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Journal of Agriculture, Pure and Applied Science and Technology ISSN 2073-8749
**Printed by Moi University Press**


# Role of Organic Nutrient Levels on the Distribution of Macroinvertebrates: A Case Study of River Sosiani, Eldoret Town, Kenya.

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**J. agric. pure appl. sci. technol. 4**, 32 - 38 (2009); received September 10/November 20, 2009

In current study, the relationship between phosphate and nitrite concentration levels and the distribution of benthic macro-invertebrates in river Sosiani, Eldoret was investigated. The concentration of phosphate and nitrite and the number of macro-invertebrates was established by spectrophotometric (spectronic21D and the Dip-net) methods respectively. The study showed that the concentration of both phosphate and nitrite were higher than the threshold levels and that the macro-invertebrate species were fewer in the more polluted regions of the river. Thus, phosphate, and nitrite concentration levels plays a role in the distribution of macro-invertebrates.

## Introduction

Effects of organic and inorganic pollutants on the distribution and abundance of macro-invertebrate communities has been widely studied in temperate and polar environments (Brinkhurst, 1965 andHarper *et al*., 1977). However, limited studies have been carried out in the tropical zone due to logistical problems and inaccessibility of most tropical riverine habitats (Mason, 1994 and FAO, 1994). As a result, the rate at which macro-invertebrates are continually destabilized and eliminated is not clearly understood, yet the council on environmental quality has identified macro invertebrates as the most reliable indicators of riverine environmental changes (U.N.E.P, 1990 and Hayward, 1992). In Australia macro - invertebrates are used to assess the levels of industrial and municipal wastes in general and specific river pollution (Owen, 1976).

Studies on this have reported significant negative effects of these pollutants on macro-invertebrates communities (Burrows and Whitton, 1983). Simulated laboratory experiments with these pollutants have reported similar massive die offs of macro-invertebrates. This indicates that organic and inorganic materials in fresh water systems contribute significantly to the loss of macro-invertebrates. Mason (Mason, 1994) reported that members of the same genus differ variably in the susceptibility to pollutants; some are tolerant while others get eliminated in the presence of a particular type of pollutant. In

this study the concentration levels of phosphate and nitrite was determined and the concentration correlated with the macro-invertebrate species in river Sosiani.
The study provides valuable baseline information for assessing the impacts of phosphate and nitrite pollutants on the macro-invertebrates of river Sosiani.

## Materials and Methods

### *Sample Collection*

Field sampling was carried out in two phases. Phase one was done in April-1997 (end of dry season), while phase two was done in February-1998 (end of wet season). The river was divided into three zones: upper zone (region before the river enters Eldoret town), the middle zone (region within Eldoret town) and lower zone (region after Eldoret). For each zone at least ten random stations were selected. The stations were 1 km apart. Three samples were collected in triangular pattern. From each station, macro invertebrates were sampled by scooping at least six times at different points using D-Shaped dip-net and then identified using the standard keys according to method by Welch 1992. Filtration was done as soon as samples were brought to the laboratory and then preserved by addition of 0.2 ml formalin per 50 mls of sample. This prevented the action of microorganisms from working the phosphates and nitrites which could change their concentrations.

### *Samples Analysis*

The samples were analyzed using Spectronic 21D spectrophotometer. Data obtained were analyzed and tested using the statistical packages; SPSS and Excel-spreadsheet.

## Results and Discussion

### *Phosphate* ($PO_4^-$) *Levels*

The concentration levels of phosphate varied among sampling sites and seasons ($F=7.15$, $df=9$, $p<0.001$). The following were the main characteristic features:
(i) More ions were recorded in site **A** and **B** during wet compared with dry season, indicating that the adjacent human activities contributed to this increase during wet compared with dry season (**Fig. 1**). A higher concentration of phosphate was recorded at site C during dry season compared with **B**. This trend was not apparent in wet season (**Fig. 4**).

