Biological aspects of the Ganges River sprat *Corica soborna* (Clupeidae) in the Mathabhanga River (SW Bangladesh)

by

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ABSTRACT. - The present study describes some biological parameters, including sex ratio, length-frequency distributions, size at sexual maturity, fecundity as well as length-weight (LWR) and length-length (LLR) relationship of the Ganges River sprat *Corica soborna* (Hamilton, 1822) (Clupeidae), an important target species for small scale fisheries in the Mathabhanga River in Bangladesh. A total of 135 specimens ranging from 30.6-48.9 mm TL (total length) and 0.22-1.20 g BW (body weight) were analysed. Sampling was done using traditional basket traps and funnel bag nets between January and December 2004. The sex-ratio showed no significant differences from expected value of 1:1 ($\chi^2 = 0.07$, $p > 0.05$). The size at sexual maturity (TL_{50}) for *C. soborna* females was estimated to be 44.4 mm TL and the mean fecundity of the sampled population was 1,280 ± 870 eggs, ranging from 420 to 3,240. The allometric coefficient *b* values of the LWR indicated isometric growth (~3.0) for both males and females (2.946 and 2.968, respectively). The LLR analysis between TL and fork length (FL) showed a highly significant correlation in both sexes ($r^2 > 0.911$, $p < 0.001$). The data presented in this study would be useful for the sustainable management of the Ganges River sprat fishery in the Mathabhanga River in Bangladesh and neighbouring countries.

RÉSUMÉ. - Quelques aspects de la biologie du sprat du Gange *Corica soborna* (Clupeidae) dans la rivière Mathabhanga (SO du Bengladesh).

Cette étude décrit quelques paramètres biologiques, dont la sex ratio, les distributions de fréquence des tailles, la taille à la maturité sexuelle, la fécondité, ainsi que les relations longueur-poids (LWR) et longueur-longueur (LLR) du sprat du Gange *Corica soborna* Hamilton, 1822) (Clupeidae), une espèce cible importante de la pêche artisanale dans la rivière Mathabhanga au Bengladesh. Un total de 135 individus, variant en taille de 30,6 à 48,8 mm LT (longueur totale) et en masse de 0,22 à 1,20 g, ont été analysés. L'échantillonnage a été réalisé grâce à des pièges paniers traditionnels et des filets-entonnoirs entre janvier et décembre 2004. La sex ratio n'était pas différente de la valeur attendue de 1 : 1 ($\chi^2 = 0,07$, $p > 0.05$). La taille à maturité (TL_{50}) des femelles *C. soborna* a été estimée à 44,4 mm LT et la fécondité moyenne pour la population échantillonnée à 1 280 ± 870 œufs, variant de 420 à 3 240 œufs. Les valeurs du coefficient d'allométrie *b* de la LWR indiquent une croissance isométrique (~3,0) pour les mâles et les femelles (respectivement 2,946 et 2,968). L'analyse LLR entre LT et LF (longueur à la fourche) montre une corrélation très significative chez les deux sexes ($r^2 > 0,911$, $p < 0,001$). Les données présentées ici devraient s'avérer utiles pour la gestion d'une exploitation durable du sprat du Gange dans la rivière Mathabhanga et les pays voisins.

Key words. - Clupeidae - *Corica soborna* - Bangladesh - Mathabhanga River - Size at sexual maturity - Fecundity - Length-weight relationships.

A member of the family Clupeidae, the Ganges River sprat *Corica soborna* (Hamilton, 1822) is one of the dominant species of the ichthyofauna in the Mathabhanga River, southwestern Bangladesh. This fish widely occurs in Asian countries including Bangladesh, India, Thailand, Malaysia, Brunei and Indonesia (Froese and Pauly, 2007). It is an important target species for small-scale fisheries employing a variety of traditional fishing gears such as basket traps (Kibria and Ahmed, 2005). *C. soborna* is categorised under the small indigenous species (SIS) of Bangladesh and is typically consumed whole with the bones (Felts *et al*., 1996).

