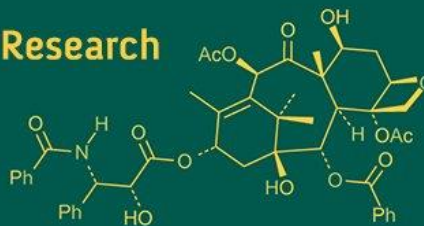


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Length-weight relationship and reproductive biology of Bombayduck *Harpadon nehereus* (Hamilton, 1822) from Veraval fishing harbour, Gujarat

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Abstract

The Bombayduck *Harpadon nehereus* (Hamilton, 1822) is a common species and a major contributor to the fishery in the northern Arabian Sea. The biology of *H. nehereus*, exploited by trawlers from the Veraval fishing harbour, Gujarat, was investigated from March 2025 to February 2026. The length-weight relationship was calculated separately for both sexes. For males, the b value is 3.3, For females the b value is 3.5. The b value for pooled data is 3.4, showing a positive allometric growth pattern. During the present study period, immature, maturing, and mature ovaries were observed throughout the year in varied frequencies, indicating the species to be a continuous spawner. Fecundity was estimated for gravid females, and the absolute fecundity ranged from 25,485 to 1,42,336 eggs per fish. Relative fecundity increased with body size, ranging from 252 to 435 eggs per g. The gonadosomatic index and monthly maturity stages suggested that *H. nehereus* is a continuous spawner with peak spawning season occurring from January to April.

Keywords: Bombay duck, Veraval, length-weight relationship, fecundity

1. Introduction

Bombay duck *Harpadon nehereus* (Hamilton, 1822) (Synodontidae: Aulopiformes) is a benthopelagic marine fish commonly inhabiting shallow coastal waters with muddy substrates, and it frequently enters estuarine and creek environments. The species is widely distributed throughout the Indo-Pacific region and supports important commercial fisheries (Ganga *et al.*, 2016; Froese and Pauly, 2021) ^[7, 6]. Within the northern sectors of the Indian EEZ, particularly along the coasts of Gujarat and Maharashtra in the Arabian Sea and West Bengal in the Bay of Bengal, *H. nehereus* constitutes a significant fishery resource. It supports traditional small-scale fisheries and is also regularly encountered as bycatch in various fishing gears operated in these regions. The species is locally referred to as “Bombil” in Maharashtra and “Bumla” or “Bumli” in Gujarat.

The species is predominantly distributed in the northern regions of the Indian EEZ, and several researchers have associated this restricted latitudinal occurrence with different environmental factors. Hora (1934) ^[10] related its distribution to salinity, while Raj (1954) ^[13] associated the occurrence of Bombayduck with the 80°F isotherm and prevailing monsoon conditions in its distributional range. Later, Bapat (1970) ^[4] identified sea surface temperature as the primary factor influencing the unique distribution pattern of Bombayduck along the Indian coast.

2. Methodology

30 Bombayduck samples were collected every month from Veraval fishing harbour from March 2025 to February 2026. The major fishing crafts landing Bombayduck at this centre were dol netters and trawlers operating in the north-eastern Arabian Sea at depths ranging from 70 to 90 m. The collected specimens were preserved in ice and transported to the laboratory in insulated containers for detailed analysis.

3. Length-weight relationship

Length measurements, including total length (TL) and standard length (SL), along with body weight, were recorded to the nearest millimetre (mm) and gram (g), respectively, using a digital measuring scale and electronic balance. The length-weight relationship was estimated using the equation $W = aL^b$ (Le Cren, 1951)^[12], where W represents the fish weight in grams, L denotes the total length in centimetres, a is the regression intercept, and b is the regression coefficient or slope. The significance of differences between the regression coefficients of males and females was evaluated using ANOVA (Snedecor and Cochran, 1967)^[14].

4. Reproductive biology

The Gonadosomatic Index (GSI) was calculated using the formula proposed by Kume and Joseph (1969).

$$GSI = [\text{Gonad weight}/\text{Bodyweight}] \times 100$$

Absolute fecundity (F) is the total number of ripe eggs in the ovaries just before spawning. Fecundity was calculated following the gravimetric method by preserving ovaries in 5% formalin, then the weight (g) and maturity stage (Stage IV and V) of the ovaries were recorded. The ovary was then divided into three sections: front (anterior), middle, and back (posterior). From each section, a small piece weighing 0.01 g was taken to count the number of eggs and estimate fecundity.

$$F = [\text{gonad weight} \times (\text{sub-sample egg count}/\text{gonad sub-sample weight})]$$

5. Results

5.1. Length-weight relationship

A total of 300 individuals, consisting of 196 females (158-355 mm TL) and 104 males (162-302 mm TL), were used for the calculation of the length-weight relationship. The

relationship between weight (g) and TL (cm) for males, females and combined sexes is expressed by the following equations:

$$\text{Length-weight relation (Males): } W = 0.000000672 \times TL^{3.3} \quad (R^2 = 0.89)$$

$$\text{Length-weight relation (Females): } W = 0.00000131 \times TL^{3.5} \quad (R^2 = 0.81)$$

Analysis of covariance showed no significant difference in the regression coefficients of males and females at 1 and 5% levels.

Hence, the sexes were pooled, and a length-weight relation was calculated and expressed as: Length-weight relation (pooled sexes): $W = 0.000000867 \times TL^{3.4}$ ($R^2 = 0.85$)

The b value estimated was greater than 3, and the fish showed positive allometric growth

5.2. Gonadosomatic Index

Pooled GSI varied significantly between months and ranged from 0.1 to 7. The peak value was observed in March, and a higher percentage of mature specimens was observed during January to April, indicating the peak spawning season of the species.

