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Article

The role of cladocerans in green and brown food web coupling

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ABSTRACT. Cladocerans, an important zooplankton community, are consumers from the base of the food web of aquatic environments. We investigated the contribution of producers (phytoplankton and periphytic biofilm) and particulate organic carbon (POC). Collections were carried out in lakes of the Upper Paraná River Floodplain, the last stretch free of dams in the second-largest South American basin. Isotope ratios ($\delta^{13}C$ and $\delta^{15}N$) were measured, besides the contributions of probable food sources to the cladocerans biomass. The phytoplankton constituted the source of carbon for cladocerans, followed by POC. Thus this work, in addition to emphasizing the importance of cladocerans in nutrient cycling, highlighted the need for the conservation of environments surrounding the lakes as they are the sources of organic matter for aquatic communities. Besides, the analyzed zooplanktonic organisms demonstrated their role in the interconnection between the green and brown food webs, which have been studied separately for a long time.

KEYWORDS. Trophic web, stable isotopes, herbivores, detritivores.

RESUMO. O papel dos cladóceros no acoplamento da teia alimentar verde e marrom. Os cladóceros, importante comunidade zooplanctônica, são consumidores da base da cadeia alimentar dos ambientes aquáticos. O objetivo foi identificar a real contribuição dos produtores (fitoplâncton e biofilme perifítico) e do carbono orgânico particulado (COP) na biomassa dos cladóceros. As coletas foram realizadas em lagoas da planície de inundação do alto rio Paraná, último trecho livre de barragens na segunda maior bacia da América do Sul. As razões isotópicas ($\delta^{13}C$ e $\delta^{15}N$) e as contribuições de prováveis fontes de alimento para a biomassa de cladóceros foram medidas. Verificou-se valores enriquecidos de $\delta^{15}N$ para o fitoplâncton de ambiente sob impacto antrópico, COP com valores de d13C semelhante a plantas C3 e diferenças na assinatura do d13C do fitoplâncton dos ambientes estudados. Ademais, que o fitoplâncton constituiu a maior fonte de carbono para os cladóceros (35% ou mais da biomassa dos cladóceros), seguido pelo COP (30% ou mais). Assim, o presente trabalho, além de enfatizar a importância dos cladóceros na ciclagem de nutrientes, destacou a necessidade de conservação dos ambientes no entorno dos lagos, uma vez que são fontes de matéria orgânica para as comunidades aquáticas. Além disso, os organismos zooplanctônicos analisados demonstraram seu papel na interconexão entre as cadeias alimentares verde e marrom, que há muito vêm sendo estudadas separadamente.

PALAVRAS-CHAVE. Teia trófica, isótopos estáveis, herbívoros, detritívoros.

The knowledge of energy transfer pathways in an ecosystem is essential to understanding the structure and functioning of its food webs (Degerman *et al.*, 2018). Food webs can have two main origins: photosynthetic organisms, in the case of green food webs, or detritivorous organisms, also known as brown food webs (Nelson, 2021; De Guzman *et al.*, 2022; Chappuis *et al.*, 2022). These two mechanisms have long been studied separately (Evans-White & Halvorson, 2017; Eckert *et al.*, 2020). However, these two energetic pathways should be coupled in ecological studies (Mougi, 2020; Atkinson *et al.*, 2021), since even in simplified webs, quite different results can be obtained (Dickman *et al.*, 2008; Heath *et al.*, 2014), thereby making the understanding of energy flow pathways in food webs challenging (Degerman *et al.*, 2018).

