

## Quantitative and Qualitative Analysis of the Feeding Ecology of *Harpadon nehereus* (Hamilton 1822) from the North-East Coast of India

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### ABSTRACT

The feeding habit of 217 Bombay ducks was analysed by their gut contents and species were identified and observed in different frequencies for a year (2024-25). The species that were identified are *Coilia dussumieri* (CD), *Johnius dussumieri* (JD), *Otolithes cuvieri* (OC), *Setipinna* sp. (HA), *Leptracanthus savala* (RF), *Stolephorus* sp.(SC), *Harpadon nehereus* (HN), *Non-Penaeid* sp. (PS), X (unidentified). The frequency of gut contents was arranged in decreasing order, such as – PS > CD > HA > HN > OC > X > (SC, JD, RF) based on the frequency table of the gut content. The percentage Index of Relative Importance (IRI) was also provided, where PS (78.51178%) is the dominant prey, followed by CD (7.255529%), HN

(7.092837%), HA (3.262283%) and OC (2.679047%). JD (0.487117%), X (0.296222%), RF (0.284903%), and SC (0.130269%) - occasional prey. The Degree of fullness (DF) and Stomach Fullness Index (SFI) predicted a low feeding intensity. Shannon-Wiener index ( $H' = 1.4854$ ) and Pielou's evenness index ( $J' = 2.197225$ ) were calculated and indicating that the feeding habit is moderately generalized with moderate diversity and evenness of prey. The type of species obtained from the gut is also provided.

**Keywords** Gut content, *Harpadon nehereus*, Index of relative importance, Shannon-wiener index, Pielou's evenness index.

### INTRODUCTION

*Harpadon nehereus* (Hamilton 1822), belongs to the order Myctophiformes, Family: Harpadontidae, mostly located in estuaries and coastal areas (Talwar and Kacker 1984). It is commonly known as Bombay duck (Talwar and Kacker 1984), and locally in West Bengal, it is known as "lotty". In Maharashtra and Gujarat, it is known as "bombil" and "Bumla" respectively (Anulekshmi *et al.* 2024). *H. Nehereus* are present in the Northern EEZ of India, which is North-West (Maharashtra, Gujarat) and East Coast (West Bengal) (Anulekshmi *et al.* 2024). In many regions of India, Bombay ducks are consumed as food. Bombay duck in dried form is a good source of protein with well-balanced amino acids, lipids, high in

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omega-3 fatty acids, and also contains essential micro and macro elements (Parkhey and Jadhav 2025). 98% of the Bombay duck catch comes from the West Coast, majorly from Maharashtra and Gujarat; West Bengal and Orissa, together show only 1.18% of the total catches of Bombay duck (CMFRI 1980).

Here feeding habit of Bombay duck was analyzed both quantitatively and qualitatively. In quantitative analysis, the frequency of each prey was calculated and the index of relative importance of each prey was analyzed to predict the preferred and dominant prey types. Feeding intensity was measured to understand how they are involved in feeding activity. Diversity and evenness of the gut content were also predicted. In qualitative analysis, the identification of gut contents was done, and a figure plate is presented.

## MATERIALS AND METHODS

217 specimens were collected from the North-East Coast of India (Kakdwip, Namkhana, Mohana, Shankarpur and Fraserganj) during a period of 1 year (August 2024 to July 2025). Each specimen was dissected, and its gut contents were examined.

The number and types of species obtained from the guts were identified, and the frequency of each species was recorded. The total weight of each species category was taken and tabulated. A frequency table was provided for each category species, and an index of relative importance (IRI) was calculated. Index of relative importance was calculated from the frequency of occurrence (%F) of each species from examined guts, total percentage of each species category obtained (%N) and percentage of weight of each species category (%W);  $IRI = (\%N + \%W) \%F$  (Ghosh 2014, Rajesh *et al.* 2017a, Mahesh *et al.* 2019, McCully Phillips *et al.* 2020). Here, IRI was measured by including empty guts (IRI<sub>i</sub>) and excluding empty guts (IRI<sub>e</sub>). The IRI percentages of each obtained species group were also included.

