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COMPOSITION, BODY-SIZE STRUCTURE AND BIOMASS OF ZOOPLANKTON IN A HIGH-ELEVATION TEMPORARY POND (MINAS GERAIS, BRAZIL)

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ABSTRACT
Small ponds are vital inland water bodies, recognized as small repositories of freshwater biodiversity, but neglected in terms of conservation. Although high-elevation ponds are difficult to sample and monitor, it is important to extend their study, in view of their importance to aquatic biodiversity. The aim of this study was to analyze the composition, size structure biomass and diversity of zooplankton community in a temporary pond (Lagoa Seca) of a low-alpine area in the southern part of Serra do Espinhaço mountain in Minas Gerais State, Brazil. Three ecological aspects were analyzed: (I) the taxonomic composition of the zooplankton assemblage, (II) the size structure and biomass of the main groups in the zooplankton community and (III) whether the morphometric characteristics and biomass of the zooplankton result from the dominance of the microzooplankton, as expected in habitats subjected to frequent and strong disturbances, such as temporary ponds. Zooplankton samples were taken during the rainy period (October 2010 to January 2011) in different mesohabitats, from the shallowest areas covered by emergent macrophytes to the open water area covered mainly by submerged macrophytes. The zooplankton community consisted of a small number of taxa (29). Rotifera showed the highest richness, with 21 taxa recorded, of which the most constant species were the cosmopolitan *Lecane lunaris*, *L. obtusa* and *Lepadella patella*. Among the Cladocera, *Bosmina freyi* and *Moina minuta* were the pelagic species recorded. The other cladoceran species observed are associated with littoral vegetation, and represented mainly by *Alona ossiani*, *Chydorus pubescens*, *Ephemeroporus tridentatus* and *Ilyocryptus spinifer*. The zooplankton biomass was very low (the maximum dry weight, observed at the peak of the rainy period in January was 62 $\mu g.m^{-3}$). The zooplankton community was dominated by the microzooplankton, with the maximum body length below 900 μm. This assemblage was very changeable in the short term, both in numerical density and size structure, probably because of the highly variable hydrological regime of the pond. The results from zooplankton composition, including the first record of the rotifer *Microcodon clavus* to Minas Gerais state and the second in Brazil, highlighted the important role that high-elevation temporary ponds can play as aquatic biodiversity reserves. These unique ecosystems deserve greater efforts of research and monitoring, including studies of their hydrological patterns, biological diversity, and adaptive mechanisms of the zooplankton community.
Keywords: Iron Quadrangle; mountain; shallow lake; zooplankton community.

INTRODUCTION

The occurrence of a species of aquatic invertebrate in temporary and semi-temporary ponds is largely determined by its tolerance to changing environmental conditions or its capacity for dispersal and colonization of new habitats in periods of adversity (Carter *et al*. 1980, Hebert & Hann 1986, Girdner & Laron 1995). For this reason, the study of the structural patterns of aquatic communities in these temporary systems can be valuable for the elucidation of questions about the resistance of species to extreme environmental stress and about built-in features for the reestablishment and maintenance of the population (body size, emission of propagules, dispersion, and so forth) and the mechanisms by which species adjust to an extremely short succession, ruled exclusively by the rhythm of the seasons in these shallow systems. Studies carried out in temperate ponds at high elevation have pointed to the behavioral and life-history plasticity of zooplankton as essential strategies to maintain their long-term persistence in such lakes, as well as to minimize the effects of the intense predation and competition in small aquatic bodies (Havens & Beaver 2010, Iglesias *et al*. 2011).

Very little information has been recorded yet about the diversity of the zooplankton communities in high-altitudinal ponds, particularly in Brazil. By virtue of the exceptional topography, which restricts these montane ecosystems to regions of difficult access in the Brazilian landscape, and also because the study of temporary lakes and ponds is still at an early stage, these ecosystems have received little attention (Santos-Wisniewsky *et al*. 2002, Eskinazi-Sant'Anna *et al*. 2011). Although mountain lakes remain hard to sample and monitor, it is important to maintain and extend their study, in view of their relevance to endemism and evolutionary processes (Psenner 2002).

Various mountain lakes are found in the region of Minas Gerais State known as the Iron Quadrangle (Oliveira *et al*. 2005), a region known nationally and internationally for its great mineral deposits. On account of the mining activity, the shallow lakes located in areas with outcrops of iron ore are viewed as critically threatened ecosystems (Carmo *et al*. 2012). In this context, the aim of this study was to analyze the composition of the zooplankton community in a temporary lake at high elevation in the Iron Quadrangle (MG, Brazil), namely "Lagoa Seca". The following topics were investigated: (I) the composition and diversity of zooplankton species in a shallow temporary freshwater ecosystem; (II) the biomass and body size structure of zooplankton in this system; and (III) whether these characteristics show patterns similar to those expected in highly disturbed habitats, such as low biomass and dominance of small forms (microzooplankton).

MATERIAL AND METHODS

Study area, general characteristics of Lagoa Seca and abiotic variables

Lagoa Seca is a small pond (300 m^2 of area when completely filled) located at Itacolomi State Park, a Conservation Unit situated in the Districts of Ouro Preto and Mariana (Minas Gerais state). This pond is a temporary natural freshwater body, formed in a small depression at 1,609 meters above sea level (m a.s.l.) and coordinates 20°22'30" - 20°30'00" S and 43°32'30" - 43°22'30" W; Figure 1). The pond is filled during the rainy season by surface runoff reaching a maximum depth of 1.5 m and usually remaining completely dry throughout the dry season, from April to September. The climate is altitudinal, warm temperate (with mean annual temperature of 18.9°C. Mean temperature is 21.4°C in January and 15.7°C in July. Historical mean annual rainfall is 1,475 mm, with a monthly mean of 308 mm in December, the wettest month, and 15 mm in July, the driest month in the year (INMET 2015).

