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Diet and feeding ecology of black-barred halfbeak *Hemiramphus far* (Forsskal, 1775) (Hemiramphidae) from Karachi coast of Pakistan

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ABSTRACT

Objective: To describe the diet and feeding ecology of *Hemiramphus far* (*H. far*) through investigating the stomach contents.

Methods: Sampling of total 430 individuals of *H. far* was carried out from commercial catches landed at West Wharf fish harbor of Karachi coast, Pakistan during January–December 2010. The total length and weight of each individual were recorded. Samples were parted into Group 1 (15–20 cm, n = 240) and Group 2 (21–26 cm, n = 190), to estimate changes in diet with fish size. To remove alimentary canal, fishes were dissected and kept into 10% formalin. Then gut contents were examined under a light microscope for each intestine. Stomach fullness as well as dietary composition was ascertained from gut contents. Examination and analyses were conducted using frequency of occurrence and numerical method.

Results: The examination confirmed 47.67% stomach as empty. Furthermore, our study revealed that the diet of *H. far* consists of fishes, isopods, ostracods, *Daphnia*, shells, algae, unidentified plants and animal materials. This study proved that *H. far* is an omnivorous fish feeding on fishes, isopods, shells, algae and plant and animal originated different food items. According to the Schoener overlap index, there was no significant difference in feeding of the two length groups of *H. far* (C = 0.833). In addition, the Shannon-Wiener index presented that in Group 1, the prey diversity of the halfbeak was lower (H = 0.90) than that of Group 2 (H = 1.02).

Conclusions: The findings of the present study would be very effective for sustainable management of black-barred halfbeak fishery in the Karachi coast of Pakistan and the surrounding ecosystems.

1. Introduction

The black-barred halfbeak, *Hemiramphus far* (*H. far*) is a member of the family Hemiramphidae, an important species in Pakistani waters. *H. far* occurs in coastal waters generally in areas rich in vegetation and sand flats[1]. The halfbeaks of the family Hemirhamphidae have generally been described as herbivores feeding mainly on the fronds of Zosteracean seagrass[2-5]. Species specific information of feeding ecology is still rare. In fisheries management and aquaculture practices, food and feeding habits of fishes have great importance[6] for knowing the population level, growth rate and condition of fishes, which helps the fish farmers to have the clear idea about fish dietary requirements to reduce intra-specific and inter-specific competition of fishes in the habitat[7,8]. Moreover, data on the feeding habits of marine fishes, such as the predatory-prey relationship are very helpful in the ecosystem[9]. Information on stomach composition could be useful to fish farmers for multispecies fishery[10,11] and these are important requirements for the Ecopath model[12] used for elucidating aquatic ecosystem functioning and providing critical biological information for fisheries management[13,14].

According to authors' knowledge, there have been no sound works on the diet of *H. far* yet. So, this study aims to equip the first report on the diet and feeding ecology and stomach contents of the *H. far* in Karachi coast of Pakistan.

2. Materials and methods

A total of 430 individuals of *H. far* were sampled by nylon gill nets with the mesh size of 60.0 mm from the Karachi coast (24°51'36"

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N 67°0'36" E) of Pakistan from January to December 2010 (except June–July) (Figure 1). Fishes were sorted in coolers containing ice then transported to laboratory for further analysis. The total length (TL, cm) and whole body weight (BW, g) for each individual were measured by slide calipers and an electronic balance, respectively.

Figure 1. Map showing the sampling locations (black circles) of *H. far* from Karachi coast, Pakistan[15].

The alimentary tract of individuals were removed by dissection of fishes and then preserved in 10% formalin. Each intestine was split open and the gut contents were emptied into a Petri dish. Lastly, gut contents were observed under a light microscope. Stomach fullness was categorized as follows: class 0, empty or containing only traces of food; class 1, medium fullness; and class 2, full or nearly full (fully distended stomach). The diet of *H. far* was carried out using the frequency of occurrence and numerical method. The percentage number and frequency of occurrence were used to estimate the dietary importance of each prey category[16-18].

Number (%) = 100 × (Number of prey/Number of all identifiable preys);

Frequency of occurrence = 100 × (Number of stomach with prey I/ Number of stomach with food item)

However, unidentified food items were not used in the calculation. The diet similarity among length classes and seasons was investigated using the Schoener overlap index[19] as $C_{xy} = 1 - 0.5 (p_{xi} - p_{yi})$, where p_{xi} and p_{yi} were the proportions by number of prey type I in the diet of groups (Length or Seasons), x and y, respectively. If the C value was bigger than 0.80, it meant that the diet of the two groups was similar. The extent of the diet was calculated using the diversity index[20] as $H = -\sum (p_i \log 2\ p_i)$, where, p_i is the proportion by the number of prey type I. The index had adequate sensitivity for detecting changes in diversity and provided a general indication of the relative magnitude of trophic specialization[21].