Sustainable fisheries management relies on understanding the regenerative ability of fish populations and having an accurate assessment of biological parameters, including reproductive traits such as size and age at maturity and fecundity (Tracey *et al*., 2007). Estimating the size at first sexual maturity in fish is important not only for distinguishing between different populations of the same species, but

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also principally for establishing a basis for later estimation whether eventual changes in length at first maturity are because of fisheries pressure or other reasons (Templeman, 1987). Besides, assessment of fecundity is having paramount importance in fisheries management as it provides knowledge about the number of offspring produced in a season and the reproductive capacity of the species (Qasim and Qayyum, 1963). Moreover, length-weight relationships (LWR) are an important tool in fishery management (Bagenal and Tesch, 1978; Gonzalez Acosta *et al*., 2004). They are used in various aspects including estimation of weight from length observations, calculation of production and biomass in the assessment of fish populations, in addition providing information about body condition of specimens in stocks or populations (Lai and Helser, 2004; Gerritsen and McGrathb, 2007). Further, length-length relationships (LLR) are important in fisheries management for comparative growth studies (Moutopoulos and Stergiou, 2002; Hossain *et al*., 2006a).

Although some studies on LWR and LLR of freshwater fishes from the South Asian sub-continent have been conducted (Hossain *et al*., 2006a, 2006b; Haniffa *et al*., 2006), little or no detailed studies on these aspects of the Ganges River sprat from the Mathabhanga river have been attempted. Moreover, information on any aspects of the biology and ecology of the Ganges River sprat in Bangladesh is scarce (Craig *et al*., 2004). This paper describes for the first time some biological parameters of the Ganges River sprat including sex-ratio, length-frequency distributions, size at sexual maturity, fecundity, LWR and LLR relationships in Mathabhanga River, southwestern Bangladesh.

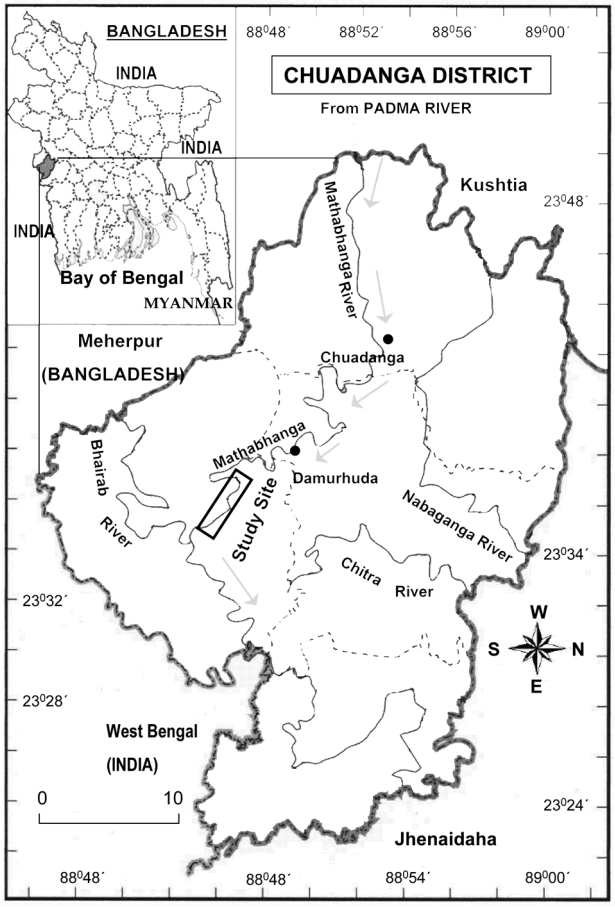

Figure 1. - Location of the sampling site (rectangle) of *Corica soborna* in the Mathabhanga River, southwestern Bangladesh. *[Localisation du site d'échantillonnage (rectangle) de* C. soborna *dans la rivière Mathabhanga, sud-ouest du Bengladesh.]*

MATERIALS AND METHODS

The Mathabhanga River is a tributary of the Ganges-Padma River system, one of the three major river systems of Bangladesh. It is located in the Chuadanga district of Bangladesh, at 23º21'-23º51' N and 88º38'-88º62' E (Fig. 1). The river is part of the northern area of the western Ganges delta and drains into the Bay of Bengal as the Ichimati River. A large number of fishes including some commercially important species are fished by small-scale fishermen throughout the year. The Mathabhanga River is believed to be an important spawning and feeding ground for riverine fish species of southwestern Bangladesh (Hossain *et al*., 2006a).