This pond has a rounded outline, with arms in the form of narrow canals radiating in several directions (Fig. 1), and being surrounded by natural alpine vegetation, predominantly grasses and small herbaceous plants. Lagoa Seca pond is almost entirely covered by macrophytes, notably *Eleocharis densa*, *Juncus densiflorus* and *Egeria minima*. There is no record of fish and the potential zooplankton predators are the benthic macroinvertebrates (mainly insect larvae) and tadpoles.

Sampling and analysis of zooplankton community

Zooplankton samples were collected in October, November and December 2010 and January 2011, during the rainy season at distinct mesohabitats, including the shallowest areas of the littoral pond region covered by emergent macrophytes and the open water area, covered mainly by submerged macrophytes. Around 90 L of water were collected with a plastic bucket and filtered through a plankton net of 68 µm mesh. Samplings were performed in three evenly spaced points in the littoral zone of the pond and then integrated in one sample. In the open water area, zooplankton samples were also obtained in 3 sites, equally distributed from the beginning to the end of the open water line, and also integrated. Samples were preserved in 4% formaldehyde and stained with Rose of Bengal. The microcrustaceans (cladocerans and copepods) were identified and counted under a stereo-microscope (50×

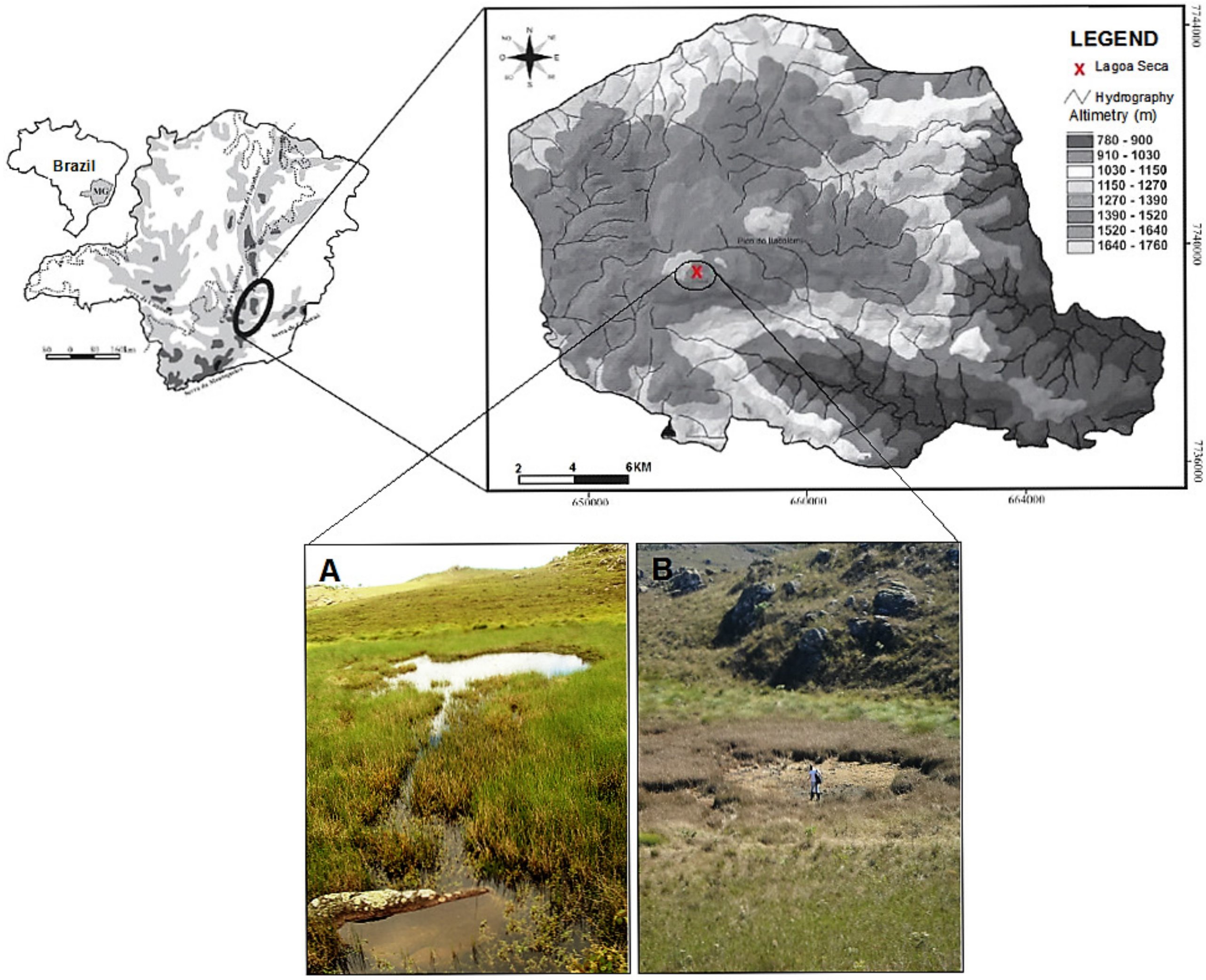

Figure 1. Map showing the location of Lagoa Seca in Brazil, in Minas Gerais State (physical map with height contours) and then in photos of the State park of Itacolomi: (a) with water during the rainy season, when the samples were collected; (b) in the dry period, when the lake was completely dry.

magnification), the entire sample being included. For the rotifers, 1 mL sub-samples were analyzed under an optical microscope in a Sedgewick-Rafter cell. A specialized literature was used for rotifers taxonomic identification, (Edmondson 1959, Olivier 1963, Paggi 1973, Koste 1978, Paggi 1978, Berner 1985, Segers 1993, 1995, Elmoor-Loureiro 1997, Elmoor-Loureiro 2014).