H. far were parted into two size groups, Group 1: 15–20 cm TL (n = 240) and Group 2: 21–26 cm TL (n = 190) to justify changes in diet with fish size

3. Results

A total of 430 specimens of *H. far* were examined in present study, where 205 (47.67%) fishes had empty stomachs (Table 1). Analysis of monthly variation in empty stomach showed that the highest occurrence of empty stomach was in August 2010 (60.0%), while the lowest was noted in October 2010 (40.0%) (Figure 2). Dissimilarity in empty stomach according to size groups showed that the Group 2 of *H. far* had the lowest number of empty stomach (36.84%) (Table 2). Stomach contents were classified into 9 categories: fishes, isopods, ostracods, *Daphnia*, shells, algae, unidentified plant materials, unidentified animals materials, unidentified materials (Table 3). It was found that *H. far* in Group 1 were fed on fishes (12.26%), isopods (20.24%), ostracods (6.13%), *Daphnia* (18.40%), shells (4.96%), algae (8.58%), unidentified plant materials (4.90%), unidentified animals materials (12.88%), unidentified materials (11.65%). On the other hand, *H. far* Group 2 fed on fishes (11.11%), isopods (25.00%), ostracods (5.55%), *Daphnia* (10.41%), shells (13.19%), algae (9.75%), unidentified plant materials (6.25%), unidentified animals materials (11.11%) and unidentified materials (7.63%) (Table 3). *Daphnia* and isopods were the dominant food for the small size group but *Daphnia* and shells were the dominant food items for the large size group.

Table 1

Monthly changes of empty stomachs for *H. far* from the Karachi coast of Pakistan.

Month	Number of fish examined	Number of empty stomach	Eempty stomach (%)
January	35	18	51.42
February	28	15	53.57
March	20	10	50.00
April	27	15	55.55
May	25	13	52.00
August	30	18	60.00
September	50	24	48.00
October	75	30	40.00
November	80	35	43.75
December	60	27	45.00
Total	430	205	47.67

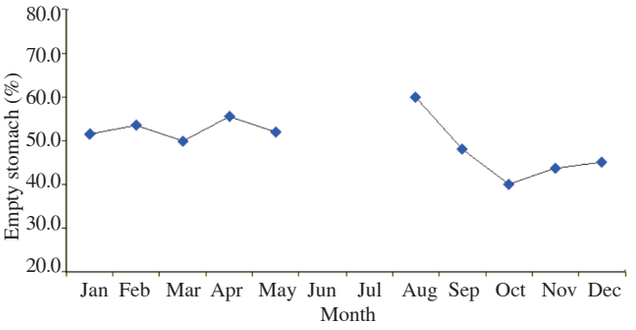

Figure 2. Monthly changes of empty stomachs of *H. far* from the Karachi coast of Pakistan during January to December 2010 (no sampling was conducted in June–July 2010).

Table 2

Variations in empty stomachs by size of *H. far* from the Karachi coast of Pakistan.

Size/ TL (cm)	Number of fish examined	Number of empty stomach	Empty stomach (%)
15–20	240	135	56.25
21–26	190	70	36.84
Total	430	205	47.67

Table 3

Frequency of occurrence, and percentage in number of various food items in different size groups of *H. far* from Karachi coast, Pakistan.

Food items	Group 1		Group 2	
	N (%)	FO (%)	N (%)	FO (%)
Fishes	12.26	64.70	11.11	52.17
Isopods	20.24	70.58	25.00	73.91
Ostracods	6.13	35.29	5.55	19.13
Daphnia	18.40	76.47	10.41	35.65
Shells	4.96	27.05	13.19	56.52
Algae	8.58	52.94	9.75	15.50
Unidentified plant materials	4.90	29.41	6.25	26.08
Unidentified animals materials	12.88	69.41	11.11	39.13
Unidentified materials	11.65	70.58	7.63	20.00

N: Percentage number; FO: Frequency of occurrence.

The results showed that there was no significant difference in feeding habits of the two groups (C = 0.833) based on the Schoener overlap index (C). On the contrary, the Shannon-Wiener index indicated that the prey diversity of the Group 1 was lower (H = 0.90) than that of Group 2 (H = 1.02). A *Chi*-square test revealed no significant differences based

on the relationship between the size classes of *H. far* and the change in the stomach contents.

4. Discussion

Only a limited study has been conducted on the food and feeding habit of this species. Previous study on the halfbeaks indicated that these fishes are assumed to be mid water and surface feeding and have been noticed eating detached sea grass leaves drifting near the water surface[22,23]. However, the food and feeding habits of the fish differ from age, size, the time of the day, season, different ecological factors and various food substances presenting in the water body[24,25]. In the present study, monthly variation in empty stomachs indicated that the highest percentage (60.0%) of empty stomach was in August, while the lowest was in October. The fullness or empty of stomachs might be related to the reproductive biology of the species. However, more detail studies on this issue is strongly recommended.

In the present study, the gut content analysis showed some innate difficulties, such as intricacy in taxonomic identification because of the digestive process[26], trouble in quantifying some components in the diets, such as gelatinous plankton and detritus[27]. However, stomach content analysis is used widely to reveal food composition, feeding strategies, trophic position, energy flow, trophic structure and trophic partitioning of predator and prey, and it is the most commonly applied method to evaluate these relationships[28-30]. The present findings mentioned that *H. far* takes small fish, algae and other plant materials as their food items and can be categorized as omnivore.

Conflict of interest statement

We declare that we have no conflict of interest.

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