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# Effect of micronutrients on the zooplankton community

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## ABSTRACT

Zooplankton are microscopic organisms that live suspended in the water column and are said to environmental bioindicators The zooplankton community is influenced by abiotic and biotic factors, including micronutrients, which are introduced into the environment by anthropogenic activities or natural processes. Micronutrients are chemical compounds used in small amounts by the bodies which act primarily as cofactors of physiological reactions of these organisms, however studies on the influence of these chemicals have been focused mainly in marine environments showing the negative effect as bioaccumulation of metals in these ecosystems. Works carried out in freshwater environments are rare. This study aims to understand the influence of micronutrients on zooplankton communities, with emphasis on freshwater ecosystems

**Keywords:** zooplankton, metals, lentic ecosystem.

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## INTRODUÇÃO

The zooplankton is generally formed by microscopic animals living in suspension in the water. They inhabit the most diverse environments, both freshwater (Herbert et al., 2016;.. Manickan et al.,2015) as marine (Wielb, et al 2016; Alcaraz et al 2016). In freshwater environments, the structure and composition of aquatic organisms are influenced by both biotic factors (Adrian et al, 2009), as abiotic, such as temperature (Pinese et al., 2015), dissolved oxygen (Dantas et al., 2009), light (Paes et al., 2015), electrical conductivity, seasonality (Gumiri et al. 2016), micronutrients (Zamora et al., 2015), among others.

Micronutrients can be defined as chemical compounds used by organisms in small quantities. These chemicals can be introduced into the aquatic environment by anthropogenic activities, such as domestic and industrial effluents, the mining process (Silva et al., 2013; ) or by the use of pesticides contamination (Ebrahimpour & Mushrifah, 2008) in addition to the cycles biogeochemical (Moraes & Jordan, 2002; De Souzai et al., 2009). Micronutrients or trace elements participate in quantities less than 0.2% of dry organic weight of a living being (Odum, 2012). Included in the group of micronutrients, metals can be introduced through human actions, potentially affecting the biota and the food chain which it is inserted (Fernández-Severini et al, 2013;. Bat et al, 2015;. Rubio-Franchini et al., 2016).

Studies regarding the influence of micronutrients on zooplankton community have been conducted mainly in marine environments, such as the influence of cadmium and copper on the mortality of copepods (Zamora et al, 2015.); nickel, copper, cobalt and lead related to genotoxic effects on Cladocera (Goswami, 2014), adverse effects of silver on Cladocera density (Ataci et al., 2000), among others. In freshwater environments, studies have shown the negative interference of copper and lead in the development of zooplankton species, both in the ecosystem (Gagneten & Paggi, 2009), as in laboratory studies (Luciana et al., 2014), possibly due to the effect of bioaccumulation of these metals in various zooplankton species (Bat et al., 2015; Mendoza-Carranza, 2016). Still *in vitro,* studies showed toxic effect of nickel and copper on the growth of cladocerans species (Taylor et al., 2016). Thus, these studies mainly consider the influence of heavy metals on the zooplankton community, especially marine environments. Work focusing on other micronutrients in freshwater environments are scarce in the literature.

Metals such as Fe, Zn, Mn, Cu, Co, Mo and Bo are essential to organisms, because contribute to the metabolism of aquatic environments through physiological processes. The elements such as Hg, Pb, Cd, Ag, Cr, Ni and Sn, has no known biological function and are often toxic to certain organisms. However metals, even those that have known biological function when above a bioavailability limits may cause toxicity to aquatic organisms (Marengoni et al., 2013).

It is important to understand the influence of micronutrients on zooplankton in freshwater environments, as their limnological characteristics differ from the marine ecosystems in relation to biotic and abiotic factors and biogeochemical cycles. These differences may affect the availability of these substances for zooplankton. Moreover, the literature has focused on the toxic role of micronutrients, usually citing heavy metals. However we must consider that other micronutrients have beneficial effect on planktonic organisms, influencing the biochemical and physiological reactions.

## REVIEW

### 1.1 Zooplankton Communities

Plankton is constituted by microscopic animals and plants living in suspension in the water, because they offer little or no resistance to water flow (Esteves, 2011). According Odum & Koogan (2012), the planktonic organisms are divided into producer (phytoplankton), primary and secondary consumers (zooplankton) and decomposer (bacterioplankton). In lentic systems, plankton community is identified as major components of an aquatic environment as energy transfer plays a role in complex food webs formed in the ecosystem, providing a balanced environment (Dalu et al., 2013).