### *Nitrite* ($NO_2^-$) *Levels*

As with phosphates, an increase in nitrites was recorded at site **A** during wet season compared with dry season ($F=2.96$, $df=9$, $p<0.05$). Unlike in phosphate, where more Phosphate ions were recorded at site C during dry season compared with site B, the concentration of nitrites during dry season were, in fact, lower at site C compared with site B during dry season (**Fig. 2**). From all the analyses, one thing was

clear: human influence contributed to changes in the concentration levels of Zinc, copper, Lead, Phosphates, and nitrites.

**Fig. 1**: Comparison of the levels of $PO_4$-P (PPM) in 10 stations of experimental site A and B during the dry and wet seasons in River Sosiani (April 1997 to Feb., 1998).

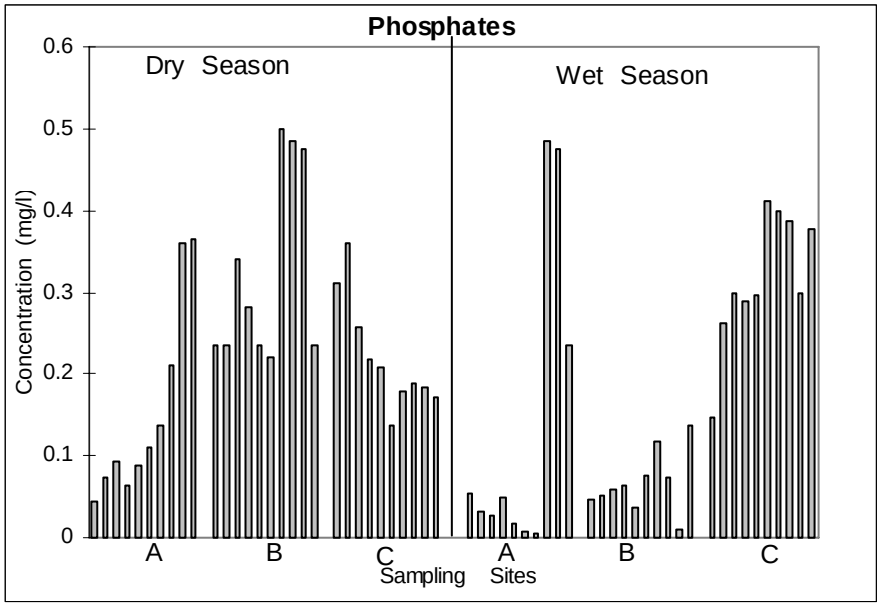
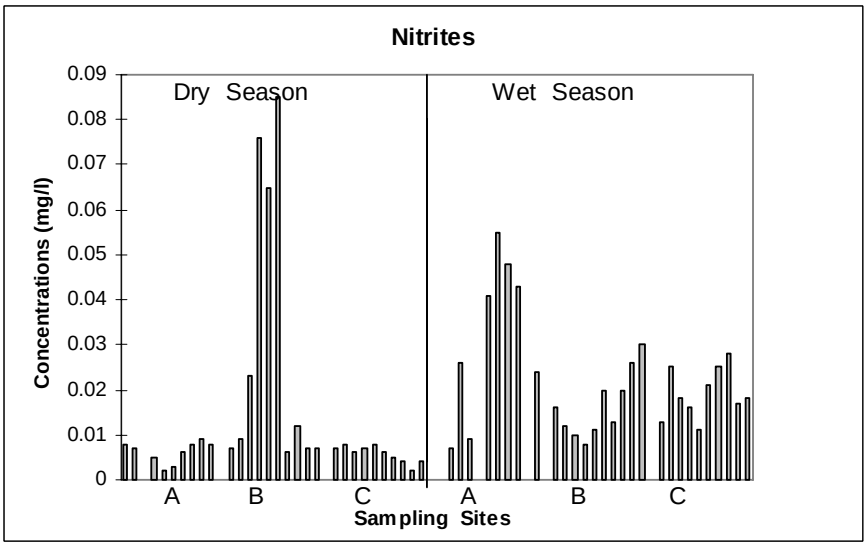



**Fig. 2**: Comparison of the levels of $NO^-_2$ (PPM) in 10 stations of experimental sites, A and B during the dry and wet seasons in River Sosiani (April, 1997 to Feb., 1998)




*Benthic community Structure*

The numbers of taxa and individual organisms varied significantly among stations at the Sosian River, but differences were dependent on season (**Fig. 3**). The number of taxa in the wet season was similar at sites **A** and **C**, but was significantly reduced at site **B**. The number of individual organisms increased significantly going from upstream to downstream during this period. During the dry season, the number of taxa

was significantly reduced at both sites downstream from site **A**, but abundance of the organisms was similar among sites.

