BIOLOGY OF BOMBAY DUCK, *HARPODON NEHEREUS* (HAM., 1822), FROM MUMBAI WATERS, INDIA

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ABSTRACT

Morphometric and meristic study of *Harpodon nehereus* (Hamilton, 1822) from Mumbai waters indicated that the specimens belonged to a homogenous population. Based on the meristic study, the fin formula can be written as B_{23-26}, D_{12-13}, P_{11-13}, V_9, A_{13-15}, C_{19}, L_{40}. Length-weight study revealed an allometric relationship, presented as Log W = -3.1362 + 3.6059 Log L. The analysis of food and feeding habits revealed the species to be voracious, carnivorous and cannibalistic, feeding mainly on *Acetes* spp., juveniles of *H. nehereus* itself, prawns and *Coilia dussumieri*. The feeding intensity was found to be the maximum during September and November, and also in mature specimens which may be the preparation for the ensuing spawning activity. Reproductive biology indicated two peak spawning seasons in November and March. However, the species as a whole has prolonged breeding season and spawning occurs throughout the year. Average fecundity was estimated as 314 ova/g body weight of fish and the length at which 50% of female specimens mature (Lc_{50}) was calculated as 255 mm.

Keywords: *Harpodon nehereus*, morphometry, length-weight relationship, food and feeding habits, reproduction

INTRODUCTION

About 90% of all India landings of Bombay duck, *Harpodon nehereus* (Ham., 1822) are from the states of Gujarat and Maharashtra contributing about 5% of the all India marine fish landings. Fishing for Bombay duck is carried out by stationary bag net known as 'dol' that works entirely by the forces of tide. Investigations carried out on the biology of Bombay duck in different parts of India include Chopra (1939), Bapat *et al.* (1951) and Pillay (1951, 1953) from River Matlah (Bengal); and Bapat (1970) and Khan *et al.* (1992) off Saurashtra coast. Ray and Datta (2003) studied the predaceous adaptation of the head of Bombay duck.

MATERIAL AND METHODS

For the present study, samples were collected at weekly intervals from

New Ferry Wharf, Sassoon Docks and Versova landing centres in Mumbai during October 2003 to June 2005. A total of 450 fishes ranging from 170 to 322 mm in total length and 20 to 185 g in total weight were measured for different morphometric and meristic characters in fresh condition following the standard methods. Length-weight relationship and relative condition factor were calculated following Le Cren (1951). The Index of Preponderance method (Natarajan and Jhingran, 1961) was used to rank the different food items recorded in the stomach contents. For the determination of feeding intensity, degrees of fullness of the stomachs were classified as 'gorged', '100% full', '75% full', '50% full', '25% full', 'trace' and 'empty'. Gastrosomatic index (GSI) was also calculated to know the feeding status in different months.

The frequency polygons of ova diameter were plotted to know the spawning activity as described by Clark (1934) as followed by Palekar and Karandikar (1952). The percentages of occurrence of various stages of maturity in different months were determined in 252 females for 21 months, pooled to 12 months and the percentage of cumulative frequency plotted against the length groups so as to determine the size at which 50% of fishes mature. Fecundity was estimated using 20 mature ovaries. Sex ratio was based on the number of specimens of each sex sampled every month excluding indeterminates, calculated monthwise and lengthwise.

RESULTS

The study of morphometric characteristics of *H. nehereus* indicated a high degree of correlation between the compared characters. The relationship indicated positive allometric growth and high degree of correlation between the compared characters as evident from the 'r' values. The relationship of total length with other morphometric characters showed the slowest growth in the caudal depth (b = 0.056) and the fastest growth in standard length (b = 0.817). Eye diameter has the slowest (0.082) and the pectoral fin length, the fastest growth (1.255) compared with head length (Table 1).

Table 1: Relationship between various morphometric characters in *Harpodon nehereus*

