



Community structure and diversity of Chironomine midges (Chironomidae: Diptera) in the paddy fields of Murshidabad, West Bengal, India

Atanu Ghosh, Abhijit Mazumdar

Entomology Research Unit, Department of Zoology, the University of Burdwan, Burdwan, West Bengal, India

Abstract

Paddy fields from different rice growing areas of Murshidabad district of West Bengal, India were selected to investigate the community structure, diversity and abundance of Chironomine midges. Bimonthly sampling was done for two years constituting of four rice growing seasons. 13 species from 10 genera of Chironomidae were documented from the 3076 sampled larvae. *Chironomus striatipennis* (51.04%) was the most abundant species, followed by *Tanytarsus fuscimarginalis* (9.62%), *Tanypus grandis* (9.46%) and *Tanypus bilobatus* (8.02%). *Dicrotendipes pelochloris* (0.23%) was the least abundant among all the recorded species. Various diversity indices were calculated to find out dominance, species diversity, evenness and species richness of the midge larvae.

Keywords: Murshidabad, chironomidae, dominance, species diversity, evenness and species richness

1. Introduction

The “non-biting midges” are soft bodied flies often confused with the mosquitoes due to its similarity^[1]. The larvae known as red midge larvae or “bloodworms”, possess hemoglobin in extra-cellular medium, and are used as bait for fishes. They construct short, loose tube-like dwellings in soft muddy sediments^[2, 3]. Though capable of thriving in low resource and undesirable locations, these chironomids lack natural widespread movement but still manage to get transported to a long distance via human assisted means^[4, 5, 6, 7]. Invasive, opportunist, resilient and rapid colonizing capabilities make them highly suitable for successful invasion of new aquatic territories^[8]. Paddy fields are a unique man-made environment, rather a modified marsh ecosystem supporting a wide range of aquatic organisms which is closely related to environmental changes of rice agro-ecosystems. Routine agricultural practices, wide variation of various water parameters along with wet and dry cycles influence diversity of inhabiting aquatic communities^[9]. The larvae of Chironomid midges are ubiquitous in rice fields throughout the world, with some species being regarded as crop pests^[10]. They closely follow changes in rice plant growth, cultivation practice, and seasonal climatic changes and the succession of insect community depends on the pattern of water availability and paddy growth^[11].

2. Materials and Methods

2.1 Study Area

The district Murshidabad, with its total area of 5316.11 sq. km lies almost in the middle of the state West Bengal between 23°43'N and 24°52'N latitude and 87°49'E and 88°44'E longitude. Within the district western part of Bhagirathi River with harsh soil and climatic conditions was chosen. Five paddy fields from five different regions of Rarh alluvial soil were selected as study area. The areas are Kandi- Plot A

(23°56'48.46"N, 88° 2'58.99"E), Khargram- Plot B (24° 1'35.33"N, 87°59'6.75"E), Hijal- Plot C (23°57'13.21"N, 88° 8'17.70"E), Batur- Plot D (23°58'59.91"N, 88° 1'39.73"E) and Gokarna- Plot E (24° 2'48.55"N, 88° 7'11.54"E).

2.2 Sampling and rearing of larvae

Samples of larval Chironomids were collected bimonthly at random from the five investigating sites for a span of two years covering four rice growing seasons i.e., Two Kharif seasons (July- October) and two Rabi seasons (February-May), spanning from July 2012 to May 2014. Scoop sampler and mud scrapers were used to collect larvae from mud bottom (about 10-15 cm) of the rice fields^[12]. Samples were immediately transferred to a plastic bucket, washed with water and passed through a sieve (300-µm pore). The sieved residues containing bloodworm were transferred to a tray and were cleared to retrieve the larvae. The larvae were subjected to rearing following suitable methods^[13, 14]. They were placed in shallow PVC trays (30 x 30 cm) with a little substrate from the rice field and a moderate amount of water to a depth of 2-3 cm. Small amount algal filament or leaves of aquatic macrophytes were provided to the rearing trays^[15]. The trays were kept inside separate cages (45 X 45 cm) so that the emerging adults do not escape. Supplies of air were provided daily by electric air pumps to maintain steady aeration and oxygen supply. After emergence, the adults rested on the inner periphery of cages from where they were caught by moist brushes. Adults were preserve in corked glass vials containing 70–80% ethyl alcohol sealed with wax paper and properly labelled.

2.3 Mounting and identification of adults

For mounting of adults the phenol-balsam technique was followed^[16]. Specimen mounted on microslides were observed under compound light microscope and identified

upto species level following suitable literature [17, 18, 19, 20, 21, 22, 23].

2.4 Data Analysis

Microsoft Excel 2013 was used to perform the basic calculations. The diversity indices of the Chironomids were assessed using PAleontological STatistics (PAST), Version 3.16 [24].

