Document heading   doi:10.12980/JCLM.2.2014J24

Diets of Halfbeak *Hemiramphus lutkei* (Valenciennes, 1847) from Karachi Coast, Pakistan

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PEER REVIEW

ABSTRACT

Objective: To investigate the diets of the Lutke's halfbeak, *Hemiramphus lutkei* (*H. lutkei*) to determine the food and feeding habits.
Methods: Samples of *H. lutkei* were collected from the landing sites of Karachi Coast, Pakistan. Total length was measured to the nearest 0.01 cm using digital slide calipers, and total body weight was measured using an electronic balance with 0.01 g accuracy. The dietary composition was determined from gut content examination and analysis was done using frequency of occurrence and numerical methods. To assess the changes in diet with size, *H. lutkei* were divided into two size groups, Group 1: 14–20 cm (*n*=250) and Group 2: 21–25 cm (*n*=160).
Results: The total length and body weight of the sampled specimens ranged from 14 to 25 cm and 10 to 23.5 g, respectively. Out of the studied specimens, 45.12% fish stomachs were found to be empty. Dietary composition revealed daphnia, small fish, isopods, unidentified animal materials, ostracods and unidentified plant materials in the gut contents of Lutke's halfbeak. Therefore, *H. lutkei* is omnivore fish feeding on algae, zooplankton, small fishes and different food items of both plant and animal origin. According to the Schoener overlap index (C), there was no significant difference in feeding of the two length groups of *H. lutkei* (C=0.833). On the other hand, the Shannon–Wiener index showed that the prey diversity of the Lutke's halfbeak in Group 1 was lower (H$^{/}$=1.545) than that of Group 2 (H$^{/}$=1.653).
Conclusions: This study reports the first description of diets for *H. lutkei*, which would be useful for the sustainable management of this fishery in the coast of Pakistan and also neighboring countries.

1. Introduction

The Lutke's halfbeak, *Hemiramphus lutkei* (*H. lutkei*), belongs to the family Hemiramphidae and is an important member of fish diversity in Pakistani waters. The Lutke's halfbeak inhabits in coastal waters rich in vegetation. However, *H. lutkei* is more often found offshore than other species of *Hemiramphus* in the western central Pacific; nonetheless, it is relatively common that juveniles and immature individuals are far from shore, usually among floating plants[1]. It reaches up to 40 cm in standard length[2].

Food is the main source of energy and plays an important role in determining the population level, rate of growth and condition of fishes. Food and feeding habits of fishes have great significance in fisheries management and aquaculture practices. It enables the fish farmer to have

clear understanding of fish dietary requirements and helps reducing intra– and inter– specific competition of fish in the ecosystem[3,4]. Studies on stomach composition could provide useful information to fishery managers and biologist in positioning of the fishes in a food web in their environment and in formulating management strategy options in multi species fishery[5].

Nonetheless, to the best of the authors' knowledge, there are no previous studies on the diet of *H. lutkei* in the literature. Therefore, this study aims to furnish the first report on the food and feeding habits of the Lutke's halfbeak.

2. Materials and methods

2.1. Study site

Karachi is the biggest fishery hub in Pakistan, handling about 90% of fish and sea food catches in Pakistan. Fisheries play an important role in Karachi's economy, providing direct employment to about 300 000 fishermen. In addition, another 400 000 people are employed in ancillary industries. Fisheries are also a major source of export earnings in Pakistan.

2.2. Sampling and laboratory procedure

A total of 410 specimens of *H. lutkei* were collected from fishermen catch landed at the landing sites in Karachi Coast (Pakistan) from August 2011 to July 2012. Fishes were caught using nylon gill nets of 60 mm mesh size. The fish were examined in fresh or kept in a deep freezer for subsequent examination. The total length of the fish was measured from the tip of the anterior part of mouth to caudal fin using meter ruler calibrated in 'cm'. Body weight of individual fish was measured to the nearest 'g' with an electronic balance after removing the adhered water and other particles from surface body.

