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Dynamics of zooplankton diversity in dal lake of Kashmir Himalaya: a brief review.

Dinámica de la diversidad del zooplancton en el lago dal del Himalaya de Cachemira: una breve revisión

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ABSTRACT

The present review work focuses on the zooplankton community of Dal Lake in Kashmir Himalaya to understand and evaluate the status of zooplankton diversity between 2000-2020. The perusal of the literature suggests that Rotifers showed the dominance than crustaceans due to the increase in eutrophic stature of the lake over the years. The input of nutrients and subsequent fluctuations in water quality of the lake has led to changes in the composition of planktons within the water column. Further, the literature revealed the dynamics in ecological features of lake ecosystem due to various human interferences in the watershed of lake has affected the structure and distribution of zooplankton community over the years.

Keywords; Dal Lake, Zooplankton diversity, Rotifera, Crustaceans.

RESUMEN

El presente trabajo de revisión se centra en la comunidad de zooplancton de Dal Lake en Kashmir Himalaya para comprender y evaluar el estado de la diversidad de zooplancton entre 2000 y 2020. La lectura de la literatura sugiere que los rotíferos mostraron un predominio sobre los crustáceos debido al aumento de la estatura eutrófica del lago a lo largo de los años. La entrada de nutrientes y las subsiguientes fluctuaciones en la calidad del agua del lago han provocado cambios en la composición del plancton dentro de la columna de agua. Además, la literatura reveló que la dinámica en las características ecológicas del ecosistema del lago debido a varias interferencias humanas en la cuenca del lago ha afectado la estructura y distribución de la comunidad de zooplancton a lo largo de los años.

Palabras clave; Lago Dal, diversidad de zooplancton, rotíferos, crustáceos.

INTRODUCTION

Kashmir Valley, located in the northern part of India, is rich with a variety of water bodies that differ in origin and altitude. One of these water bodies, Dal Lake, has long been known as the "Jewel in the crown of Kashmir". The lake is situated within the heart of Srinagar at an altitude of 1584 m.a.s.l., between 74° 48' and 74° 08' and 34° 3' and 34° 13' within the north - east of Srinagar (Fig 1). The lake is well-endowed with biological life forms, among

them the zooplankton which occupies a significant position within freshwater ecosystems (Yaseen et al., 2021; Pandit, 1980, 1999). For observing the water quality, they have been proven quite effective (Gannon and Stumberger 1970, Pandit 1999, Caroni and Irvine 2010). Zooplankton communities influence the entire structure of an aquatic ecosystem (Murugan et al., 1998; Sinha and Islam, 2002). Rotifers, a group of zooplankton, are an essential part of the trophic analysis of a lake (Pandit, 1980), as well as a pollution indicator and water quality indicator (Singh et al., 2021; Dirican et al., 2009). Crustacea form another group of zooplankton that are valuable and nutritive (Patalas, 1972), and they contribute significantly to nutrient recycling within aquatic systems (Urabe et al., 2002). The zooplankton community reacts to a variety of disturbances like nutrient loading (Kotov et al 2022, Pace, 1986, Dadson, 1992), acidification (Fuller, 1977), contaminants (Murugan et al., 1998), and sediment inputs (Carins et al., 1993). As a result of rapid population growth, open water bodies are being transformed into floating gardens for extending agricultural production. Various factors, including encroachment from nearby houses and hotels, household discharge from surrounding areas, cause deterioration of the lake's ecology. Considering all parameters that may affect the zooplankton diversity in a lake over the period of time, this study attempted to determine how the status of zooplankton diversity has changed over time.

