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# Effects of environmental variables on non-biting midges (Diptera: Chironomidae) of Ganga Lake, Itanagar

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Density and species composition of chironomidae larvae fauna from twelve sampling sites of Ganga Lake located in the vicinity of Itanagar, the state capital of Arunachal Pradesh were investigated. Monthly sampling was done from November 2008 to October 2009. In addition, simultaneously, physical and chemical parameters of water were measured. 3624 chironomid larvae were examined and a total of twelve taxa were identified. Chironomid larvae were the third dominant group of the total zoobenthos density. *Chironomus striatipennis* was the most abundant chironomid species contributing with about 66.2% of the total chironomid fauna. Dominant species were the following: *Kiefferulus barbatitarsis* (12 sites, 12%), *Polypedilum nubifer* (11 sites, 10.2%), *Chironomus javanus* (10 sites, 4%), *Glyptotendipes barbipes* (8 sites, 1.6%) and *Microchironomus tener* (7 sites, 1.8%). Relationships between the dynamics of the Chironomidae larvae and the environmental variables were supported by the Pearson correlation index. According to Pearson correlation between average number of *Chironimus striatipennis, Chironomus javanus* and temperature, BOD was directly proportional, while *Paratendipes hirsutus*, *Paratendipes unimaculipennis*, *Polypedilum insignum* were inversely proportional.

**Key words:** *Non-biting midges, physico-chemical parameters, species richness.*

## Introduction

Chironomidae, broadly distributed worldwide, are the most abundant insects in freshwater ecosystems. Certain species show ecological adaptations to extreme environmental situations related to high temperature, pH, organic matter content in the sediment, and low dissolved oxygen in the water-sediment interface (Armitage *et al*., 1994). Chironomidae larvae play an important ecological role in the bioturbation process at the sediment water interface. In eutrophic environments, they do so in nitrogen remobilization for the primary producers. In aquatic ecosystems, these organisms participate in two webs: (a) by the detritus chain, ingesting organic fragments and associated microorganisms, (b) by the food-web, by eating smaller organisms and being consumed by other insects, aquatic birds, and benthophagous fishes. Therefore, in lake environments, they are important components needing further study.

The aim of this study is to investigate the relationship between chironomids and the limnological parameters (physical, chemical and microbiological) of the Ganga Lake. Limnological parameters include dissolved oxygen levels, biological oxygen demand, chemical oxygen demand, pH levels, nitrate levels, phosphorus levels, water temperature, fecal coliform and total coliform. These measurements were compared with the abundance and diversity of the chironomid larvae. As there was very little previous information about the zoobenthic species composition in Ganga Lake this study also contributed to the faunistic knowledge of the lake.

## Materials and Methods

### Limnological Parameters

The water samples were analyzed in the laboratory for biochemical parameters included DO, BOD and COD. The pH and temperature were measured in the field. The water samples were analyzed in the laboratory for phosphate, nitrite and nitrate. The biological parameters studied include fecal coliform, total coliform and zoobenthos. Samples were taken in two replicas with an Ekman dredge (with coverage of 0.025 $m^2$) between November 2008 and October 2009, as monthly. The bottom samples were washed *in situ* using a 200 µm mesh size, the material was preserved in 4% formalin, in the laboratory all samples were removed from the debris, sorted under a stereoscope and transferred to 70% ethanol. Some larvae were subjected to laboratory rearing following Oliver and Roussel (1983), Pinder (1983) and Epler (1995). Life stages were collected and mounted following phenol-balsam technique of Wirth and Marston (1968) and they were indentified after Ashe (1983), Chaudhuri *et* al. (1992), Cranston *et al*. (1989), Langton (1991), Epler (1995) and Epler *et al*. (2013).

### Numerical Analysis

Shannon-Wiener species diversity index and Bray-Curtis similarity index were applied to analyze taxa statistically. Also the Pearson Correlation index was used to determine whether there were any correlation between the limnological parameters and number of individuals or not.