3. Results

3.1 Community Structure

From the sampled larvae, 13 species from 10 genera of Chironomidae were documented. *Chironomus striatipennis* (51.04%) was the most abundant species, followed by *Tanytarsus fuscimarginalis* (9.62%), *Tanytus grandis* (9.46%), *Tanytus bilobatus* (8.02%), *Chironomus circumdatus* (6.21%), *Keifferulus calligaster* (6.14%), *Clinotanypus fuscognatus* (5.00%), *Microchironomus fuscitarsus* (2.34%), *Chironomus nudipes* (0.71%), *Cladotanytarsus multispinulus* (0.46), *Paramerina quinifcia* (0.36%), and *Procladius noctivagus* (0.36%). *Dicrotendipes pelochloris* (0.23%) was the least abundant among all the recorded species. None of the plots showed all the 13 taxa that were found altogether in all the plots. Plot A was found to have 16.51% of total sampled Chironomids comprising of 9 species, Plot B comprised of 28.51% individuals having 10 species, Plot C recorded 9 species among 28.28% individuals, Plot D was documented with 10.66% individuals comprising of 10 species and Plot E with just 8 species had the least number of species, which consisted of 16.03% individuals. *Chironomus striatipennis*, *Clinotanypus fuscognatus*, *Microchironomus fuscitarsus*, *Tanytus bilobatus*, *Tanytus grandis*, *Tanytarsus fuscimarginalis* were found in all the plots; on the other hand *Dicrotendipes pelochloris* was found only in Plot D and *Procladius noctivagus* was documented only from Plot C.

3.2 Diversity Indices

In this study, Margalef's Diversity Index and Menhinick's Index were calculated as representatives of Species Richness Indices. Plot D was the most species rich area as it showed maximum value for both Margalef's Diversity Index (1.554) and Menhinick's Index (0.552) and plot C was the least species rich as it showed lowest value for both Margalef's Diversity Index (1.182) and Menhinick's Index (0.305). Plot A showed maximum value for Dominance_D (0.433) and showed least evenness and diversity. On the contrary Plot E showed least dominance (Dominance_D = 0.240 and Berger-Parker = 0.375) in terms of Chironomid community. Among the Species diversity indices, which is sometimes called species heterogeneity indices; Simpson's Index, Shannon-Wiener Index and Brillouin index had been calculated. Plot E with highest value for Simpson's Index (0.760), Shannon-Wiener Index (1.650) and Brillouin index (1.614) is the area with maximum diversity among all. On the other hand Plot A was the least diversified area as it showed lowest values for Simpson's Index (0.567), Brillouin index (1.232) and Shannon-Wiener Index (1.267). Also plot E showed maximum value for species Evenness

(Evenness_e^H/S = 0.651 and Equitability_J = 0.793), and Plot A showed minimum value for species evenness (Evenness_e^H/S = 0.395 and Equitability_J = 0.577).

4. Discussion

The investigation presented in this paper is based on the morphological diagnosis of the adult Chironomids found in paddy fields of Murshidabad, West Bengal, India. Thirteen species belonging to ten genera were identified from these paddy fields. These species were also previously reported from various rice fields of West Bengal [12]. It was clearly observed that the populations of these species vanished when the field was dry. Intermittent drying was a major factor that reduced the species abundance. *Chironomus striatipennis* was the most dominant species as it showed flexibility in adaptation strategy towards the different physical and chemical conditions of the field. Rice field ecosystem provides quiet, non-agitated water along with fine mud particles, aiding tube construction which promotes *Chironomus* abundance [25]. *Dicrotendipes pelochloris* was found to be least successful due to lack of invasive nature and adaptability.

Data analysis revealed that Plot D was the most species rich area, Plot A showed dominance with regard to certain species and Plot E showed maximum species diversity. Studies regarding various physico-chemical parameters are required which will help us to relate and better understand variation of Chironomid abundance in a paddy field ecosystem.

5. Conclusion

Intermittent dry and wet phases of paddy field ecosystem promoted those Chironomid species which showed flexible life history strategies. *Chironomus striatipennis* ruled the population with its adaptation strategy. Plot E seems to be more important regarding Chironomid population as it showed maximum species diversity.

6. Acknowledgement

The authors are grateful to Department of Zoology, The University of Burdwan, West Bengal, India for allowing to use laboratory facilities for this study. Gratitude is expressed to Professor P. K. Chaudhuri, The University of Burdwan, for his valuable inputs. Help and motivation from Stephen L. Clement, Adjunct Faculty, Washington State University, is also acknowledged.

7. References

1. Epler JH. Identification manual for the larval Chironomidae (Diptera) of North and South Carolina. A guide to the taxonomy of the midges of the southeastern United States, including Florida. Special Publication SJ2001-SP13. North Carolina Department of Environmental and Natural Resources, Division of Water Quality, Raleigh, NC, 2001, 526.
2. Pinder LCV, Reiss F. The pupae of Chironominae (Diptera: Chironomidae) of the Holarctic region – keys and diagnoses. In: Chironomidae of the Holarctic region. Wiederholm, T. (ed.), Ibid. 1986; 28:299-456.
3. Cranston PS, Martin J. Family Chironomidae. In: Evenhuis NL. (ed.), Catalogue of the Diptera of the