The feeding intensity was predicted by calculating the Degree of Fullness (DF) by empty,  $\frac{1}{4}$  full,  $\frac{1}{2}$  full,  $\frac{3}{4}$  full, and full and Stomach Fullness Index (SFI), as done by other researchers (Rajesh *et al.* 2024, Rajesh *et al.* 2017b, Shalloof *et al.* 2020,

McCully Phillips *et al.* 2020, Mahesh *et al.* 2019).

With the help of the calculated frequency table of obtained species, Shannon-Wiener index and Pielou's evenness index were calculated to understand the diversity, evenness of feeding contents, and feeding habit of the specimen. Shannon-Wiener index ( $H'$ ) was calculated with the equation  $H' = -\sum P_i \ln(P_i)$ , where  $P_i$  is the total number of specimens in each species category and  $H'$  ranges from 0 to  $H'_{max}$  (Nath *et al.* 2015, Odum and Barrett 2005).  $H'_{max} = \ln(S)$ , where  $S$  is the number of species categories (Nath *et al.* 2015, Odum and Barrett 2005).

## RESULT AND DISCUSSION

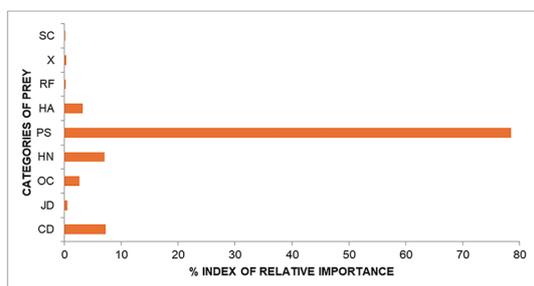
Out of 217 specimens, 43 specimens' guts consist of food or prey. From 43 guts, all the species were identified, and a frequency table was tabulated (Table 1). The identified species were *Coilia dussumieri* (CD), *Johnius dussumieri* (JD), *Otolithes cuvieri* (OC), *Setipinna* sp. (HA), *Lepturacanthus savala* (RF), *Stolephorus* sp. (SC), *Harpadon nehereus* (HN), *Non-Penaeid* sp. (PS) and X (unidentified).

The frequency table (Table 1) help us to understand which species are mostly observed in gut content. Based on the frequency table (Table 1), the arrangement is  $-PS > CD > HA > HN > OC > X > (SC, JD, RF)$ .

Index of Relative importance (IRI) calculated separately for both including (IRI<sub>i</sub>) and excluding (IRI<sub>e</sub>) empty guts. The percentage of IRIs for each species category was measured to interpret which spe-

**Table 1.** Frequency Table of Prey with Frequency Percentage (%FREQ.).

PREY	FREQ.	%FREQ.
CD ( <i>Coilia dussumieri</i> )	7	11.29032
JD ( <i>Johnius dussumieri</i> )	1	1.612903
OC ( <i>Otolithes cuvieri</i> )	4	6.451613
HN ( <i>Harpadon nehereus</i> )	5	8.064516
PS ( <i>Non-Penaeid</i> sp.)	35	56.45161
HA ( <i>Setipinna</i> sp.)	6	9.677419
RF ( <i>Lepturacanthus savala</i> )	1	1.612903
X (unidentified)	2	3.225806
SC ( <i>Stolephorus</i> sp.)	1	1.612903



**Fig. 1.** Bar Graph of % Index of Relative Importance Along With Categories of Prey.

cies are more or less dominant in the diet (Table 2). A bar graph of IRI percentage (Fig. 1) is also provided.

It was interpreted that PS (78.51178%) is the most dominant prey, i.e., mostly preferred, followed by CD (7.255529%), HN (7.092837%), HA (3.262283%), and OC (2.679047%). CD and HN are more preferred than HA and OC. JD (0.487117%), X (0.296222%), RF (0.284903%), and SC (0.130269%) are occasional prey.

A paper also suggested that the dominance of non-penaeid prawns is seen throughout the years 2007-2009; however, Sciaenids (mostly JD and OC) are more observed in guts, followed by unicorn cods, small HNs, and CDs from the Saurashtra Coast of India (Ghosh 2014).

