ORIGINAL RESEARCH PAPER

Environmental Science

IMPACT OF HEAVY METALS ON THE POPULATION DYNAMICS OF COPEPODA IN THE LENTIC ECOSYSTEMS OF MYSURU- A MODEL APPROACH

KEY WORDS: Copepoda Water Quality Index, Primary production, Species diversity, Species dominance, Community Respiration.

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ABSTRACT

Objective: to evaluate the impact of heavy metals on the population dynamics of copepod in the lentic ecosystems.

Materials and methods: The heavy metals (Zinc, Cobalt, Nickel and Lead) concentration estimated in the five lentic ecosystems of Mysuru. Different community parameters such as Shannon-Weaver Index (SWI), Breadth of Utilization (BU), Berger-Parker Index (BPI), Sequential Comparison Index (SCI), Gross Primary Production (GPP), Net Primary Production (NPP) and Community Respiration CR) are being computed to the fourteen species of copepods. These heavy metals and population parameters were subjected multivariate regression through origin pro software to derive linear regression models.

Results and discussion: The result depicted seven linear regression models such as $Y_{SWI}= 0.311_{Zn}+ 3.58_{Co}- 0.52_{Ni-}\ 2.26_{Pb}+ 3.063$, $Y_{BU}=11.7_{Zn} +105.9_{Co}-13.5_{Ni}-52.3_{Pb}+51.26$, $Y_{BPI}=-0.21_{Zn}-0.21_{Co}+0.08_{Ni}+0.366_{Pb}-0.17$, $Y_{SCI}= -0.15_{Zn}+53.97_{Co}-20.2_{Ni}-25.4_{Pb}+33.61$, $Y_{GPP}=-2.78_{Zn} -3.42_{Co} -2.92_{Ni} +1.937_{Pb} +1.275$, $Y_{NPP}=-2.98_{Zn} -3.36_{Co} -3.28_{Ni} -1.876_{Pb} +1.134$ and $Y_{CR}= 0.204_{Zn} -0.06_{Co} +0.36_{Ni} +0.061_{Pb} +0.141$ to show relationship between dependent and independent variables.

Conclusion: Increase in the heavy metal concentration decreased the Shannon-Weaver Index, Breadth of Utilization, Sequential Comparison Index, Gross Primary Production, Net Primary Production whereas increases the Berger Parker Index of dominance and Community Respiration.

INTRODUCTION

The heavy metals are persistent and bioaccumulative and do not readily breakdown in the environment or not easily metabolized. It has been noted that, heavy metals concentration has correlation with various ecological parameters of microbial mesofaunal and meiofaunal communities [1].

Heavy metal enters the human body through either food or water. Phytoplanktons are the primary producers in the aquatic ecosystem and heavy metals accumulate in these primary producers. Zooplanktons are the primary consumers, which graze on phytoplankton. Zooplanktons become live food to fishes. Through diet, heavy metals from aquatic system get access to the human body. In the human body biomagnification of these heavy metals takes place, leading to several detrimental effects on human health.

Several reports are published on the impact and toxicity of heavy metals on different biotic components [2-11]. The impact of heavy metals on the distribution of rotifers in the lakes of Mysore reported [12]. In this study an attempt is being made to evaluate the effect of few heavy metals on the population dynamics of copepod and primary production in the lentic ecosystems of Mysuru.

MATERIALS AND METHODS

Five lakes namely Kamana, Karanji, Kukkarahally, Dalavai and Devanoor lakes are selected for this study. The water samples were collected (2015-17) and analyzed for different heavy metals such as Zinc, Cobalt, Nickel and lead [13]. The copepod samples were collected, preserved and analysed for abundance and diversity studies [14, 15]. Different ecological indices such as Shannon Weaver index [16] for species diversity, Berger- Parker index [17], Breadth of utilizations [18], Sequential Comparison Index [19] and primary production of lentc ecosystem [20] were computed. The concentration of Heavy metals and different community parameters were subjected to bivariate correlation and multivariate regression to build a statistical model in the linear regression equation form through the OriginPro 7.5 software.

RESULTS AND DISCUSSION

According to the result (table 1), the concentration of heavy metals was highest in Devanoor lake followed by Dalavai lake, Kukkarahally lake, Karanji lake and lowest in the Kamana lake (table 1). Activities such as mining, smelting and agriculture have contaminated extensive areas of world [21,22]. The agricultural runoff, sewage sludge, manures and limes are the sources of heavy metals to the aquatic bodies [23, 24]. Repeated use of phosphate fertilizer is another source of heavy metal contamination in to the lentic and lotic ecosystems [25,26].

