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Assessment of Behavioural and Environmental Impact on Aggregation of Some Freshwater Oligochaet and Chironomid Species

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Abstract: This study dealt with the analysis of dispersion parameter for different species of Oligochaet and Chironomid and reasons behind the considerable variation. Results of dispersal parameter (k) revealed that all the 11 Oligochaet and 7 Chironomid species (except one i.e. *Chirnomus* sp.) showed an average annual value less than 8.00 which indicates that they show greater extent of aggregation. The value of mean number of individuals (λ) in aggregation ranged from 2.135 (*Pristina* sp.) to 642.12 (*Branchiura sowerbyi*). For Chironomids it was also found to be always more than 2. The values of mean number of individuals (λ) more than 2 depicts that the aggregation revealed by the population is their behavioural act and it is not influenced by environmental factors prevailing in the habitat.

Key words: Dispersion · Mortality · Poisson · Bioaccumulation

INTRODUCTION

The biological response of environmental impact could be variables such as migration pattern, community density and diversity, behavioral changes, bioaccumulation, distribution pattern, mortality, secondary metabolite changes and their presence or absence [1]. The analysis of niche relation among the organism of different habitats is based on the relative occurrence and also relative abundance of the organisms. This signifies the importance of patterns of distribution of the organism in different habitats. Hence the distributional pattern of the organism becomes an important aspect and a prerequisite criterion for niche analysis as well as evaluation of biological responses of the species. Out of the three major categories of distribution types viz. regular, random and contagious, the later meaning clumped or aggregated population has been studied and expressed by the binomial or Pascal distribution [2- 6]. This distribution of an organism is described by two parameters the mean of the population in different habitats and the dispersion parameter (k) which is the measure of extent of clumping of the organism concerned. As analyzed by Katti and Gurland [7] the higher values of "k" eventually approaches identical with that of poisson. An understanding of dispersion is also vital in the analysis of predator-prey and host-parasite relationships [8-10].

Studies have been done on Oligochaeta to evaluate polluted aquatic environments [11-13] and larval Chironomidae communities from a lot of habitats have also been studied [14-18]. Aquatic Oligochaetes and larval Chironomids have been studied for their seasonality, population density and bioindicator ability but no work has been done to analyze their nature of aggregation in different habitats. The present study intends to study whether pattern of distribution of aquatic Oligochaetes and larval Chironomids is their behavioural reflection or environmentally influenced.

MATERIALS AND METHODS

Macrobenthic - invertebrate were sampled from four sampling sites by means of Ekman's dredge (523 cm^2) [19]. Three dredging constituted a sample for macrobenthic fauna, which was sieved through metallic gauge (256 meshes/cm^2). The residual organisms were sorted out and preserved in laboratory. The samples were studied qualitatively and quantitatively; species and group wise and expressed as number per square meter.

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Five different habitats were sampled simultaneously and the mean value of the five samples has been taken as the representative sample for further calculation. The identification of the organisms was done with the help of literature of Ward and Whipple [20], Needham and Needham [21], Brinkhurst [22] and some were identified at Zoological Survey of India (Calcutta). Oligochaetes and Chironomid species were taken into account for the present investigation. Dispersion parameter (k) has been calculated following Katti and Gurland [7] equation. Further the mean number of individuals in aggregation (λ) was calculated by using Southwood [23] to predict the cause of aggregation.

RESULTS AND DISCUSSION

Oligochaeta is an abundant group of benthic organisms [24] and this group is registered in almost all freshwater environments and is abundant in several environments both lotic and lentic [25-28]. In this study, a total of 8 genera and 11 species (Table 1) belonging to 3 families were identified including 6 species of Tubificidae, 1 sp. of Aeolosomatidae and 4 spp. of Naididae with considerable variation in population density and seasonality. The data analyzed for dispersion parameter revealed considerable variation in the values obtained for different species and also different species showed considerable variation with seasonal succession. As shown in table 1, *B. sowerbyi* showed maximum value of k 32.465 (November) while minimum as 1.479 (March). For *L. hoffmeisteri* 0.259 was the minimum value in May and 11.996 was the maximum value in March. *T. tubifex* showed the minima (0.259) and maxima (12.161) in October and June. For *A. americanus* the minimum and maximum values for dispersion parameter were 0.259 (June) and 0.759 (July) whereas 6.734 in the month of July and 0.710 in the month of June were the highest and lowest values for *L. udekemianus*. For *L. angustepenis* 32.154 was recorded as maximum dispersion parameter value in the month of January and the minimum value was 0.665. For *Aelosoma* sp. 7.820 (August) and 0.758 (February) were the highest and lowest values of dispersion parameter.2.476 in the month of July and 0.263 in the month of June were recorded as the maxima and the minima of dispersion parameter score for *D. Pectinata* while *Chaetogaster* sp. Scored 2.809 in November as highest and 0.258 in April as lowest value. For *Dero* sp. highest and lowest values were calculated as 14.027 (April) and 0.245 (February). *Pristina* sp. showed 1.426 (April) and 0.259 (March) as the highest and lowest values respectively. The results show that the dispersion parameter is not only influenced due to specificity of species but also by the environmental variables which change with the change in season.

