Available online at http://www.journalcra.com

International Journal of Current Research
Vol. 6, Issue, 02, pp.5181-5183, February, 2014

INTERNATIONAL JOURNAL OF CURRENT RESEARCH

ISSN: 0975-833X

RESEARCH ARTICLE

IMPACT OF ELEVATED WATER TEMPERATURE ON PHYTOPHILOUS MACROINVERTEBRATE COMMUNITYOF AN EUTROPHIC LAKE IN KASHMIR HIMALAYAS

Shazia Habib* and A.R. Yousuf,

Department of Environmental Science, University of Kashmir, Srinagar, J&K

ARTICLE INFO

Article History:
Received 19th November, 2013
Received in revised form
15th December, 2013
Accepted 10th January, 2014
Published online 22nd February, 2014

Key words:
Phytophilous invertebrates,
Community,
Macrophytes,
Eutrophication.

ABSTRACT

Nageen lake is very productive eutrophic urban lake of Kashmir valley. High concentration of dissolved nutrients like nitrates and total phosphorus promotes profuse algal and macrophytic growth. The study focuses on the impact of elevated temperature on macrofaunal assemblages. A composite Gerking frame box and grappler were used for sample collection. The effect of scorching heat was conspicuous as a result of mass fish kill in the affected area. It was found that the total invertebrate number reduced from 13 different families in reference site to just two families in the affected site. The Shannon index decreased from 1.8 (reference site) to 0.7 in the affected site. Also the dominance of some species decreased from 0.8 to 0.4, but the evenness increased from 0.5 to 1.1.

INTRODUCTION

The study focuses on the impact of temperature change on phytophilous macroinvertebrates. These are those aquatic organisms which are associated with macrophytes (Rooke, 1984; Cry and Downing, 1988; Cattaneo *et al.*, 1998; Linhart, 1999), the association between the two groups can either be trophic, spatial or both (Linhart *et al.*, 1998). Many invertebrate taxa exhibit preferences for submerged aquatic plants (Dudley, 1988; Cry and Downing, 1988; Cattaneo *et al.*, 1998). The invertebrates may utilize the macrophytes or the periphyton growing on their surfaces as a direct food source (Higler, 1975; Cattaneo and Kalff, 1980; Gregg and Ross, 1985), as a shelter from predators (Harrod, 1964) and spawning and attachment sites (Keast, 1984). However, these species are susceptible to changes in temperature which in turn influence the ecosystem mediated services. There is every possibility that the temperature alterations will influence the density, diversity and distribution of individuals of invertebrate species. The population dynamics of macroinvertebrates are affected by changes in the various physico-chemical alterations in the aquatic environment. This makes them more susceptible to the cumulative effects of anthropogenic pressures.

Primarily the invertebrates have poor ability to cope up with the changes in temperature due to their narrow thermal range (Metzger *et al*., 2007; Peck, 2009). The community structure is also directly impacted by climate change through alteration of physico-chemical features of water and indirectly via changes in the biotic component. These are a primary link between fish and macrophytes (Schultz and Dibble, 2012), therefore change on this community would have direct impact on fish fauna. The quantity and diversity of the phytophilous invertebrates can indicate the status of a water body (Dvorak and Imhof, 1998). An ecological disaster in form of mass fish kill was observed in the Nageen lake in early August, 2012. Experts suggested that the average rainfall in the valley used to be 95 mm, whereas that season it was found to be 46 mm affecting eco-system of water bodies and creating drought like situation.The objective of the study was to assess the impact of scorching heat on phytophilous macroinvertebarates.

Corresponding author: Shazia Habib
Department of Environmental Science, University of Kashmir, Srinagar, J&K

Study area

Nageen lake is located on the northeastern side of Srinagar city. Geographically, the lake falls between 34^0 07' 34"N latitude and 74^0 49' 48"E longitude at an altitude of 1580 m.a.s.l and has a maximum depth of 6m. It is considered to be one of the five basins of the world famous Dal Lake, the location map of the lake is given in Fig. 1. However, it has remained as narrow stretch of water with a total surface area of 4.5 Km^2 making it an ideal place for house boats. The water supply of the basin is maintained by Dal Lake in addition to springs within the basin, and atmospheric precipitation. Smaller area makes the lake more susceptible to anthropogenic pressures. A reference site was selected in Dal lake which was not much affected by increasing temperature because of larger surface area holding more volume of water for dilution which made the effect of increase in temperature less pronounced. Two affected areas were selected in the Nageen lake where the rate of mass fish kill was highest.