S. no.	Morphometric character	Range (mm) (X)	Range (mm) (Y)	Y = a + bX	r
1.	Total length** and standard length*	170 – 322	137 – 268	Y = –1.900 + 0.817 X	0.986
2.	Total length** and body depth*	170 – 322	17 – 52	Y = –11.467 + 0.184 X	0.813
3.	Total length** and head length*	170 – 322	26 – 60	Y = –1.063 + 0.185 X	0.916
4.	Total length** and caudal depth*	170 – 322	7 – 16	Y = –2.054 + 0.056 X	0.837
5.	Total length** and pre-dorsal length*	170 – 322	58 – 120	Y = –7.126 + 0.386 X	0.960
6.	Total length** and pre-pectoral length*	170 – 322	25 – 55	Y = 1.342 + 0.155 X	0.814
7.	Total length** and pre-ventral length*	170 – 322	62 – 135	Y = –10.256 + 0.419 X	0.938
8.	Total length** and pre-anal length*	170 – 322	102 – 210	Y = –5.724 + 0.653 X	0.978
9.	Total length** and anal fin base*	170 – 322	20 – 43	Y = 0.531 + 0.126 X	0.873
10.	Head length** and pectoral fin length*	26 – 60	23 – 67	Y = –5.807 + 1.255 X	0.867
11.	Head length** and eye diameter*	26 – 60	2 – 5	Y = –0.131 + 0.082 X	0.692
12.	Head length** and snout length*	26 – 60	3 – 6	Y = 0.586 + 0.095 X	0.668
13.	Head length** and post-orbital length*	26 – 60	21 – 49	Y = –0.501 + 0.824 X	0.979
14.	Head length** and inter-orbital length*	26 – 60	6 – 18	Y = 2.492 + 0.214 X	0.594
15.	Head length** and lower jaw length*	26 – 60	24 – 47	Y = 5.622 + 0.677 X	0.899

**Represents 'X' and * corresponding 'Y', and 'r' is the correlation coefficient.

Based on the study of meristic counts, the fin formula for *H. nehereus* from Mumbai Coast could be written as

B_{23-26}, D_{12-13}, P_{11-13}, V_9, A_{13-15}, C_{19}, L_{40}.

The length-weight relationship aL^b is expressed in logarithmic forms as

Log W = -3.1806 + 3.6378 Log L (r = 0.9128) – males

Log W = -3.0675 + 3.5577 Log L (r = 0.9466) – females

Log W = -3.1362 + 3.6059 Log L (r = 0.9309) – pooled specimens

The analysis of covariance which indicated the regression coefficient within and between the sexes was not significant at 1 and 5% levels.

Gut contents analysis indicated *Acetes* spp. to rank first (67.39%) followed by *H. nehereus* itself (19.17%). These items were dominant throughout the period of study contributing nearly 90% of food. *Coilia dussumieri* (3.96%) and prawns (3.45%) ranked fourth and fifth, respectively, after the digested matter (5.96%). Prawns were represented by *Penaeus* spp., *Parapenaeopsis* spp., *Metapenaeus* spp. and *Hippolysmata* spp., while fishes by *H. nehereus, C. dussumieri, Polynemus* spp., *Bregmaceros macclellandi, and Sardinella* spp. *Acetes* spp. dominated in almost all the months except September; September had the lowest value (3.15%) and the highest was in March (86.71%). Prawns were also present in all the months except August (1.78%-15.36%). *H. nehereus* was recorded in the gut in all the months (0.07% in May to 61.70% in November). Lengthwise food analysis indicated that all the types of food items were eaten by all the length-groups; however, larger fishes showed preference towards fishes and smaller ones for *Acetes* spp. (Fig. 1).

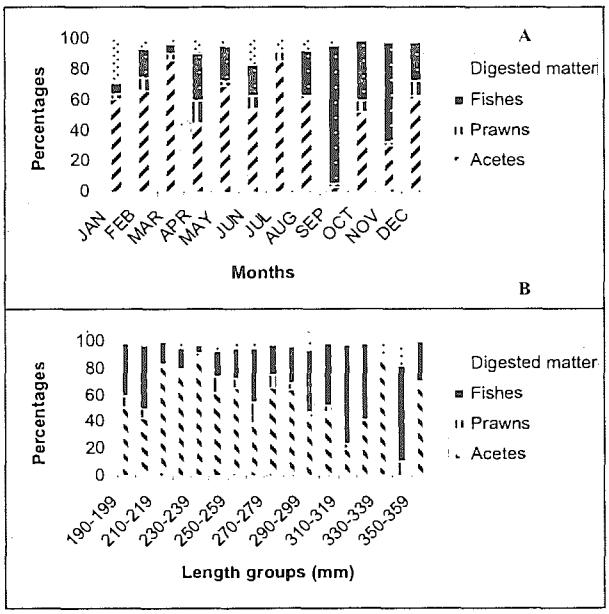

Fig. 1: Index of preponderance in* H. nehereus; *A. Monthwise, B. Lengthwise

GSI of the pooled specimens was the highest in the month of August (6.08) followed by May (5.41) and the lowest was in September (3.68). For males, the highest was recorded in February (4.80) followed by June (4.65) and the lowest was in March (3.07). In females, the highest was in August (7.88) followed by May (6.80) and the lowest value was recorded in September (3.83). Lengthwise GSI (pooled) was maximum (5.54) in length-group 200-209 mm followed by 5.49 in 310-319 mm length-group. The

lowest value (2.56) was recorded in the 340-349 mm length-group. In males, the highest value (5.43) was found in the 320-329 mm length-group, while in the females, the highest (7.11) was recorded in the 200-209 mm length-group (Fig. 2).