According to the results (table 2) Shannon-Weaver Index (SWI), Breadth of Utilization (BU), Sequential Comparison Index (SCI) for copepods, Gross Primary Production (GPP), Net Primary Production(NPP) recorded highest in the Kamana lake followed by Karanji lake, Kukkarahally lake, Dalavai lake and lowest in the Devanoor lake. Berger-Parker Index of dominance (BPI) documented highest in the Devanoor lake (0.37, for Paradiaptomus greeni) followed by Dalavai lake (0.33, for Microcyclops minutus), Kukkarahally lake (0.30, for Mesocyclops leukarti), Karanji lake (0.29, for Microcyclops minutus) and lowest in the Kamana lake (0.24, for Macrocyclops distinctus). These results clearly indicated that increase in the heavy metals concentration narrows the Breadth of utilization or availability of quantitative and qualitative food to the population growth, so that population size reduces and decreases the equal distribution of different species due to heavy metal toxicity. Because of this, species diversity decreases and dominance of particular species increases. This type of results was also demonstrated by other researchers [12, 25, 27, 28, 29] and extends support to the findings of the present investigation.

Sequential Comparison Index (SCI) estimated highest in the Kamana lake (7.87) followed by Karanji lake (6.42), Kukkarahally lake (5.18), Dalavai lake (3.64) and lowest in the Devanoor lake (2.80). The SCI usually decreases with increasing pollution [20]. A healthy water body normally has a SCI value greater than 12 (up to 24), whereas polluted water bodies are generally less than 8 [19, 20, 30, 31].

Gross and Net Primary Production (gC/m3 /hr) computed highest in the Kamana lake followed by Karanji lake, Kukkarahally lake, Dalavai lake and lowest in the Devanoor lake. Community Respiration (CR) was highest in the Devanoor lake followed by Dalavai lake, Kukkarahally lake, Karanji lake and lowest in the Kamana lake. These results indicate that, Devanoor lake was having highest pollution and lowest in Kamana lake. Pollution also affects (decreases) the production (P)/Respiration (R) ratio, a proper level of which is very essential for the sustenance of the system. In a non-polluted water, the Productivity usually exceeds Respiration, but in organically polluted systems Respiration exceeds Productivity and no organic material is left available for the bioactivity of the system leading to system's impairment [13,20,32].

From the results (table 3), it appeared that the concentration of heavy metals was negatively correlated with Shannon-Weaver index of diversity, Breadth of utilization, Sequential Comparison

Index, Gross Primary Production and Net Primary Production whereas positively correlated with Berger-Parker index of dominance and Community Respiration. This indicates that increase in the heavy metals concentration increases SWI, BU, SCR, GPP and NPP decreases, whereas BPI & CR increases.

The combined effect of different heavy metals on different community parameter was ascertained through multivariate regression analysis, wherein different community parameters are taken as dependent variables and the heavy metals concentration as the independent variables. Linear regression model was constructed depending upon the different data of these variables.

$Y_{SWI} = 0.311_{Zn} + 3.58_{Co} - 0.52_{Ni}$-

Table – 1: Concentration (ppm) of heavy metals

Lake	Zinc	Cobalt	Nickel	Lead
Kamana lake	0.28	0.21	0.22	1.22
Karanji lake	0.32	0.24	0.26	1.37
Kukkarahally	0.43	0.27	0.30	1.45
Dalavai	0.56	0.32	0.32	1.60
Devanoor	0.60	0.38	0.37	1.72

Table – 2: Biodiversity indices for copepods, productivity in the five lakes of Mysuru.

	SWI	BU	BPI	SCI	GPP	NPP	CR
Kamana lake	1.0	10	0.24 M.distinctus	7.9	1.5	1.2	0.3
Karanji lake	0.8	5.3	0.29 M.minutus	6.4	1.5	1.1	0.4
Kukkarahally lake	0.7	5.0	0.30 M.leukarti	5.2	1.1	0.7	0.4
Dalavai lake	0.6	3.7	0.33 M. minutus	3.6	0.8	0.3	0.5
Devanoor lake	0.6	3.6	0.37 P.greeni	2.8	0.6	0.8	0.5

Table – 3: Bivariate correlation coefficient (r) between Different heavy metals concentration and biodiversity indices of copepods.

Community parameters	Zn	Co	Ni	Pb
Shannon-Weaver Index (SWI)	-0.94	-0.93	-0.96	-0.98
Breadth of Utilization (BU)	-0.82	-0.80	-0.87	-0.88
Berger-Parker Index (BPI)	0.94	0.98	0.98	0.99
Sequential Comparison Index (SCI)	-0.94	-0.93	-0.97	-0.98
Gross Primary Production (GPP)	-0.99	-0.98	-0.97	-0.97
Net Primary Production (NPP)	-0.99	-0.98	-0.97	-0.97
Community Respiration (CR)	0.99	0.98	0.99	0.99

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