonionotus* of standard length, hepatosomatic index: 0.6735 (*P. sarana*) and 1.114 (*P. gonionotus*), dressing percentage: 18.96 (*P. sarana*) and 21.29 (*P. gonionotus*) and condition factor: 1.378328 ± .23041 (*P. sarana*) and 1.394224 ± .13322 (*P. gonionotus*) were found. Significant differences were found in various morphometric proportions and meristic characteristics and in hepatosomatic index, dressing percentage and condition factor between the two species.

Keywords: Taxonomy, biology, morphometric and meristic, hepatosomatic index, dressing percentage, condition factor

Introduction

There are more than 260 freshwater fish species in Bangladesh (Rahman, 1989), of which, only four of the larger indigenous varieties are used for aquaculture. There are also not less than 40-50 small indigenous fish species (SIS). The small fish occupies an important position as a popular food item among fishing communities (Hossain, 2003).

P. sarana is an important fish species of Bangladesh; while *P. gonionotus* is an exotic species from Thailand. In the year 2006-2007, total production of Sharpunti (*Puntius sarana*) was 2,562 mt and 3.41% of total beel catch but it declined to 1,729 mt and 2.23% of total beel catch in 2007-2008 (DoF, 2009). Total production of Sarpunti (*Puntius sarana*) in Kaptai lake was 3mt (DoF, 2008).

Morphometric characteristics deal with the statistical study of measurable characteristics and this study is helpful in differentiating the related species and even population within species.

*Corresponding author: <shikdersaiful.islam@gmail.com>

DOI: https://doi.org/10.53808/KUS.2013.11and12.1220-L

Various body proportions often provide valuable information for correct certification of populations in the native. The countable characteristics of population of the same species may vary according to geographic location.

Hepatosomatic index (HSI) regards percentage of liver weight with respect to the body weight of the fish. The mean HSI value is species-specific and correlates with the amount of fat deposition (Chiba and Hamna, 1981; Oguri, 1985; Ando *et al*., 1993).

Dressing percentage means percentage or proportions of dressed materials (such as; scales, fins, viscera, gut, gills etc.) which have been discarded from the body during preparation for the table. Dressing percentage increased as dietary protein increased from 24 to 36% and decreased as dietary protein increased from 36 to 40% in second-year fish, but dressing percentage was not affected by dietary protein concentration in third-year fish (Lovell and Li, 2006).

Condition factor (K) serves as a useful index of the nutritional and biological cycle viz, gonad development, spawning etc. of the species. A cycle change as condition occurs annually in the fish; particularly the female develops its gonad. While upon the fish become relatively heavier, so that 'n' increases and may be greater than three directly; after spawning the fish is thin and poor in condition so value of 'n' drops down to less than 3 (Le Cren, 1951).

The success of good scientific planning and management of fish species largely depends on the knowledge of their biological aspects (Joadder, 2006). The different aspects of biology of *Puntius sophore* were studied by Indian workers. Raj (1986) and Batnagar (1963) reported some aspects of biology of *Puntius kolus* (Ham.) and *Puntius ticto* (Ham.) has been attempted by Ibrahim (1957). The cause of variation in the morphometric and meristic characters may range from genetic variability to the influence of environmental parameters (Hubbs, 1921). This genetic variability happens because some body parts tend to grow at different rates under varying environmental conditions (Negi and Nauiyal, 2002).

Thai sharpunti, (*Puntius gonionotus*), was introduced in Bangladesh in 1977 and has become a popular fish species for its bright silvery appearance and good taste (Kohinoor *et al*., 1994).

Considering the problems attempts were made to compare the taxonomy and other biological aspects (condition factor, hepato-somatic index, food and feeding habits and dressing percentage) in order to determine the biological condition of the two species- *Puntius sarana* and *Puntius gonionotus*; as biological knowledge is essential to introduce a suitable species for aquaculture. So, an urgent need was felt to look for any possible means for protection and selective breeding of the species and inclusion of both the species into the culture. Thus the research was conducted to compare *Puntius sarana* and *Puntius gonionotus* with respect to their taxonomy and other biological characters.

