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REVIEW ARTICLE

PROSPECT OF *BRACHIONUS CALYCIFLORUS*, A HOLOPLANKTON, FOR ITS POTENTIAL BIO-INDICATOR PROPERTY: A REVIEW

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ABSTRACT

Rotifers, especially *Brachionus sp.* constitute an important link in the food chain of inland water bodies. *Brachionus calyciflorus* out of the different species of *Brachionus*, is recognized by The Society of Environmental Toxicology and Chemistry (SETAC) as a potent bioassay organism in aquatic system. *B. calyciflorus* is considerably pollution tolerant species and can endure high levels of organic nutrients. The presence of *B. calyciflorus*, in relation to hydrological parameters is an indicator of aquatic eutrophication. *Brachionus calyciflorus* can thus be favoured as 'test organism' in aquatic toxicology because of its sensitivity to most toxicants and thus can also be used in 'bio-monitoring programs' for water quality assessment in the wetlands and also in water reservoirs.

INTRODUCTION

Zooplankton are minute aquatic animals that are non motile or are very weak swimmers and they drift in water column of ocean, seas or fresh water bodies to move any great distance. Zooplankton plays important role in food web by linking the primary producers (by consuming phytoplankton, mainly various bacteria and sometimes other zooplankton) and higher trophic levels. 'Zooplankton grazing' on phytoplankton can transfer more than 50% of carbon fixed by primary production to higher trophic levels (Hart *et al*., 2000; Laws *et al*., 1988; Scavia, 1980). The freshwater zooplankton comprises Protozoa, Rotifers, Arthropoda (Cladocerans, Copepods and Ostracods).

Rotifers are the most important soft-bodied metazoans (invertebrates) having a very short life cycle among the plankton. Rotifers are also called as "pioneer organisms" because they first appear in newly created water bodies (Kippen, 2005). Only 100 widely spread rotifer species are planktonic and their life cycles are influenced by temperature, food and photoperiod. Dhanapathi (2000) found that they increase in large quantity rapidly under favourable environmental conditions.

Eutrophication is a condition of nutrient enrichments, especially of those nitrogen and phosphorous. Nutrient availability influences the predominance of rotifers and copepods (Kumar *et al*, 2004). Rotifers, especially *Brachionus sp.* constitute an important link in the food chain of inland waters. They are considered preferred food for many fish larvae (Guerguess, 1993). The rotifers were represented by many species of *Brachionus* and others, indicating eutrophicated status. Among these various species, *Brachionus calyciflorus* is recognized by The Society of Environmental Toxicology and Chemistry (SETAC) as a bioassay organism. For this reason, *Brachionus calyciflorus* is considered for this current review.

Brachionus Calyciflorus

A Holoplankton With Bio-Indicator Property

Brief Description

The freshwater rotifer, *Brachionus calyciflorus*, in the ideal size range of 180-220 microns (Rufchaie *et al.,* 2010) and with a high potential for reproduction appears to be an ideal live food for several freshwater species (Sarma *et al.*, 1999). Swimming activity of this species is performed by the coordinated beat of the cilia, and is controlled by two innerved muscles inserted on the infra-ciliature. Lorica saccate, rather flexible, very weakly flattened dorso-ventrally, smooth. Antero-dorsal lorica margin with four spines with broad base,

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pointed, length variable, usually long, equal in length or median pair longest; posterior spines present or absent; with or without postero-median spines at foot opening.

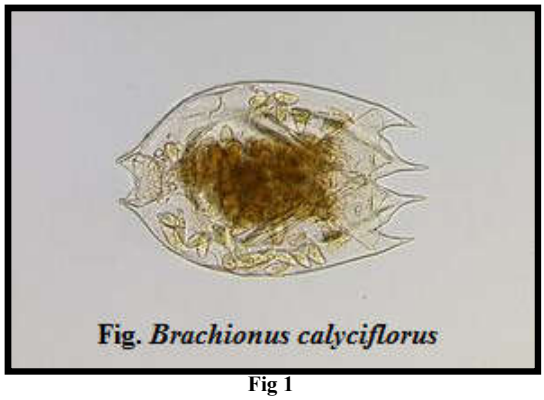

Fig 1

Distribution and importance

Brachionus calyciflorus was mentioned by Pallas (1766) for the first time, but he did not indicated the locality where collected this species. But it is now clear that *Brachionus calyciflorus* is common everywhere in all regions of the world. They are omnivorous and ingest all organic particles. Berzins *et al*. (1989) also advocated that the *Brachionus calyciflorus* is generally found in eutrophic lakes. Maemets (1983) also designate *Brachionus calyciflorus* as indicator of organic pollution in eutrophic waters. Mulani *et al*. (2009) reported *Brachionus calyciflorus* to be present in typical tropical conditions while Sampaio *et al*. (2002) reported *Brachionus calyciflorus* to be indicator of eutrophication. Sladecek (1983) also suggests that this genus is the index of eutrophic water.

