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# Sex ratio, length-weight relationships and seasonal variations in condition factor of menoda catfish *Hemibagrus menoda* (Hamilton, 1822) of the Kangsha River in Bangladesh

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**Abstract**
Assessment of fish stock assists fisheries managers in taking decisions toward sustainable fisheries. The study was conducted to find out the sex ratio, growth pattern and state of physical well being of *Hemibagrus menoda* in the Kangsha River Netrakona, Bangladesh. Report on the aspects of reproductive biology of this species in Bangladesh has so far not been documented. A total of 79 fish samples were collected from March 2016 to February 2017. The overall sex ratio was female biased (1.30:0.97) though chi-square test did not reveal any significant difference ($p<0.05$) from the expected 1:1 ratio. Analysis of the morphometric characters indicated *b* value was higher in females in terms of standard length to total length. The exponential forms of the length-weight relationship was $W= 0.00451L^{3.427}$ and $W = 0.8658 L^{1.785}$ for females and males, respectively. The highest condition factor for female (0.53) and male (1.62) was recorded in September. For conservation and management of the *H. menoda* species it is recommended that restriction on fishing of this species should be ensured.

**Keywords:** *Hemibagrus menoda*; sex ratio; Length-weight relationship; condition factor

## 1. Introduction
Fisheries stock assessments estimate a fish population biomass, age structure and provide in-depth information on such things as the average number of eggs produced, the number of females versus males (sex ratio) and their feeding habit [1]. This information guide fishery managers to detect changes in the condition of fish over time. In developing countries, most of the catch comes from fisheries that are poorly managed, because even the most basic information on the performance of fish stocks is unavailable.
*Hemibagrus menoda*, locally called Gang magur in Bangladesh, is a demersal freshwater bagrid catfish that occurs in canals, beels, rivers, haors and baors of Bangladesh[2]. *H. menoda* have been utilized as experimental animals and are valuable food fishes because of their large size (450 mm or 17.7" SL, but can attain up to 800 mm), tasty flesh and high market value but they are less frequently encountered in markets than other genera of large Bagrid catfishes such as *Rita* and *Sperata*[3,2]. The open water fish diversity of Bangladesh has been negatively impacted by a series of natural and anthropogenic actions ranging from siltation of water bodies, over-exploitation of natural fisheries to changing the habitats from small- to large-scale development interventions. Moreover, in 2015[4] IUCN assessed 253 freshwater fishes in Bangladesh and *H. menoda* was among the 26 species categorized as near threatened. It is therefore pertinent to save this stock from imminent extinction.
Sex population estimation is the abundance of any sex in a particular time in natural condition. Knowledge of the sex ratio of fishes is important to ensure a proportional fishing of two sexes and provides information necessary in assessing the reproductive potential of a population [5]. Morphometric evaluation of species is important in taxonomic study, particularly in differentiating species from their congeners [6]. It provides the relationship between body parts such as head length, head depth, caudal peduncle length relative to standard length [7]. It is therefore the quickest and straightforward method of species identification. Length-weight relationship is used by fisheries researchers and managers to establish mathematical

relationship by which we can compute the value of one variable if the other is known by using an established equation, and to know the growth pattern of the fish. The parameter estimates of the relationship for a population can then be compared to average parameters for the region, previous years, or parameter estimates among groups of fish to identify the condition or robustness of the population [8]. The condition factor is a method by which the physical condition and seasonal variation in the well-being of an individual fish could be known[9]. Ample researches have been conducted on the biology and assessment of many fish species. *Liposarcus multiradiatus* [10], *Thenus orientalis*[11], *Xenentodon cancila*[12], *Glossogobius giuris*[13], *Oreochromis niloticus*[7], *Chrysichthys nigrodigitatus*[14]. So far, there is no record of assessment of the population of *H. menoda* in aspects of its reproductive biology. The aim of this study was to establish the sex ratio, Length-weight relationship and condition factor of this stock which might be used to determine the growth pattern, yield and well-being of this fish species for effective management and conservation of the stock.