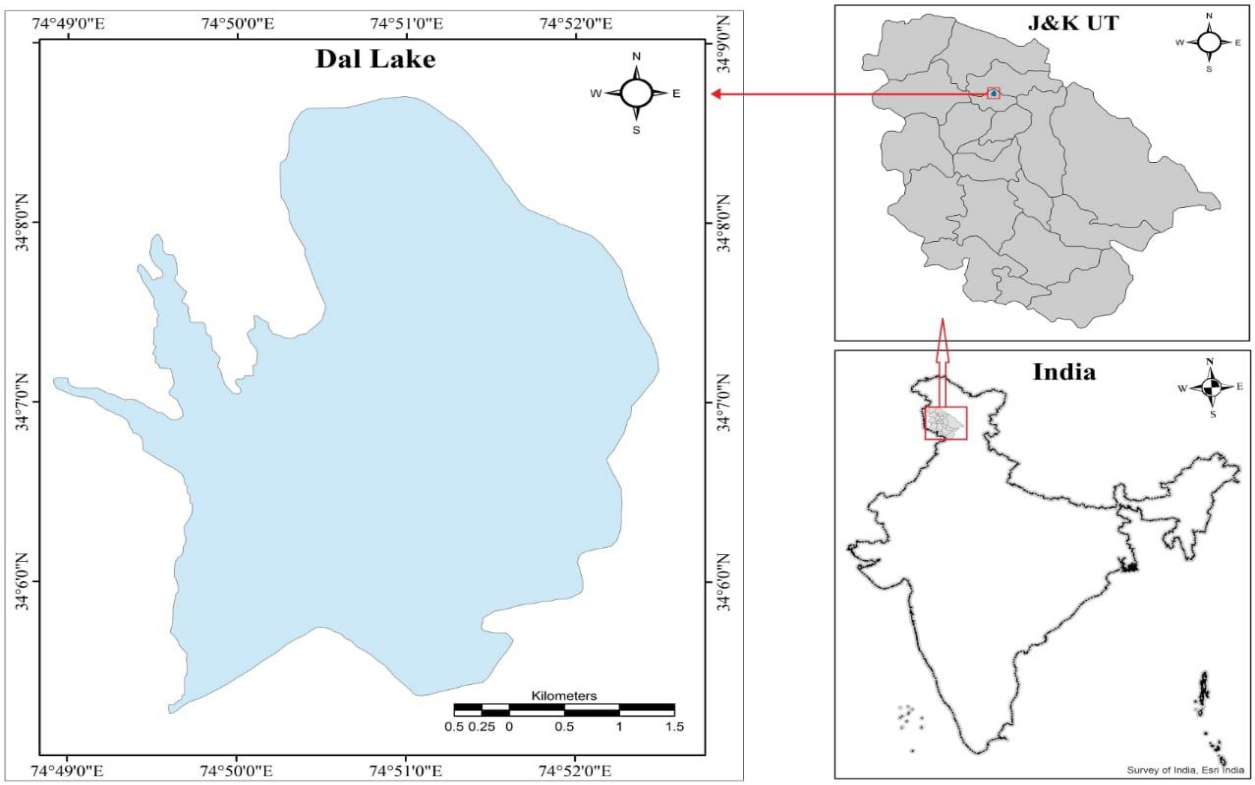

Fig. 1. Map of studied sites.

BACKGROUND STUDY

The post dredging changes and comparative limnology of Dal Lake depicts the changes in physico-chemical parameters, plankton communities between dredged and undredged parts of Dal Lake (Kundanger and Abubakar, 2001). The Rotifer community found an increasing trend both quantitatively and qualitatively from oligotrophic to eutrophic (Pandith and Yousuf, 2003). There is a significant decrease in the physico-chemical parameters as well as the zooplankton population of the Lake due to the impact of de-weeding practices (Singh et al., 2021; Kundanger and Abubakar, 2003). The change in the status of water quality induces a significant change in the plankton community of Dal Lake (Kundanger and Abubakar, 2004). A drastic change in Lake Hydrology and nutrient loads is observed which results in undesirable change in the structure of biological communities of the lake (Kundanger and Abubakar, 2004). The water close to the floating gardens was more enriched with nutrients as was indicated by increased level of chloride, phosphorus, and increased level of nitrogen and conductivity. In response to the variations in the ecological conditions, the zooplankton community around these gardens also revealed difference in species composition and abundance from the water areas of the lake (Siraj et al, 2006). The cladoceran community in Dal Lake in relation to several physico-chemical parameters has changed significantly, which seems to be related with the trophic status of the system (Seema et al., 2021; Siraj et al, 2006).

The Dal Lake is under anthropogenic pressure due to pollution from human settlements, sewage, dumping of organic matter, addition of nutrients from floating gardens leads to change on physico-chemical parameters which induces change in zooplankton composition, diversity and abundance, therefore, alter the biotic status of lake (Parveen M., 2013). The stress of environmental pollution on zooplankton community in Dal lake shows that the zooplankton community has decreased. This reduction in zooplankton diversity is due to continuous anthropogenic activities in Dal Lake (Ali, 2014). The comparative studies of zooplankton in Dal Lake found a total of 40 zooplankton species during September 2000 to August 2002, 27 rotifer and 13 crustaceans were recorded (Jeelani and Kaur, 2014). During May 2011 to April 2012, 8 rotifer and 5 crustaceans were listed, respectively (Jeelani and Kaur, 2014). The diversity of zooplankton at two different periods of study from 2002-2004 and 2010-2011 found a total of 27 rotifer and 13 crustaceans and 8 rotifer and 5 crustaceans, respectively (Tanveer and Rashmi, 2014).