The zooplankton community is considered an important link in the aquatic food web for transferring energy from primary sources to higher trophic levels (Hahn *et al.*, 2002; Arunpandi *et al.*, 2020). They are the main source of food for planktophagous fish and fingerlings (Panarelli *et al.*, 2021), in addition to controlling phytoplankton through herbivory (Silveira *et al.*, 2010). The cladoceran community is one of the main zooplanktonic groups found in Neotropical ecosystems (Sendacz *et al.*, 2006; Nogueira *et al.*, 2008; Lansac-Tôha *et al.*, 2009). They are microcrustaceans with a size between 0.3 and 3.0 mm (Elmoor-Loureiro, 1997) and exhibit different life habits, being able to live in the surroundings of aquatic macrophytes, coastal, pelagic (Błędzki & Rybak, 2016), or benthic (Elmoor Loureiro, 1997) regions. The cladoceran diet may consist of both algae and organic detritus (COD, dissolved organic carbon and COP, particulate organic carbon) due to their filter-feeding habit, as well as periphytic biofilm, due to the scraping habit of some species (Elmoor-Loureiro, 1997; Esteves, 1998; Błędzki & Rybak, 2016). Thus, floodplains where there are high inputs of organic matter, ions, and nutrients (Takeda *et al.*, 2002; Resende, 2008) coming from lotic and lentic environments subjected to flood pulses (Junk *et al.*, 1989; Ward & Stanford, 1995) represent an ecosystem capable of sustaining populations with a high number of individuals, especially cladocerans (Høberg *et al.*, 2002; Lansac-Tôha *et al.*, 2009).

In these ecosystems, the trophic state of the river influences the biogeochemical cycles and the nutrient balance of the Lagoons with which it connects (Friedl & Wüest, 2002). The upper Paraná River Floodplain (PIAP), comprising the Paraná, Baía, and Ivinhema Subsystems demonstrates two contrasts. The Upper Paraná River underwent an oligotrophication process due to the impacts of the cascade of reservoirs upstream of the PIAP, which resulted in numerous physical and chemical changes in the water (Granzotti *et al.*, 2018; Mantovano *et al.*, 2019). On one hand, the reservoirs retain a large amount of organic matter, decreasing turbidity, which in turn causes changes in the phytoplankton community and alter the possible food sources for cladocerans (Pineda *et al.*, 2017). On the other hand, the Ivinhema Subsystem, due to its lack of impoundment and a considerable degree of conservation (Agostinho *et al.*, 2004; De Carvalho, 2019), has higher turbidity values, as well as a high value of suspended particles in the water (Carvalho *et al.*, 2019). Therefore, it is essential to understand the trophic dynamics of cladocerans in the different environmental contexts of PIAP, an ecosystem that sustains a high diversity of the zooplankton community (Lansac-Tôha *et al.*, 2009).

Because of the complex trophic dynamics of zooplankton, isotopic analysis of $\delta^{13}C$ and $\delta^{15}N$ presents itself as an essential and viable tool (Santana *et al.*, 2009) to identify the energy flow in the food web. The stable isotope of carbon ($\delta^{13}C$) can be used as a carbon flux tracer in systems with different food items with values of $\delta^{13}C$ (Manetta & Benedito-Cecilio, 2003). Due to the mechanisms of carbon fixation (Albrecht, 2021), C_3 plants have a fractionation of -20‰ and C_4 plants of -8‰. Aquatic macrophytes may vary in their $\delta^{13}C$ because of their sources (e.g. CO_2 dissolved in water or atmosphere). Phytoplanktonic algae, in general, present values close to -35‰ (Fry, 2006). It allows the estimation of a consumer's energy sources as the $\delta^{13}C$ values are equal or slightly enriched in its energy sources, with a fraction of about 0.4‰ (Post, 2002). $\delta^{15}N$, however, presents a fractionation of 3.4‰ from one trophic level to the other, thus allowing the estimation of the trophic position of organisms (Fry, 1988; Layman *et al.*, 2007). Therefore, stable isotopes are tools that help understand the dynamics of energy flow in aquatic ecosystems (Kling *et al.*, 1992; France & Peters, 1997).

