UTTAR PRADESH JOURNAL OF ZOOLOGY

43(9): 22-30, 2022
ISSN: 0256-971X (P)

GUT CONTENT ANALYSIS OF ENDEMIC LARVIVOROUS FISH FROM SUSWA RIVER OF DOON VALLEY, DEHRADUN

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AUTHORS' CONTRIBUTIONS
This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

Article Information

DOI: 10.56557/UPJOZ/2022/v43i93020

Editor(s):
(1) Dr. Villagomez Cortes Jose Alfredo Santiago, University of Veracruz, Mexico.
Reviewers:
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Received: 09 March 2022
Accepted: 18 May 2022
Published: 25 May 2022

Original Research Article

ABSTRACT

Food is the basic prerequisite for growth, development, survival and existence of all organisms. Gut content analysis of fish provides an important insight into feeding patterns and quantitative assessment of feeding habits of fish. The objective of present study is to identify the endemic fish having larvivorous potential in natural condition by gut content analysis. Fish were collected from Suswa river, Doon valley by following the standard techniques of fishing during July 2018 to June 2019. The collected fishes were shorted and identified using standard identification keys and catalogues. Fish were dissected and gut content were examined microscopically and numerical methods was used by calculating percentage composition of food items in total contents of fish stomach. A total of 200 fish of 20 species belonging to 13 genera were dissected for gut content analysis. The contents were classified based on food types and fish were differentiated into herbivorous, omnivorous and carnivorous. Choices of food by fish were based on the availability of food at a particular habitat and the fish species showed omnivorosity habit of feeding. Further, feeding potential of fish were estimated based on the percentage composition of insect content only among animal content and categorized as voracious feeder, moderate feeder and opportunistic feeder.

Keywords: Endemic larvivorous fish; gut contents analysis; mosquito larvae; mosquito pupae, Doon valley.

1. INTRODUCTION

Using fish as biocontrol agent in mosquito abatement has been well-known for more than 100 years. In India, as far back in 1904, larvivorous fishes were used in Mumbai City for the control of malaria vector *Anopheles stephensi*. In the 21st century, using larvivorous fish was become an important tool for mosquito borne diseases control, particularly in urban and periurban areas [1]. The use of biological control

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agents to target mosquito population at larval stage has been found to be a promising alternative to chemical control. However, utilizing a controlled system via aquaponics provides the mosquito control without any adverse effects to the ecosystem [2]. Larvivorous fish feeding on immature stages of mosquito form an efficient bio-control agent. According to Job 1940 [3], larvivorous fish must be small, hardy, drought resistant and a prolific breeder in confined water with a short life span. It should be a surface feeder and carnivorous in habit with a preference for mosquito larvae.

The study of the feeding habits of fish and other animals based upon analysis of stomach content has become a standard practice [4]. Lagler (1949) [5] pointed out that the gut contents only indicate what the fish would feed on. Some considerable works on feeding habits of larvivorous fish with gut content analysis as study methods are [6-12] can be listed here. From the study area lots of works have been done on fish and fish diversity [13- 20] but only a few literatures are available on larvivorous context [21-24]. Hence, it can be very well said that till date no systematic study on gut content analysis of larvivorous fish from Doon Valley has been carried out. So, the objective of our present study is to identify the endemic fishes having larvivorous potential in natural condition by gut content analysis.

2. MATERIALS AND METHODS

2.1 Collection of Fish and Analysis of Gastro-intestinal Contents

Fish were collected from Suswa river of Doon valley by following the standard techniques of fishing using locally employed fishing nets and gears, during July 2018 to July 2019. The collected fishes were brought to laboratory, shorted and identified on the basis of morphometric and meristematic characters as mentioned in standard keys and catalogues [25-31]. For gut analysis fishes were dissected and gut content were examined microscopically for various food contents. Whenever required the collected items were preserved in 4% formaldehyde solution for taxonomical identification.