Systematic Position

Kingdom – Animalia
Phylum – Rotifera
Class – Eurotatoria
Subclass – Monogononta
Superorder – Pseudotrocha
Order – Plioma
Family – Brachionidae
Genus – *Brachionus*
Species – *Brachionus calyciflorus*

Original name – *Brachionus calyciflorus* Pallas 1766

Species

A total of 21 species of the genus *Brachionus* are known from India (Sharma *et al*., 1987). *Brachionus calyciflorus* form the dominant and diversified genus among the rotifers and are found extensively in eutrophic waters (Berzins *et al*., 1989; Sampaio *et al*., 2002). Mageed (2008) and Uzma (2009) stated that presence of more than five species of *Brachionus sp.* reflects eutrophication of water bodies.

Food and feeding

B. calyciflorus feed successfully on micro-algae like *Scenedesmus acuminatus, Ankistrodesmus convolutus* and *Chlorella vulgaris* (Ovie *et al*., 2002). Even though, algae of Cyanophyta have a negative effect on the development of the rotifers, the species, *Brachionus calyciflorus* have a great ability to utilize colonial Cyanophicae as food and exhibit a great tolerance to their blooms (Fulton *et al*., 1987), so that they become abundant in such conditions and may be considered as bio-indicator of eutrophication (Sampaio *et al*. 2002). Plainly live green algae are the best food for the growth of *Brachionus calyciflorus* (Lucia-Pavon *et al*., 2001). When cultured on green algae at 20-25ºC, *B. calyciflorus* usually reaches peak population in less than two weeks (Pavón-Meza *et al*., 2004). It is also noted that, *Brachionus calciflorus* is one of the strong species against environmental stress and to be able to ingest and survive on a diet of toxic *Microcystis aeruginosa* (Agrawal *et al.,* 2011). Studies by Bernardi *et al*. (1990) and Gilbert (1994) demonstrated that the feeding and reproductive rates of this rotifer in the presence of cyanobacteria in eutrophic environments are not affected, which means that their tolerance to these factors explains their high densities in water reservoirs.

Adaptation, sensitivity and tolerance of Brachionus calyciflorus to aquatic environment

To edaphic factors

B. calyciflorus tolerates temperature between the ranges of 15-31ºC with the optimum pH of 6-8 at 25^{0}C and can tolerate the minimum dissolved oxygen level upto 1.2 mg/L (Ludwig, 1993).

To organic pollutants

Among the zooplankton, rotifers respond quickly to the environmental stress so they can be used as bio-indicators of pollution. Rotifers may be ideal bio-indicators as they are discriminating in their responses to the environment, they are typically numerically dominant in the zooplankton, species rich, and communities likely integrate environmental conditions over time (Duggan *et al*., 2001).

Brachionus calyciflorus is indicative of nutrient rich status of the water body (Berzins *et al*., 1987). Abundance of *Brachionus calyciflorus* is considered as biological indicator for eutrophy (Nogueira, 2001). *B. calyciflorus* considered to be a good indicator of eutrophication (Manickam *et al*., 2012; Rajagopal *et al*., 2010). Sladecek (1983) and Bohrer (1995) reported that *B. calyciflorus* is tolerant to high levels of organic pollution, giving rise to high density populations in wastewater treatment plants, such as stabilization ponds. The genus *Brachionus* is considered as a biological indicator for the eutrophication (Nogueira, 2001; Sampath *et. al*., 1978; Bahura *et. al*., 1996). According to sensitivity of organisms to water pollution, zooplankton has been classified into two categories namely; sensitive and tolerant species. *B. calyciflorus* is a pollution tolerant species. As per Sampaio *et al*. (2002); Dulic *et al*. (2006) and Sousa *et al*. (2008) *Brachionus* genus is renowned to tolerate polluted waters. Similar observation was also noticed by various workers like Arora (1996) and Patil *et al*. (2006). Rajagopal *et al*. (2010) in their study at three perennial ponds of Virudhunagar district of Tamilnadu, on the

basis of abundance of *Brachionus calyciflorus* concluded that the Chinnapperkovil and Nallanchettipatti pond's water have already reached the eutrophication stage.

Mola (2011) studied the seasonal and spatial distribution of *Brachionus sp.* in lake El-Manzalah, Egypt and conclude that the presence of the *B. calyciflorus* in high numbers indicates the changing of Lake El-Manzalah from moderate eutrophication to highly eutrophic water. According to Goel (1991) the species of *B. calyciflorus* are the pollution tolerant species and indicate accumulation of organic matters. Among the species identified as indicators of eutrophication in the water bodies, the rotifer *B. calyciflorus* stands out for its great tolerance to extremely eutrophic environments (Sladecek, 1983) and to high conductivity (Berzins and Pjeler, 1989). *Brachionus calyciflorus*, accounted for 80% of all individuals collected throughout the study span in a tropical inverse estuary of Northeast Brazil by Silva *et al*. (2009), and they suggested an ecological plasticity for the species and further supported the notion that this tolerant species are able to survive in highly dynamic environment.