Ganges River sprats were sampled monthly between January and December 2004 in the Rogunathpur area of the Mathabhanga River (Fig. 1). Fishing was done during daytime (10:00-17:00 hours) using traditional basket traps fabricated from bamboo and funnel bag nets locally known as *Sruti jal*. These basket traps are rectangular in shape measuring 1.0 x 0.3 x 0.5 m and fabricated from small narrow bamboo sticks interwoven with iron wire. The *Sruti jal* is a single large funnel shaped two-winged bag net measuring about 4-5 m long. The mouth of the net is kept open and the two wings stretched laterally against the water current using bamboo stakes fixed to the river bottom. The mesh sizes of *Sruti jal* gear range 8-10 mm at the mouth, 15-20 mm at the wings, and 2-3 mm at the cod-ends of the two pouches. During the July-September flood season, no sampling was done due to adverse weather conditions. Collected fish specimens were preserved in plastic bottles using 10% buffered formalin and transported to the laboratory for identification. All specimens were sexed by gonad observation under a binocular microscope; the sex-ratio was statistically tested for deviance from the expected 1:1 ratio by a chi-square test. Both total length (TL) and fork length (FL) were measured with a slide caliper to the nearest 0.01 cm while body weight (BW) was determined using a digital electric balance to the nearest 0.01 g.

TL_{50} was defined as the smallest length interval in which 50% of the specimens were mature. For the calculation of the TL_{50} we applied the logistic curve (King, 2007) of the

Table I. - Descriptive statistics and estimated parameters of the length-weight relationships for both sexes of *Corica soborna* in the Mathabhanga River (southwestern Bangladesh) from January to December 2004. *n*, number of individuals; Min, minimum; Max, maximum; SD, standard deviation; *a*, intercept; and *b*, slope; CI, confidence intervals; r^2, coefficient of determination. *[Statistiques descriptives et paramètres estimés de la relation longueur-poids pour les deux sexes de* C. soborna *dans la rivière Mathabhanga, sud-ouest du Bengladesh, de janvier à décembre 2004.]*

Sex	*n*	Total length (mm)			Body weight (g)			Regression parameters		95% CI of	r^2
		Min	Max	Mean ± SD	Min	Max	Mean ± SD	*a*	*b*	*b*	
Male	69	30.62	47.88	37.56 ± 3.39	0.22	0.90	0.40 ± 0.12	0.000093	2.946	2.778 - 3.302	0.895
Female	66	34.10	49.90	41.83 ± 3.38	0.33	1.20	0.63 ± 0.17	0.000094	2.968	2.804 - 3.314	0.896

form: $P = 1/(1+\exp\{-r(TL-TL_m)\})$; where, P is the percentage of mature females in each size, r is the slope of the curve and TL_m is the mean length at sexual maturity or the length which corresponds to a proportion of 50% in reproductive condition.

For the estimation of fecundity, first the whole ovaries were weighed (using a digital electronic balance) and then three sub-samples were taken from the front, mid and rear sections of each ovary and weighed. The total number of eggs in each ovary sub-sample was counted to estimate the number of eggs (F) of the ovary using the proportion, F = (Gonad weight x number of eggs in the sub-sample) / sub-sample weight (Yeldan and Avsar, 2000). Individual female fecundity (F_e) was calculated from the mean of the three fecundities (F_1, F_2, F_3). The relationships between F_e and morphometric measurements (TL, BW) were determined by the equations $F_e = a \cdot TL^b$ and $F_e = a \cdot BW^b$, based on the natural logarithms transformed equations, $\ln F_e = \ln a + b \cdot \ln TL$ and $\ln F_e = \ln a + b \cdot \ln BW$ respectively, where a and b are constant parameters in the linear regression analysis.

The LWR were calculated using the equation, $BW = a \cdot TL^b$. The parameters a (equation intercept) and b (regression coefficient, slope) were estimated by linear regression analyses based on the natural logarithms transformed equations, $\ln BW = \ln a + b \cdot \ln TL$. The regression coefficient is generally between 2.5 and 3.5 and the relation is said to be isometric when it is equal to 3 (Ecoutin *et al.*, 2005). A *t*-test was used to determine if the b of relationships was significantly different from 3 using equation described by Pauly (1984). The determination coefficient (r^2) was used as an indicator of the quality of the linear regressions (Scherrer, 1984). Additionally, 95% confidence limits of the parameter b for *LWR* and the statistical significance level of r^2 were estimated. Parameters a and b were compared by analysis of covariance (ANCOVA) using *Vassar-Stats* add-in Microsoft Excel®2003 software and all statistical analyses considered significantly different at $\alpha = 0.05$. The LLR between *TL* and *FL* were calculated by linear regression.