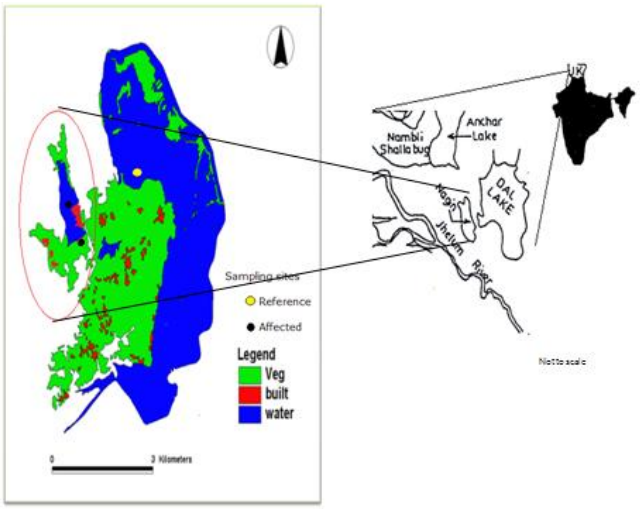

Fig. 1. Location map of Nageen lake

MATERIALS AND METHODS

Sampling was done in August, 2012. A composite Gerking frame box (Gerking 1957) and grappler (Habib and Yousuf, 2014) was used for sample collection. The population density was determined by calculating the number of individuals per meter square. Biotic indices like Shannon diversity index (Shannon and Weaver 1976), Simpson index (Simpson 1949) and evenness index (Pielou 1966) were also determined. The dissolved oxygen was determined in accordance with standard methods prescribed in APHA (1998).

RESULTS AND DISCUSSION

During the study and under normal environmental conditions it was found that the leaf architecture played an important role in determining the abundance of invertebrate community. Despite the increased area for colonization which provide a better habitat to the invertebrates, the community structure of this important group was altered as a result of the rise in temperature during the end of July and beginning of August, 2012. The air and water temperature in Nageen lake was found to be 35^{O}C and 31^{O}C respectively as against the normal range of 26^{O}C -29 ^{O}C and 24^{O}C - 26^{O}C respectively. The dissolved oxygen value varied from 6-8 mg/l to 0.4 mg/l indicating anoxic condition in the water body. Warmer waters cause a decrease in the amount of dissolved oxygen in the water (Wetzel 2001). This is adversely affects the aquatic invertebrate community as higher temperature leads to lack of oxygen for respiration and increase in the metabolic rate. Thirteen invertebrate families were recorded in the reference site (Fig. 2). But in the affected site of Nageen lake had only two families- Chironomidae and Erpobdellidae. *Chironomus* sp. and *Erpobdella* sp. were found to be tolerant to thermal stress and low oxygen concentrations (Sawyer 1974; Barton and Metcalfe, 1986 ; Rossaro, 1991).

A statistically significant difference ($p<0.05$) was found between the abundance of invertebrates in reference and affected site indicating a drastic decline in the population density. A decline from 149 ind.m^2 to 12 ind.m^2 was observed in the reference- and affected- sites respectively (Fig. 3).

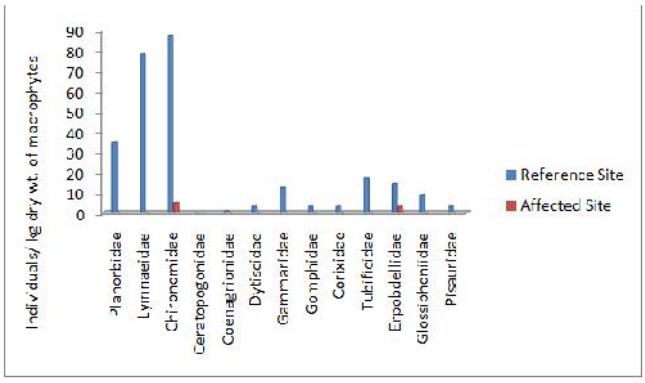

Fig. 2 Population density of phytophilous macroinvertebrate community in reference site and affected site in Nageen lake