The diversity and abundance of zooplankton diversity in Nageen Lake from June 2014 to November 2014, found a total of 25 taxa of zooplankton, among them Cladocera was the most dominating group defined by 12 taxa, rotifera represented by 10 taxa and copepod the least contributed group having only 3 taxa. The prevalence of these species indicates the overall eutrophic nature of the Lake (Asma et *al.,* 2015).The impact of organic and inorganic pollutant load, change in water quality and biological oxygen demand, found that the Dal Lake is at the critical stage of deterioration which leads to change in the biotic community of Dal Lake and the Lake will soon turn into eutrophic (Sharma et al., 2015).The study of rotifers of four Kashmir lakes constituted the dominating character with 44

species. The domestic sewage and storm runoff water seems to act together to impact the disposal and abundance of rotifers (Jamila, 2015).

The impact of de-weeding on Dal Lake found that the mechanical deweeding had a profound impact on the species number composition and on the other communities of both phytoplankton and zooplankton of Dal Lake (Ticku and Aparna, 2015). 42 Rotifera species were isolated from four basins of Dal Lake. This high number of Rotifer population and presence of various indicator species is indicative of high nutrient enrichment of the lake (Monisa et al., 2016). The environmental changes due to dredging activity influenced the configuration and disposal of zooplankton community. The abundance of rotifers decreased, and the crustaceans increased (Musharaf et al., 2016). The study carried out during autumn 2012 and summer 2013, 11 species of rotifera, 3 species of cladocera, and 2 species of copepod were identified. The species abundance was lower in summer as compared to autumn, which may be due to change in environmental character of the Lake water (Dilip et al.,2017). The water quality of Dal Lake has undergone enormous changes due to various anthropogenic pressures which in turn change the biological community of the Lake (Mudasir et al.,2017). There is an increase in BOD,COD, alkalinity, hardness, and other physico-chemical dimensions due to nutrient load in Dal Lake which reduce the stable lake ecosystem and damages the aquatic life particularly zooplankton, fish community(Bhat et al.,2017).The trophic status and population change of Cladocera in Dal Lake discloses that Dal Lake has experienced degradation that has directly altered the distribution of Cladocera (Masooda and Imtiyaz, 2018).The impact of anthropogenic activities on Dal Lake, found that environmentally unsound management methods are the prime source of the disturbance of the Lake (Ali ,2019).

INTERPRETATION OF OBSEVATIONS AND DISCUSSION

The zooplankton of Dal Lake is primarily comprised of Rotifers and crustaceans (Jeelani et al., 2005). There has been a marked variation in zooplankton status or population over nearly two decades as evident from the studies. Between the study periods of 2000-2002 and 2002-2004, 27 rotifers and 13 crustaceans were found in the lake (Jeelani and Kaur 2014). The higher abundance of rotifers than crustaceans indicate the lake is eutrophic. The study conducted in 2006 yielded 32 rotifers, 28 Cladocera, and 5 copepods (Siraj et al., 2006). The richness of rotifers is an indication of the eutrophic nature of the Lake. That showed the prevalence of rotifers over other classes within the lake, each in terms of taxa and population density. The change in abiotic elements exerts a significant impact on zooplankton richness and diversity. The studies carried out during 2010-2012 and 2012-2013 indicate a decrease in the population of zooplankton (8 rotifers and 5 crustaceans). An excessive load of nutrients leads to excessive growth of aquatic vegetation, but mechanical de-weeding results in the loss of crustacean species that rely on aquatic vegetation for food and shelter. In 2013-2014, a study was conducted to identify changes in the zooplankton community caused by dredging, 25 rotifers and 29 crustaceans were discovered, with a decrease in the rotifer population and an increase in crustaceans, indicating that rotifers were primarily affected by nutrients, whereas crustaceans were primarily affected by physical conditions within the lake. Rotifers are more sensitive to nutrient