Array of Brachionus calyciflorus bio-indicator property

According to Cairns (1979) and Herzig (1983) Rotifer *Brachionus calyciflorus* which are important in food chain are also indicative of quality and eutrophication status of the water body that they live in. According to Dirican *et al*. (2009) permanent dominancy of rotifer species such as *Brachionus calyciflorus* is indicative of eutrophic condition and their abundance was due to the presence of high levels of organic matter in the water body. Bahura *et al*. (1993) reported *Brachionus calyciflorus* as indicator of eutrophication.

At international level

Marneffe *et al*. (1998) during their work on ecological water quality assessment in one lake and river Warche of Belgium used *Brachionus calyciflorus* as bio-indicator and assessed the water. The presence of *B. calyciflorus*, in any mesoplankton distribution in relation to hydrology water body is an indicator of eutrophy (Pejler, 1957). According to Ruttner-Kolisko (1974) and Shiel (1979), tropical lakes are characterized by the predominance of *Brachionus sp.*, a genus very adapted to the eutrophic waters. Newmann-Leitão *et al*. (1989) found *Brachionus calyciflorus* and *Brachionus falcatus* as the most representative species in a eutrophic reservoir in Pernambuco state. Infante (1982) also mentioned these two species as eutrophic indicators in a lake in Venezuela. *B. calyciflorus* are very good indicators of subtle alterations in water quality because they respond quickly to environmental changes i.e. eutrophication (Gannon *et al*., 1978). Arak *et al.* (2014) concluded from their study that amongst the other species in Kagzipura Lake the most abundant species was represented by *Brachionus calyciflorus* and this may be due to the decreased water level by evaporation which led higher population of bacteria and dead and decayed organisms with eutrophic condition of that lake. El-Bassat *et al*. (2007). concluded that the presence of *Brachionus calyciflorus*, which is known as a freshwater species, during their study on the zooplankton community of Lake Abo Zaabal, a newly-formed mining lake in Cairo, Egypt, could be attributed to the brackish condition of the lake. Sousa *et al.* (2008) in their studies noted that the structure of zooplankton assemblages was significantly influenced by different water quality of four man-made lakes in a tropical semi-arid region. This response of zooplankton assemblages to water quality of these lakes, caused by eutrophication and siltation and they investigated this by means of canonical correspondence analysis and concluded *Brachionus calyciflorus* as good indicators of eutrophic condition. In Brazil, Sendacz *et al*., (1985) reported the associated abundance of *Brachionus sp.* to more eutrophic environments in reservoirs in South east of São Paulo State. Abdel and Aboul (2004) mentioned that *B. calyciflorus* prefers mixotrophic environments rich in nutrients.

At national level

Sharma (1998) while reviewing the work on rotifera stated that *B. calyciflorus* can be considered as eutrophic indicators of Indian waters. Kaushik and Saxena (1995) have also reported abundance of *Brachionus calyciflorus* in various eutrophic water bodies of central India. Bhat *et al.* (2014) found that in Bhoj wetland of Bhopal (India), high densities of Rotiferan *Brachionus calyciflorus* can indicate the rising fertility of the wetland. Kundari *et al*. (2005) also reported that the presence of *Brachionus calyciflorus* in Timmapur, Gudgur, Gangibhabi, Battigeri and Kadkol tanks of Haveri district of Karnataka, suggest that these tanks have reached eutrophic stage. Thirupathaiah *et al.* (2013) during their studies on zooplankton diversity of lower Manair Reservoir, Karimnagar (A.P.), India noted that *Brachionus calyciflorus* were dominant than the other rotifera and they are present for most of the times throughout the study period. Pandey *et al.* (2013) also concluded from their studies on seasonal variation in zooplanktonic community in swamp of Purnia (Bihar), India, that the abundance of *Brachionus calyciflorus* indicates organic pollution in the studied swamp. Their study also indicates that *B. calyciflorus* were observed throughout the year while other species showed fluctuations.

CONCLUSION

Biological assessment has emerged as a valuable alternative for aquatic ecosystems assessments; since planktonic species are cosmopolitan in distribution and inhabiting biological communities show the integrated effects of the environment including water chemistry (Singh *et al*., 2013; Thakur *et al*., 2013; Singh *et al*., 2014). *Brachionus calyciflorus* can be favoured as test animals in aquatic toxicology because of their sensitivity to most toxicants. *Brachionus calyciflorus* is a suitable live food for larval feeding and can be cultured, enriched with nutrients and used along with other freshwater rotifers (Rufchaie *et al*., 2012). To conclude, results of different experiments and observations confirm that *Brachionus calyciflorus* significantly respond to major changes in the water quality of water reservoirs driven mainly by eutrophication. Thus, *Brachionus calyciflorus* can be considered as a potential biological indicator for the cultural as well as natural eutrophications. Consequently, they should be used in bio-monitoring programs of water quality in the wetlands and water

reservoirs, where the sparse water resources often limit both aquatic ecosystem, biodiversity and wildlife development.

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