The zooplankton is a term assigned to a set of microscopic animals living in suspension in the water column. These organisms inhabit the most diverse environments, both freshwater (Manickan et al 2015; Herbert et al 2016), as saltwater (Wielb et al 2016;. Alcaraz 2016). Among the main zooplankton groups of freshwater environments are included rotifers, cladocerans and copepods, whose structure, composition and abundance are influenced by both biotic factors (Adrian et al. 2009), as abiotic, which can act synergistically influencing the dynamics of communities (Serafim-Júnior et al. 2010). Among the abiotic factors, we can highlight the temperature influence (Pinese et al. 2015), dissolved oxygen (Dantas et al. 2009), light (Paes et al. 2015), electrical conductivity, seasonality (Gumiri et al. 2016), macronutrients (Dodds & Smith 2016) and micronutrients (Zamora et al. 2015), among others.

Biotic factors such as competition and predation directly influence the zooplankton community, because when interspecific competition and predation are few or nonexistent, the abundance of species is higher and the distribution is more homogeneous, however when predation and competition are intense, there is a reduction in abundance and species overlap in the niche (Santos 2009). One can also mention the relationship between zooplankton and phytoplankton, which has indirect influence on zooplankton, as the biomass and the development of these organisms depend on the presence of phytoplankton species more or less palatable (Dantas-Silva & Dantas 2013)

How to abiotic parameters, the temperature influences the spatial distribution of zooplankton community, because it controls the reproduction rate, population size and metabolism of many species (Winder & Schindler 2004). In stratified ecosystems, zooplankton can be distributed vertically, with species located both in epilimnion as hypolimnion, avoiding competition and predation between species (Esteves 2011).

Temperature and precipitation patterns are influenced by seasonality. Among these events, *El Niño* is reported in studies of planktonic communities (Caballero et al. 2015; De Serpont Domis et al., 2015; Havens et al. 2016). Their climatic effects include changes in growth, structure and composition of phytoplankton species due to variation in nutrient and light availability (Abirhire et al 2015), providing the imbalanced the food chain in the ecosystem.

According to Silva et al. (2013), Brazil's Northeast region is facing the worst drought in 30 years.

Extreme seasonality periods may change the availability of nutrients due to leaching processes, domestic and industrial effluents, besides the silting process and concentration of abiotic components in the ecosystem, contributing to variations in zooplankton (Sampaio et al., 2002 ).

Finally, eutrophication, characterized by increased productivity in aquatic systems, can cause changes in aquatic communities (Bhandarkar 2015). According to Dodds & Smith (2016), the load of nutrients such as nitrogen and phosphorus alter the phytoplankton composition, which will act as one of the determinants of zooplankton composition, considering the complex food webs present in these environments (Dantas-Silva & Dantas 2013).

**1.2 Influence of micronutrients on the zooplankton community**

Micronutrients can be defined as chemical compounds used by organisms in amounts less than 0.2% of its dry organic weight (Odum & Koogan 2012), such as Cu, Fe, Zn, Mn. Regarding the action of these elements on organisms, it can classified as essential or non-essential micronutrients.

Among the essential elements are the metals Fe, Zn, Mn, Cu, Co, Mo and Bo that contribute to the metabolism of aquatic organisms as cofactors in various physiological reactions (Reynolds 2006). As an example may be mentioned superoxide dismutase enzyme responsible for cellular antioxidant activity and can present as cofactors Cu, Zn, Fe or Mn (Yang et al., 2013, Kim et al. 2015).

Studies have shown the action of these metals on phytoplankton community (Van de Perre 2016), allowing predict an indirect action on the zooplankton community as both paticipate in aquatic food webs.

Direct effects of these chemicals on the zooplankton are scarce in the literature. While considered essential, these elements may lead adverse effects to the zooplankton communities, especially when present in high concentrations. Mesocosm study conducted with planktonic communities showed that high concentrations of Cu caused reproductive failure of cladocerans, among other effects (Taylor et al. 2016). Negative influence of metals on zooplankton reproduction was also observed *in vitro* studies. Xu et al. (2015) studied the effect of metals alone and separately on the reproduction of zooplankton and observed negative effect of the mixture Cu + Zn + Mn on rotifer species.

On the other hand, characterized as non-essential, are Hg, Pb, Cd, Ag, Cr, Ni and Sn which have unrecognized biological role, and are often toxic to certain organisms. All metals, essential or not to be alive, when above a threshold, can cause toxicity to aquatic organisms (Marengoni et al. 2013).