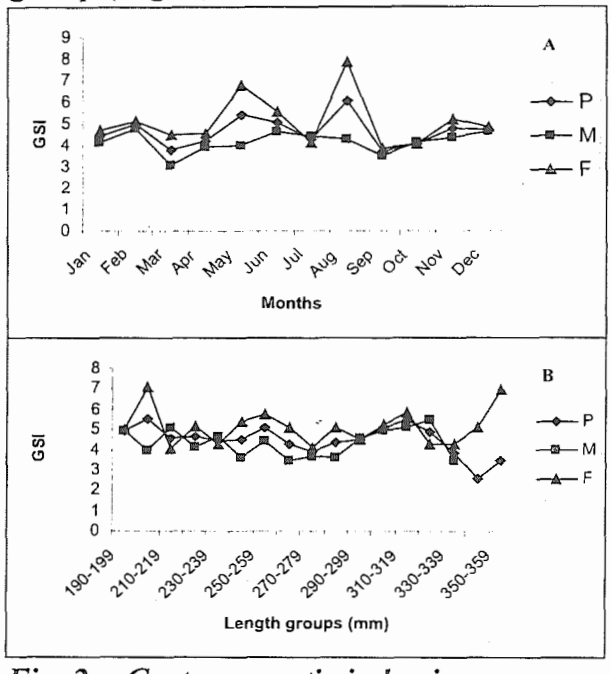

Fig. 2: Gastro-somatic index in **H. nehereus**; *A. Monthwise, B. Lengthwise (P = Pooled, M = Male, F = Female)*

The cumulative percentages of females were plotted against their length groups at 10-mm class intervals taking III to VI stages of maturity. The length at which 50% of the female fishes attained maturity was estimated to be 255 mm (Fig. 3).

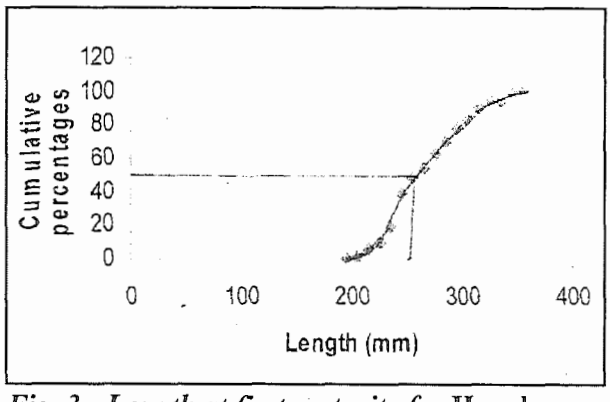

Fig. 3: Length at first maturity for **H. nehereus**

The ripe ova (VI stage) were recorded in January, March, May, October and November. Two peaks were observed which occurred in November and March. Stages I-V were observed almost throughout the year with the exception of August. The VII stage (spent ovaries) was found in almost all the months of the year with the exceptions of July and September. The peaks of this stage were observed in the months of August, June, October, November and February.

Monthwise sex ratio of male to female varied from 1:0.20 (lowest) in August to 1: 0.80 (highest) in November and a significant difference was in male to female ratio at 5% level of significance which was tested by 1:1 method of chi-square. However, the overall sex ratio of the population was 1:0.45.

Absolute fecundity was determined from 20 specimens, which ranged from 21,182 to 116,067 ova in ovaries weighing between 4.32 and 26.22 g in the length range of 246-356 mm in total length and weighing 70-300 g. Relative fecundity was estimated to be 314 ova/g body weight. The relationship of fecundity with total length, total weight and ovary weight was obtained as:

$\text{Log } F = -1.1127 + 3.9284 \text{ Log } L$ ($r = 0.7233$)

$\text{Log } F = 2.1689 + 1.1307 \text{ Log } L$ ($r = 0.799$)

$\text{Log } F = 3.7254 + 0.9718 \text{ Log } L$ ($r = 0.9791$)

Two hundred and fifty-two females were examined for the calculation of GSI; prominent peaks were indicated in May (5.09), April (4.98) and March (4.55). The lowest value was in September (1.37). However, the lengthwise GSI indicated a peak (5.82) in 340-349 mm length-group, followed by 5.29 in the 240-249 mm length-group and 5.35 in the 210-219 mm length-group. The lowest value (0.41) was obtained in the 330-339 mm length-group.