Zooplankton density was obtained by multiplying counting data versus the water volume of the sample (90L of water). The indices of diversity, dominance and evenness were calculated using the statistical program PAST 1.94 (Hammer *et al*. 2001). The patterns of dominance and richness of the zooplankton community were represented by dominance curves in which the species are shown in decreasing order of abundance against its respective ranking (Lambshead *et al*. 1983, Clarke 1990).

The Constancy Index of Dajoz (Lobo & Leigthon, 1986), was calculated based on the frequency of occurrence of each zooplankton species, as follows: $c = 100\ n/N$, being: n = number of samples with the species occurrence; N = total number of samples analyzed. According to the value of this index the species were classified as: constant, if occurring in more than 50% of samples; accessory, if occurring in more than 25% and less than 50% of samples and accidental or rare, if occurring in less than 25% of samples.

During the zooplankton sampling, some physical and chemical parameters (water temperature, pH and electrical conductivity) were measured with a Horiba (model U-50) multiprobe analyzer.

Determination of the size-structure and biomass of the zooplankton

The size of the organisms in each group was measured for around 30 animals (or fewer for less abundant taxa), under an optical microscope with a graduated eyepiece. Combined with the density data, the measured lengths of the organisms were used to estimate the biomass of each genus/species, expressed in µg dry weight per cubic meter (µg DW m^{-3}).

Microcrustacean species biomass was calculated from their length by means of a model proposed by Bottrel *et al*. (1976). For rotifers, the biomass was obtained according to Ruttner-Kolisko (1977) biovolume formulas. The biovolume was then calculated as the wet weight, taking the specific density to be 1.0 and the conversion from wet weight to dry weight was performed assuming a multiplication factor of 0.1 (Doohan 1973, according to Bottrell *et al*. 1976).

RESULTS

Abiotic variables, taxonomic composition and abundance of populations

The mean pH in Lagoa Seca reveals that water was slightly acid, with mean value of 6.52 ± 0.07. We did not observe the occurrence of thermocline in the water column, with mean water temperature from 19.2 ± 0.18°C. Very low value of conductivity was registered during all the sampling period; the mean value was 0.008 ± 0.006 mS cm^{-1}.

We registered the occurrence of 29 taxa of zooplankton, being 8 Cladocera and 21 Rotifera taxa. Only juvenile phases (nauplii and copepodites) of Copepoda (Cyclopoida and Harpacticoida) were recorded, so that the individual taxa could not be identified. The highest species richness was observed in the Rotifera group followed by Cladocera in the month of October, and the nauplii of an anostracan crustacean, *Dendrocephalus* sp (Daday 1908) were found in the lake.

The constant taxa (> 50% of samples) were: *Alona ossiani*, *Chydorus pubescens*, *Ilyocryptus spinifer* and *Ephemeroporus tridentatus* (Cladocera), *Lecane lunaris*, *Lecane obtusa*, *Lepadella patella*, *Microcodon clavus*, *Monommata sp.*, *Trichocerca insignis*, *Trichocerca myersi* and *Trichocerca similis* (Rotifera). Nauplii and copepodites of Cyclopoida and copepodites of Harpacticoida (Copepoda) as well as rotifers of the Subclass Bdelloidea were also constant in the samples. The rare taxa (occurring in one sample) were: *Alona glabra* and *Moina minuta* (Cladocera) and *Colurella obtusa*, *Filinia opoliensis*, *Filinia longiseta*, *Keratella reducta*, *Lecane furcata*, *Lecane haliclysta*, *Trichocerca sp* (Rotifera). Adult Harpacticoida copepods also occurred in one sample.

The highest total zooplankton densities were always observed in samples from the littoral zone in December and January (Figure 2). The species that contributed most to these results were: one species of Rotifera Bdelloidea (154,700 ind.m^{-3}) and the rotifers *Microcodon clavus* (56,100 ind.m^{-3}) and *Euchlanis dilatata* (30,000 ind.m^{-3}). The lowest densities were recorded for the rotifer species *Filinia longiseta* (10 ind.m^{-3}) and *Ptygura* sp. (49 ind.m^{-3}) in the littoral zone (Table 1).

The results showed a variation in space and time of the zooplankton biomass, which generally showed rather low values (maximum density was 14,208 µg DW.m^{-3} in the littoral zone in October, the beginning of the rainy period; Figure 3). In January, there was a notable peak with total biomasses of 62,797 µg DW.m^{-3} and 44,280 µg DW.m^{-3} in the littoral and pelagic zones, respectively.

Cladocera and Copepoda contributed with the largest fraction of zooplankton biomass in all samples, but Cladocera contributed more remarkably in January, when their biomass was higher than 30,000 µg DW.m^{-3}, being *Ephemerorus tridentatus* (littoral zone) and *Alona ossiani* (pelagic zone) the dominant species. The high biomass recorded for Copepoda resulted from the considerable abundance and biomass of the Cyclopoid copepodites.