## 2. Materials and Methods

Seventy nine (79) fish samples of *Hemibagrus menoda* were collected monthly (March 2016 – February 2017) from Kongsha river located at Jaria – Jhanjail, Lat $25^0$ 0′ 41.10″ N and Longitude $90^0$ 38′ 27.16″ E [15] in the Netrakona district, Bangladesh. Standard length ranged from 16.9 to 40 cm for both sexes while body weight ranged from 220 – 1370 g. Males were distinguished from females primarily by the possession of genital papillae just before the anal fin. Sex ratio was determined by dividing the number of females with the number of males. The chi-square test was adopted to determine whether the proportion of females differ from the proportion of males using the formula:

$$\chi^2 = \sum (O-E)/E,$$

Whereby;
$\chi^2$ =Chi-square test
O = observed values
E = expected values
The null hypothesis ($H_O$) that there is no difference between the proportion of females and the proportion of males was tested at p (0.05).

Standard length (SL), Fork length (FL) and Total length (TL) were measured using a meter scale mounted on a wooden support while the Head length (HL), Head depth (HD) and Depth of Caudal peduncle (DCP) were measured using a slide caliper. The body weight was taken using a digital balance with a precision of 0.01 g (Model: HL-300A AND company limited).
The relationship between the SL and the various lengths was established using the least squared linear regression equation Y = a + bX, whereby Y stands for different body lengths, X for SL while *a* and *b* are constants of the equation. The point estimates obtained from this equation were then used to estimate population data at 95% confidence level.
To establish a mathematical relationship between length and weight and the growth pattern of the *H. menoda* based on the 12 months data of the samples obtained from the Kangsha river, the Length – weight equation $W = aL^b$ was used, whereby W = weight of the fish, L = length while *a* and *b* are constants.
This cubic equation was first log transformed to linear equation thus: ln W = ln a + b ln L. In this equation, *a* is the intercept and *b* is an exponent indicating the growth pattern. The growth pattern of the *H. menoda* samples will be regarded as isometric when the *b* value is equal to 3 and allometric when it significantly differs from 3. The Fultons condition factor was calculated from the predetermined L-W equation $W = aL^b$. The `a′ value in the equation is considered the ideal physical condition of an individual fish in the sample which is compared with the value obtained from the Fultons condition factor using the formula:
$K = W/L^b$
All data analysis was performed using SPSS version 20 software.

## 3. Results

The results for sex ratio of the *Hemibagrus menoda* fish species determined over the 12 months study period indicated a female to male ratio of 1.03:0.97 (Table 1). Chi- square test indicated a non-significant difference ($p > 0.05$) in monthly sex ratio between the proportion of females to males in March, April, June, August, September, December and January, with chi – square values less than the critical value (3.84).

**Table 1:** Sex ratio of *Hemibagrus menoda* collected from the Kongsho River at Zanzail, in the Netrakona district (March 2016 - February 2017)

| Month | No. of fish | No. of female | % of female | No. of male | % of male | Sex ratio | $\chi^2$ | Critical value |
|---|---|---|---|---|---|---|---|---|
| March | 5 | 3 | 60.00 | 2 | 40.00 | 1.5:1.0 | 0.20 | 3.84 |
| April | 6 | 4 | 66.67 | 2 | 33.33 | 2.0:1.0 | 0.66 | 3.84 |
| May | 6 | 3 | 50.00 | 3 | 50.00 | 1.0:1.0 | 0.00 | 3.84 |
| June | 9 | 3 | 33.33 | 6 | 66.67 | 1.0:2.0 | 1.00 | 3.84 |
| July | 8 | 4 | 50.00 | 4 | 50.00 | 1.0:1.0 | 0.00 | 3.84 |
| August | 8 | 5 | 62.50 | 3 | 37.50 | 1.7:1.0 | 0.50 | 3.84 |
| September | 7 | 3 | 42.86 | 4 | 57.14 | 1.0:1.3 | 0.14 | 3.84 |
| October | 6 | 3 | 50.00 | 3 | 50.00 | 1.0:1.0 | 0.00 | 3.84 |
| November | 6 | 3 | 50.00 | 3 | 50.00 | 1.0:1.0 | 0.00 | 3.84 |
| December | 7 | 3 | 42.86 | 4 | 57.14 | 1.0:1.3 | 0.14 | 3.84 |
| January | 5 | 3 | 60.00 | 2 | 40.00 | 1.5:1.0 | 0.20 | 3.84 |
| February | 6 | 3 | 50.00 | 3 | 50.00 | 1.0:1.0 | 0.00 | 3.84 |
| For the year | 79 | 40 | 51.52 | 39 | 48.48 | 1.3:0.9 | 0.24 | 3.84 |

The results for the relationship between SL and other morphometric characters are presented in Table 2. This was essentially carried out for preliminary identification of the species to pave way for further research on other aspects of its

conservation.

