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# Role of chironomid larvae in the diet of catfish, *Clarias batrachus*

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**Abstract:** Six months-long experiment was carried out in a fish pond at Kahara Block in Saharsa (Bihar), India from September 2018 to February 2019 to evaluate the role of Chironomid larvae in the diet of catfish, *Clarias batrachus*. The composition of the benthic macro-invertebrates at the bottom indicated that Chironomidae was most dominant group in this pond. The body-weight percentage of the organisms showed that Chironomids and Oligochaetes were major two groups. The quantitative and qualitative studies of Chironomid larvae indicated that there was monthly variation in the abundance of Chironomids. The highest (3695.19 $m^{-2}$) and the lowest (517.15 $m^{-2}$) abundance of Chironomids in 3 samples were recorded in the month of January 2019 and October 2018, respectively. Gut content analysis suggested that Chironomids was dominant food item in the diet of *Clarias batrachus*. The maximum 768 and minimum 25 occurrences were recorded in the months of December and October 2018, respectively in 5 fishes sampled from the experimental pond. The electivity indices suggested a shifting to Chironomid larvae from negative selection to positive selection in different months.

**Key words: Catfish, *Clarias batrachus*, diet, Chironomid larvae, electivity indices**

## INTRODUCTION

Bihar is endowed with rich and extensive fisheries resources. Fish and fisheries have been a part and parcel of life and culture of the people of Bihar, particularly northern Bihar from time immemorial. Selection of species is also an important factor of consideration for successful fish culture, because all fish species are not suitable for intensive aquaculture in the fish ponds. Catfish is an important group of fishes and its popularity is increasing day by day showing a promising future for commercial culture[1]. *Clarias batrachus* (Linn.), locally known as 'magur' is an important catfish in the local market for aquaculture, it is a delicious and widely accepted fish. However, this fish is rarely cultured in farmer's level in Saharsa (Bihar), although it can thrive in any type of freshwater habitat and can survive well in extremely oxygen depleted conditions[2]. One of the main setbacks of its culture is the non-availability of fry to stock as per their demand. However, some pioneer works on its breeding technology were done by Rahmatullah *et al.* and Mollah *et al.*[3,4]. Considerable amount of work has been done which included the larvae rearing aspects of this species[5]. However, no detailed study has been conducted on the role of Chironomid larvae in the diet of *C. batrachus* in a fish pond.

Chironomidae is one kind of benthic organisms found in large quantities in the mud. These are one of the most common and essential organisms in an aquatic medium. The bottom fauna forms a very important element in the food chain and a source of potential food for *Clarias*

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*batrachus*. Thus, the capacity of fish production of an aquatic environment is often evaluated on the basis of the kinds and abundance of Chironomid larvae. The Chironomidae is considered to be one of the most important group of fish food and is most widely distributed and frequently the most abundant group of insects in freshwater environments[6]. Larval Chironomidae have been reported to be important secondary producers in the benthic environment of lakes[7] and to be an important element of invertebrate communities of shallow lakes[8,9]. Despite the enormous literatures on various aspects of the ecology of Chironomidae there is a dearth of information on the biology and ecology of Chironomid populations in fish pond environments[10,11]. The principal reason for such deficiencies is probably due to the difficulty in identification of the various stages coupled with a large number of species frequently encountered within even a small waterbody[6]. Considering the importance of this unexplored area, the study was undertaken in pond, subjected to yearly drying up at the end of one fish culture cycle.

Considering the above facts, it was felt necessary to conduct a research work on the role of Chironomid larvae in the diet of *Clarias batrachus.*

## MATERIALS & METHODS

The experiment was carried out from September, 2018 to February, 2019 in the pond water at KaharaBlock in Saharsa (Bihar), Indiafor a period of six months. *Clarias batrachus* at the average size of ±23.39 cm were collected from commercial fish trader and were stocked in the pond. The stocking density 1 fish $m^{-2}$ was maintained for better growth of fish. To ensure better survival and production of fish'sproper feeding management measure were taken.

**Collection of Chironomid larvae from pond bottom**: Composition of the bottom mud was recorded with visual identification and subsequent quantification was accomplished in accordance with the weight of the types of benthos. Bottom mud was collected from three different locations in the experimental pond (middle and two corner) using an Ekman Grab. Chironomid larvae were collected by using a standard brass sieve (mesh size 0.92 mm). Each sample was washed on the sieve with water in order to washout the soil content from the sieve. Chironomid larvae remaining within the sieve were collected with care and poured in to small vials containing 5% formalin. These were carried to the laboratory for detailed quantitative and qualitative analysis:

**Microscopic slide preparation and examination:** Chironomid larvae were mounted in polyvinyl lacto phenol, each individual was mounted on a separate slide. The head capsule was separated from the body with the help of a needle. The body and head capsule of each individual was placed on the same slide under separate cover slips. Care was taken to remove excess water from the body by touching with tissue paper before placing on a slide because water along with ethanol makes the mounting difficult. Then, the specimens were ready for identification.