RESULTS

From the 135 specimens of Ganges River sprat collected in the Mathabhanga River during study period, 48.9% were males and 51.1% females, a sex-ratio that statistically did not differ from the expected 1:1 ratio ($\chi^2 = 0.07$, $p > 0.05$). Size of Ganges River sprat males ranged 30.6-47.8 mm TL with a mode in 36–38 mm for, while females were significantly larger (Mann-Whitney U-test, $p < 0.001$) with a mode in 42-44 mm and ranging from 34.1 to 49.9 mm TL. The results also showed that BW of *Corica soborna* females (0.63 ± 017, range 0.33-1.20 g) was significantly (Mann-Whitney U-test, $p < 0.001$) higher than in males (0.40 ± 0.12, range 0.22-0.90) (Tab. I).

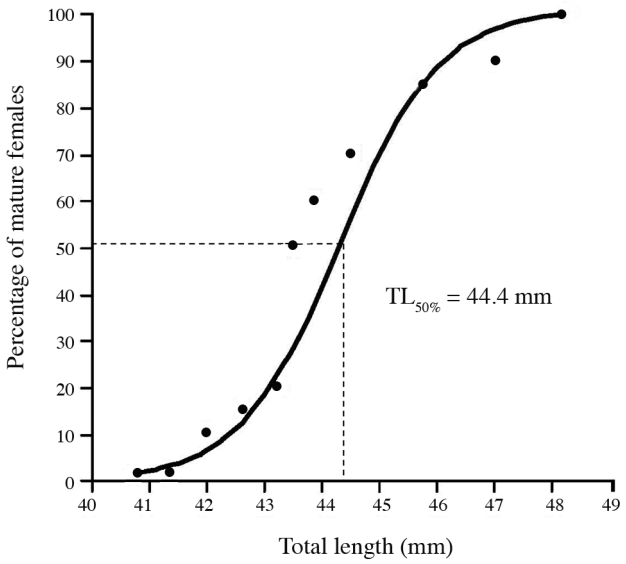

Figure 2. - *Corica soborna* maturity curve as a function of size (total length, TL mm) in the Mathabhanga River, southwestern Bangladesh. *[Courbe de maturité de* C. soborna *en fonction de la taille (longueur totale TL en mm) dans la rivière Mathabhanga, sud-ouest du Bengladesh.]*

The percentage of mature *Corica soborna* females for each length class (TL) group is shown in figure 2. No mature females were found below 39.0 mm TL. The estimated total length at median sexual maturity (TL_{50}) was 44.4 mm TL in the Mathabhanga River. From June 2004 samples, a total number of 16 mature female specimens were used for the estimation of fecundity. The mean fecundity of the sampled population was 1,280 ± 870 eggs and ranged from 420 to 3,240. The regression analyses revealed significant positive relationships between fecundity and morphometric measurements (TL and BW) $F_e = 5 \cdot 1^{-12} \cdot TL^{8.798}$ ($r^2 = 0.951$) and