Table 1: Monthly GSI for *H. nehereus*

Month	Pooled	Male	Female
Mar-25	7.00	5.00	9.00
Apr-25	5.00	3.50	6.50
May-25	3.00	2.60	3.40
Aug-25	0.80	0.50	1.10
Sep-25	0.10	0.07	0.13
Oct-25	0.50	0.10	0.90
Nov-25	2.00	0.80	3.20
Dec-25	2.50	1.00	4.00
Jan-26	5.00	3.00	7.00
Feb-26	5.6	4	7.2

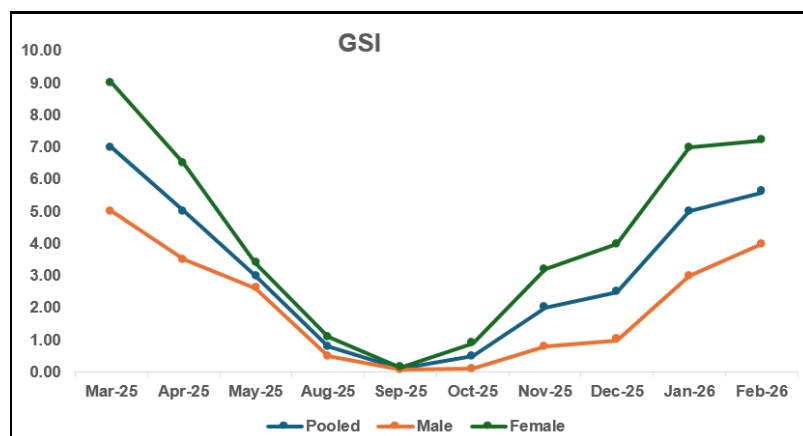


Fig 1: Monthly GSI for *H. nehereus*

5.3. Absolute fecundity (F)

A total of 62 mature females were observed in this study. The absolute fecundity ranged from 25,485 to 1,42,336 eggs per fish, and relative fecundity from 252-435 eggs per gram.

6. Discussion

Knowledge of the length-weight relationship (LWR) is essential for stock assessment studies, as it serves as a fundamental input and provides insights into the growth

pattern, condition, and overall fitness of fish (Abdurahman *et al.*, 2004)^[1]. The LWR of *H. nehereus* obtained in the present study indicated positive allometric growth. Earlier reports on the length-weight relationship of *H. nehereus* are summarised in Table 2, and the findings of the present investigation are in agreement with previous studies conducted in the north-eastern Arabian Sea.

Differences observed in the 'b' values across studies may be attributed to ecological variation, seasonal influences,

feeding conditions, and differences in the composition and number of juvenile and adult specimens examined (C. Anulekshmi *et al.*, 2024) ^[2].

Intense fishing pressure, coupled with the effects of climate change, has been influencing fish populations in the northern Arabian Sea. The susceptibility of fish species is largely governed by their biological characteristics, environmental conditions, and anthropogenic disturbances. Bombay duck *H. nehereus* has been identified as a species with high climate vulnerability and low adaptive capacity and is considered a non-hardy coastal species exposed to multiple environmental stressors (Dineshbabu *et al.*, 2020) ^[5].

During the present study period, immature, maturing, and

mature ova were observed throughout the year in varied frequencies, suggesting that spawning is a continuous activity with a peak from January to April. Fecundity was estimated for gravid females, and the absolute fecundity ranged from 25,485 to 1,42,336 eggs per fish. Relative fecundity ranging from 252 to 435 eggs per g.

The absolute fecundity ranges of 21,182-1,16,067, and the relative fecundity was estimated to be 314 ova/g body weight, were reported by Balli *et al.* (2006) ^[3] from Mumbai waters. Ghosh (2014) ^[8] reported a relative fecundity of 388 eggs per gram body weight for the species. C. Anulekshmi *et al.* (2024) ^[2] reported that the absolute fecundity ranged from 23,444 to 1,34,432 eggs per fish, with a mean of 82,884 eggs per fish, and the relative fecundity increased with body size and ranged from 235-430 eggs per g.

Table 2: Length-weight relationship of *H. nehereus* by study area

Authors	'a' and 'b' value	Region
Kurian and Kurup (1992) ^[11]	Pooled: a = 0.00117, b = 2.0279	Maharashtra
Balli <i>et al.</i> (2006) ^[3]	Male: a = 0.000659, b = 3.638 Female: a = 0.000855, b = 3.558 Pooled: a = 0.000731, b = 3.606	Mumbai
Ghosh <i>et al.</i> (2009) ^[9]	Male: a = 0.0106, b = 2.8097 Female: a = 0.00867, b = 2.871 Pooled: a = 0.00535, b = 3.024	Saurashtra
Ghosh (2014) ^[8]	Male: a = 0.00066, b = 3.638 Female: a = 0.000856, b = 3.558 Pooled: a = 0.000731, b = 3.606	Saurashtra
C. Anulekshmi <i>et al.</i> (2024) ^[2]	Male: a = 0.000000417, b = 3.44 Female: a = 0.000000143, b = 3.64 Pooled: a = 0.000000237, b = 3.53	Mumbai
Present study	Male: a = 0.000000672, b = 3.3 Female: a = 0.00000131, b = 3.5 Pooled: a = 0.000000867, b = 3.4	Veraval

7. Conclusion

In the present investigation of *H. nehereus* from the Veraval coast, the length-weight relationship showed a positive allometric growth in this region ($b > 3$). High GSI values were observed during January to April, indicating the peak spawning season of the species. The absolute fecundity ranged from 25,485 to 1,42,336 eggs per fish, showing the high number of recruitments in the new population.

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