The study indicated slight variations in the relative condition factor for both sexes in the different months of the year; however, pooled values showed slight peaks in May (1.03), and October, December and March (1.02). The peak value (1.03) was observed in October and March in males, meanwhile, the same value was shown in December and May by the females. The overall value for both males and females was calculated at 1.01. The peak value (1.04) was found in the 330-339 mm length-group and the lowest value (0.5) in the 340-349 mm and 350-359 mm length-groups. In male, the peak (1.07) was observed in the 330-339 mm length-group and in females, it (1.02) was observed in the 230-239, 270-279 and 310-319 mm length-groups. The overall values were 1.02 for males and 1.01 for females (Fig. 4).

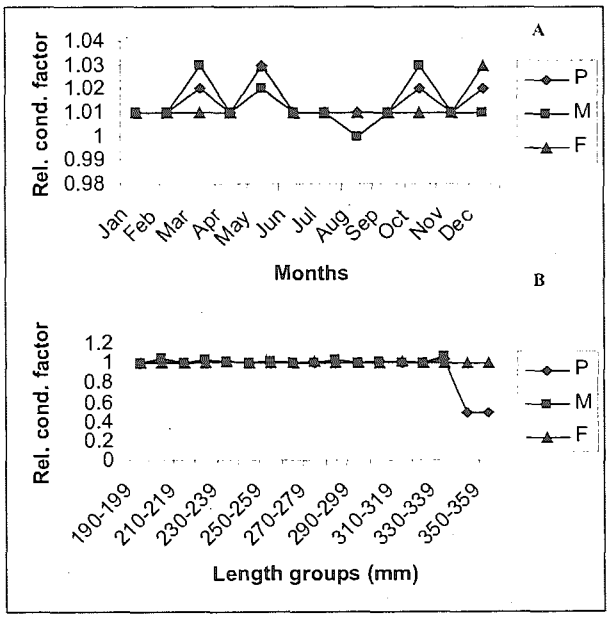

Fig. 4: Relative condition factor in **H. nehereus**; *A. Monthwise, B. Lengthwise (P = Pooled, M = Male, F =Female)*

Out of the 30 ovaries selected for ova diameter studies, ten are represented in Fig. 5, where one each

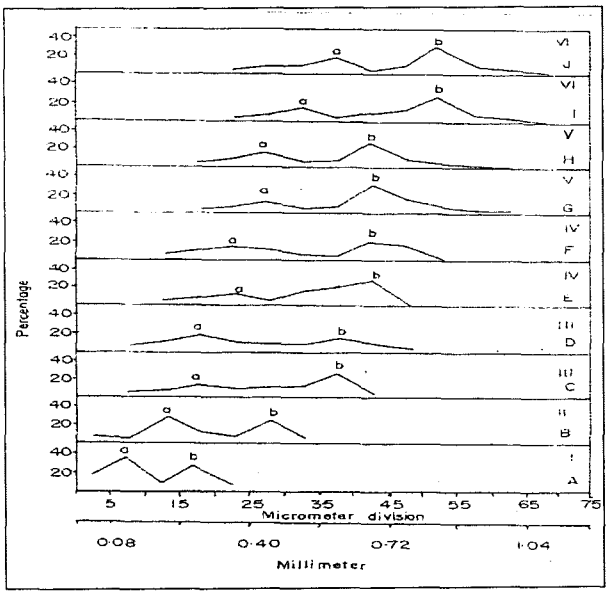

Fig. 5: Ova diameter frequencies for different maturity stages of **H. nehereus**

belongs to the stages I and II, and two each for stages III-VI. They are presented in the figure as A-J. Ovary 'A' represents ova of two modes, one 'a' at 0.128 mm and 'b' at 0.288 mm. All the eggs belong to the immature stock. Ovary 'B' also represents eggs of immature stock showing modes 'a' and 'b' at 0.208 and 0.448 mm, respectively. Ovaries 'C' and 'D' represent ova of maturing stock with diameters of 0.228 and 0.608 mm as the dominant modes. There is virtually not much of a shift in the modes 'a' and 'b' in ovaries 'G' and 'H' showing modes at 0.448 and 0.688 mm of 'a' and 'b', respectively. Ovaries 'I' and 'J' also show two modes, 'a' and 'b', at 0.56 and 0.84 mm for 'I' and 0.62 and 0.84 mm for 'J'.