Materials and methods

The experimented fish was collected from Kumar river of Faridpur district and local market of Khulna city. Fifty one specimens of *Puntius gonionotus* and sixty of *Puntius sarana* were scored for different morphometric and meristic characters and other biological aspects such as; liver weight, dressing percentage, total weight etc.

The study was conducted for a period of 3 months from November 2009 to January 2010. Measurements were made point to point with dial calipers and data were recorded to tenths of a centimeter. Counts and measurements were made on the left side of specimens whenever possible. Subunits of the head were presented as proportions of head length (HL). Head length itself and measurements of body parts were given as proportions of standard length (SL). Fin rays were counted under a magnifying glass using transmitted light.

Hepatosomatic index determination: Hepatosomatic index was determined by using the following formula:

$$HSI = LW \times 100/BW$$

Where, LW= liver weight (g) and BW = body weight (g) (de Vlaming *et al.* 1982)

Dressing percentage determination: Dressing percentage = [Weight of dressed materials/total body weight] x 100

Condition factor determination: The condition factor was calculated by the following formula:

$$K = \frac{W \times 10^2}{L^3} \quad \text{(King, 1997)}$$

Where, W= body weight in g, L= total length in cm

The obtained data from the experiment was analyzed by using the software Microsoft excel and SPSS. Microsoft excel was used to determine mean, standard deviation, graphs etc. and SPSS was used for regression analysis and for paired sample t-test of characteristic proportions of both the species.

The equation used for regression model was as follows-

$$Y = a + bX$$

Results

The taxonomy of the two species, *Puntius sarana* (Hamilton) and *Puntius gonionotus* (Hamilton) was evaluated. A total of 111 (60 of *Puntius sarana* and 51 of *Puntius gonionotus)* specimens were examined. Analysis of meristic and morphometric data resulted in the recognition of two different species.

External morphology: Scales on lateral line in case of *Puntius sarana* was found to be 30-34 and of *Puntius gonionotus* was 30-33. Caudal peduncle length was found to be 13.25% in case of *Puntius sarana* and 14.17% in case of *Puntius gonionotus* of standard length. Head length of *Puntius sarana* was 3.494 times of eye diameter. And head length of *Puntius gonionotus* was 3.435 times of eye dia. Fin formula was constructed for *Puntius sarana* as: D.10-11(II/8-9); P1.15 (I/14); P2.9-11 (I/8-10); A.8-9 (I/7-8); C.22-24 and for *Puntius gonionotus* as: D.10 (I/9); P1.14 (I/13); P2.9 (I/8); A.8 (I/7); C.22 (Table 1).

Table 1: Mean of morphometric characteristics of *Puntius sarana* and *Puntius gonionotus*

Sl. no.	Characteristics	*Puntius sarana*	*Puntius gonionotus*
1	Total length (TL)	13.9868±1.06723	16.8098 ±1.12112
2	Standard length (SL)	11.3233±.94013	13.2941±.88440
3	Fork length (FL)	12.6017±1.05179	14.7569±.97329
4	Preorbital length (PrOL)	.6717±.09405	.8588±.11345
5	Post orbital length (PsOL)	1.3692±.15434	1.5788±.11520
6	Eye diameter (ED)	.8267±.07099	.9784±.07018
7	Head length (HL)	2.8767±.23819	3.3529±.33903
8	Dorsal fin base length (DBL)	1.6708±.20836	1.6941±.19226
9	Anal fin base length (ABL)	.9667±.12270	1.3167±.19891
10	Length of pectoral fin	1.8358±.21845	2.4824±.18837
11	Length of pelvic fin	1.7083±.14531	2.2824±.17967
12	Pre anal length (PrAL)	7.8533±.69635	9.5235±.64081
13	Pre dorsal length (PrDL)	5.65±.52513	7.0098±.55435
14	Pre pelvic length (PrPL)	5.5417±.40809	6.4549±.45092
15	Pre pectoral length (PrpL)	2.7350±.26091	3.2784±.22567
16	Caudal fin base (CBL)	1.5900±.14344	1.9686±.15555
17	Caudal peduncle (CPL)	1.5±.16077	1.8843±.13766
18	Height of the body (HB)	3.833±.36991	5.5706±.51353

Taxonomic analysis: For analyzing taxonomy of *Puntius sarana* and *Puntius gonionotus* multiple comparisons were done by using paired sample t-test. Because *Puntius sarana* and *Puntius gonionotus* differ in morphometric and meristic characters significantly in different important characteristic proportions as: total length: standard length, standard length: head length, head length: eye diameter etc.