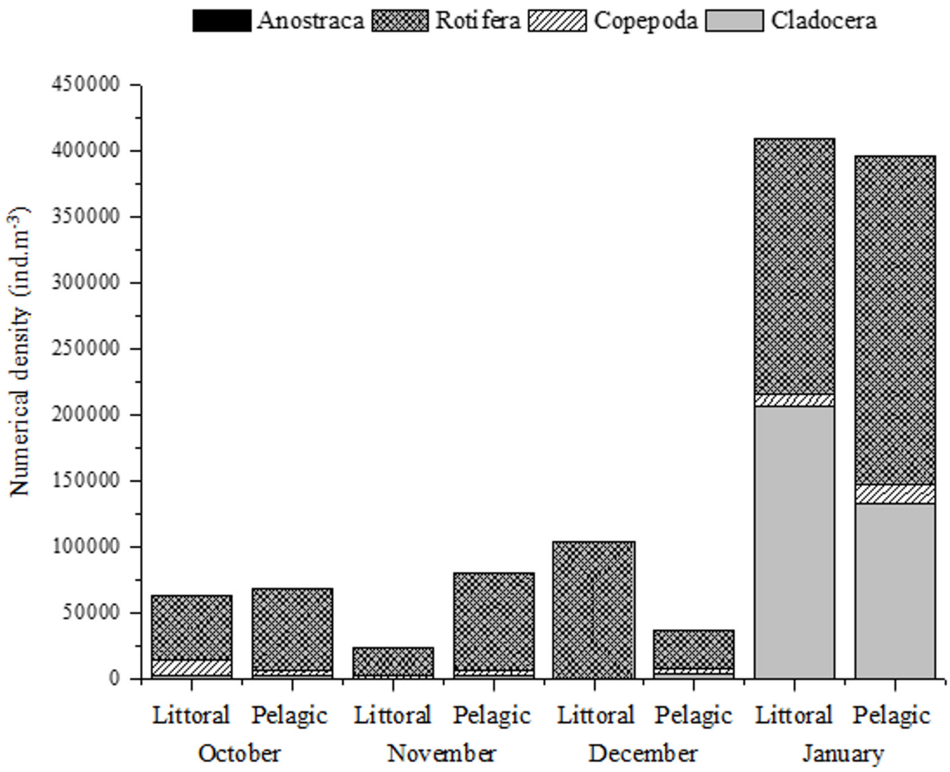

Figure 2. Variation in the numerical density of the main component groups of the zooplankton community and the whole community, in the littoral and pelagic zones of Lagoa Seca, in October 2010 to January 2011 (rainy season).

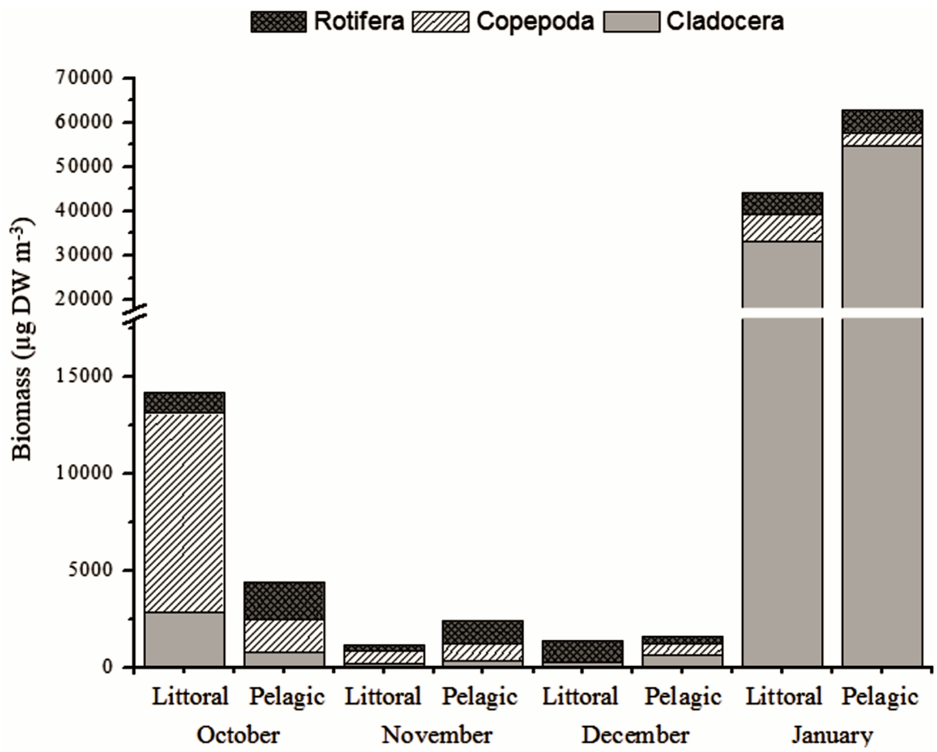

Figure 3. Zooplankton biomass and its main component groups, in the pelagic and littoral zones of the mountain lake Lagoa Seca, in the rainy season from October 2010 to January 2011.

Table 1. Composition, density (ind.m^{-3}) and constancy (Dajóz constancy index-DCI) of zooplankton taxa sampled in Lagoa Seca, a temporary mountain lake in the Iron Quadrangle, MG (Brazil), from October 2010 to January, 2011. ICD: C = Constant; A = Accidental; R = Rare.