The identification of energy transfer routes from producers to primary consumers makes it possible to assess future changes on the upper levels of the food web subjected to multiple impacts, especially concerning the operation of dams on hydrological regimes. Thus, it is necessary to know the functioning of zooplanktonic communities for a clear understanding of the aquatic ecosystem (Litchman *et al.*, 2013). The cladoceran generally shows selectivity for algae compared to organic debris (particulate organic carbon, POC) (Tõnno *et al.*, 2016). In this context, the present study aimed to investigate the proportions of phytoplankton and particulate organic carbon in the composition of cladoceran biomass. So, in environments directly impacted by dams (Paraná and Baia Rivers), there is less carbon assimilation from phytoplankton to the protected area (Ivinheima River) of the Upper Paraná River Floodplain.

MATERIAL AND METHODS

Study area.

The study area comprises of three lentic environments of the Ivinhema, Baía, and Paraná Subsystems of the Upper Paraná River Floodplain between the Ivinhema River and Paranapanema River, the last stretch free of dams in Brazilian territory (Agostinho *et al.*, 2002) (Fig. 1). Among the three Subsystems, the only one in which the dam upstream of the PIAP has the least amount of effect is the Ivinhema River, which is located within the Várzeas State Park of the Ivinhema River. It is a more conserved Subsystem, despite having degraded forest remnants in different stages of recovery, often suffering from fires arising from illegal fires by farmers in the surrounding park for pasture renewal (Carvalho *et al.*, 2019). The collections in Ivinhema River were carried out in the Ventura Lagoon (22°51'23.7"S; 53°36'1.02"W), with a total area of 89.8 ha and 2,984.8 meters in length (Comunello, 2000).

The limnological characteristics in the rivers are different for the Subsystems directly subjected to the impacts of the upstream dams. The Paraná Subsystem presents a high state of oligotrophy, mainly due to the operation of the Porto Primavera Hydroelectric. This condition provides homogenization of its biological characteristics (Braghin *et al.*, 2018). However, the Baía SSubsystem does not shows a change in the water turbidity index after its damming (Granzotti *et al.*, 2018). Samplings in the Paraná River and Baía River were carried out in Lagoon das Garças (22°43'27.18"S; 53°13'4.56"W) and Lagoon Fechada (22°42'37.92"S; 53°16'33.06"W) (Comunello, 2000), respectively.

Sampling.

Collections were carried out in December 2009. It is a period characterized by rains and thus represents the entry of organic matter into adjacent areas, even under the effect of the operation of upstream dams (Ferreira *et al.*, 2019). During sampling, dissolved oxygen and turbidity samples were obtained with portable potentiometers and water transparency (m) with a Secchi disk. Water samples were obtained for laboratory determination of chlorophyll, nitrogen, and total phosphorus concentrations. Cladocera and phytoplankton were collected with a plankton net (opening 53µm) in the central region of the lagoon, away from macrophyte beds. Periphytic biofilm samples were