variation than crustaceans, implying that they are more sensitive to nutrient variation than crustaceans (Rehman et al., 2016). The change in the environment as a result of dredging damaged the composition and disposal of the zooplankton community. It alters the physicochemical parameters of the body of water and changes the zooplankton composition. In 2016, rotifers again exhibited dominance (27 rotifers and 13 crustaceans), indicating that the nutrient load is increasing. Based on the 2017 data, to determine the diversity and dispersal of rotifers in Dal Lake 44 species of rotifers were found. The Hazratbal basin has a higher diversity of species, whereas the Brarinumbal basin has a lower diversity of species but a high population of rotifers, which indicates eutrophic conditions. While studying the nutrient load in Dal Lake, it has been found that high-level pollutants, mainly organic matter in the lake water, cause an increase in biological oxygen demand, chemical oxygen demand, alkalinity, hardness, and other physicochemical parameters that degrade the stable lake ecosystem and damage the aquatic life, especially zooplankton, fish community (Bhat et al., 2017). In 2018, 18 species of crustaceans were found, of which Chydoridea dominated, followed by Daphnidea, Bosminidea, etc. The abundance of crustaceans shows variations in the physicochemical properties of the lake (Akhter et al., 2018).

Table 1: Population of Rotifers and Crustaceans over the last 20 years in the Dal Lake

S. No.	Years	Rotifers	Crustaceans
1	2000-2002	27	13
2	2002-2004	27	13
3	2006	32	33
4	2010-2012	8	05
5	2012-2013	8	05
6	2013-2014	25	29
7	2016	27	13
8	2017-2018	44	18

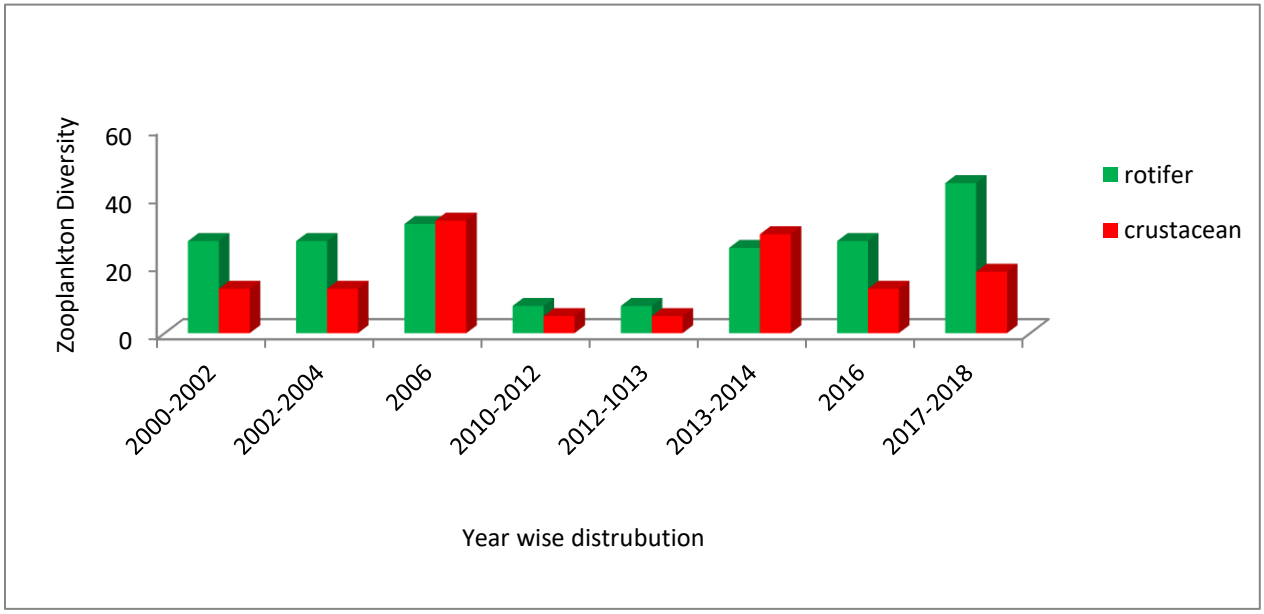

Fig 2: Showing status/variations of zooplankton during different study periods.