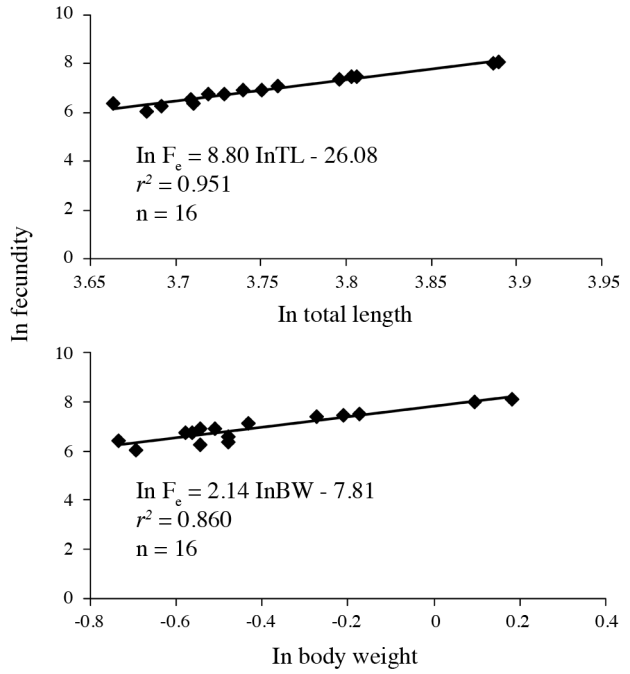

Figure 3. - Double-logarithmic plot of fecundity (F_e) against total length (*TL*, above) and body weight (*BW*, below) of *Corica soborna* females in the Mathabhanga River, southwestern Bangladesh. *[Graphe (échelle log-log) de la fécondité (F_e) en fonction de la longueur totale (*TL*, dessus) et de la masse corporelle (*BW*, dessous) pour des femelles de* C. soborna *dans la rivière Mathabhanga, sud-ouest du Bengladesh.]*

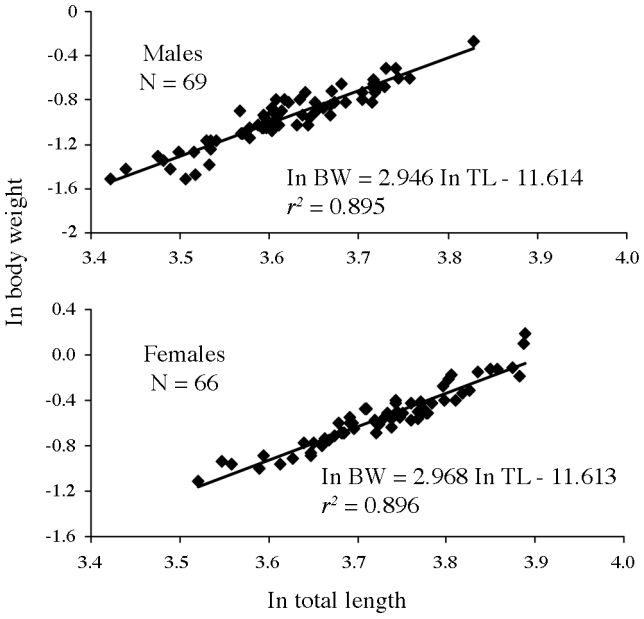

Figure 4. - Double-logarithmic plot of body weight (*BW*) against total length (*TL*) for *Corica soborna* males (above) and females (below) from the Mathabhanga River, southwestern Bangladesh. *[Graphe (échelle log-log) de la masse corporelle (*BW*) en fonction de la longueur totale (*TL*) pour des mâles (dessus) et des femelles (dessous) de* C. soborna *dans la rivière Mathabhanga, sud-ouest du Bengladesh.]*

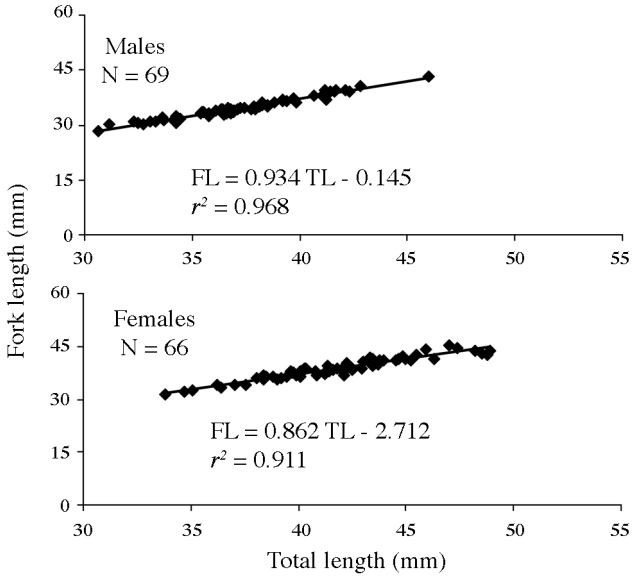

Figure 5. - Relationship between fork length (*FL* mm) total length (*TL* mm) for *Corica soborna* males (above) and females (below) from the Mathabhanga River, southwestern Bangladesh. *[Relation longueur fourche (*FL *mm) longueur totale (*TL *mm) pour des mâles (dessus) et des femelles (dessous) de* C. soborna *dans la rivière Mathabhanga, sud-ouest du Bengladesh.*

$F_e = 2469.3 \cdot BW^{2.138}$ ($r^2 = 0.860$) based on natural logarithms transformed equations (Fig. 3).