Micronutrients, both essential and non-essential, can be introduced into the aquatic environment by anthropogenic activities, such as the launch of domestic sewage, industrial or mining (Silva et al. 2013) or the contamination of pesticide use (Ebrahimpour & Mushrifah 2008), besides chemical weathering process of rocks and bleaching soils (Moraes & Jordan, 2002, Souza et al., 2009), potentially affecting the biota and food chains which it is inserted (Fernandez-Severini et al., 2013, Bat et al. 2015, Rubio-Franchini et al. 2016).

Studies on the influence of micronutrients in relation to zooplankton mainly conducted in marine environments, has appointed sensory responses on the influence of cadmium and copper in copepods mortality in various stages of development (Zamora et al 2015.); nickel, copper, cobalt and lead related to genotoxic effects on Cladocera (Goswami 2014), adverse effects of silver on Cladocera density (Atici et al., 2000), among others. In turn, studies in freshwater environments are scarce, being able to highlight the work of Gagneten & Paggi (2009) reporting the negative interference of copper and lead in the development of zooplankton species. *In vitro* experiments have shown the effect of bioaccumulation of these metals in various zooplankton species (Luciana et al., 2014; Bat et al., 2015; Mendoza-Carraza 2016). Furthermore *in vitro* study of nickel and copper showed toxic effect of these metals for the growth of cladocerans species (Taylor et al. 2016).

### 1.3 Studies on zooplankton communities in Pernambuco State (Northeastern Brazil)

Studies on zooplankton are of great relevance to aquatic ecosystems. Research on zooplankton in Pernambuco began with the pioneering work of Ahlstrom (1938), which made an inventory with the identification of these organisms in lentic systems in the region. In the 1980s, we highlight the work done by Neumann-Leitão and various colleagues, mainly focusing on inventory of species. Piglets and Neumann (1981) and Neumann-Paranaguá and Piglets (1982) described some rotifer species occurring in reservoirs used for carcinoculture. Neumann-Leitão and Nogueira (1986) performed a description of species belonging to three major zooplankton groups (cladocerans, copepods and rotifers) in carcinoculture environment. Neumann-Leitão and Souza (1987, 1989) carried out an inventory of species in a São Francisco River stretch. Correlation studies of these organisms to the water trophic status were performed by Neumann-Leitão et al. (1987, 1989) and Neumann-Piglet et al (1989). Although most of work with zooplankton communities are carried out in in marine environment, in Pernambuco State, some studies have been conducted in estuarine and freshwater ecosystems.

In estuarine environments, works done by Eskinazi-Sant'Anna and Tundisi (1996), Eskinazi-Sant'Anna (2000), Dos Santos et al (2009) and Neto et al (2009), have highlighted composition and distribution of species and the use of these organisms as environmental indicator.

Ecological studies on freshwater environments have been carried out by Bouvy et al. (2001) on the species composition and seasonal succession as well as the relationship between phytoplankton and zooplankton in ecosystem located in a semiarid region. Almeida et al. (2006) studied the horizontal distribution in lentic ecosystems taking into account data of richness, density, diversity and evenness, for rotifer community. Almeida et al. (2009) conducted research regarding the structure and dynamics of zooplankton related to the trophic state in six reservoirs in six regions of the state. Dantas et al. (2009) conducted studies on the effect of abiotic variables and phytoplankton on the zooplankton community and observed a seasonal pattern. These authors reported that in the dry season, the physical variables controlled the development of zooplankton favoring the establishment of high algal densities and in the rainy season there was an increase of the density of concurrent zooplankton concentrations of nutrients, leading to competition for resources between zooplankton and phytoplankton, controlling algal densities.

Over the past five years, it has been developed work with cladocerans species expanding knowledge about the occurrence and distribution of this group (Smith & Elmoor-Loureiro 2011). In the semiarid region of the state, studies conducted by Diniz et al. (2013) allowed the knowledge of the composition and species diversity of the group of cladocerans. In stream ecosystems, De Melo et al. (2014) conducted studies regarding the distribution of the major zooplankton groups in such environments. In estuarine environments, we can emphasized the work carried out by Correia et al. (2014) who evaluated the density, diversity and abundance of zooplankton species in coral reef ecosystem. In this same ecosystem, Person et al. (2014) evaluated the dynamics of copepod species in relation to the lunar cycle.

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