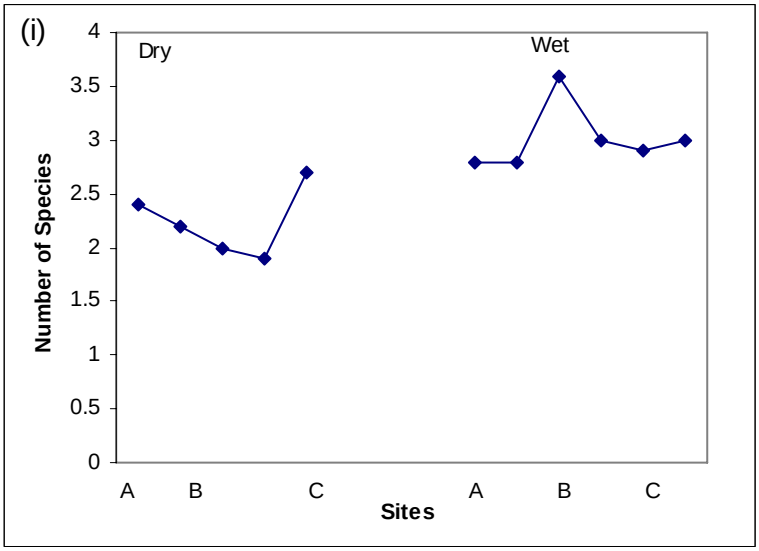
Benthic community composition at *the Sosi*an River was significantly altered downstream from site **A** during both seasons (**Fig. 3**). In the dry season, the population of *Hydropsyche instabilis* (stoneflies) was significantly reduced at site **B** but recovered downstream at site **C**. Benthic communities at site **B** were dominated by *Ishnura elegans* (dragonflies). The effect of metals and other pollutants on community composition was greater during dry season, as percentage composition of stoneflies *Hydropsyche instabilis* remained significantly reduced at site **B**. *Ishnura elegans* constitutes at least 70 percent of the benthic community at downstream stations sites **B** and **C**.

*Effect of Site and Season, on the Macro-invertebrates*

Analysis of the effects of site (**Table 4**) on macro-invertebrates showed that, the mean number for most species increased from site **A** to **B** and then decreased at **C**. *Baetis rhodan* and *Ishnular elegans* showed the most significant difference in population among the three sites. At the same time, *Isoperlagramatica* and *Ecdyonurus venusus* showed the least mean number of species in site **B**.

There was an overall increase in the mean number of most macro-invertebrates from the dry to the wet season (**Table 5**) and particularly *Baetis rhodan*, *Dineutus spp* and *Hydropsyche instabilis* ($F=6.558$, $F=18.40$ and $F=18.405$, $df=1$ and $p<0.05$) were the most significantly different. Exceptions were *Isoperlagramatica* and *Ecdyonurus venusus* ($F=0.671$ and $F=2.475$ at $df=1$ and $p<0.05$) which showed a decreased mean in the number of species from the dry to wet season. The Pearson correlation (r-values at, $p<0.05$) between the Concentration levels of the pollutants and the total number of Macro-invertebrates at various sites and seasons are shown in **Table 6**.

**Fig.3**. Numbers of Species (i) and individuals at the three sites on the Sosian river in the dry (April 1997) and wet (February 1998). Data are means ±1.0 SD seasons