DISCUSSION

In the present study on morphometry and meristic characters of *H. nehereus,* a high growth rate was found in standard length and pre-anal length in relation to total length. Statistical analysis of various morphometric characters indicated that the fish samples were from a homogenous stock. Regression coefficient 'b' for length-weight relationship was 3.64 for males, 3.65 for females and 3.61 for the pooled specimens. The analysis of variance between both the sexes showed that there was no significant difference at 5% level. Comparison of meristic characters with the work from other investigators (Table 2) showed similarity with the exception of pectoral fin rays which had one more ray.

Table 2: Comparison of meristic characters of *H. nehereus* with investigations carried out by other workers from Indian coasts

Author	Dorsal fin rays	Anal fin rays	Pectoral fin rays	Ventral fin rays	Caudal fin rays	Branchiostegal rays	Lateral line scales
Weber and de Beaufort (1929)	12 –14	14-15	11 – 12	9	---	23 – 26	40
Day (1958)	12 –13	13-15	11 - 12	9	19	23 – 26	40
Bapat (1970)	12 –14	14 -15	11 – 12	9	---	23 – 26	40
Talwar and Kacker (1984)	12 –14	14 -15	---	---	---	---	---
Present study	12 - 13	13 -15	11 – 13	9	19	23 – 26	40

The food items observed are in conformity with the observations of the earlier workers (Bapat, 1970; Khan *et al.*, 1992) except the occurrence of *Nematopalaemon tenuipes,* which has been recorded by earlier workers but could not be recorded during present study. Khan *et al.* (1992) also observed that the monthly feeding activity was high during the post-monsoon and low during the monsoon seasons. Total average values of GSI were higher in females (5.11) than in males (4.16) in the monthwise analysis and also values for females (5.12) were higher than in the males (4.32) in the lengthwise analysis. It showed that the females feed more than the males, which probably indicates that the females require more food for the physiologically active period of development and maturation of ovaries. In the case of the females, September and October recorded the lowest values meaning low feeding which may indicate the maturity of ovaries.

Length at which 50% of the females of *H. nehereus* attained sexual maturity was 255 mm, while Bapat *et al.* (1951) found the minimum size of maturity as 200 mm, Palekar and Karandikar (1952) as 240 mm, Bapat (1970) as 210 mm, Khan (1989) as 250 mm, Khan *et al.* (1992) as 232.5 mm, Kurian and Kurup (1992) as 230 mm and Kurian (2000) as 230 mm. The overall monthwise male to female sex ratio was calculated as 1:0.45 with males being more than females in all months of the year. Males seemed to dominate the females in terms of their numbers. Bapat (1970) calculated the sex ratio as 1:1.71 and Khan *et al.* (1992) found it as 1:0.9. Lengthwise sex ratio in this study showed an increase in the number of females with the increase in length. Kurian and Kurup (1992) also observed that there is a progressive reduction in males with the increase in size. The average fecundity of *H. nehereus* was estimated to be 314 ova/g body weight. Fecundity was generally noted to be higher in bigger than smaller fishes. GSI in higher length groups indicated low values in the months of August, September and October which indicated the presence of females with large ripe ovaries during this period. Ova diameter studies showed that the ova have two modes representing immature and mature ova, respectively, in the ovary. Ripe ova had larger diameters than immature ova. These observations probably indicate that *H. nehereus* spawns once a year. The presence of spent ovaries in almost all the months of the year also showed that spawning occurs throughout the year and the species is a total spawner. The peaks of ripe ova were observed to occur in November and March which is indicative of two peak spawning seasons. Bapat (1970) indicated that *H. nehereus* has a prolonged breeding season and ovaries have ova with two modes representing the immature and mature crop where individuals spawn once a year and the species breeds throughout the year. Deshmukh and Kurian (1980) also concluded that Bombay duck breeds throughout the year. Khan *et al.* (1992) observed that

the spawning activity is high during December-January and June, indicating two peaks in the spawning seasons. They calculated the average fecundity as 340 ova/g body weight and noted the presence of two batches of ova, each of immature and mature ova depending upon the stage of maturity of fish. They also concluded that individual fish spawns once a year. Kurian (2000) also noted the bimodality in the distribution of the oozytes and that the development progresses in a paired manner. Fecundity increased with the total length of the fish and there is complete absence of any ripe ovum in the spent ovary indicating total spawning.

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