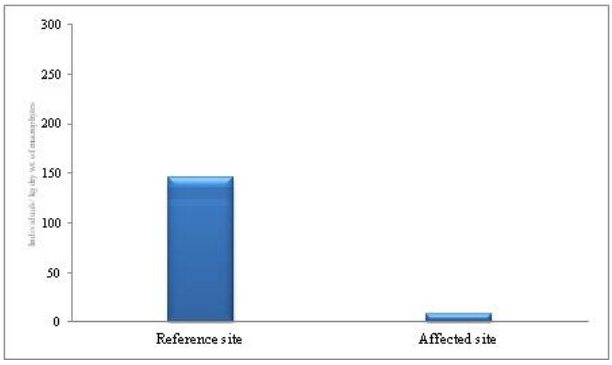

Fig. 3 Abundance of macroinvertebrates per kg macrophyte dry weight in the two study sites.

A statistically significant difference ($p<0.05$) was found between the abundance of invertebrates in reference and affected site indicating a drastic decline in the population density. A decline from 149 ind.m^2 to 12 ind.m^2 was observed in the reference- and affected- sites respectively (Fig. 3).

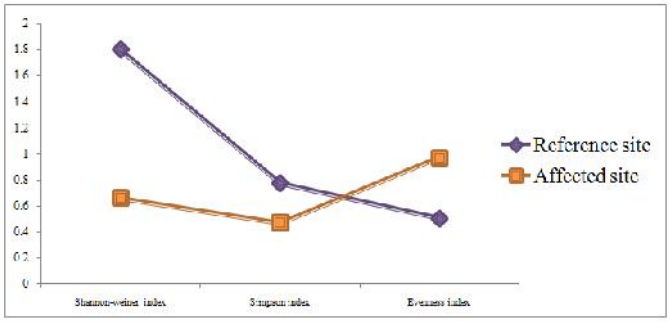

Fig. 4 Impact of temperature change on biotic indices in reference and affected site

The Shannon diversity decreased from 1.8 (reference site) to 0.7 in the affected site. The loss of habitat due to heat, causes decline in invertebrate diversity. The data revealed that the dominance of some species decreased from 0.8 to 0.4 in reference and affected sites respectively.Also the evenness increased from 0.5 to 1.1 (Fig. 4). Understanding the fact that the previous studies with respect to this community has been patchy and incomplete, there might be possibility that we have already lost many of the rare species due to the anthropogenic

pressures. In order to address this issue the need of the hour is to evaluate the invertebrate response to climate change. This might provide critical future directions to propose ways to tackle the complex issue of sustaining invertebrate- mediated services under changing climate.

Conclusion

All the three phyla (annelida, mollusca and arthropoda) were affected by the unusual rise in temperature. On an average the reference site had higher density of invertebrates as compared to affected area. Species richness and composition in both the sites were dissimilar as portrayed by biotic indices. If the destabilization of aquatic freshwater systems vis-à-vis change in temperature goes on regularly and repeatedly over a long period of time, it may lead to permanent changes in the community structure of this important group in the lake. This community forms an integral component of the lake ecosystem that links macrophyte resource with the fish. Hence in due course of time it may have implications on the energy transfer through changes in the food web and other ecosystem services.

REFERENCES

APHA. 1998. *Standard Methods for the Examination of Water and Wastewater*. 20th ed., American Public Health Association, Washington, DC., pp. 1270.

Barton, D. R. and Metcalfe, J.L. 1986. Life cycles, reproduction, and diets of *Dina dubia* and *Erpobdella punctata* (Hirudinea: Eropobdellidae) in Canagagigue Creek, Ontario. *Canadian Journal of Zoology*, , 64 (3), 640-648, DOI 10.1139/z86-095

Cattaneo, A. and Kalff, J. 1980. The relative contribution of aquatic macrophytes and their epiphytes to the production of macrophyte beds. *Limnol. Oceanogr*. 25:280-289.