From 2008-2009, the composition of prey of *H. nehereus* was investigated in the Sundarban area, West Bengal, where non-penaeid prawns were dominating, and after that, the 2<sup>nd</sup> dominating prey was

juveniles of Bombay duck, and among small pelagic fishes, CD is mostly encountered (Kumar *et al.* 2012). Non-penaeid prawns are the main prey of the Bombay duck; by tracking their shoal, we may predict the locomotion of the Bombay duck (Kumar *et al.* 2012). Other important components are juveniles of *Harpodon nehereus*, *Bregmaceros mccllelandi*, *Coilia dussumieri* and *Polynemus heptadactylus* observed from Maharashtra, Bombay coast (Bapat 1970).

Hence, shrimp, mainly the non-penaeid ones, are the most dominant prey, along with a common fin-fish, *Coilia dussumieri*. The presence of Bombay duck juveniles showed the cannibalistic nature of *H. nehereus*.

The Degree of fullness (DF) analysis showed that 80.2% of the collected specimens' stomachs were empty, 19% showed (¼) full, 0.46% showed (½) full, and 0.46% showed full (Table 3). Therefore, a low feeding activity was predicted for the collected sample population. The mean Stomach Fullness Index (SFI) percentage, i.e.,  $1.18 \pm 3.53$  is also indicates a low feeding intensity (Table 3).

The calculated  $H' = 1.4854$  and  $H'_{max} = 2.197225$ . Therefore, the diversity of the diet is moderate, and the feeding habit is not highly specialised nor highly generalised, hence it is showing the feeding habits of a moderately generalist species.

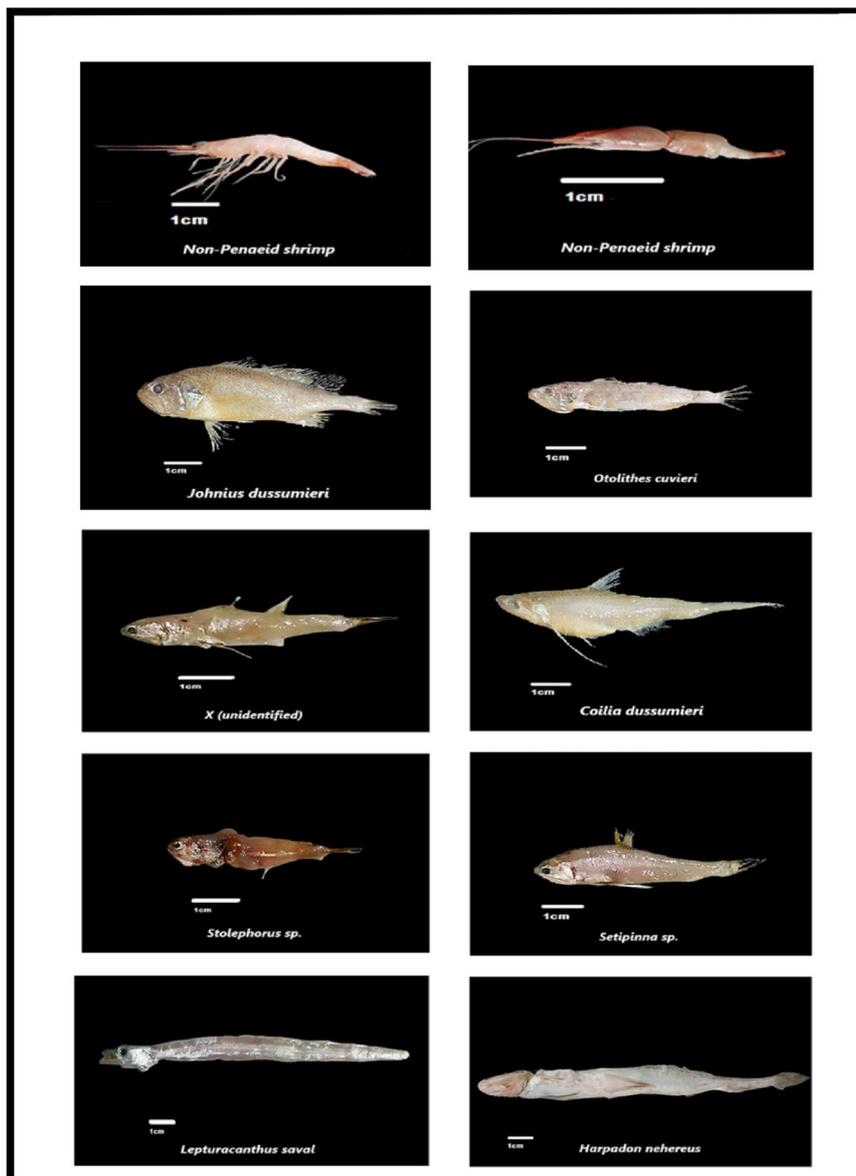
Pielou's evenness index ( $J'$ ) is calculated by the equation  $J' = H'/H'_{max}$  (Nath *et al.* 2015, Odum and Barrett 2005). The calculated value of  $J' = 0.676035$ . The evenness ranges from 0-1, where 0 represents no evenness and 1 represents the highest evenness (Nath