Numerical methods were used in gut content analysis (Number method). The number of individuals of each food category in each stomach were recorded and expressed as a percentage of the total number of food items in all fish stomachs examined or as a proportion of the food items of each stomach of fishes examined, which raised to the total percentage composition (Hynes1950). Following formula used in counting of stomach contents:

Percentage by number, $\mathbf{\% O_i = N_i / N_t \times 100}$
where, $\% O_i$ is the percentage of food item i
N_i is the number of particular food item i
N_t is the total number of food (gut content) items

3. RESULTS

A total of 200 fish of 20 species of fish belonging to 4 order, 6 family and 13 genera, have been dissected for gut analysis. Food contents were differentiated into remains of algae, plant, crustaceans, insect, tadpoles, rotifers, gastropods, worms, detritivores and miscellaneous. Percentage count of different foods found in each dissected fish species was listed in Table 1. Fish content showed mixed types of feeding habit, omnivorosity. Fig. 1 depicted percentage composition of algae/plants, animals and detritivores/miscellaneous contents of the dissected fish. *Amblypharyngodon mola*, *Garra gotyla*, *Pethia ticto* showed higher content of plants and algae remains (more than 50%). *Channa marulius*, *Channa punctata*, *Channa gachua* were found with less percentage of plant and algae remains (less than 6%). Animals remains were found highest in *Channa punctata* followed by *Channa gachua*, *Channa marulius*, *Mystus vittatus* contributing more than 75% of the food contents. Based on the percentage count of gut contents, whether it prefers plants or animals or both, feeding habits was listed as herbivores / planktivores or carnivores or omnivores respectively. Among the contents of animal remains, percentage content of insect remains (larvae and pupae of mosquitoes) were incorporated. With highest insect remains was leaded by *Trichogaster fasciata* followed by, *Pethia ticto*, *Amblypharyngodon mola*, *Puntius sophore*, *Rasbora daniconius* and *Esomus danrica* in succeeding order. Further, feeding potential of fish were analysed in comparison to percentage composition of insect content among the animal content (Fig. 2) and categorized as voracious, moderate and opportunistic feeders (Table 2). Those fish having large percent of insect remains were grouped as voracious, having average amount was as moderate and those fish with more or less equal amount of animal remains were considered as opportunistic feeders.

Table 1. Gut content analysis (in Percentage) of some selected fishes from Suswa River in Doon valley

S.N.	Name of fish species	Algae	Plants	Crustaceans	Insects	Tadpoles	Rotifers	Gastropods	Worms	Detritivores	Miscellaneous
1	*Trichogaster fasciata* Bloch & Schneider, 1801	20.81	21.81	7.38	20.13	3.36	5.70	6.04	7.05	3.69	4.03
2	*Channa punctata* (Bloch, 1793)	2.56	2.7	12.5	14.49	13.78	12.5	13.21	14.20	10.51	3.55
3	*Channa gachua* (Hamilton, 1822)	3.22	2.76	11.81	13.80	13.19	14.42	12.73	13.19	10.28	4.60
4	*Channa striata* (Bloch, 1793)	3.77	4.81	12.34	15.06	12.55	11.09	9.83	13.18	12.97	4.39
5	*Channa marulius* (Hamilton, 1822)	3.11	1.95	10.12	12.58	13.75	13.75	11.67	15.95	12.19	4.93
6	*Mystus vittatus* (Bloch, 1794)	6.94	7.64	15.63	12.85	10.76	12.15	10.42	13.19	6.60	3.82
7	*Mystus tengara* (Hamilton, 1822)	8.19	11.21	14.22	12.07	10.78	7.33	12.07	14.66	5.17	4.31
8	*Mystus seengtee* (Sykes, 1839)	9.76	11.79	16.67	11.79	10.98	7.32	9.35	11.79	5.28	5.28
9	*Esomus danrica* (Hamilton, 1822)	22.08	15.91	8.12	18.83	6.17	6.82	7.14	8.12	3.25	3.57
10	*Devario devario* (Hamilton, 1822)	17.85	16.62	9.54	16.92	7.08	8.62	6.77	9.54	3.69	3.38
11	*Amblypharyngodon mola* (Hamilton, 1822)	36.45	31.03	2.96	9.85	0.99	6.40	2.96	2.96	1.97	4.43
12	*Rasbora daniconius* (Hamilton, 1822)	20.75	21.09	5.78	17.69	5.10	6.12	7.14	6.80	5.10	4.42
13	*Barilius vagra* (F. Hamilton, 1822)	18.01	21.69	9.93	11.03	4.78	5.15	5.51	8.46	7.35	8.09
14	*Barilius bendelisis* (Hamilton, 1807)	23.10	20.69	8.97	13.45	5.52	6.90	5.52	7.93	4.14	3.79
15	*Puntius sophore* (Hamilton, 1822)	22.18	21.76	7.95	18.41	3.35	6.28	4.60	8.37	1.67	5.44
16	*Pethia*	28.25	27.51	6.32	13.75	1.49	5.20	4.46	4.83	3.72	4.46