Head length of *Puntius sarana was* 3.4311±0.2899 times than eye diameter and for *Puntius gonionotus* it was 3.4347±0.3338 times than the eye diameter (Table 2). In the same time standard length of *Puntius sarana* was 3.9562±0.2068 times than the head length and for *Puntius gonionotus* it was 4.0043±0.4836 than the head length (Table 2) and was not significantly different from *Puntius sarana*.

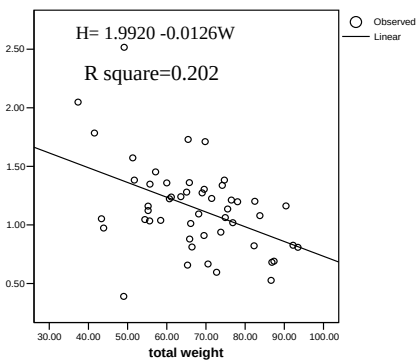
Table 2: Comparisons among different proportions of *Puntius gonionotus* and *Puntius sarana*

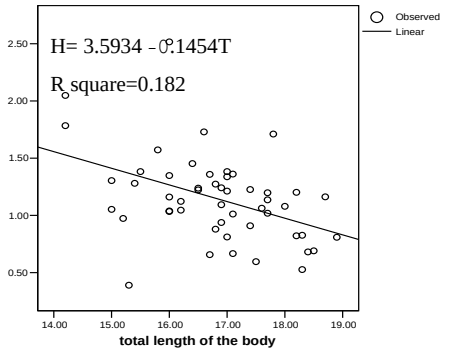
Proportions	*Puntius sarana*	*Puntius gonionotus*	t-value	p-value
TL:SL	1.2453±.03031[a]	1.2655±.05027[b]	2.819	.007*
FL:SL	1.1154±.02622[a]	1.1109±.04163[a]	-.641	.525
SL:HL	3.9562±.20683[a]	4.0043±.48369[a]	.602	.550
SL:PDL	2.0174±.09120[a]	1.9021±.12922[b]	-4.959	.000*
SL:DBL	6.8599±.77860[a]	7.9029±.60568[b]	7.784	.000*
SL:ABL	11.7613±1.12809[a]	10.2538±1.1943[b]	-7.465	.000*
SL: CpL	7.6198±.42742[a]	6.9627±.63742[b]	-6.435	.000*
SL: HB	2.9573±.14728[a]	2.3825±.12750[b]	-21.343	.000*
HL: PrOL	4.3821±.51239[a]	3.9516±.51867[b]	-3.835	.000*
HL: ED	3.4311±.28994[a]	3.4347±.33387[a]	.059	.953
HL: PsOL	2.1276±.15808[a]	2.1244±.16574[a]	-.096	.924
HB: CpL	2.5798±.14757[a]	2.9578±.19665[b]	10.675	.000*

*significantly different at 5% level of significance

Here, TL – total length; SL – standard length; FL- fork length; HL – head length; PrOL- pre-orbital length; PsOL – post orbital length; ED – eye diameter; PDL- pre-dorsal length; DBL – length of dorsal fin base; ABL – length of anal fin base; CPL – length of caudal peduncle; HB – body height.

From the present study it was found that the hepatosomatic index of *Puntius sarana* was 0.6735 and in case of *Puntius gonionotus* it was 1.114 and it was significantly different from the other. From the regression line of hepatosomatic index of both the species it was found that the line was negatively sloped in case of *Puntius sarana* whereas, in *Puntius gonionotus* it was more negatively sloped and better fit than *Puntius sarana* (Fig. 1 and 2).





Islam S.S; Shah M.S; Rahi M.L; Biswas P; Islam M.R and Bir J. 2013. Taxonomy and some aspects of biology of *Punitis sarana* and *Punitus gonionotus*. *Khulna University Studies* Volume 11 (1&2) and 12(1&2): ??-??