	October		November		December		January		
	Littoral	Pelagic	Littoral	Pelagic	Littoral	Pelagic	Littoral	Pelagic	ICD
Cladocera									
Alona glabra	1,333								R
Alona ossiani	296	300	85	46			4080	25,600	C
Bosmina freyi	37					180			A
Anthalona verrucosa	1,333	1,600							A
Chydorus pubescens		133	340	2,208	85	1,800			C
Ilyocryptus spinifer	296	133	14	15		180	680	2,400	C
Ephemeroporus tridentatus		200	340			1,800	20,1960	105,600	C
Moina minuta					85				R
Copepoda									
Cyclopoida									
Copepodites	7,407	1,200	85	368		180	5,440	1,600	C
Nauplii	296	2,000	1,700	3,680	12	1,800	3,400	8,000	C
Harpacticoida									
Adults			340						R
Copepodids	3,556	400	340	368		180		800	C
Nauplii	74	1,200				1,800		4,000	A
Rotifera									
Bdelloidea	8,889	8,000	5,100	14,720	6,800	3,600	154,700	124,000	C
Colloteca sp.				46		180	1,700	8,000	A
Colurella obtusa				5,520					R
Euchlanis dilatata	8,889	30,000		1,840		180			A
Filinia opoliensis		200							R
Filinia longiseta			10						R
Keratella reducta		200							R
Lecane furcata	2,222								R
Lecane haliclysta	2,222								R
Lecane lunaris	6,667	1,200	1,700	1,840	68	180		4,000	C
Lecane obtusa			1,700	7,360	680		6,800	12,000	C
Lecane stichaea	37	4,000					1,700		A
Lepadella patella	1,778	200	24			180	1,700	4,000	C
Microcodon clavus			1,700	20,240	56,100	1,800	13,600	40,000	C
Monommata sp.	2.222		11	368	340	1,800	8,500	12,000	C
Notommata sp.	4,444	200	1,700					16,000	A
Ptygura sp			49	7,360		5,400			A
Trichocerca sp.		12,000							R
Trichocerca insignis	4,444	4,000	6,800	5,520	5,100	5,400		8,000	C
Trichocerca myersi	6,667	800		368	680	1,800	1,700	4,000	C
Trichocerca similis		400	1,700	9,200	34,000	9,000	3,400	16,000	C
Anostraca									
Nauplii *Dendrocephalus*		400							R
Total	**63,111**	**68,767**	**23,738**	**81,067**	**103,950**	**37,440**	**409,360**	**396,000**	

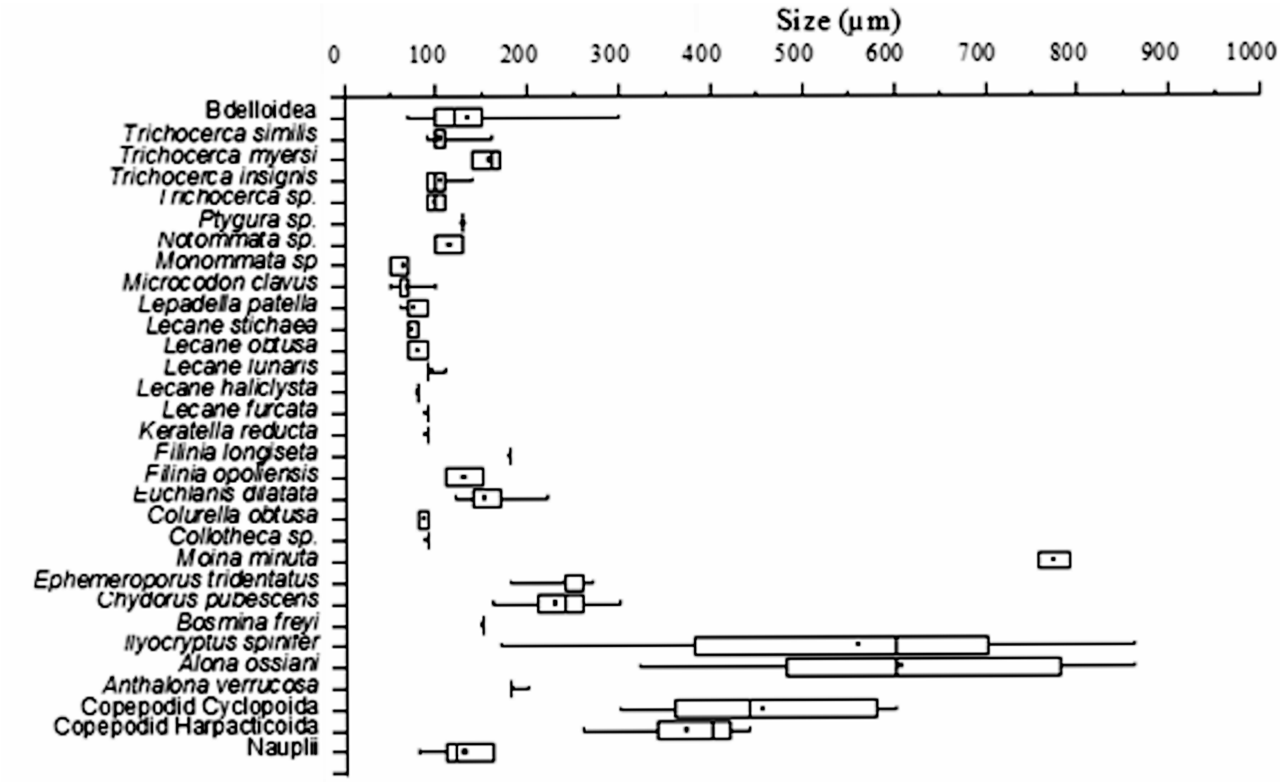

Figure 4. Box plots representing body sizes ranges (µm) for each species, or developmental phases, as in the case of Copepoda, for the main zooplankton groups occurring in Lagoa Seca from October 2010 and January 2011.