Examination of the morphometric characters of *H. menoda* species in the Kangsha river showed percentages of Head length, Head depth and Depth of caudal peduncle to Standard length of female and male to be 33.69 and 32.97, 14.84 and 14.8 and 8.31 and 8.33 cm, respectively. The percentages of TL to SL, FL to SL and DCP to SL were highest in males while highest percentage of HL to SL, HD to SL occurred in females. However, the *b* value was higher in females than males in terms of SL to TL.

**Table 2:** Relationship between SL and other morphometric characters of *H. menoda*

| Relationship between | | Sex | Mean ±SE | Mean ±SE | % of SL | Values of the parameter | | $r^2$ |
|---|---|---|---|---|---|---|---|---|
| `X' | `Y´ | | `X' | `Y´ | | `a´ | `b´ | |
| SL | TL | Female | 29.23±1.08 | 36.97±1.32 | 126.47 | 2.291 | 1.186 | 0.957 |
| | | Male | 27.35±1.43 | 35.47±1.24 | 129.68 | 14.53 | 0.765 | 0.774 |
| | | | | | | | | |
| SL | FL | Female | 29.23±1.08 | 31.02±1.10 | 106.12 | 1.525 | 1.009 | 0.984 |
| | | Male | 27.35±1.43 | 29.65±1.11 | 108.4 | 6.44 | 1.139 | 0.784 |
| | | | | | | | | |
| SL | HL | Female | 29.23±1.08 | 9.85±0.43 | 33.69 | 0.346 | 0.348 | 0.786 |
| | | Male | 27.35±1.43 | 9.02±0.47 | 32.97 | 3.416 | 2.603 | 0.982 |
| | | | | | | | | |
| SL | HD | Female | 29.23±1.08 | 4.34±0.16 | 14.84 | 0.049 | 0.15 | 0.998 |
| | | Male | 27.35±1.43 | 4.05±0.21 | 14.8 | 0.031 | 0.149 | 0.998 |
| | | | | | | | | |
| SL | DCP | Female | 29.23±1.08 | 2.43±0.09 | 8.31 | 0.034 | 0.084 | 0.998 |
| | | Male | 27.35±1.43 | 2.28±0.13 | 8.33 | 0.111 | 0.087 | 0.997 |
| | | | | | | | | |
| SL: standard length; | | | TL: total length; FL:fork length; | | | HL: head length | | |
| HD: head depth; | | | DCP: depth of caudal peduncle | | | | | |

The $r^2$ values indicated strong relationship between SL and all the other variables analysed (Table 2). The Confidence interval (CI) obtained from the Length-length relationship between TL and SL are shown below:

Length-length relationship

a) TL = 2.291 + 1.186 SL; $r^2$ = 0.957; CI of *b* = 1.0112-1.3620 (Female)
b) TL = 14.53 + 0.765 SL; r2 = 0.774; CI of *b* = 0.4741-1.0570 (Male)

Length-weight relationship

The graph (Fig. 1) of W = ln a +b (ln SL) gave a Y – axis intercept of – 5.401 and a slope of 3.427 (female) while for male (Fig. 2) a Y-axis intercept of -0.144 and a slope of 1.785 was obtained. The exponential forms of the Length-weight relationship obtained for both sexes are:

Female:

$W = 0.00451L^{3.427}$

CI for b at 95% CL= 2.508588 - 4.345729

Male

$W = 0.8658\ L^{1.785}$

CI for b at 95% CL=0.857056 - 2.714133

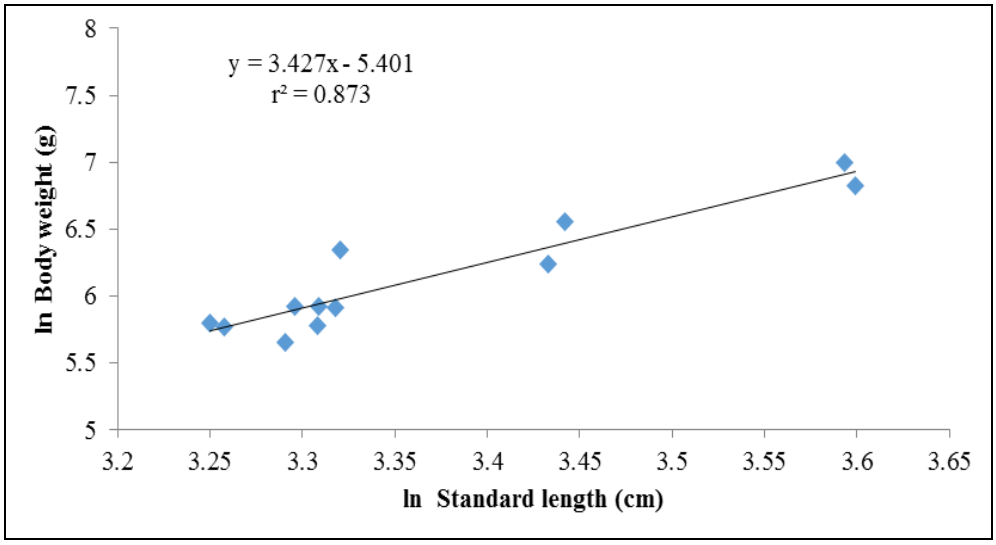


**Fig 1:** Natural log transformed SL and BW of female *H. menoda* from Kangsha river, Netrakona, March 2016 – February 2017

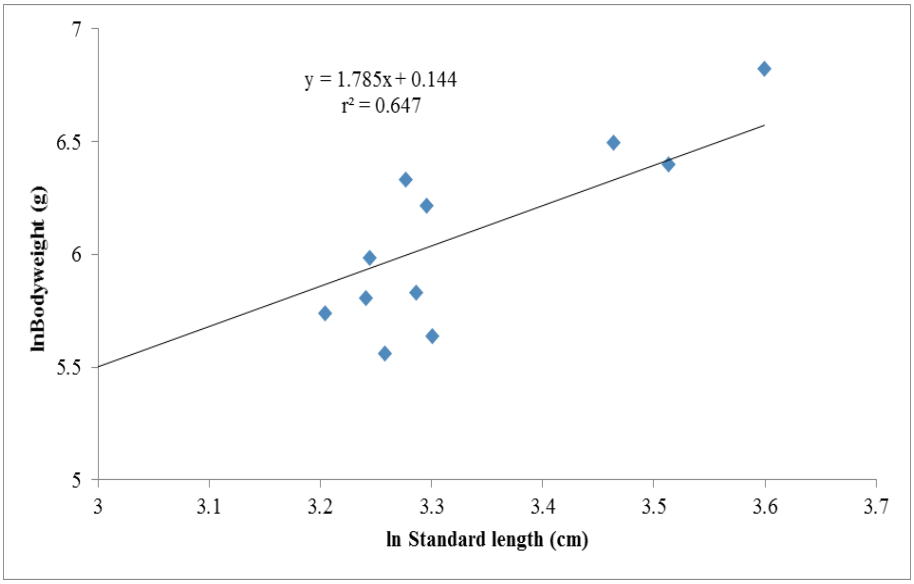


**Fig 2:** Natural log transformed SL and BW of male *H. menoda* from Kangsha river, Netrakona, March 2016– February 2017

The yearly condition factor for female and male *H. menoda* in the Kangsha river Netrakona was 0.4500 and 0.8658, respectively. The variation in monthly condition factor for female and male are presented in Table 3. The highest condition factor was recorded in September for both female (0.53) and male (1.62).

**Table 3:** Monthly condition factor of female and male *H. menoda* in Kangsha river, Netrakona (March 2016 – February 2017).