S.N.	Name of fish species	Algae	Plants	Crustaceans	Insects	Tadpoles	Rotifers	Gastropods	Worms	Detritivores	Miscellaneous
	ticto (Hamilton,1822)										
17	*Puntius sarana* (Hamilton, 1822)	21.33	22.75	11.85	11.37	3.79	8.53	5.69	7.11	4.27	3.32
18	*Xenentodon cancila* (F. Hamilton, 1822)	7.69	6.92	16.15	15.38	10.77	6.54	6.54	17.69	6.54	5.77
19	*Nemacheilus botia* (Hamilton, 1822)	23.83	19.63	10.75	9.81	3.74	7.01	6.54	7.94	6.07	4.67
20	*Garra gotyla* (Gray, 1830)	23.24	42.70	5.95	3.78	1.62	3.78	4.86	4.32	3.78	5.95

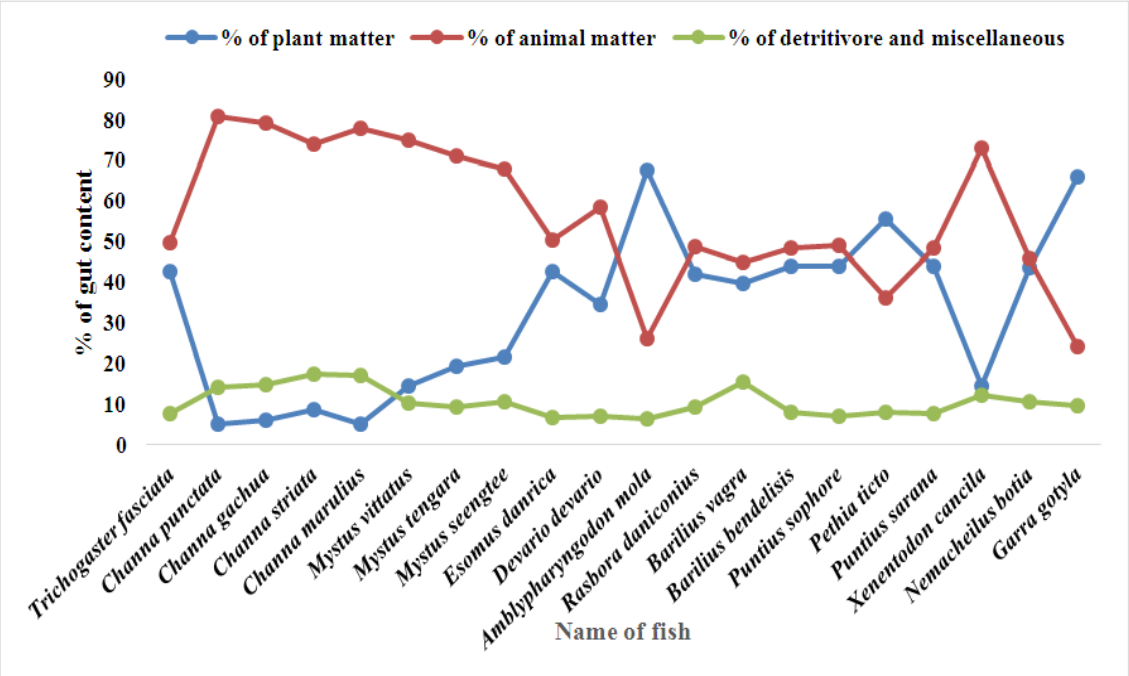

Fig. 1. Percentage composition of plant, animal and detritivores and miscellaneous contents in different fish.

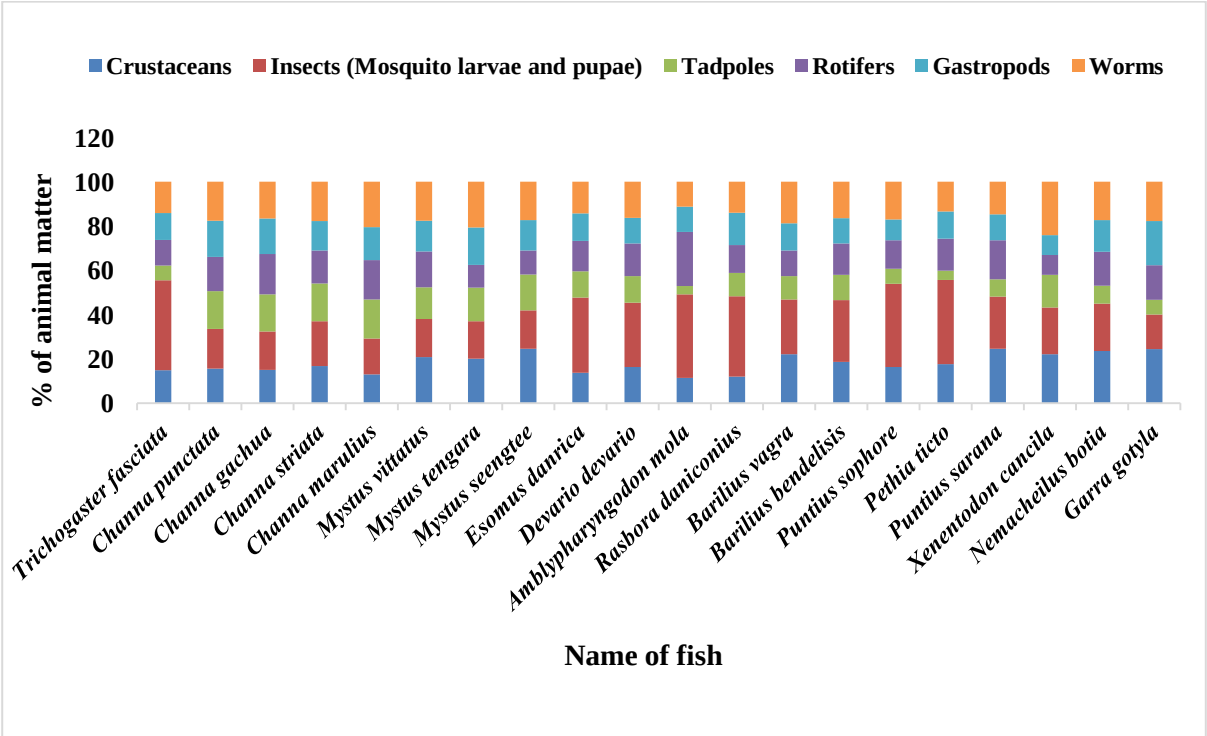

Fig. 2. Percentage composition of varying items in animal content

Table 2. Categorization of larvivorous fish on the basis of food habit and feeding potential

