Effects of different concentrations of inorganic compounds on the survival of *Cloeon perkinsi* larvae (Ephemeroptera)

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Abstract

The baetid mayfly *Cloeon perkinsi* is widely distributed in most freshwater ecosystems in Africa. It abounds in most reservoirs including IITA lake in Ibadan, Nigeria. Larvae were collected from the lake and subjected to 48hr laboratory static bioassay, using 1, 5, 10, 15 and 20mg/l of sodium chloride, sodium sulphate, sodium hydrogen phosphate and potassium nitrate solutions respectively as test concentrations. Larval survival was low (below 10%) at all concentrations of phosphate solution. Survival also decreased as nitrate concentration increased. Analyses of variance (ANOVA) showed that there was no significant difference in the number of survivors in all concentrations of the compounds except Potassium nitrate. Significant difference occurred when mean survivors in 1, 5, 10 and 15mg/l test concentrations of nitrate were compared with that in 20mg/l. LC_{50} was 13.5mg/l. It was recommended that *C. perkinsi* could be used in biomonitoring and setting of water quality criteria for freshwater ecosystems.

Keywords: *Cloeon perkinsi*, bioassay inorganic compounds.

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Introduction

During the study of the ecology of mayfly species in IITA lake, it was observed that the concentration of some inorganic ions correlated negatively with the abundance of larvae of *Cloeon* LEACH, 1815 (Ogbogu, 1991). In other words, as the concentration increased, the abundance of larvae decreased. It seems that the inorganic ions negatively affect the abundance of larvae. The ions include nitrate, phosphate, sulphate and chloride. Their concentrations in the reservoir ranged from 1.37 to 25mg/l for phosphate, 2.50 to 31.0mg/l for chloride, 0.6 to 11.66mg/l for sulphate and 0.35 to 3mg/l for nitrate. The lake is important because it provides water for irrigation of experimental farms that are around it. During rains, agrochemicals used in the farms are washed into the lake. Although routine monitoring of water quality is carried out by IITA management, there has been no attempt to relate the changes in abundance of insect larvae to changes in the concentrations of inorganic ions.

The observed close correlation between the abundance of *Cloeon* larvae and the inorganic ions necessitated this study on the pattern of response of the larvae. The use of aquatic insects in biomonitoring and toxicity testing for establishing the impairment of aquatic ecosystem quality has become popular in recent times (Oseid and Smith, 1975; Walton, 1989; Sweeney *et al.*, 1993; Raddum and Fjellheim, 1995). This paper reports the results of laboratory short-term static bioassay experiments to determine the pattern of response of *Cloeon perkinsi* (BARNARD, 1932) larvae to varying concentrations of solutions of some inorganic compounds namely; sodium chloride, sodium sulphate, sodium hydrogen phosphate and potassium nitrate. This is imperative because the mayfly is ubiquitous, inhabiting almost all lotic freshwater ecosystems (Gillies, 1980; 1985). Furthermore, it is generally considered to be very sensitive to environmental disturbance (Fremling, 1970; Hubbard and Peters, 1978; Brittain, 1982). It is important therefore, to have an insight into how the mayfly survives in IITA lake, given the observed fluctuations in the inorganic ions.

Material and Methods

Cloen perkinsi larvae ranging from 3.0 to 5.0mm in length were collected from IITA lake in April 1998. Before using them for experiments, they were kept in lake water for at least 12 hours to acclimatize to laboratory conditions. Stock solutions of sodium chloride, sodium sulphate, sodium hydrogen phospate and potassium nitrate were prepared according to the method in Reish and Oshida (1987). Five test concentrations (1, 5, 10, 15 and 20mg/l were then prepared from each stock solution. The test chambers were crystallizing dishes (5cm radius and 5cm high) filled to ¾ mark with the test solutions. To the crystallizing dishes, ten larvae were added. A control experiment with ordinary lake water was also set up. All experiments were replicated three times. The number of surviving larvae were counted after 48hrs. The percentage survival of larvae was calculated for each test concentration.

To compare the effects of different concentrations of solution, a single factor analysis of variance (ANOVA) (Zar, 1974) was used to determine if there are differences in the number of survivors between concentrations. Where a statistical difference was found, the concentrations having significantly different results from others were determined using the least significant difference (L.S.D.). Pairs of means (i.e. means of survivors in the three replicates for a test concentration) which differ by more than the L.S.D. were regarded as significantly different.

Results

Survival of *C. perkinsi* larvae was below 10% at all concentrations of phosphate solution (Fig. 1).