Fig 1: Regression line of hepatosomatic index with respect to total body weight and total length of *Puntius sarana*

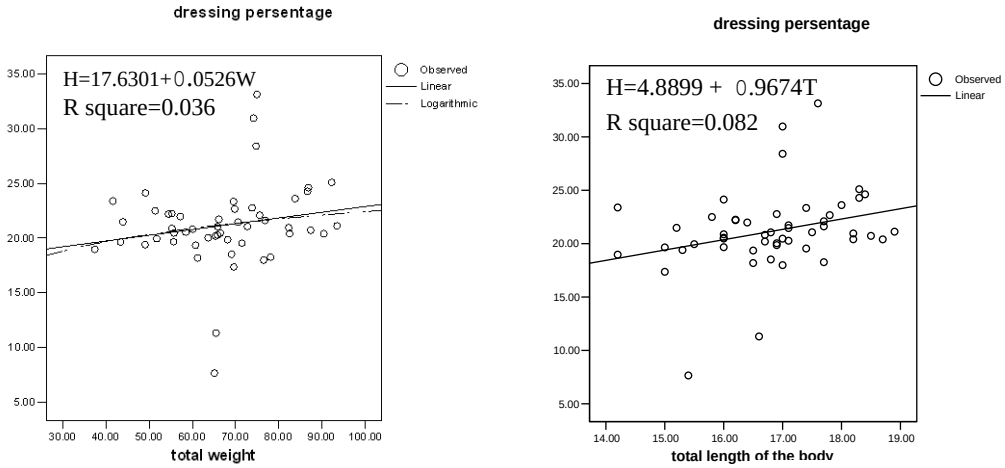


Fig. 2: Regression line of hepatosomatic index with respect to total weight and total length of *Puntius gonionotus*

From the present study it was found that the dressing percentage of *Puntius sarana* was 18.96 ±4.6906 of the total weight and in case of *Puntius gonionotus* it was 21.29±3.8317 (Table 5). From the regression line of dressing percentage it was found that it was positively sloped for both the species but better fit in case of *Puntius gonionotus* than *Puntius sarana* (Fig. 3 and 4).

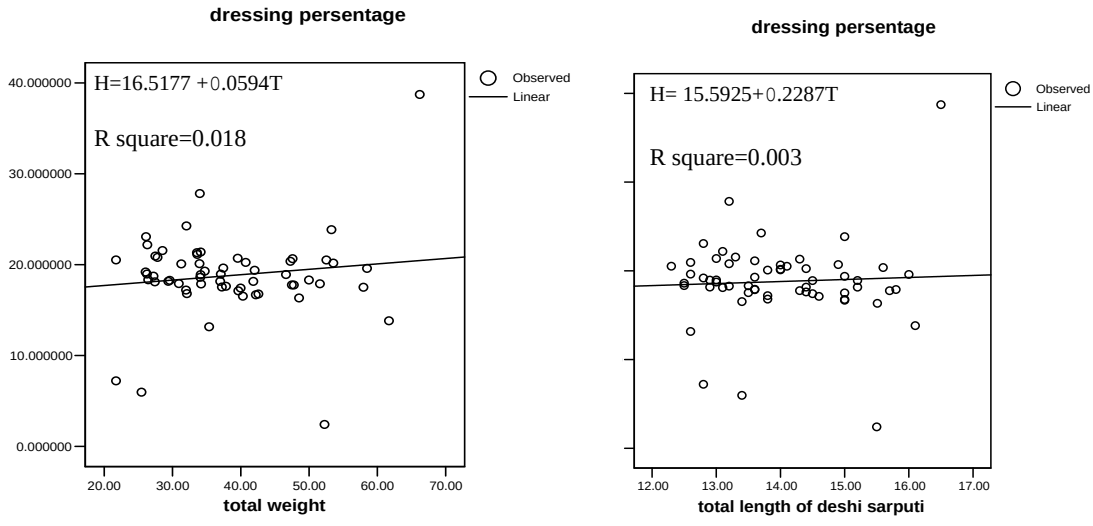


Fig. 3: Regression line of dressing percentage with respect to total weight and total length of *P. gonoionotus.*