LWR indicated isometric growth in both males ($BW = 0.000093 \cdot TL$) and females ($BW = 0.000094 \cdot TL^{2.968}$) as the statistical *t*-test revealed that *b* values were not significantly different from 3 ($p > 0.05$) (Fig. 4, Tab. I). ANCOVA showed no significant differences between slopes of the regression lines of both sexes ($p > 0.05$). Estimated parameters of the LLR between TL and FL and the coefficient of determination are presented in figure 5. These positive linear regressions showed highly significant differences for males and females ($p < 0.001$) with the coefficient of determination values being 0.968 and 0.911, respectively.

DISCUSSION

Information regarding any biological aspects of *Corica soborna* from Bangladeshi waters is quite insufficient (Craig *et al*., 2004). To the best of our knowledge, no references dealing with sex-ratio, length-frequency, size at sexual maturity, fecundity as well as length-weight (LWR) and length-length (LLR) relationship for *C. soborna* are available from the Mathabhanga River, Bangladesh. Therefore, this study presents the first attempt to describe these biological parameters for the Ganges River sprat from the Mathabhanga River.

The absence of small-sized fish in the 10-30 mm TL class may be attributed to the selectivity of the fishing gear used

rather than the absence of small sized individuals. However, the recorded maximum sizes, 47.88 and 49.90 mm TL for *Corica soborna* males and females respectively, are useful data for several calculations in fisheries.

The size at sexual maturity is of special interest in fisheries management cause is widely used as an indicator for minimum permissible capture size (Lucifora *et al*., 1999). Available information on size at sexual maturity of other fishes from plot of percentage occurrence of mature females against length class can be obtained from the resulting logistic equation. However, no references dealing with the size at sexual maturity and fecundity for *C. soborna* are available, thus it was not possible to compare the results of this work with previous ones. As it has been reported in a number of fishes (Khan and Jhingran, 1975), the fecundity of the sampled population of *C. soborna* was positively correlated with the morphometric measurements, revealing that fecundity increased in proportion to the 8.798 power of TL and 2.138 power of BW.

Length-frequency distributions and LWR analyses revealed that females were slightly heavier than males for any given length. Since estimated values of the parameter *b* were not significantly different from 3, isometric growth can be assumed in both sexes for the Ganges River sprat. The present results were comparable with available previous studies (Hossain and Afroze, 1991), although they did not include the 95% confidence intervals in their results (Froese and Pauly, 2007). Hossain and Afroze (1991) also in Bangladesh gave similar to our isometric growth results (a = 0.0069; b = 3.0520). However, Kamal (1982) recorded positive allometric growth (*a* = 0.0061; *b* = 3.6900) in the Ganga River (India) but this estimation was obtained from a narrower size range (26-38 mm TL) than ours. A number of factors such as growth phase, season, degree of stomach fullness, gonad maturity, sex, size range, health and general fish condition as well as preservation techniques are known to influence the LWR in fishes (Tesch 1971; Weatherley and Gill 1987; Hossain *et al*., in press). However, during the present study, these factors have not been considered and the difference in the calculated coefficient (*b*) values may be attributed to the combined effect of one or more of the unaccounted factors. The parameters *a* and *b* would be treated as mean annual values, although the samples of *Corica soborna* were not collected throughout the year. Previous studies on another fish species (*Mystus vittatus* (Bloch, 1794), Siluriformes: Bagridae) from the same study site reported similar results (Hossain *et al*., 2006a). The results of the LLR analyses between the TL-FL showed a highly significant difference between males and females with coefficients of determination above 0.900 with positive slopes of the regression lines.

In conclusion, the current study provides basic information on size at sexual maturity, fecundity, length-weight relationships and length-length relationships useful in the development of a harvest strategy and management for the Ganges River sprat fishery in the Mathabhanga River and neighbouring drainage basins. Further, the information provides a platform for future research into other growth and reproductive attributes of this fish species. All year extended monitoring is needed to monitor changes and trends in the length-weight and length-length relationships of the Ganges River sprat that may be a result of ecological changes as well as adaptive changes in the species due to fishing pressure and food availability within the Mathabhanga river in Bangladesh.

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