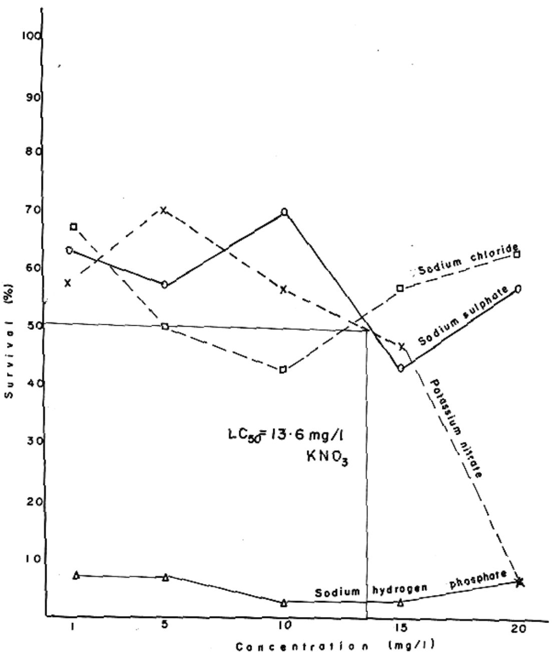

Fig. 1 - Effect of varying concentrations of solutions of inorganic compounds on the survival of *Cloeon perkinsi* larvae.

Table 1 - Results of analyses of variance for the comparison between the effects of different concentrations of inorganic compounds on *Cloeon perkinsi* larvae.

	Solution			
	Chloride	Sulphate	Nitrate	Phosphate
F	2.022	0.148	6.127	0.300
Conclusion	ns	ns	s	ns

ns = not significant (p>0.05), s = significant (p<0.05)

Table 2 - Summary of analysis of variance for the effects of different concentrations of potassium nitrate solution on *Cloeon perkinsi* larvae.

Source of variations	Degrees of Freedom (DF)	Sum of Squares (SS)	Mean Squares (MS)	F
Treatments	4	70.263	17.506	
Error	10	28.670	2.867	
Total	14	98.933	20.433	6.127**

** Value significant at 1% level (p<0.01)

Table 3 - Comparison of treatment means for the effects of different concentrations of potassium nitrate solution on *Cloeon perkinsi* larvae using the least significant difference (L.S.D.).

Comparison of treat. concent. (mg/l)	Difference in means	L.S.D.	Conclusion
Control *vs* 1	7.0	3.080	Different
Control *vs* 5	5.667	3.080	Different
Control *vs* 10	7.0	3.080	Different
Control *vs* 15	8.0	3.080	Different
Control *vs* 20	12.0	3.080	Different
1 *vs* 5	1.333	3.080	Not different
1 *vs* 10	0	3.080	Not different
1 *vs* 15	1.0	3.080	Not different
1 *vs* 20	5.0	3.080	Different
5 *vs* 10	1.333	3.080	Not different
5 *vs* 15	2.333	3.080	Not different
5 *vs* 20	6.333	3.080	Different
10 *vs* 15	1.0	3.080	Not different
10 *vs* 20	5.0	3.080	Different
15 *vs* 20	4.0	3.080	Different

$L.S.D. = t_{0.05}\sqrt{(2S^2/n)}$, where t has k(n-1) degrees of freedom, S^2 = the error mean square, n = number of replicates, and k = number of treatments (test concentrations).

For nitrate solutions, survival was high (70%) at 5mg/l before it started decreasing as concentration increased, reaching the minimum (7%) at 20mg/l. In chloride and sulphate solutions, survival of larvae varied between 40% and 70%.

Analysis of variance showed that there was no significant difference in the number of survivors for the five test concentrations of all the compounds except potassium nitrate (Table 1, 2). The mean survivors in all the test concentrations of potassium nitrate solution were significantly different from that of the control experiment

(Table 3). Significant difference was also observed when the mean survivors in 1, 5, 10 and 15mg/l test concentrations were compared with that in 20mg/l test concentrations one after the other. The LC_{50} of potassium nitrate was 13.5 mg/l.

Discussion

Results of this study show that *C. perkinsi* is very sensitive to sodium hydrogen phosphate. Low concentration less than 1mg/l are deleterious to larvae. This accounts for the low percentage survival of larvae at various concentrations of the phosphate solution. The trend of survival in nitrate solution indicates that survival decreased as concentration increased. Only the results of tests with nitrate solutions corroborates field observation (Ogbogu, 1991) in which nitrate ion negatively correlated with the abundance of *Cloeon* larvae. Perhaps there are other factors that come into play in natural ecosystems which make the larvae not to respond in the same way to the chloride, sulphate and phospate compounds.

To conclude, it has been established that very low levels of phosphate concentration in water can impair the production of *C. perkinsi* in reservoirs. Moreover, higher concentrations of nitrates around 20mg/l can also impair mayfly production. Based on these findings, *C. perkinsi* can be used for biomonitoring and the setting of water quality standards for freshwater ecosystems.

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