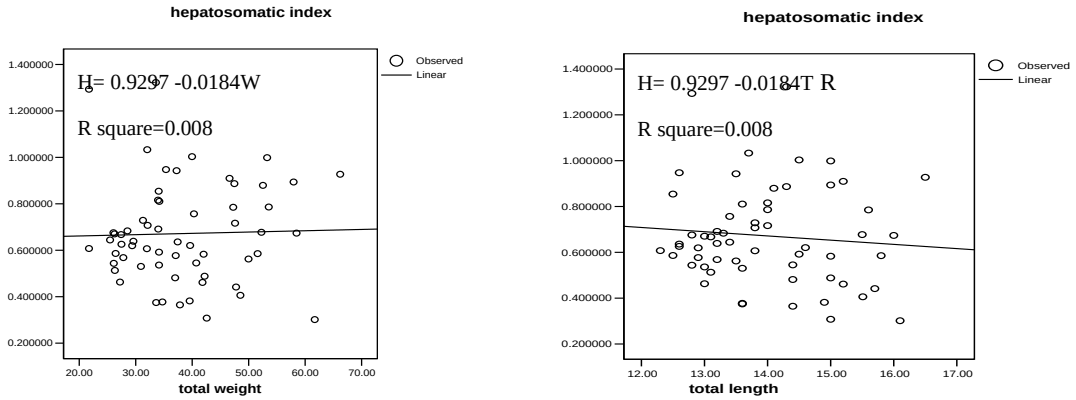


Fig. 4: Regression line of dressing percentage with respect to total weight and total length of *Puntius sarana*

In the present experiment, condition factor of *Puntius sarana* and *Puntius gonionotus* was found to be 1.3783 ± 0.2304 and 1.3942±0.1332 respectively.

Discussion

The purpose of this study was to determine if there is any differences exist in the taxonomy and other biological aspects of the two species viz., *Puntius sarana* and *Puntius gonionotus.* The meristic and morphometric characteristics used in the distinction of *Puntius sarana* and *Puntius gonionotus*; lateral line was complete and the scales on lateral line in case of *Puntius sarana* was 30-34 and for *Puntius gonionotus* was 30-33 (Table 3). Talwar, *et al.* (1991) estimated that scales on lateral line in *Puntius sarana* were 30-33 which is almost similar to the present study. In the taxonomic study the attributes and fin formula are two important criteria. For this purpose "fin formula" was constructed using the letter D for dorsal; D1 and D2 for first and second dorsal; P1 for pectoral; P2 for pelvic A for anal and C for caudal fins. Talwar, *et al.* (1991) estimated that fin formula of *Puntius sarana* is D. 11-12 (III-IV/8), A.8 (III/5), P.15-17(I/14-16).

From the present study of the taxonomy of *Puntius sarana* and *Puntius gonionotus* it was found that the fin formula for *Puntius sarana* was D.10-11(II/8-9); P1.15 (I/14); P2.9-11 (I/8-10); A.8-9 (I/7-8); C.22-24 and for *Puntius gonionotus* was D.10 (I/9); P1.14 (I/13); P2.9 (I/8); A.8 (I/7); C.22 (Table 3).

Table 3: Mean of meristic characteristics of *Puntius sarana* and *Puntius gonionotus*

Sl. no.	Characteristics	*Puntius sarana*	*Puntius gonionotus*
1	Number of scales on the lateral line	32.83±0.4928	30.353±0.8203
2	Number of scales above lateral line	6±0.0	6±0.0
3	Number of scales below the lateral line	5±0.0	5±0.0
4	Gill racker On lower limb	12±0.0	17.8627±0.6639
5	Gill racker On upper limb	12±0.0	18±0.0

6	Fins number (dorsal fin)	11±0.0	10±0.0
7	Fin rays total (caudal fin)	22±0.0	22±0.0
8	Fins number (anal fin)	8±0.0	8±0.0
9	Fin number in pectoral fin	15±0.0	14±0.0
10	Fin number in pelvic Fin	9±0.0	9±0.0

Form the present taxonomic study of gill rackers on the first arch of *Puntius sarana* were 10-12 with a mean of 11.8833± 0.4154 and in case of *Puntius gonionotus* were 16-20 with a mean of 17.8627± 0.6639 and on the second gill arch of *Puntius sarana* and of *Puntius gonionotus* were 12 with a mean of 12 and 18 with a mean of 18 respectively (Table 4).