| Month | Sex | SL(cm) Mean ±SE | BW(g) Mean ±SE | K | Comment |
|---|---|---|---|---|---|
| March | Female | 27.66±0.43 | 566.67±4.38 | 0.47 | Plump |
| | Male | 27.00±0.48 | 300.00±0.00 | 0.84 | Plump |
| April | Female | 26.86±0.60 | 285.33±3.85 | 0.36 | Lean |
| | Male | 27.13±0.60 | 280.67±3.57 | 0.78 | Lean |
| May | Female | 30.97±0.95 | 510.67±6.85 | 0.40 | Lean |
| | Male | 33.57±1.36 | 600.67±10.04 | 1.13 | Plump |
| June | Female | 27.60±0.79 | 368.00±4.75 | 0.42 | Lean |
| | Male | 26.00±0.40 | 260.33±3.05 | 0.78 | Lean |
| July | Female | 36.57±1.42 | 919.67±11.92 | 0.40 | Lean |
| | Male | 36.57±0.93 | 919.67±5.83 | 1.49 | Plump |
| August | Female | 36.35±1.56 | 1088.00±14,12 | 0.49 | Plump |
| | Male | 31.95±0.18 | 663.50±3.41 | 1.37 | Plump |
| September | Female | 31.25±1.27 | 703.50±8.01 | 0.53 | Plump |
| | Male | 26.50±1.61 | 562.50±7.30 | 1.62 | Plump |
| October | Female | 27.00±0.68 | 373.33±3.10 | 0.46 | Plump |
| | Male | 25.57±0.52 | 332.33±4.72 | 1.02 | Plump |
| November | Female | 27.35±0.90 | 373.50±2.85 | 0.44 | Lean |
| | Male | 25.65±0.67 | 398.50±1.57 | 1.22 | Plump |
| December | Female | 26.00±0.59 | 320.00±2.65 | 0.45 | Ideal |
| | Male | 26.75±1.02 | 340.50±3.25 | 0.96 | Plump |
| January | Female | 25.80±0.90 | 330.33±6.43 | 0.48 | Plump |
| | Male | 24.65±1.08 | 311.00±7.13 | 1.02 | Plump |
| February | Female | 27.33±0.43 | 321.67±7.17 | 0.38 | Lean |
| | Male | 16.90±0.41 | 235.00±2.09 | 1.51 | Plump |

## 4. Discussion

Sex ratio constitutes basic information in assessing reproductive potential in fish populations [16]. The deviation from the expected sex ratio of 1:1 of *Hemibagrus menoda* population in the Kangsha river showed a slight dominance of females over males during the study period. This could be attributed to partial segregation of mature forms through habitat preferences and migration or behavioural differences between sexes thus rendering one sex to be more easily caught than the other[17]. Month wise sex ratio of *H. menoda* was also not equal throughout the 12 months study period. It has been stated that in different periods of the year we can get information about the abundance of the sex at a particular time or throughout the year [18]. However, the insignificant difference recorded between the sexes implies the non-existence of seasonality in sex distribution within the population.

For fish species identification, the morphometric and meristic methods remains the simplest and most direct method to date [19]. Examination of the morphometric characters of this species did not differ from the taxonomic features of *H. menoda* reported by Ng and Ferraris, 2000 [2], Rahman, 2005 [20] and Hossain in 2014[21].

Estimation of the Length-weight relationship showed the growth pattern of female and male menoda catfish as positive allometric and negative allometric, respectively. This implies

that female *H. menoda* put on weight faster than corresponding increase in length while the males weight does not increase with corresponding increase in length. It has been stated that if b > 3 then the fish tends to become plumper as the fish increases in length [22]. Variation in the parameters length-weight relationship can occur according to sex and season, growth phase, and physical condition [23] and have also been linked to the larger size and development of females.

Condition factor indicates the physical wellbeing of a population based on the fish's relative plumpness or fatness. Determination of the condition of a particular fish is carried to ascertain if it weighs more or less than would be expected based on its length[8]. Comparatively higher `K′ values observed in males might have been influenced by sex of the fish, age, stage of maturation, fullness of gut, type of food consumed and/or degree of muscular development. Fluctuations of the K values observed for both male and female *H. menoda*, with September being the highest may indicate the breeding season as well as the high productivity of the water body during this month. Neelakantan and Pal (1985)[24], Kurup and Samuel (1987) [25] and Narejo and Rahmatullah (2002) [26] reported fluctuations in the condition factor of many fishes in relation to their feeding rhythm, physico-chemical factors of environment and their physiological state.

## 5. Conclusion and recommendation

The research revealed that female *H. menoda* population slightly predominates in the Kangsha river, Netrakona. It was found that though the female fishes showed a positive allometric growth pattern, overall, the male menoda catfish exhibited better physical condition. The findings from this study would serve as yardstick for the identification and prediction of the Length-weight relationship of *H. menoda* in Kangsha river Netrakona. For sustainable management of this fishery, it is recommended that restrictions on fishing of both female and male fish should be ensured especially during the breeding season.

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