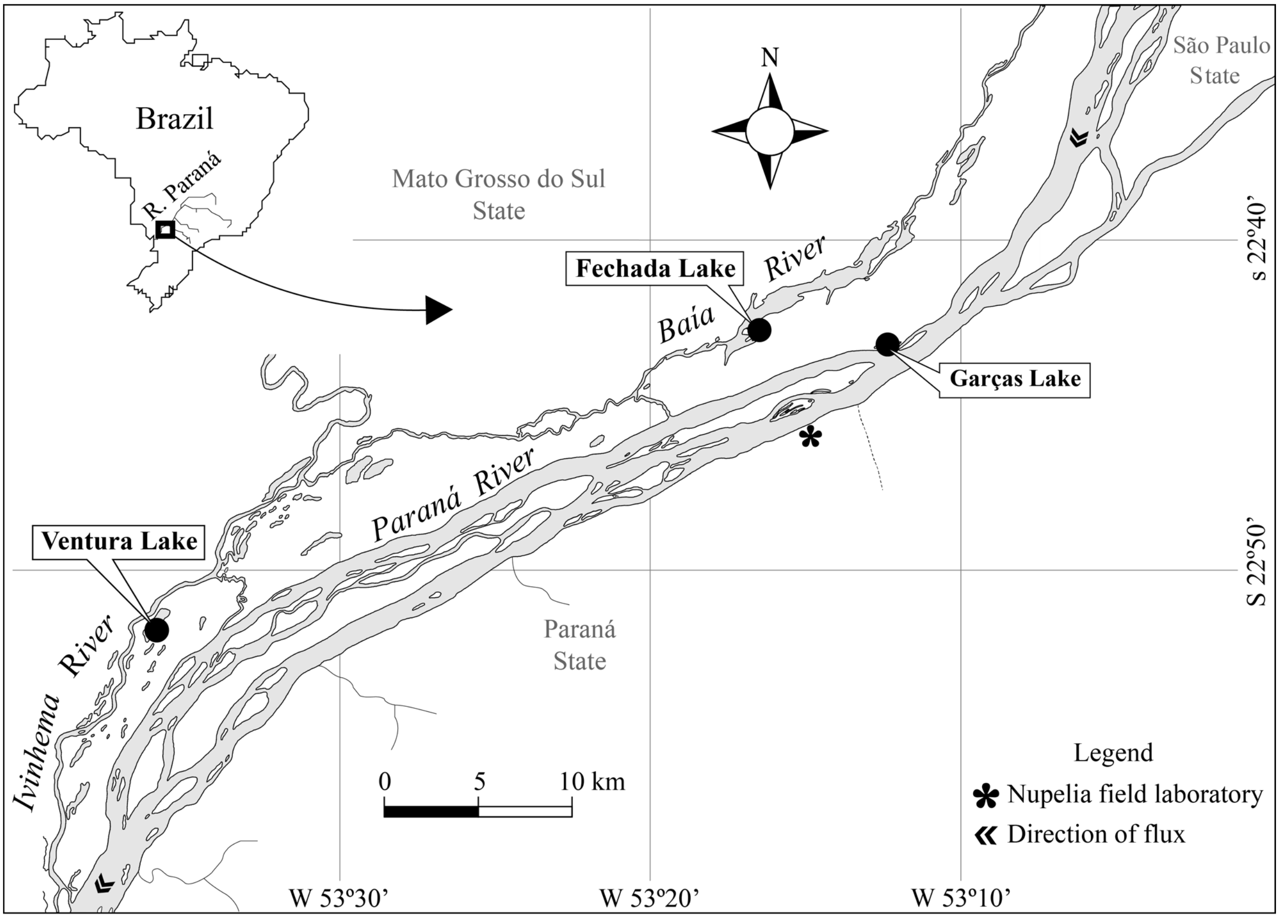

Fig. 1. Map of the sampling locations. Font: PEREIRA, Jaime Luiz Lopes, 2021.

obtained by scraping the petioles of the aquatic macrophyte *Pontederia azurea* Sw. 30 cm from the surface of the lagoon (Benedito-Cecilio *et al.*, 2000).

Subsequently, the phytoplankton and POC samples were filtered and retained in glass fiber filters (Whatman GFC) with an opening of 47 µm, which were calcined previously for four hours at 450°C. Then, the samples were dried in a forced ventilation oven for 72 hours at 60°C, macerated to obtain a fine powder, and sent to the U0C Davis Facility Stable Isotope (USA) laboratory for isotopic determination of carbon and nitrogen, expressed in delta (δ) and parts per thousand (‰), which is relative to the international standard PeeDee Belemnite (PDB) for $\delta^{13}C$ and atmospheric nitrogen for $\delta^{15}N$. The analyzes were performed in a mass spectrometer as stated in the expression (Lajtha & Michener, 1994): $\delta (‰) = (R_{sample}/R_{standard} -1)*1000$, where: $R = {}^{13}C : {}^{12}C$ ou ${}^{15}N : {}^{14}N$

Data analysis.