Table 4: Comparison of important meristic characteristics of *Puntius sarana* and *Puntius gonionotus*

Proportions	*Puntius sarana*	*Puntius gonionotus*	t-value	p-value
number of scale on lateral line	32.7843±0.54088[a]	30.3529±.8203[b]	17.628	.000*
number of scale above lateral line	6±0.0	6±0.0		
number of scale below lateral line	5±0.0	5±0.0		
gill racker on lower limp	12±0.0[a]	17.8627±.66392[b]	-63.063	.000*
gill racker on upper limp	12±0.0	18±0.0		
fin number in dorsal fin	11±0.0	10±0.0		
fin number in caudal fin	22±0.0	22±0.0		
fin number in anal fin	8±0.0	8±0.0		
fin number in pectoral fin	15±0.0	14±0.0		
fin number in pelvic fin	9±0.0	9±0.0		

*significantly different at 5% level of significance

From the study of meristic characteristics it was found that number of scales above lateral line, number of scales below the lateral line, number of fin rays in pelvic fin, fin rays of anal fin and total fin rays of caudal fin were equal in both the species of *Puntius sarana* and *Puntius gonionotus.* But in case of other meristic characteristics such as number of scales on the lateral line, gill rakers on lower limb, gill rakers on upper limb, fin rays in dorsal fin and fin rays in pectoral fin were significantly different in *Puntius sarana* from that of *Puntius gonionotus* (Table 4).

It was observed that the head length of *Puntius sarana* was 3.48 times than the eye diameter and for *Puntius gonionotus* it was found that the head length was 3.43 times than the eye diameter (Table 2). Total length of *Puntius sarana* and *Puntius gonionotus* were 1.2453±.03031 and 1.2655±.05027 times higher than standard length respectively with a significant difference at 5% level of significance (Table 1). Fish base reports that total length is 1.15 times higher than standard length. It was observed that the standard length of *Puntius sarana* was 3.94 times than the head length. In case of *Puntius gonionotus* it was found that the standard length was 3.96 times than the head length (Table 2). In present study standard length was 3.9562±.20683 and 4.0043±48369 times higher than head length for both the species respectively with no significant difference at 5% level of significance (Table 2). Rahman (2005) reported that standard length is 3.4-3.7 times higher than the head length.

In the present study standard length was 2.0174±0.0912 and 1.9021±0.1292 times higher than pre-dorsal length for both the species respectively and a significant difference was found. According to Fish Base, standard length is 2.51 times higher than pre-dorsal length (Table 2).

In present study standard length was 6.8599±0.7786 and 7.9029±0.6056 times higher than dorsal fin base for *Puntius sarana* and *Puntius gonionotus* respectively. Significant differences were found at 5% level of significance (Table 2).

Significant differences were found for SL: CpL in case of both the species having value 7.6198±0.4274 and 6.9627±0.6374 respectively. The standard length was 2.9573±0.1472 and 2.3825±0.1275 for *Puntius sarana* and *Puntius gonionotus* respectively (Table 1). Head lengths were 3.4311±0.2899 and 3.4347±0.3338 times higher than the eye diameter in case of *Puntius sarana* and *Puntius gonionotus* respectively with no significant difference at 5% level of significance (P>0.05) in the two species (Table 2).

Average number of scales on lateral line in case of *Puntius sarana* was 32.7843±0.5408 and for *Puntius gonionotus* was 30.3529±0.8203. Where as, average number of scales above lateral line and below lateral line was found as 6 and 5 in case of both the species. However, the three parameters of lateral line were found not significantly different (P<0.05) between the two species. The average number of total dorsal fin ray in *Puntius sarana* and *Puntius gonionotus* was 11 and 10 respectively with no significant differences at 5% level of probability (P>0.05) between the two species (Table 4). Average number of anal fin rays of *Puntius sarana* and *Puntius gonionotus was* found 8 in each (Table 4). However, the average number of anal fin was not found significantly different between the two species at 5% level of probability (P<0.05).