## Results

### Chironomidae Species Richness and Diversity

The zoobenthic invertebrate fauna of Ganga Lake mainly consisted of Oligochaeta (35.6%), Nematoda (27.7%), and Gastropoda (10.7%). The chironomid community comprised 12.3% of the total zoobenthic fauna and it was the third dominant macroinvertebrate group in the studied lakes during the study period. Other organisms were found sporadically and in insignificant amount. In the present investigation, 12 species of Chironomidae were identified, three species belonging to Tanypodinae, two species belonging to Orthocladiinae, six species belonging to Chironomini and only one species belonging to Tanytarsinini. A monthly abundance of the total Chironomidae in 12 sampling stations showed considerable fluctuations during the study period ranging from 0 (Station 3, September, 2009) to 101 individuals (Station 8, February, 2009). In addition, the average number of individuals of Chironomidae at 12 sampling stations was significantly different from each other ($P \leq 0.05$). The highest average number of chironomid observed at stations 8$^{th}$ and 9$^{th}$ were 43 and 28 individuals, respectively. And the lowest number of individual observed at stations 11$^{th}$ and

4th were 3 and 8 individuals, respectively. Of Chironomidae the subfamily Chironominae was found in the greatest number. The genus *Chironomus* was represented mainly by *Chironomus striatipennis*, (12 sites, 66.2%) and the highest individual number of this species was found at Station 8 (February, 2009, 101 individuals.). The second most important chironomid was the *Kiefferulus barbatitarsis* (12 sites, 12%) followed by *Polypedilum nubifer* (11 sites, 10.2%), *Chironomus javanus* (10 sites, 4%), *Glyptotendipes barbipes* (8 sites, 1.6%) and *Microchironomus tener* (7 sites, 1.8%). Except *Dicrotendipes nervosus* all other species occurred at <4 sites (between 0.04-0.6%). During each sampling, the minimum chironomid species (<4) was found at stations 3rd, 8th-11th. On the other hand, the maximum number of species (10) was usually observed at station 12th where the vegetation was dense.

The lowest number of taxa was found in lake stations 3rd, 8th, 9th, 10th and 11th (except station 3, other stations were located at the east of the lake) whereas the highest number of taxa was found at station 12. Generally, species richness and diversity were significantly higher at this station than the others. Important differences between the sampling stations were the vegetation. High diversity and taxonomic richness of the station 12 may be partly due to their rich vegetation and substrate types.

**Limnological Parameters**

The variations of the limnological parameters are represented in and the highest DO was recorded in cooler months, temperature of the sampling stations reflected the seasonal changes and ranged from 11.2°C to 27.3°C. It is known that DO is inversely related to water temperature. DO is probably that level of decomposer activity versus photosynthetic activity was also a contributing factor in the seasonal changes observed in DO, pH of the water varied between 7.8 and 9.1.

**Numerical Analysis**

According to the Shannon-Wiener index, the species diversity in lake was found as 0.73 at average, station 12 and March were determined to have the highest diversity while station 3 and August were determined to have the lowest diversity. According to Bray-Curtis similarity index, stations 2-10, 4-12 and 1-7-3 are the most similar to each other while stations 8 and 9 are the most different for the dynamics of chironomid larvae (both the numbers and species) in Ganga Lake.

With regard to the Pearson correlation index between the average number of Chironomid species and the parameters, the relation between the number of *Chironomus striatipennis, Chironomus javanus* and temperature ($P<0.05$, $r=+0.634$ and $r=+0.652$ respectively) was directly proportional while the relation between the number of some taxa, *Paratendipes hirsutus, Paratendipes unimaculipennis, Polypedilum insignum* was inversely proportional ($P<0.05$, $r=-0.650$). In addition, between the average number of *Chironomus striatipennis, Chironomus javanus* and DO was inversely proportional ($P<0.05$, $r=-0.673$ and $r=-0.650$, respectively).