All data analysis was performed using R software packages (R Core Team, 2020). As a preliminary step, a two-way analysis of variance (two-way ANOVA) was performed, both with the Subsystem factors (levels: Baía, Ivinhema and Paraná) and groups (levels: cladocerans, biofilm, phytoplankton, and POC) and the response variables of each analysis were the values of $\delta^{13}C$ and $\delta^{15}N$. Two-way ANOVA was performed by creating a linear model with the "lm" function of the "stats" package and by calculating the analysis of this model with the "Anova" function, type III, of the "car" package. The post-hoc interactions of the factors for the values of δ13C (GL = 6; F = 23.066; p < 0.01) and $\delta^{15}N$ (GL = 6; F = 2.8968; p = 0.021) were analyzed using the Tukey's method, calculated with the "glht" function of the "multcomp" package. A confidence interval of 95% was adopted.

The posterior trophic position was calculated in the tRophicPosition package (Quezada-Romegialli *et al.*, 2018). The package used two baselines (organic matter (POC) and living organisms (phytoplankton and periphytic biofilm)) to estimate the mode of posterior trophic position and used the enrichment factor proposed by Post (2002) of 0.39 ± 1.3 for $\delta^{13}C$ and 3.42 ± 0.98 for $\delta^{15}N$. The package performed 10,000 adaptive interactions, 10,000 interactions as recordings discarded, and 10,000 interactions (Quezada-Romegialli *et al.*, 2018).

To obtain the relative contribution of possible food sources to consumers' biomass, the stable isotope mixture model, SIMMr, was used (Parnell *et al.*, 2019). Initially, the posterior trophic position mode values calculated in the tRophicPosition package (Quezada-Romegialli *et al.*, 2018) were multiplied by the mean and standard deviation values of δ^{15}N (3.42 and 0.98, respectively), and δ^{13}C (0.39 and 1.3, respectively) (Post, 2002) to obtain the corrected fractionation. The SIMMr package uses the JAGS programmer (Jusr Another Gibbs Sampler) to run the Baysian model of isotope mixing. The model executes through the simmr_out function together with the sim_mcmc argument, which uses a Markov Chain Monte Carlo (MCMC) to find the contribution value that best fits the data. Thousands of initial interactions are performed and are discarded in the burn-in phase, the later interactions are stored, and the best ones are used by the model (Parnell *et al.*, 2010, 2019). The results of the mean and standard deviation of the contributions of the basal sources and the confidence intervals of 2.5%, 25%, 50%, 75%, and 97.5% were obtained through the summary function, using the 'statistics' 'argument' and 'quartiles', respectively.

RESULTS

Lagoon Fechada and Lagoon Ventura were characterized by their high values of turbidity, nitrogen, total phosphorus, and the low value of water transparency, in contrast to Lagoon das Garças; chlorophyll showed higher values in the Ventura Lagoon and Garças Lagoon in comparison to the Fechada Lagoon (Tab. I). In Lagoon Fechada, there was a significant difference in the values of δ^{13}C of the biofilm in phytoplankton ($t = -5.423$; < 0.01) and POC ($t=-5.515$; $p < 0.01$) and in cladocerans ($t = - 5.205$; $p < 0.01$). There was no significant difference in δ^{15}N values between groups in this Subsystem. In Ventura Lagoon, POC and cladocerans were significantly different for δ^{13}C ($t = -3.517$; $p = 0.048$). In this Subsystem, there was also no significant difference in δ^{15}N values between groups (Fig. 2).