Cattaneo, A., Galanti, G., gentinetta, S. and Romo, S. 1998. Epiphytic algae and macroinvertebrates on submerged and floating – leaved macrophytes in an Italian lake. *Freshwat. Biol.* 39: 725-740.

Cry, H. and Downing, J.A. 1988. The abundance of phytophilous invertebrates on different species of submerged macrophytes. *Freshwat. Biol.* 20: 365-374.

Dovrak, J. and Imhof, G. 1998. The role of animals and animal communities in wetlands. In: D.F. Wst lake, J. Kvet and A. Szczepanski (Eds.), The Production Ecology of Wetlands. The IBP Synthesis, Cambridge University Pres., Cambridge. 211-318 pp.

Dudley, T.L. 1988. The roles of plant complexity and epiphyton in colonization of macrophytes by stream insects. *Verh. Int. Ver. Theor. Angew. Limnol*. 23:1153-1158.

Gerking, S. D. 1957. A method of sampling the littoral macrofauna and its application. *Ecology*, 38(2): 219–226.

Gregg, W.W. and Ross, F.L.1985. Influences of aquatic macrophytes on invertebrate community structure, guild structure and micro-distribution in streams. *Hydrobiol.* 128:45-46.

Habib, S. and Yousuf, A. R. 2014 . Impact of mechanical deweeding on the phytophilous macroinvertebrate community of an eutrophic lake. *Environmental Science and Pollution Research* 1-7. DOI 10.1007/s11356-013-2470-

Harrod, J.J. 1964. The distribution of invertebrate on submerged aquatic plant in a chalk stream. *Journal of Animal Ecology*, 33(2): 335-348.

Higler, L. W. G. 1975. Analysis of the macrofauna-community on *Stratiotes* vegetation. *Verh. Int. Ver. Theor. Angew. Limnol*. 19: 2773-2777.

Keast, A. 1984. The Introduced aquatic macrophyte, Myriophyllum spicatum, as habitat for fish and their invertebrate prey. *Can. J. of Zoo*. 62(7): 1289-1303.

Linhart, J. 1999. Phytophilous macrofauna in the *Stratiotes aloides* Vegetation of the lake Lukie, Poland. *Biol.* 37:67-76

Linhart, J., Uvira, V., Rulik, M. and Rulikova, K. 1998. A study of the composition of phytofauna in Batrachium aquatile Vegetation. *Acta Univ. Palacki. Olomuc., Fac. Rer. Nat. Biol.* 36:39-60.

Metzger, R., Sartoris, F. J., Langenbuch, M., and Portner, H. O. 2007. Influence of elevated CO2 concetrations on thermal tolerance of the edible crab Cancer pagurus, *J. Therm. Biol*., 32, 144–151,

Peck, L.S., Clarke, M.S, Morley, S.A., Massey A. and Rossetti, 2009. Animal temperature limits and ecological relevance: effects of size, activity and rates of change. *Functional Ecology*. Volume 23(2): 248-256 DOI: 10.1111/j.1365-2435.2008.01537.x

Rooke, J.B. 1984. The invertebrates fauna of four macrophytes in a lotic system. *Freshwat. Biol.* 14: 507-513.

Rossaro B. 1991. Chironomid and water temperature .*Aquatic Insects: International Journal of Freshwater Entomology* Volume 13(2) DOI:10.1080/01650429109361428

Sawyer RT.1974. Leeches (Annelida: Hirudinea). In: Hart CW Jr and SLH Fuller,editors. Pollution ecology of freshwater invertebrates. New York:Academic Press, p.81-142

Schultz, R. and Dibble, E. 2012. Effects of invasive macrophyte on freshwater fish and macoinvertebrate communities: the role of invasive plant traits. *Hydrobiol.* 684:1-14.

Shannon, C. E. and Weaver, W. 1976. Mathematical theory of communication. Univ. of Illinois, Press Urbana,pp.117.

Simpson, E.H.1949. Measurement of diversity. Nature, 163: 688.

Wetzel, R.G. 2001. Limnology of Lake and River Ecosystems. Third Edition. Academic Press, San Diego, CA. 1006 pp.

****