S.No.	Fish name	Food Habit	Feeding potential
1	*Trichogaster fasciata* Bloch & Schneider, 1801	Omnivorous	Voracious
2	*Channa punctata* (Bloch, 1793)	Carnivorous	Oppourtunistic
3	*Channa gachua* (Hamilton, 1822)	Carnivorous	Oppourtunistic
4	*Channa striata* (Bloch, 1793)	Carnivorous	Oppourtunistic
5	*Channa marulius* (Hamilton, 1822)	Carnivorous	Oppourtunistic
6	*Mystus vittatus* (Bloch, 1794)	Carnivorous	Oppourtunistic
7	*Mystus tengara* (Hamilton, 1822)	Carnivorous	Oppourtunistic
8	*Mystus seengtee* (Sykes, 1839)	Carnivorous	Oppourtunistic
9	*Esomus danrica* (Hamilton, 1822)	Omnivorous	Voracious
10	*Devario devario* (Hamilton, 1822)	Omnivorous	Moderate
11	*Amblypharyngodon mola* (Hamilton, 1822)	Herbivorous	Voracious
12	*Rasbora daniconius* (Hamilton, 1822)	Omnivorous	Voracious
13	*Barilius vagra* (F. Hamilton, 1822)	Omnivorous	Moderate
14	*Barilius bendelisis* (Hamilton, 1807)	Omnivorous	Moderate
15	*Puntius sophore* (Hamilton, 1822)	Omnivorous	Voracious
16	*Pethia ticto* (Hamilton, 1822)	Herbivorous/Planktivorous	Voracious
17	*Puntius sarana* (Hamilton, 1822)	Omnivorous	Moderate
18	*Xenentodon cancila* (F. Hamilton, 1822)	Carnivorous	Opportunistic
19	*Nemacheilus botia* (Hamilton, 1822)	Omnivorous	Opportunistic
20	*Garra gotyla* (Gray, 1830)	Herbivorous	Opportunistic

4. DISCUSSION

Earlier studies on faunal diversity of fish from the study region supported occurrence of the present reported species of fish. Studies on larvivorous fish [21-24] mainly focus on experimental observation of feeding efficacy and food preferences. Similar studies with reference to screening of indigenous larvivorous fish by gut contents analysis were conducted by [8, 11] but from different regions and on different species of fish. Food and feeding pattern of *Channa punctata* of the present study was similar to the findings of [33] as their gut contents mainly consists of crustacean, insects, molluscs, small fish and semi-digested material. Another study of Gaur et al. 2013 [34] on food and feeding habits of *Garra gotyla*, revealed as herbivorous fish and algae is found in a sufficient quantity, markedly supported the present finding. Further, higher animal contents in *Mystus* species were supported by the findings of Yeragi and Yeragi 2014 [35].

Jain et al. 2016 [36] revealed that rasborine fishes are predominantly larvivorous and further stated that fishes like *Amblypharyngodon mola*, *Barilius bendelisis* and *Esomus danrica* were mainly depended on plants matter while *Barilius vagra*, *Danio devario*, *Rasbora* (Rasbora) *daniconius* depended on animal matter. These findings are slightly varied while comparing with the present reports. The finding of Hoque et al. 2016 [37] that *P. ticto* as planktivorous fish with Chlorophyceae was the most preferable food was similar to present findings of *P. ticto.* In aspect of categorization of fish, it is highly close to earlier findings of [22] but their report is based on the experimental observation on consumption rate while present results is on gut contents of naturally occurring fish.

5. CONCLUSION

Gut content analysis studies help to determine the choice of food of particular fish in particular habitat. It helps to identify the feeding habit and screening of potential endemic larvivorous fish for the control of mosquitoes. Using indigenous/endemic fish as biocontrol agent of mosquito has been eco-friendly and would be a dual benefited strategies for future prospects.

ACKNOWLEDGEMENT

The authors are thankful to the Principal D.B.S.(P.G.) College, Dehradun for providing laboratory facilities.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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