It is evident from the results that all the 11 species showed considerable variation in dispersion parameter value in different months of the year, yet the annual average value of any species never crossed the value of 8.000 (Table 1) which indicate that these Oligochaetes show greater a extent of aggregation. As analyzed by Katti and Gurland [7], the values of k are if over 8 the distribution approaches a poisson i.e. is virtually random. Hence out of eleven only four i.e. *B. sowerbyi* from September to November, *L. hoffmeisteri* in March, *T. tubifex* in May and June, *L. angustepenis* in January showed some degree of randomness in distribution which might be due to density dependent factors or habitat disturbance leading to dispersion. In order to test further

Table 1: Seasonal variation in dispersal parameter (k) of different Oligochaet species

Name of species	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Mean ± SD
Branchiura sowerbyi	2.633	3.524	1.479	2.113	10.97	3.707	4.501	3.246	12.564	32.465	2.885	7.952 ±0.916
Limnodrilus hoffmeisteri	0.711	0.595	11.996	1.162	0.259	0.662	0.919	0.254	2.085	1.383	0.606	1.725 ±0.328
Tubifex tubifex	1.207	0.886	1.633	2.613	9.055	12.161	3.659	9.896	2.243	4.135	0.263	3.952 ±0.403
Aulodrilus americanus	0.000	0.000	0.000	0.000	0.262	0.259	0.759	0.262	0.263	0.000	0.000	0.150 ±0.022
Limnodrilus undekemianus	1.554	1.342	1.292	1.913	2.262	0.710	6.734	1.453	4.096	1.727	1.761	2.283 ±0.163
Limnodrilus angustepenis	32.15	0.665	5.949	2.635	2.459	4.912	1.481	7.759	3.513	2.025	4.905	5.835 ±0.855
Aelosoma sp.	1.691	0.758	1.206	6.789	4.776	2.321	2.082	7.820	6.330	26.952	1.600	5.386 ±0.720
Dero pectinata	0.940	0.275	0.759	0.236	0.897	0.263	2.476	1.565	0.940	0.406	0.499	0.837 ±0.064
Chaetogaster sp.	0.662	0.542	0.697	0.258	0.263	0.652	0.640	0.940	0.263	2.809	1.805	0.843 ±0.074
Dero sp.	3.197	0.245	11.413	14.027	1.903	7.244	6.037	4.799	2.650	2.587	3.668	4.996 ±0.441
Pristina sp.	0.448	0.263	0.259	1.426	0.345	0.606	1.284	0.277	1.507	0.625	0.662	0.641 ±0.049

whether the Oligochaet population showed contagious distribution by virtue of environmental influences or it is their behavioural activity, the data was analyzed for the mean number of individuals (λ) in the aggregation. The value of mean number of individuals in aggregation ranged from 2.135 (*Pristina* sp.) to 642.12 (*Branchiura sowerbyi*). Values showed that the pattern of distribution is a reflection of their behaviour. Environmental factors have not influenced the pattern of distribution. Only *Aulodrilus americanus* showed λ value 0 in the entire duration of experiment except May to September (Fig 1). *Limnodrilus hoffmeisteri* and *Pristina* sp. also exhibited $\lambda = 0$ in October. The value was 0 because their mean density was 0 in that month and it might be due to environmental act. The value of λ if less than two for the species indicate environmental impact on distribution [23].

Chironomids are also one of the most abundant macro - invertebrate group and they often account for the majority of aquatic insects in freshwater environments [29, 30]. Results indicated that total of 7 Chironomid identified species were *Tanypus* sp. (Meigen, 1803), *Coelotanypus* sp., *Procladius* sp. (Skuse, 1889), *Chironomus* sp. (Meigen, 1803), *Glyptotendipus* sp., *Orthocladius* sp. (Kieffer, 1906), *Polypedilum* sp. (Kieffer, 1912). Ozkan *et al.*, [31] have also recorded all these Chironomid spp. in Ergene river basin (Turkish Thrace).