Average number of total pectoral fin rays of *Puntius sarana* and *Puntius gonionotus* were found 15±0.0 and 14±0.0 (Table 4). However, significantly different between the two species was not found at 5% level of significance (P<0.05). Average number of total pelvic fin rays of *Puntius sarana* and *Puntius gonionotus* were found 9±0.0 and 9±0.0 (Table 4). These were found no significantly different (p>0.05) between the two species.

The observed values of the average caudal fin rays of *Puntius sarana* and *Puntius gonionotus* were found 22 and 22 respectively (Table 4). Similarly insignificance (p>0.05) was recorded in this case also.

The mean HSI value in *Puntius sarana was* 0.6735±0.1875% and in case of *Puntius gonionotus* this value was 1.114±0.38186% with respect to the total weight of the body. Oguri (1978) states that in osteichthyes the HSI is about 1-2% versus values as high as 10-20% in Elasmobranches and Holocephalian fish. As the HSI value of *Puntius gonionotus* was found significantly higher than that in *Puntius sarana*, the former can effectively be incorporated for the culture for more profit. Higher value of HSI indicated more stored energy in liver of the particular species in the form of glycogen.

The dressing percentages of *Puntius sarana* and *Puntius gonionotus* were found as 18.96±4.69 and 21.29±3.83 respectively (Table 5). Dressing percentage indicates the proportion of non edible percentage of the body. Thus the fishes having a lower dressing percentage is more suitable for culture providing higher profit and also demandable to the buyer/consumer because of having more meat or muscular portion (more edible portion).

Table 5: Dressing percentage of *Puntius sarana* and *Puntius gonionotus*

Species	Mean total weight (g)	Mean weight of dressed materials (g)	Dressing percentage
Puntius sarana	38.2619	7.2535	18.96 ±4.69067459
Puntius gonionotus	66.96217647	14.25988235	21.29±3.831746119

Condition factor of *Puntius sarana* and *Puntius gonionotus* was found 1.3783±0.2304 and 1.3942±0.1332 respectively (Table 6). Dewan (1973) worked on the condition factor of *Puntius sophore* and found that it was 1.003. Condition Factor (CF) calculated by weight/body length has been used to compare growth conditions of fish. Condition factor is the significant predictors of energy reserves (lipid, protein, glycogen and total energy). Condition factor also performs better as predictors of energy content per unit body weight. A high condition factor reflects good environmental quality; while a low condition factor reflects poor environmental quality.

Table 6: Condition factor of Puntius sarana and *Puntius gonionotus*

Specices	Mean total weight (g)	Mean total length (cm)	Condition factor
Puntius sarana	38.26195	13.98683333	1.378328 ± .23041
Puntius gonionotus	66.96217647	16.80980392	1.394224 ± .13322

Conclusion

Puntius sarana is a Small Indigenous Species (SIS) of Bangladesh but *Puntius gonionotus* is an exotic species. The present experiment was successful in determining the morphometric, meristic characters and some other biological aspects of *Puntius sarana* and *Puntius gonionotus*. There were significant differences in proportions of different biological attributes. There was no significant difference in scales above lateral line, scales below the lateral line, and fin rays in pectoral, caudal and pelvic fins. In the present study, various biological aspects clearly indicated the suitability of *Puntius gonionotus* for aquaculture practice for more profit. On the other hand, *Puntius sarana* is a popular fish species to the people of Bangladesh for its delicious taste. Thus, proper steps must be taken to introduce the culture of *Puntius gonionotus* to inland aquaculture of Bangladesh to prevent any environmental and ecological disorder. Besides, better management and conservation strategies must be taken for *Puntius sarana* for maintaining the fish biodiversity as this species is now threatened and has been going towards its extinction.

Reference

Ando, S.; Mori, Y.; Nakamura, K. and Sugawara, A. 1993. Characteristics of lipid accumulation types in five species of fish. *Nippon Suisan Gakkaisi*, 59: 1559-1564.