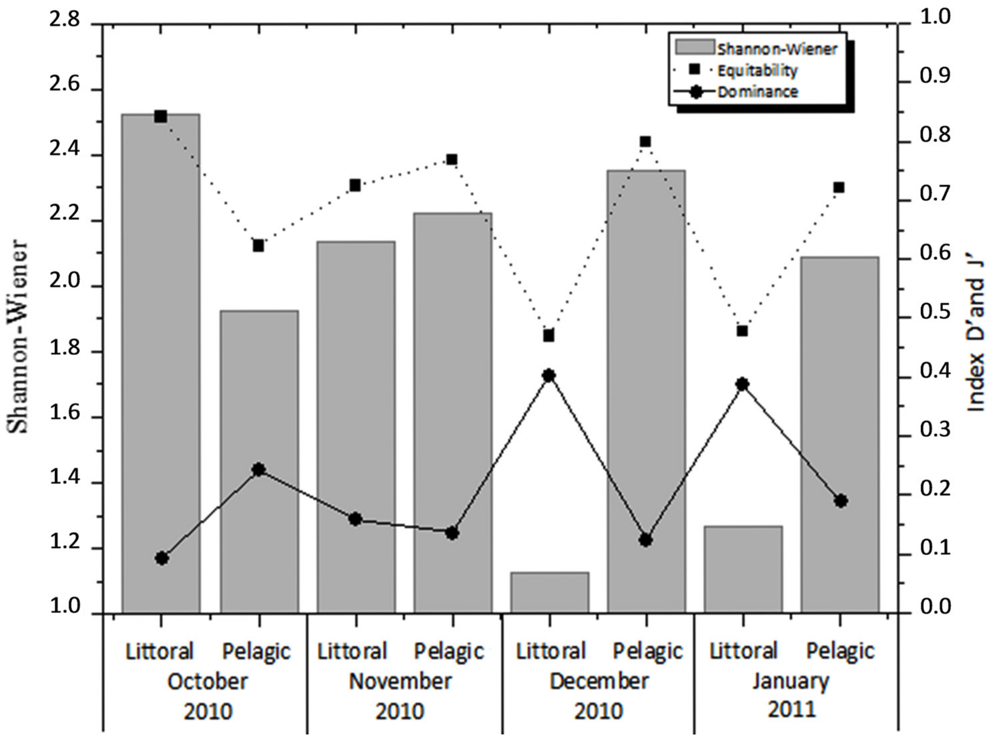

Figure 5. Variation in the values of Shannon-Wiener Diversity, Dominance index (D') and Pielou Equitability index (J) for the zooplankton community of Lagoa Seca.