So far the variation in dispersion parameter value of Chironomid taxa is concerned the overall highest value was revealed by *Chironomus* sp. The value was maximum (52.880) in April and minimum (0.819) in December (Table 2). Next to *Chironomus* sp., *Polypedilum* sp. revealed the higher values for the parameter value, 19.845 in January and 0.499 in May were recorded as maximum and minimum value respectively. *Tanypus* sp. revealed the maxima of the score in March (18.140) and minima of the score for the species was 0.277 in November. For all other taxa of Chironomids the highest score was little more than unity while the lowest score was always in fraction indicating the distribution tending towards the logarithmic series. Results of dispersal parameter (k) for Chironomid spp. also revealed that all the 7 species showed average annual value less than 8 except for *Chirnomus* sp. whose value was 14.163 (Table 2) which also indicate higher degree of aggregation among all these *Chironomus* spp. The mean number of individuals (λ) in the aggregation was also found to be always more than 2 (Fig. 2). The values of mean number of individuals (λ) more than 2 depicts that the aggregation revealed by the population is their behavioural act and it is not influenced by environmental factors prevailing in the habitat.

The distribution pattern of the two aquatic communities which are important from pollution assessment, nutrient dynamics and Lake Typology viewpoints is behavioural act of the community.

Table 2: Seasonal variation in dispersal parameter (k) of different Chironomid species

Name of species	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Mean ± SD
Tanypus sp.	2.074	7.515	18.140	10.784	0.561	0.793	1.019	0.765	1.123	1.656	0.277	0.537	3.770 ±0.579
Coelotanupus sp.	0.735	1.839	1.600	1.351	0.711	0.587	1.192	1.318	2.182	0.277	0.255	1.503	1.129 ±0.061
Procladius sp.	0.678	0.885	0.529	0.552	0.253	0.262	1.507	0.406	0.374	1.507	0.662	0.516	0.677 ±0.042
Chironomus sp.	9.830	8.058	35.416	52.880	6.720	11.091	7.409	2.837	11.497	9.477	13.929	0.819	14.163 ±0.79
Glyptotendipes sp.	0.365	0.644	0.475	1.191	0.329	0.263	0.275	0.781	1.101	0.263	0.589	0.933	0.600 ±0.033
Orthocladius sp.	1.809	0.998	0.706	0.534	0.612	0.672	1.214	0.833	0.818	0.639	1.027	0.952	0.909 ±0.034
Polypedilum sp.	19.845	1.101	4.369	1.295	0.499	7.054	0.957	2.168	0.907	2.718	0.757	0.918	3.549 ±0.547

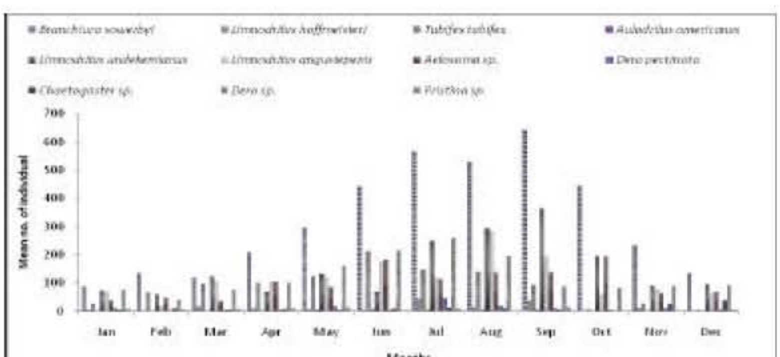

Fig 1. Seasonal variation in mean number of individual (λ) of different Oligochaet species

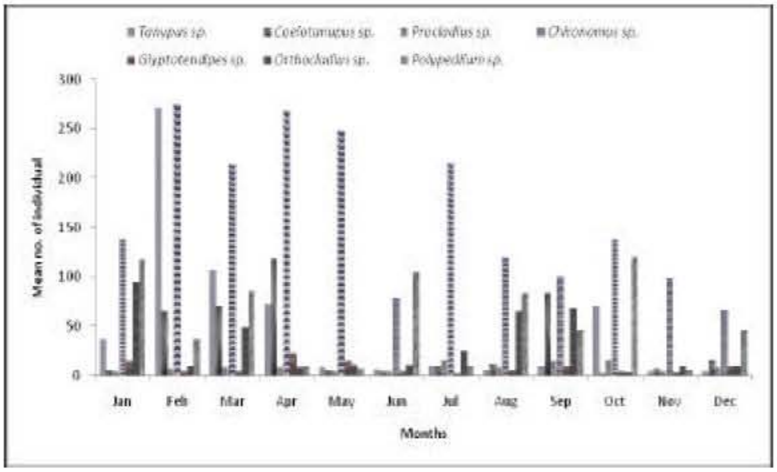

Fig 2. Seasonal variation in mean number of individual (λ) of different Chironomid species

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