It is clear from the Table 1 and Figures 2 & 3, that in most of the cases rotifers shows the dominance than crustaceans which indicates that the lake is experiencing a heavy load of nutrients (Ismail and Adnan 2016). The study periods indicating increase in crustacean population shows the alteration in the physico-chemical properties of lake (Musharaf et al 2016). The class wise distribution of rotifers and crustaceans as indicated in figure 2 in Dal Lake clearly indicate that the most dominant group among zooplankton species is rotifers followed by crustaceans.

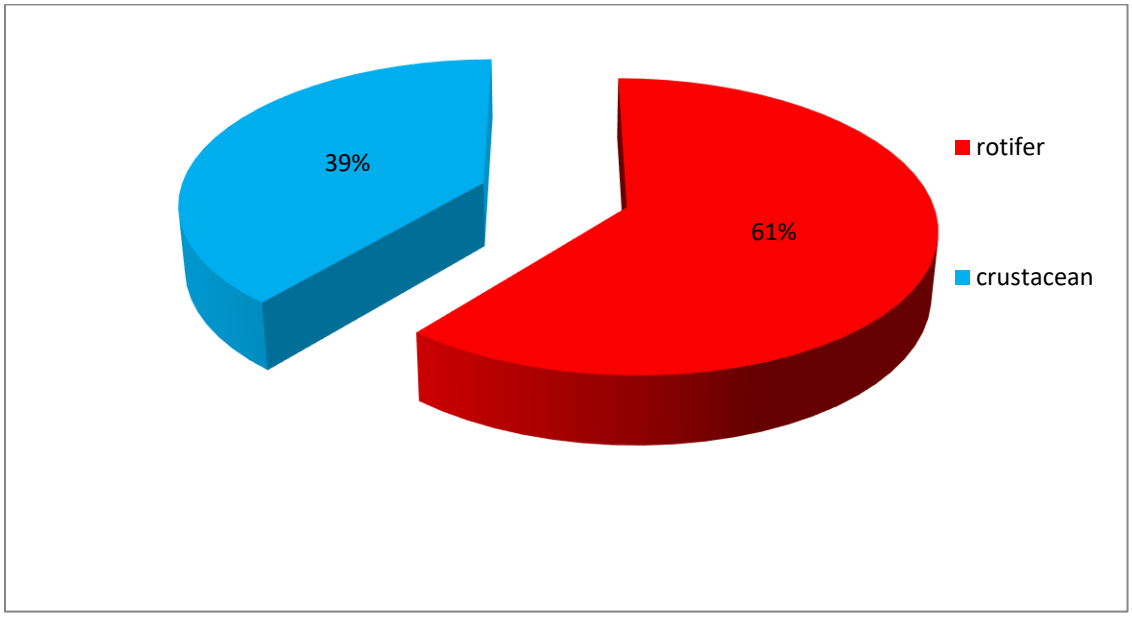

Fig 3: Showing the dominance of rotifers.

Thus, change in the status of zooplanktons in the Dal Lake depends either on the change in the pollution load or nutrient loading of Dal Lake or fluctuations in the physico-chemical properties of lake (Rehman et al 2016).

CONCLUSION

The dynamics in zooplanktons in Dal Lake are associated with the changes in lake ecology primarily attributed to sewage disposal, solid waste disposal, encroachment, and nutrient load from floating gardens. The same is reflected by the changes in abundance, growth, and species composition of zooplankton communities. Zooplanktons are effective indicators of Dal lake's trophic status. The presence of rotifers in abundance and their preferences to grow in nutrient rich waters indicates eutrophication, indicating an excessive nutrient loading of the lake. Dramatic changes in composition of various rotifer species is thought to be the result of the change in trophic status, as deterioration of the water quality contributed to the change in species composition. Time and again, measures taken to restore lake's pristine glory have also adversely affected the lake's ecology. The machines like mechanical de-weeder installed for controlling the eutrophication of the lake resulted in the loss of biological

diversity. The population status of rotifers and crustaceans is declining because of mechanical de-weeding, which results in a reduction in the growth of aquatic plants that provide shelter and food for zooplankton. To conserve the lakes ecology for ecological and socio-economic concerns, viz-a-viz to conserve biodiversity, both point and nonpoint sources of pollution need to be managed and perimeter areas should be designated as protected areas. Further, complete ban on the use of fertilizers and pesticides, or a substitute of non-persistent pest control products should be preferred. Improvement in water quality and subsequent growth of life can be achieved by the restoration of outflow channels and supporting the eco-restoration projects that aim to drain the excess pollutants from water column.

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