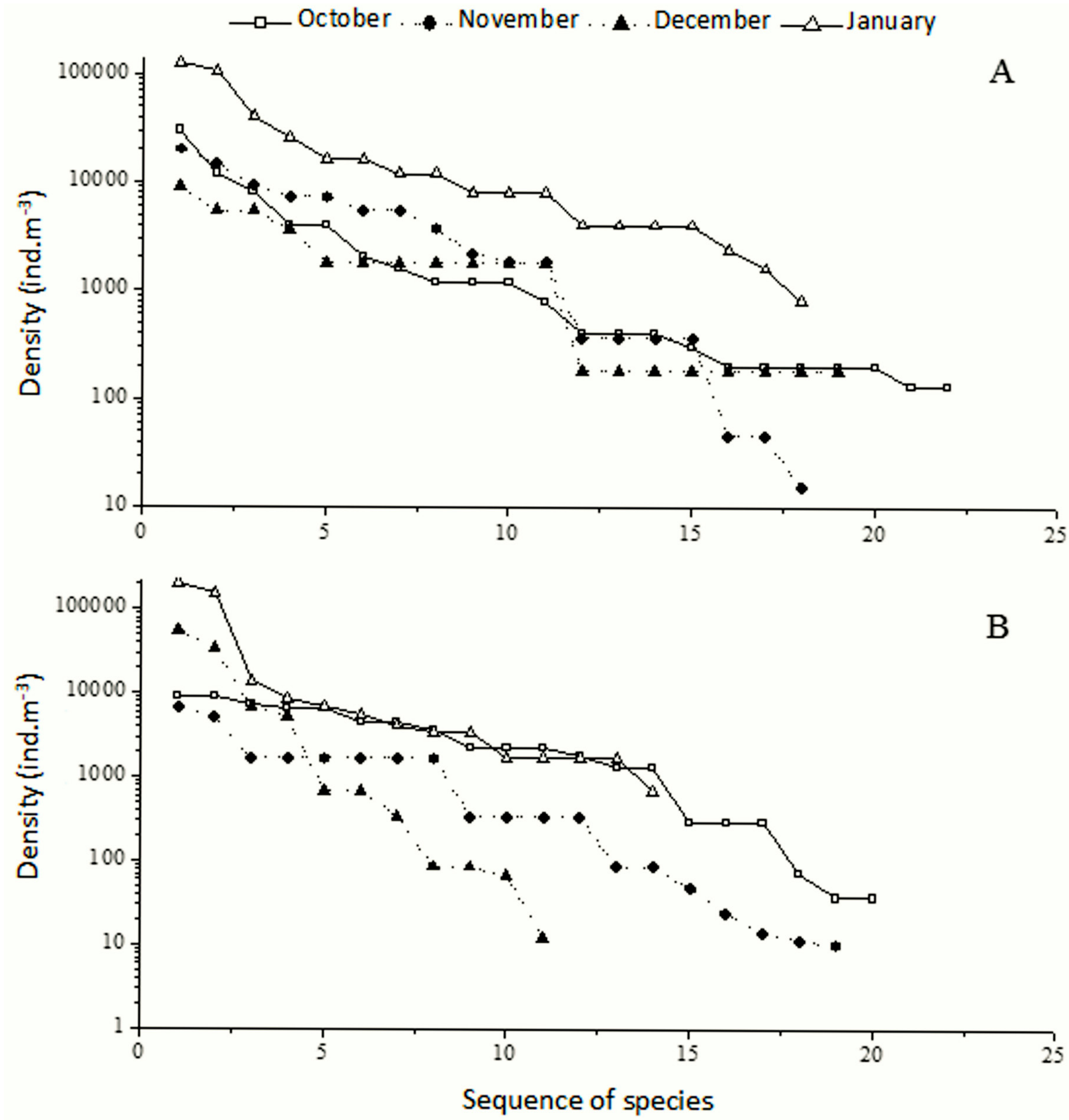

Figure 6. Dominance component curves and richness of species of the zooplankton community of Lagoa Seca, MG sampled in the period from October 2010 to January 2011 (A – pelagic region and B – littoral region).

The size structure of zooplankton community

In general the community was mainly represented by the small microzooplankton with sizes varying between 50 and 300 µm. Rotifera individuals were the smallest, most with sizes in the range 50-100 µm. Some Cladocera species, especially *Bosmina freyi*, *Ephemeroporus tridentatus, Chydorus pubescens* and *Anthalona verrucosa* were in the size range of 150-300 µm (Figure 4).

A second size range comprised the copepodids of Cyclopoida and Harpacticoida copepods, with sizes in the range of 300-700 µm. The third size range comprised the cladocerans as *Ilyocryptus spinifer*, *Alona ossiani and Moina minuta* with sizes ranging between 170 and 850 µm.

Zooplankton species richness, Dominance and Shannon Wiener diversity

Species diversity indices for zooplankton community varied from 1.1 to 2.5 bits.ind^{-1}, with lower values in the littoral zone (Figure 5). The lowest values of dominance index (1.1) coincided with highest values of equitability (2.5) and diversity (2.5) indices. The highest value for the dominance index (0.40) was recorded for samples from the littoral zone in December 2010 and January 2011.

The dominance component curves followed the broken-stick model with low dominance and relatively high richness (Figure 6). The curves evidenced the lowest richness and highest dominance in the littoral region in the period of December - January which coincided with the peak of abundance of *Microcodon clavus* (Rotifera) and *Ephemeroporus tridentatus* (Cladocera).

DISCUSSION

The zooplankton of Lagoa Seca was temporally dominated by Neotropical or cosmopolitan species, in which a new occurrence was registered for the state of Minas Gerais: the rotifer *Microcodon clavus*. The low species richness in the zooplankton community is probably related to a number of factors acting simultaneously, being the geographic isolation only one among these factors. According to Tavernini *et al*. (2009) there is a linear decrease of the species richness among the meso-zooplankton as altitude increases. Also, according to the Theory of Island Biogeography (McArthur & Wilson 1967, Rosindell & Phillimore 2011), as more isolated the habitat, lower is the probability of colonization by other species, especially for zooplankton species that are passively dispersed (Cáceres & Soluk 2002, Adamowicz *et al*. 2009).

Therefore, a large fraction of local diversity seems to be maintained by dormancy mechanisms (resting eggs) and some by passive dispersion (anemocoric or zoocoric), that favor mainly the microzooplankton morphotypes (Frisch *et al*. 2007; Meutter *et al*. 2008). Resting eggs from Chydoridae were observed during the sampling analysis (personal communication). This seems to be an efficient strategy for the reappearing of local populations and maintenance of local diversity. The Lagoa Seca is also a hotspot for amphibian species and tadpoles (Drummond 2009), which can represent an extremely efficient zooplankton dispersal agent (Vanschoenwinkel *et al*. 2008).

The occurrence of nauplii and copepodids of Copepoda (Cyclopoida and Harpacticoida), in high numbers during the study period, although no adults were collected, is an important fact to the populations dynamics and food web, considering that these initial phases can have a distinct niche from that of adults, thus increasing local functional diversity (Vogt *et al*. 2013). Nauplii and early instars of copepodids phases among Cyclopoida copepods are mainly herbivore filterers, whereas the last developmental stages and adults have raptorial feeding habits (Adrian & Frost 1992) but some species can be exclusively herbivorous, as *Cyclops vicinus* (Santer & Van den Bosch 1994).

Cladocerans were mainly represented by epibenthic species. Only two small-bodied and pelagic species were registered: *Bosmina freyi* and *Moina minuta*. The predominance of phytophylous Chydoridae species is a constant pattern in wetlands and shallow lakes (Araújo *et al*. 2013, Diniz *et al*. 2013) and some high-elevation temporary ponds (Coronel *et al*. 2007) probably due to the presence of macrophytes, which act as both shelter against predation and food source (Cazzanelli *et al*. 2008). Chydoridae species are particularly successful in temporary ponds (Dole-Olivier *et al*. 2000) because also are adapted to harsh environmental conditions (*e.g.* high temperatures and low oxygen concentrations) and able to exploit both the littoral and pelagic zones of permanent and temporary water bodies (Alonso 1996, Santos-Wisniewski *et al*. 2002). The occurrence of exclusive species and the highly specialized crustacean fauna play a substantial role in these temporary ponds to be a hot spot to Cladocera diversity.