**Table 2.** Index of Relative Importance (IRI) and % IRI with Including (IRI<sub>i</sub>) and Excluding Empty Guts (IRI<sub>e</sub>).

PREY	%W	%N	%Fi	%Fe	IRI <sub>i</sub>	IRI <sub>e</sub>	%IRI <sub>i</sub>	%IRI <sub>e</sub>
CD	16.26016	11.29032	2.764977	13.95349	76.17646	384.4254	7.255529	7.255529
JD	9.485095	1.612903	0.460829	2.325581	5.114285	25.8093	0.487117	0.487117
OC	8.807588	6.451613	1.843318	9.302326	28.12756	141.9461	2.679047	2.679047
HN	24.25474	8.064516	2.304147	11.62791	74.46834	375.8053	7.092837	7.092837
PS	28.72629	56.45161	9.677419	48.83721	824.3023	4159.851	78.51178	78.51178
HA	2.710027	9.677419	2.764977	13.95349	34.251	172.8481	3.262283	3.262283
RF	4.878049	1.612903	0.460829	2.325581	2.991222	15.09524	0.284903	0.284903
X	3.523035	3.225806	0.460829	2.325581	3.110065	15.69498	0.296222	0.296222
SC	1.355014	1.612903	0.460829	2.325581	1.367704	6.902132	0.130269	0.130269

**Table 3.** Feeding intensity of *H. nehereus* Degree of Fullness (DF) & Stomach Fullness Index (SFI).

Specimen No.	% of Specimen	Mean 'DF'± SD	Categories	Mean SFI± SD%
174	80.1843318	0.0239 ± 0.08	Empty	1.18 ± 3.53
41	18.89400922		¼ full	
1	0.460829493		½ full	
0	0		¾ full	
1	0.460829493		Full	

**Fig. 2.** Gut contents of *H. nehereus*.

et al. 2015, Odum and Barrett 2005). The calculated  $J'$  is interpreted as moderately even, along with a highly dominated PS in the diet.

Each image of all types of species obtained during the gut analysis is given (Fig. 2).

## CONCLUSION

The dietary analysis of *Harpadon nehereus* revealed a predominant preference for non-penaeid prawns, as indicated by their highest Index of Relative Importance (IRI: 78.51178%). Among fin fishes, *Coilia dussumieri* showed considerable dominance, followed by juvenile *H. nehereus*, suggesting cannibalistic feeding behavior. Other prey items, such as *Setipinna* sp., *Otolithe scuvieri*, and *Johnius dussumieri*, occurred occasionally.

The degree of fullness (DF) and stomach fullness index (SFI:  $1.18 \pm 3.53$ ) indicate a low feeding activity among the sampled population, with 80.2% of the specimens having empty stomachs. The moderate dietary diversity ( $H' = 1.4854$ ) and evenness index ( $J' = 0.676035$ ) suggest that *H. nehereus* exhibits a feeding habit like a moderately generalist species, with a strong dietary dominance by non-penaeid prawns. Overall, the species shows a clear preference for crustaceans, particularly non-penaeid prawns, followed by a select group of small pelagic fin fishes, highlighting its opportunistic yet slightly selective feeding behavior in the studied region.

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