The fishes were dissected to remove the alimentary tract, which then was kept in 10% formalin solution. Each intestine was slit open and the gut contents were emptied into a Petri dish. Finally, gut contents were examined under a light microscope. Analysis of data was done using frequency of occurrence and numerical methods as follows[6,7]:

$F_i = N_i/N \times 100$

Where, F_i = frequency of occurrence of the ith food items in the sample;

N_i = number of stomachs in which the ith item was found;

N = total number of stomachs with food in the sample.

$N_i = F_i/F \times 100$

Where, N_i = numerical percentage of the ith food item in the stomach;

F_i = total number of ith food item;

F = total number of all food items.

Unidentified food items were not used in calculations.

Diet similarity among length classes and seasons was investigated using the Schoener Overlap Index (C)[8]:

$C_{xy} = 1 - 0.5 \sum |p_{xi} - p_{yi}|$

Where, p_{xi} and p_{yi} are the proportions by number of prey type i in the diet of groups (length class or seasons) x and y, respectively. If the C value is bigger than 0.80, it means that the diets in both groups are similar.

In addition, prey diversity in the diet, which is a measure of trophic niche complexity[9], was calculated using the Shannon–Weaver Index (H'):

$H' = -\sum p_i \ln p_i$

Where, p_i is the proportion of individuals of prey type i[10]. This index has adequate sensitivity for detecting changes in species diversity and provides a general indication of the relative magnitude of trophic specialization[11].

To asses changes in diet with fish size, *H. lutkei* were divided into two size groups, Group 1: 14–20 cm (*n*=250) and Group 2: 21–25 cm (*n*=160).

2.3. Statistical analysis

Statistical analyses were performed using GraphPad Prism 5. The differences in diet composition in relation to fish size were assessed using χ^2 test[12]. All statistical analyses were considered significant at 5% (*P*< 0.05).

3. Results

The stomachs of 410 individuals of *H. lutkei* were analyzed during the present investigation. Average total lengths (mean ±SD) of the studied specimens were (17.00±1.71) cm and (22.00±1.23) cm for Group 1 and Group 2, respectively. On the other hand, average body weights (mean±SD) in Group 1 and Group 2 fishes were (13.00±1.68) g and (18.50±2.24) g, respectively. Out of the studied stomachs, 185 were found empty (Table 1). Variation in empty stomach by size group (Table 1) indicated that the large size group of *H. lutkei* had lower number of empty stomach (34%).

Table 1

Empty stomachs by size of *H. lutkei* from Karachi coast, Pakistan.

Total length (cm)	Number of fish examined	Number of fish with empty stomach	% Empty stomach
14–20	250	130	52
21–25	160	55	34

The frequency of occurrence, percentage in number and the size range of prey for different life stages of *H. lutkei*

are provided in Table 2. *H. lutkei* from Group 1 were found to be feeding on daphnia (23.46%), fishes (21.93%), isopods (19.89%), unidentified animal materials (18.36%), ostracods (9.18%) and unidentified plant materials (7.14%). On the other hand, isopods (33.92%), fishes (20.83%), daphnia (14.28%), unidentified plant materials (13.09%), unidentified animal materials (11.90%) and ostracods (5.95%) were found in the stomachs of Group 2 *H. lutkei*.

Table 2

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

Food items	14–20 cm length group		21–25 cm length group	
	N%	FO%	N%	FO%
Fishes	21.93	84.0	20.83	71.4
Isopods	19.89	82.4	33.92	92.4
Ostracods	9.18	33.6	5.95	21.9
Daphnia	23.46	80.0	14.28	47.6
Unidentified plant materials	7.14	20.0	13.09	47.6
Unidentified animal materials	18.36	68.0	11.90	42.8

N%: percentage in number of various food items; FO%: Frequency of occurrence of various food items.

The results based on the Schoener overlap index (C) indicated that there was no significant difference in feeding habits of 2 length groups of *H. lutkei* (C=0.833). On the other hand, the Shannon–Wiener index showed that the prey diversity of the Group 1 Lutke's halfbeak was lower ($H^{/}$=1.545) than that of Group 2 ($H^{/}$=1.653). A *Chi*–square test based on the relationship between the size classes of *H. lutkei* and the change in the stomach contents revealed no significant differences (P>0.05).