**Discussion**

Present study shown that zoobenthic fauna of Ganga Lake was dominated by three group invertebrates, Oligochaetes, nematodes and chironomids that is typical of many freshwater systems and they have been known as tolerant organisms. Some species of them are sensitive to specific forms of pollution and exact species are quite tolerant, such as *Chironomus striatipennis*, *Chironomus javanus*. Large numbers of pollution-tolerant chironomids are often indicative of poor water quality (characterized by low dissolved oxygen and high nutrient concentrations). Chironomid species diversity and their sensitivity to eutrophic conditions were used to create trophic status classifications of lakes (Langdon *et al*., 2006). Our result indicated that Chironomidae fauna of Ganga Lake consists mainly of taxa with wide ecological tolerances and extensive geographical ranges. The chironomids were mainly represented by *Chironomus striatipennis* and it was the only species obtain regularly from all stations during the study and it also occurred in large numbers (Stations 8, 9, 10 and 11 as 95.7%, 92.7%, 79.6%, 53.35%, respectively. This species is frequently referred to in the literature as being positive indicators of organic pollution. By contrast *Paratendipes unimaculipennis*, and *Polypedilum insignum* were not detected at those stations. These two species were found only in one station ($12^{th}$) associated with aquatic plants, like found in other study (Brodersen *et al*., 2001). Physiological adjustment is shown in several species of Chironomidae. It has been found by various workers that some Chironomidae containing erythrocruorin (haemoglobin) can exist in the complete absence of dissolved oxygen for 30 to 120 days. The presence of *Chironomus striatipennis* and *Chironomus javanus*, their high abundance may be interpreted as an indication of organic pollution. Finally, we can conclude from our results three commonly occurring taxa, *Kiefferulus barbatitarsis*, *Polypedilum nubifer* and *Chironomus striatipennis* appeared to be indicators of the pollution.

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**References**

Armitage, P., Cranston, P.S. and Pinder, L.C.V. 1994. *The Chironomidae: the biology and ecology of non-biting midges.* Chapman-Hall, London, pp. 1-572.

Ashe, P. 1983. A catalogue of chironomid genera and subgenera of the world including synonyms (Diptera: Chironomidae). *Entomologica Scandinavica*, Supplement. **17**:1–68.

Brodersen, K.P., Odgaard, B., Vestergaard, O. and Anderson, N.J. 2001. Chironomid stratigraphy in the shallow and eutrophic Lake Søbygaard, Denmark: Chironomid macrophyte co-occurrence. *Freshwater Biology*, **46**: 253–267.

Chaudhuri, P.K., Das, S.K. and Sublette, J.E. 1992. Indian species of genus *Chironomus* Meigen (Diptera: Chironomidae). *Zoologische Jahrbucher Systematik*. **119**:1–51.

Cranston, P.S., Dillon M.E., Pinder, L.C.V. and Reiss, F. 1989. The adult males of Chironominae (Diptera: Chironomidae) of the Holarctic region. In: Wiederholm T, editor. Chironomidae of the Holarctic region, keys and diagnoses, Part 3. Adult males. *Entomologica Scandinavia*, Supplement. **34**; p. 353–502.

Epler, J.H. 1995. Identification Manual for the Larval Chironomidae (Diptera) of Florida. Revised edition. Florida Department of Environmental Protection, Tallahassee, Florida, pp. 1-317.

Epler, J., Ekrem T. and Cranston P.S. 2013. The larvae of Chironomidae (Diptera: Chironomidae) of the Holarctic region − keys and diagnoses. In: Andersen T, Cranston PS, Epler JH, editors. The Chironomidae of the Holarctic region − keys and diagnoses. *Insect Systematics & Evolution*, Supplement. **66**: 1−573.

Langdon, P.G., Ruiz, Broderson, Z.K.P. and Foster, DL. 2006. Assessing lake eutrophication using chironomids: Understanding the nature of community response in different lake types. *Freshwater Biology*, **51**: 562-577.

Langton, P.H. 1991. A key to pupal exuviae of West Palaearctic Chironomidae. Privately published by PH. Langton, 3, St. Felix Road, Ramsey Forty Foot, Huntingdon, Cambridgeshire, England PE17 1YH; pp. 1-386.

Oliver, D.R. and Roussel, M.E. 1983. The Genera of Larval Midges of Canada (Diptera: Chironomidae), Part 11. The insects and arachnids of Canada. Research Branch, Agriculture Canada, Publication, Biosystematics Research Institute, Ottawa, 1746; pp. 1-263.

Pinder, L.C.V. 1983. The larvae of Chironomidae (Diptera), of the Holarctic region. Introduction. In: Weiderholm T, editor. Chironomidae of the Holarctic region keys and diagnoses. Part 1. Larvae. *Entomologica Scandinavica*, Supplement. **19**: 7–10.

Wirth, W.W. and Marston, N. 1968. A method for mounting small insects on microscope slides in Canada balsam. *Annals of the Entomological Society of America*. **61**: 783–784.