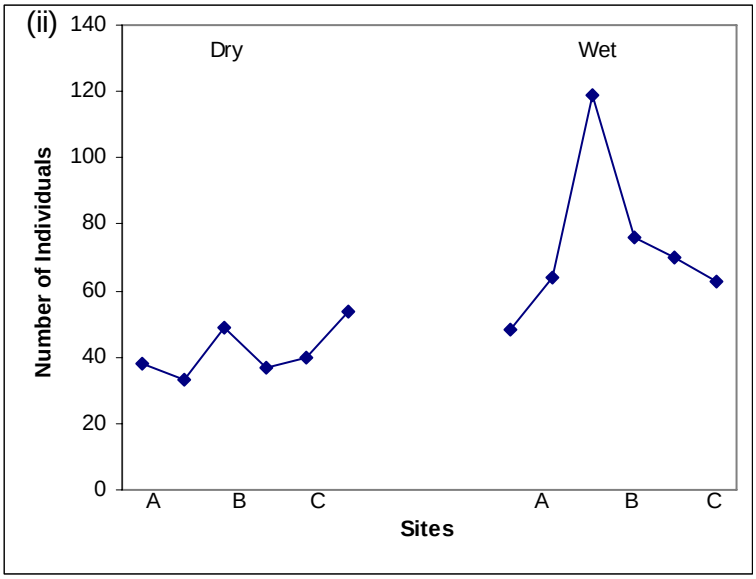



**TABLE 4:** Mean number of selected macro-invertebrate species at the three sites on the Sosiani River in the dry (April 1997-June 1997) and Wet (December! 997- February 1998) periods.

| SPECIES | SITES | | | F | df |
|---|---|---|---|---|---|
| | Site **A** | Site **B** | Site **C** | | |
| *Ishnura elegans* | 2.700 | 6.250 | 3.600 | 4.153 * | 2 |
| *Hydropsycheinstabilis* | 3.350 | 4.400 | 3.350 | 0.342 | 2 |
| *Baetis rhodan* | 0.600 | 1.700 | 1.900 | 3.766 * | 2 |
| *Isoperlagrammatica* | 3.650 | 0.000 | 0.900 | 2.127 | 2 |
| *Ecdyonurus venusus* | 0.550 | 0.150 | 0.800 | 2.217 | 2 |
| *Chironomus thummi* | 0.000 | 5.00E-02 | 0.100 | 1.024 | 2 |
| *Corixa dorsalis* | 5.0E-02 | 0.000 | 0.200 | 1.247 | 2 |
| *Dineutus sp* | 0.150 | 0.650 | 0.350 | 2.643 | 2 |
| *Caenis maesta* | 0.000 | 0.000 | 0.200 | 3.027 * | 2 |

** -indicates significance of $p<0.05$*

**TABLE 5:** Mean number (± 1 SD) of selected macro-invertebrate species at the two seasons in the Sosiani River in the dry (April 1997-June 1997) and Wet (December! 997- February 1998) periods.

| SPECIES | SEASON | | F | df |
|---|---|---|---|---|
| | Dry | Wet | | |
| *Ishnura elegans* | 3.633 | 4.733 | 1.106 | 1 |
| *Hydropsyche instabilis* | 1.133 | 6.267 | 18.405 * | 1 |
| *Baetis rhodan* | 0.867 | 1.933 | 6.558 * | 1 |
| *Isoperlagrammatica* | 2.133 | 0.900 | 0.671 | 1 |
| *Ecdyonurus venusus* | 0.700 | 0.300 | 2.475 | 1 |
| *Chironomus thummi* | 6.67E-02 | 3.33E-02 | 0.341 | 1 |
| *Corixa dorsalis* | 0.000 | 0.166 | 2.397 | 1 |
| *Dineutus sp* | 0.000 | 0.767 | 18.400 * | 1 |
| *Caenis maesta* | 0.000 | 0.133 | 3.027 | 1 |

** -indicates significance of p<0.05.*

**Table 6:** The table shows the Pearson correlation (r-values at, p<0.05) between the Concentration levels of the pollutants and the total number of Macro-invertebrates at various sites and seasons.

| Pollutant | Site | Season | r values |
|---|---|---|---|
| Phosphate | A | Wet | 0.046 |
| | | Dry | 0.021 |
| | B | Wet | -0.594* |
| | | Dry | -0.708* |
| Nitrite | A | Wet | 0.002 |
| | | Dry | 0.042 |
| | B | Wet | -0.259 |
| | | Dry | 0.589* |

** -Shows significance level of p<0.05*

## Acknowledgement

The authors are grateful to Department of Chemistry, Moi University for all the technical support

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