- Australasian and Oceanian Regions. Bishop Museum Press, Honolulu, Hawaii, 1989, 252-274.
4. Brodin Y, Andersson MH. The marine splash midge *Telmatogon japonicus* (Diptera; Chironomidae)—extreme and alien? *Biological Invasions*. 2009; 11:1311-1317. <http://dx.doi.org/10.1007/s10530-008-9338-7>.
 5. Hughes KA, Worland MR. Spatial distribution, habitat preference and colonization status of two alien terrestrial invertebrate species in Antarctica. *Antarctic Science*. 2010; 22:221-231. <http://dx.doi.org/10.1017/S0954102009990770>.
 6. Evenhuis NL, Eldredge LG. The nuisance marine midge, *Kiefferulus longilobus*, is established in Hawaii (Diptera: Chironomidae). *Occasional Papers*. 2013; 114:59-60.
 7. Gruszka PJ, Rokicka-Praxmajer J, Cupak J, Wolska M, Radziejewska T. Unintended biological cargo of ships entering the River Odra estuary: assemblages of organisms in ballast tanks. *Zeszyty Naukowe*. 2013; 33:22-29.
 8. Jacobsen RE, Perry SA. *Polypedilum nubifer*, a chironomid midge (Diptera: Chironomidae) new to Florida that has nuisance potential. *Florida Entomologist*. 2007; 90:264-267.
 9. Che Salmah MR, Hassan STS, Abu Hassan A, Ali AB. Influence of physical and chemical factors on the larval abundance of *Neurothemis tullia* (Drury) (Odonata: Libellulidae) in a rice field. *Hydrobiologia*. 1998; 389:193-202.
 10. Surakarn R, Yano K. Chironomidae (Diptera) recorded from paddy fields of the world: a review. *Makunagi/Acta Dipterologica*. 1995; 18:1-20.
 11. Che Salmah MR, Hassan STS, Abu Hassan A, Ali AB. Life history of *Neurothemis tullia* (Drury) (Anisoptera: Libellulidae) in a tropical rain fed rice field. *Odonatologica*. 2000; 28(1):1-11.
 12. Chaudhuri PK, Chattopadhyay S. Chironomids of the rice paddy areas of West Bengal, India (Diptera: Chironomidae). *Tijdschrift voor Entomologie*. 1990; 133(2):149-195.
 13. Campbell BC, Denno RF. The structure of aquatic insect community associated with inter tidal poles on a New Jersey salt marsh. *Ecological Entomology*. 1978; 3:181-187.
 14. Epler JH. Identification manual for the larval Chironomidae (Diptera) of Florida. Florida Department of Environmental Regulation, Orlando. 1992; 1(1):96.
 15. Agra AR, Soares AMVM. Effects of two insecticides on survival, growth and emergence of *Chironomus riparius* Meigen. *The Bulletin of Environmental Contamination and Toxicology*. 2009; 82:501-504.
 16. DasGupta SK, Wirth WW. Revision of Oriental species of *Stilobezzia* Kieffer (Diptera, Ceratopogonidae). *Bulletin of the United States National Museum*. 1968; 283:1-164.
 17. Chaudhuri PK, Guha DK, Ghosh M. Tanytarsini Diptera: Chironomidae) from India, *Oriental Insects*. 1984; 18:31-41.
 18. Chaudhuri PK, Das SK, Debnath RK. Studies of the Indian Tanytarsini (Diptera, Chironomidae), genus *Tanytus* Meigen. *Bulletin Entomologique De Pologne*. 1988; 55:99-109.
 19. Chaudhuri PK, Ghosh M. Two new species of *Kiefferulus* Goetghebuer (Diptera: Chironomidae). *Sys. Ent. London*. 1986; 11:277-292.
 20. Cranston PS, Dillon ME, Pinder LCV, Reiss F. The adult males of Chironominae (Diptera: Chironomidae) of the Holarctic region. In: *Chironomidae of the Holarctic region, Keys and diagnoses. Part. 3. Adult males*. Weiderholm, T. (ed.). *Ent. Scand. Suppl.* 1989; 34:353-502.
 21. Pinder LCV. The adult males of Chironomidae (Diptera), of the Holarctic region. Introduction in *Chironomidae of the Holarctic region. Keys and diagnoses. Part 3. Adult males*. Weiderholm, T (ed.). *Entomologica scandinavica Suppl.* 1989; 34:5-9.
 22. Chaudhuri PK, Das SK, Sublette JE. Indian species of genus *Chironomus* Meigen (Diptera: Chironomidae). *Nomenclator Zoologicus*. 1992; 119:1-51.
 23. Datta T, Majumdar A, Chaudhuri PK. Taxonomic studies on *Tanytarsus* v.d. Wulp (Diptera: Chironomidae) in India. *Oriental Insects*. 1992; 26:39-66.
 24. Hammer Ø, Harper DAT, Ryan PD. PAST: Paleontological Statistics Software Package for Education and Data Analysis. *Palaeontologia Electronica*. 2001; 4(1):9.
 25. Petr T. Benthic fauna of a tropical manmade lake (Volta Lake, Ghana 1965-1968). *Archiv für Hydrobiologie*. 1972; 70(4):484-533.