Rotifers constituted the group with highest species richness and population densities in Lagoa Seca, a recurrent pattern in tropical freshwater environments (Matsumura-Tundisi 2007), and also being most representative in lakes and reservoirs throughout the world (Segers *et al*. 1993, Rocha *et al*. 1995, Bozelli 2000, Sharma & Sharma 2012). The predominance of rotifers can be related to detritus food webs. According to Lijklema (1994), decomposition of macrophyte detritus in shallow lakes can be responsible for half of the observed flux of dissolved total phosphorous and dissolved organic matter from the littoral to the pelagial zone. In some cases feeding on detritus can be more important to zooplankton species than the consumption of live biomass (Melão & Rocha

2006), what can end up in a convergence of the zooplankton assemblage to microfilterers.

Body size is ubiquitously recognized as a critically important attribute of animal functional biology and ecology (Havens *et al*. 2014). From the ecosystem view, size structure of zooplankton affects biological interactions (predation, feeding response and efficiency), behaviour (*e.g.* vertical migration), feeding, metabolic rates, fecundity, growth rates, and play a fundamental role on ecosystem production rates, gas storage and release (*e.g.* CO_2) (Schmitz *et al*. 2014), and net production rates (Kerr & Dickie 2001, Edvardsen *et al*. 2002).

Despite being a topic from many papers (see review in Hart & Bychek 2011), zooplankton size-structure is still a matter of ample controversy in aquatic ecology. In the classical paper of Brooks & Dodson (1965), zooplankton size was used to test the size-efficiency hypothesis, and vertebrate predation played a fundamental role in shaping zooplankton size structure. Recent studies have shown that not only vertebrate predation can constrain zooplankton body size, but invertebrate predation and water temperature can be decisive in determining zooplankton body size (Bonecker *et al*. 2011, Havens *et al*. 2014).

The size structure of the zooplankton community from Lagoa Seca was characterized by the dominance of microzooplankton with small sized species (< 800 µm). Usually, systems that are subjected to intense disturbances (*e.g.* eutrophication, top-predator effect, food quality changes) are characterized by the dominance of microzooplankton (Nogueira & Matsumura-Tundisi 1996, Brito *et al*. 2011). Rapid life cycles and growth can explain their success in these fluctuating and stressing ecosystems. In zooplankton community of Lagoa Seca, microzooplankton was mainly represented by rotifers (generalist feeding) and scrapers Cladocera (mainly Chydoridae), which are ineffective at controlling algal production and thus, less dependent of algal food sources.

According to Hart & Bychek (2011), literature on zooplankton feeding reveals the effect not only of food quantity, but also of food quality on individual body size. Food quality is a complex topic, involving and/or influenced by physical/morphological attributes, besides biochemical features of food particles. Studies that have considered their influence on body size reveal a general decline in size when food quality is low (Gulati & DeMott 1997). Unfortunately we do not have phytoplankton composition data available to Lagoa Seca, but a recent finding (Moreira *et al*. 2015) reveal that the dinoflagellate *Ceratium furcoides* occurs in the phytoplankton of this lake. Dinoflagellates are considered a low quality food for zooplankton, and the size of the cell (over 1000 µm) is also a limiting feature to zooplankton feeding. Trophic condition can be a determining factor driving the dominance of microzooplankton possibly via detritus consumption considering the oligotrophic condition of Lagoa Seca, as already described by Eskinazi-Sant'Anna *et al* (2011).

A pattern of zooplankton biomass increasing during the peak of rainy period (November and December) with Cladocera contributing most to total zooplankton biomass was observed in Lagoa Seca. Although there are few data available concerning zooplankton biomass in natural, temporary, altitudinal ponds, the same pattern was also observed in other Brazilian freshwater systems (Matsumura-Tundisi *et al.* 1989, Pinto-Coelho et al. 2005, Viti *et al.* 2013).

The short-term variability of the zooplankton community in ponds can be attributed to its natural variability and to its temporal heterogeneity regarding physical and chemical patterns of the ecosystem (Downing 2010). The low pH values observed in the water of Lagoa Seca (mean pH 6.52 ± 0.07) reinforce the role of the altitudinal aquatic ecosystems as early warning ecosystems to natural or anthropogenic impacts (Thompson *et al*. 2009, Eggermont *et al*. 2010). Low pH values in the water can occur when intense decomposition of macrophytes takes place (Carpenter & Lodge 1986). On the other hand, mountain lakes are also very sensitive to atmospheric deposition of pollutants, and acidification is a very common effect of the deposition of chemicals (Gélinas *et al*. 2000, Camarero *et al*. 2009, Murphy *et al*. 2010).

The classic paper from Dodson (1974) concluded that "if vertebrate predators are present, small herbivores species and cryptic invertebrate predators will co-exist, and the size of both classes of invertebrates will depend on the vertebrate predator's voracity". In fact, the role of vertebrate predation in shaping zooplankton size-structure has been highlighted in many studies (as reviewed in Hart & Bychek 2011). Nevertheless, our study was conducted in a fishless lake and even without the direct action of vertebrate predators, zooplankton size-structure in Lagoa Seca was quite similar for those fish-lakes. Therefore, invertebrate lake predators (mainly belonging to Trichoptera, Odonata, Belostomatidae and Plecoptera) are very abundant in the lake, and some specimens have been caught in the zooplankton samples (Eskinazi-Sant'Anna, personal observation). Thus, invertebrate predation may play a crucial role in shaping zooplankton size-structure in this temporary lake. According to Havens *et al*. (2014), invertebrate predation can be a source of variation in zooplankton size-structure, as important as temperature and vertebrate predation. In this sense, experiments looking for answers regarding these insights for tropical temporary ponds can provide new and a more consistent basis to the understanding of the factors regulating zooplankton size structure. Additionally, the results here obtained revealed the importance of such small humid areas to the aquatic biodiversity and the need to expand the knowledge regarding the adaptations and interaction of the altitudinal tropical aquatic communities.

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