Batnagar, G.K. 1963. On some aspects of biology of *Puntius kolus* (Sykes) of the Tangabhadras reservoir. *Indian journal of fisheries*, 10(2): 500-520.

Chiba, A. and Hamna, Y. 1981. Histological observation of some organs in the porcupine fish, *Diodon holacanthus*, stranded in naiigata on the Coast of Japan Sea. *Japanese Journal of Ichthyology*, 28: 287-294.

de Vlaming, V.; Grossman, G. and Chapman, F. 1982. On the use of gonadosomatic index. *Comparison of Biochemistry and Physiol*ogy, 73A: 31-39.

Dewan, S. 1973. Investigation in to the ecology of fishes of Mymensingh lake. Ph.D. Dissertation, Bangladesh Agricultural University, Mymensingh, Bangladesh. pp.235.

DoF (Department of Fisheries). 2009. Fishery Statistical Year Book of Bangladesh 2007-2008. Department of fisheries, Ministry of Livestock and Fisheries, Dhaka, Bangladesh, pp.42.

DoF (Department of Fisheries). 2008. Fishery Statistical Year Book of Bangladesh 2006-2007. Department of fisheries, Ministry of Livestock and Fisheries, Dhaka, Bangladesh, pp.42.

Hossain, M.A. 2003. Some aspects of biology and nutrition of *Scylla serata* from the south-western region of Bangladesh. M.Sc thesis, Fisheries and Marine Resource Technology Discipline, Khulna University, Khulna, Bangladesh.

Hubbs, C.L. 1921. Geographic variation of Notemigonus crysoleucas on American minnows. *Transactions I llinois Study Academy of Science* (II), 1018: 147-151.

Ibrahim, K.M. 1957. Observation on the fecundity of three common species of minor burbles. *Journal of Bombay natural history society*, 54(4): 834-862.

Joadder, M.A.R. 2006. Food and feeding habits of *Gagata youssoufi* (Rahman) from the river Padma in Rajshahi. *University journal of zoology, Rajshahi Univ*ersity, 25: 69-71.

King, M. 1997. Fisheries biology assessment and management. Third edition, Fishing News Books, Blackwell Science Ltd. London.

Kohinoor, A.H.M.; Hossain, M.G.; Mazid, M.A.; Jahan, D.A. and Gupta, M.V. 1994. Comparative production performance of Rajputi (*Puntius gonionotus)* and local sharpunti (*Puntias sarana)* in a semi-intensive culture system. *Progressive Agricultural Science*, 5(1): 79-88.

Le Cren, E.D. 1951. The length-weight relationship and seasonal cycle in gonad weight and condition in perch (*Perca fluviatilis). Journal of animal ecology*, 20(2): 201-210.

Lovell, R.T. and Li, M. 2006. Growth, feed efficiency and body composition of second-and third-year channel catfish fed various concentrations of dietary protein to satiety in production ponds. Department of Fisheries and Allied Aquacultures, Auburn Univ., Auburn, Alabama, USA.

Negi, R.S. and Nautiyal, P. 2002. Analysis of Growth Pattern and Variation in Some Morphometric Characters of Sympatric Hill Stream Teleosts *Barilius bendelisis* and *Barilius vagra. Asian Fisheries Science,* 15(2002): 335-346.

Oguri, M. 1985. On the liver tissue of fresh water string rays and balloon fish. *Bulletin of the Japanese Society of Scientific Fisheries,* 51:717-720.

Oguri, M. 1978. On the hepatosomatic index of holocephalian fish. *Bulletin of the Japanese Society of Scientific Fisheries,* 44 (2): 131-134.

Rahman, A.K.A. 2005. Freshwater fishes of Bangladesh. 2nd ed. Zoological Society of Bangladesh, Dhaka, Bangladesh; XVIII + 394 pp.

Rahman, A.K.A. 1989. Freshwater Fishes of Bangladesh. First edition, The Zoological Society of Bangladesh, pp.364.

Raj, B.S. 1986. Notes on the freshwater fishes of Madras. *Indian journal of fisheries,* 20(1): 35-42.

Talwar, P.K. and Jhingran, A.G. 1991. Inland fishes of India and adjacent countries. India, 1: 541 pp.