**Sampling of fish:** Fishes were sampled monthly by using a cast net and 5 fishes were taken for gut content analysis.

**Gut content analysis:** The gut contents of the collected fish samples were examined in thisexperiment. The composition of food was recorded and the components were quantified according to the body weight of food items present. The abdomen of the individual fish was cut by the help of scissors and gut content were taken out carefully and guts were collected and stocked in vials containing 5% formalin until the gut contents were examined. During analysis the guts were taken out from the vials and kept on petri dish. Then each gut was pieced and a small portion was washed with distilled water. Then, the washed water was sampled on a glass slide and observed under microscope. Thus, the qualitative and quantitative study of the Chironomid larvae was done.

**Electivity Index:** In order to gain an idea of the proportion of organisms in the diet relative to the proportion measured in the benthos, an index of selective feeding or electivity was calculated using the formula given by Ivlev[12] as cited by Brown and Oldham[13].

$$E = \frac{(Pg - Pm)}{Pg + Pm}$$

Where:

E = Electivity index value

Pg = Relative content of Chironomid larvae in the gut, expressed as percentage of total ration

Pm = Relative proportion of the same organism present in the bottom mud

The numerical assessment of gut contents and collected benthic faunal data provided the required information for measuring electivity index in this study. Electivity or selection for an organism is expressed by values from +1 to -1.

**Enumeration of benthos:** Bottom mud samples were taken with the help of an "Ekman dredge" which covered an area of 225 $cm^2$. The Chironomid larvae were enumerated for the study of abundance in the investigated area. The specimens were counted species wise, recorded and converted to their abundance ($m^{-2}$).

The abundance was expressed as density (individual $m^{-2}$) by following formula:

$$n = \frac{o}{(a\ x\ s)} x\ 10000$$

Where:

n = Number of individuals in one sq. meter
o = Number of individuals totally/actually counted
a = Area of samples in square centimetre
s = Number of samples taken at one sampling spot

**Statistical analysis:** The data obtained from monthly abundance of Chironomid fauna from the studied pond was tabulated for statistical analysis. Analysis of variance was done with the help of computer package SPSS version 10.0. The mean values were compared by Duncan's New Multiple Range Test at 5% level of significance.

## RESULTS

**Chironomid population:** Quantitative and qualitative studies of Chironomid larvae were made in every month both from the bottom mud of the experimental pond and from the gut of the sampled fishes. A summary of the data on the population abundance of the Chironomid larvae recorded during the experimental period is provided in Table-1.

**Table-1: Abundance of Chironomid larvae in different months from 3 locations in bottom mud of the experimental pond during September 2018 to February 2019.**

| Month | Average no. of Chironomid larvae |
|---|---|
| September | 592.59 |
| October | 517.15 |
| November | 1866.67 |
| December | 3365.94 |
| January | 3695.19 |
| February | 2681.48 |

The monthly abundance of Chironomid larvae in the bottom mud of the experimental pond during the study period was found to be between 517.15 to 3695.19 individual $m^{-2}$. The second highest abundance was 3365.93 individual $m^{-2}$. The maximum abundance of Chironomid larvae was found in the month of January 2019. The second highest abundance was recorded in the month of December 2018. The minimum abundance was recorded in the month of October 2018.

**Gut content analysis of Chironomid larvae:** Monthly recorded number of Chironomid larvae in the gut of 5 sampled fishes during the study period was found to vary between 25 and 768 in number. The second highest occurrence was 410 larvae. The most Chironomids were found in the intestine of the sampled fishes. The maximum occurrence of Chironomid larva was found in the month of December 2018. The second highest occurrence was recorded in the month of November 2018. The minimum occurrence was recorded in the month of October 2018. (Table 2-4).

**Table-2: Monthly observation of gut content of chironomid larvae in the experimental pond during September 2018 to February 2019**

| Month | No. of samples observed | Buccal cavity | Pharynx | Oesophagus | Stomach | Intestine | Total | Average |
|---|---|---|---|---|---|---|---|---|
| **September** | 5 | 0 | 3 | 0 | 15 | 12 | 30 | 6.0 |
| **October** | 5 | 0 | 3 | 0 | 13 | 9 | 25 | 5.0 |
| **November** | 5 | 0 | 7 | 0 | 33 | 370 | 410 | 82.0 |
| **December** | 5 | 0 | 6 | 0 | 52 | 710 | 768 | 153.6 |
| **January** | 5 | 0 | 0 | 0 | 21 | 252 | 275 | 55.0 |
| **February** | 5 | 0 | 0 | 0 | 19 | 18 | 37 | 7.4 |