4. Discussion

The present study provides the first report on the food and feeding habits of the Lutke's halfbeak from a large set of specimens. A total of 6 types of food items were identified in the gut contents of *H. lutkei*. Findings of this study reveal that, this species is omnivore in nature feeding, and it mainly feeds on algae, zooplankton, small fishes and different other food items from plant and animal origin. Earlier studies on the garfish and halfbeaks showed that these fishes are presumed to be mid water and surface feeding fish and have been observed taking detached sea grass leaves floating near the water surface[13,14]. However, no studies about the diets of this species were found in the literature, inhibiting the comparison with previous findings and thereby, the present research forms the basis for further studies.

Moreover, higher number of empty stomachs was found during the study which might be due to the limitation of the study methods rather than the original number of fish with empty stomachs in the natural water bodies. The gut content analysis method presents some inherent difficulties, such as complexity in taxonomic identification because of the digestive process[15], trouble in quantifying some components in the diets, such as gelatinous plankton and detritus[16],

and finally because stomach contents are based on prey consumed shortly before capture, they represent a limited view of the diet in time and space[16,17], and often high percentages of stomachs are found empty[18]. Nonetheless, stomach content analysis is used widely to determine food composition, feeding strategies, trophic position, energy flow, trophic structure and trophic partitioning of predator and prey, and it is the most commonly employed method to evaluate these relationships[6,19–21].

This study further reveals the differences in diets between two length classes. The percentage number and frequency of occurrence were found more or less the same in both length classes but their proportion changed with fish length. However, differences in stomach contents between two length groups of the Lutke's halfbeak can be attributed to the variations in feeding intensity, diversity of food and to the difference in ability to digest food items. Nonetheless, the food and feeding habits of fish vary with the time of the day, season, size of fish, age, various ecological factors and different food substances present in the water body[22,23].

In conclusion, *H. lutkei* is an indispensible part of the aquatic ecosystem of Pakistan. This study provides some basic information on diet which will assist in determining the trophic position, energy flow, trophic structure and trophic partitioning of predator and prey of this species. These information would be useful for the sustainable management of multiple fishery in the coasts of Pakistan and also neighboring countries.

Conflict of interest statement

We declare that we have no conflict of interest.

Acknowledgements

Comments

Background

The Lutke's halfbeak, *H. lutkei* belonging to the family Hemiramphidae is an important member of fish diversity in Pakistani waters. *H. lutkei* is more often found offshore than other species of *Hemiramphus* in the western central Pacific. Studies on stomach composition could provide useful information to the fishery managers and biologist in positioning of the fishes in a food web in their environment and in formulating management strategy options in multi species fishery.

Research frontiers

There is no study prevails on the diet of *H. lutkei* in

the literature, therefore, this study aims to furnish the first report on the food and feeding habits of the Lutke's halfbeak.

Related reports

Information regarding on the diet of *H. lutkei* in the literature is scare, and this study observed the first report on the food and feeding habits of the Lutke's halfbeak using a large number of specimens. The Lutke's halfbeak is omnivore fish feeding on algae, zooplankton, small fishes and different food items of both plant and animal origin.

Innovations and breakthroughs

Differences in stomach contents between two length groups of the Lutke's halfbeak can be attributed to the variations in feeding intensity, diversity of food and to different ability to digest food items.

Applications

This study would be useful for the sustainable management of this fishery in the coast of Pakistan and also neighboring countries.

Peer review

The manuscript is written well. This is the first study, where diets of the Lutke's halfbeak *H. lutkei* were investigated to determine the food and feeding habits using samples from fishermen catch landed at the landing sites in Karachi Coast, Pakistan from August 2011 to July 2012. Several mathematical models including Schoener overlap index (C) and Shannon–Wiener index were used in this study, which would be useful for the sustainable management of this fishery in the coast of Pakistan and elsewhere.

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