**Table-3: Composition (%) of benthic organisms present in the bottom mud of the experimental pond during September 2018 to February 2019**

| Month | Chironomidae | Oligochaete | Mosquito & other insects | Mollusca |
|---|---|---|---|---|
| September | 22 | 25 | 16 | 37 |
| October | 23 | 26 | 13 | 38 |
| November | 32 | 25 | 10 | 33 |
| December | 25 | 33 | 11 | 31 |
| January | 35 | 30 | 9 | 26 |
| February | 29 | 31 | 12 | 28 |

**Table-4: Composition (%) of diet as revealed by the stomach content analysis of the sampled from the experimental pond during September 2018 to February 2019**

| Month | Chironomidae | Oligochaete | Mosquito & other insects | Organic matter & debris |
|---|---|---|---|---|
| September | 11 | 5 | 46 | 38 |
| October | 15 | 5 | 50 | 30 |
| November | 25 | 22 | 35 | 18 |
| December | 65 | 27 | 6 | 2 |
| January | 76 | 19 | 5 | 0 |
| February | 59 | 25 | 16 | 0 |

**Table-5: Monthly variation observed in the electivity for chironomid larvae during September 2018 to February 2019**

| Month | Proportion in gut (%) | Proportion in mud (%) | Electivity Index (E) |
|---|---|---|---|
| September | 12 | 21 | -0.272727 |
| October | 15 | 23 | -0.210530 |
| November | 25 | 32 | -0.122810 |
| December | 65 | 25 | 0.444444 |
| January | 76 | 35 | 0.369369 |
| February | 59 | 29 | 0.340909 |

**Electivity index**: Electivity indices were calculated for every month and it varied from -0.27 to +0.44. The high electivity was observed in December 2018 and the lowest value was calculated for the month of November 2018. For the first two months, the fishes showed negative selection in feeding the Chironomid larvae. For the last three months the fishes showed greater preferences to the Chironomids (Table-5).

## DISCUSSION

A total of 837 Chironomid larvae were collected from the sampling stations in the pond during 6 months of study period (September, 2018 – February, 2019). Monthly observed total no. of Chironomid larvae in the bottom mud of the experimental pond during the study period was found to be between 517.15 and 3695.19 individual $m^{-2}$. A distinct seasonal variation in the population of Chironomids was observed in this study. The observed lower number in February 2019 might be due to heavy grazing by *Clarias batrachus*, which agrees with the observation of Brown and Oldham[13]. The ecological conditions of the ponds were probably favourable for the growth of these organisms. The soft bottom mud of the tropical fish ponds has been found to exert a significant influence upon the occurrence of the bottom organisms especially the Chironomids. There were qualitative and quantitative variations of the

Chironomid larvae. Higher abundance in the pond seems to be due to better feeding, environmental conditions and probably breeding. Seasonal changes in the population abundance of Chironomidae were investigated by many workers[13,14,15]. A distinct seasonal variation in total Chironomidae was observed in this study. Olfsson had similar observation where he found the highest number of individuals in June in the pond and lowest number was recorded in August[16].

Food composition of sampled fishes in the experimental pond suggested that Chironomids comprised a major component of the diet of *Clarias*. The food comprised mainly of insects, polychaetes, oligochaetes and debris. This result is similar to that observed by Dewan[17]. The electivity indices showed negative selection (E =-0.27) to Chironomids at first and thereafter it shifted to the greater preferences (E = +0.44) over the time elapsed as the fish grew older in months. Ali and Begum observed positive selection for insects[18]. The information on electivity of *Clarias* on Chironomids seems to be lacking as well. Since, Chironomids were found to dominate in the diet of *Clarias* as it grows, efforts should be made to enhance Chironomid production in the catfish ponds for better fish production.

## CONCLUSION

The composition of the benthic macro-invertebrates in the bottom and indicated that Chironomidae was the dominant group. The body-weight percentage of the organisms showed that Chironomids and Oligochaetes were two major groups. The quantitative and qualitative studies of Chironomid larvae indicated that there was monthly variation in the abundance of Chironomids. The highest abundance of Chironomids 3695.19 individual $m^{-2}$ in 3 samples was recorded in the month of January 2019. The lowest abundance 517.15 individual $m^{-2}$ in 3 samples was observed in the month of October 2018.

The gut content analysis showed that Chironomids was the dominant food item in fish diet as they grow up. Maximum Chironomids were found in the intestine. The maximum occurrence of Chironomid larvae, 768 in number, was recorded for 5 fish samples in the month of December 2018. The minimum occurrence was recorded in October 2018.The electivity indices calculated for Chironomid larvae in each month showed that fish had negative selection for Chironomids for the first 2 months; a shift in the electivity to greater preferences to Chironomids was observed thereafter. It may be concluded that a greater abundance of Chironomid larvae may be required in the *Clarias* culture ponds for better fish production.

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