In Lagoon das Garças there was also a significant difference in the δ^{13}C values of the biofilm and all sources, phytoplankton ($t = -13.420$; $p < 0.01$) and POC ($t = -11.825$; $p < 0.01$), and cladocerans ($t = -8.885$; $p <0.01$). In addition, a remarkable difference in these values between phytoplankton and consumers ($t = -4.898$; $p < 0.01$) was also observed. Only in this Subsystem was there a significant difference in the values of δ^{15}N between the groups: biofilm and POC ($t = -4.665$; $p < 0.01$). The δ^{15}N values of the biofilm showed a high average compared to all other energy sources in all environments, but it was significantly different only for the phytoplankton of the Fechada Lagoon ($t = -33.725$; $p = 0.028$) and the Ventura Lagoon ($t = -4.137$; $p < 0.01$) and the POC of the Ventura Lagoon ($t = - 4.154$, $p < 0.01$). Comparing the differences between the groups between the Subsystems, only the δ^{13}C values of the biofilm differed significantly between all the Subsystems: Paraná and Ivinhema ($t = 10.721$; $p < 0.01$), Paraná and Baía ($t = 4.656$; $p < 0, 01$), and Baía

Tab. I. Abiotic data obtained from lagoons sampled. NT = nitrogen total, PT = total phosphorus

Lakes	Oxygen (mg/L)	Turbidity (NTU)	Water transparency (m)	Chlorophyll (ug/L)	TN (ug/L)	TP (ug/L)
Fechada	1.66	6.0	0.8	1.950	1126.517	60.298
Ventura	4.04	11.0	0.7	6.825	1600.758	65.607
Garças	5.57	2.6	2.2	4.368	705.855	25.126

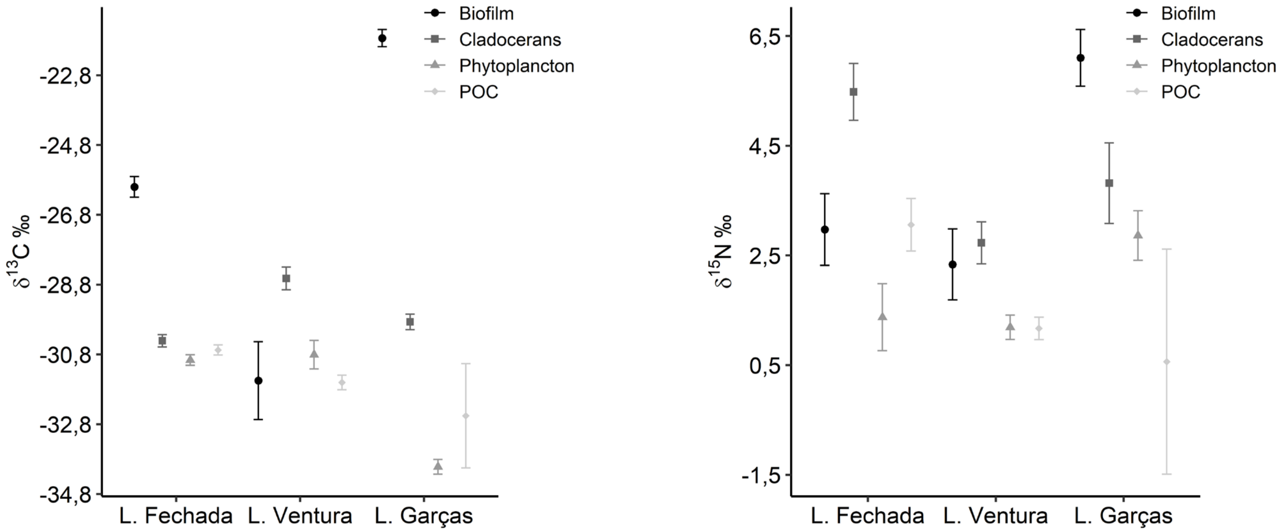

Fig. 2. Mean and standard error for values of δ^{13}C and δ^{15}N for the three lagoons analyzed.

and Ivinhema ($t = -6.551$; $p < 0.01$). In addition to this, the phytoplankton of Paraná and Ivinhema had significantly different δ^{13}C values ($t = -3.792$; $p = 0.024$) (Fig. 2).

The posterior trophic position mode for the cladocerans of the analyzed environments was 2.3 for the Ventura and Garças Lagoon and 2.7 for the Fechada Lagoon. A trend toward the greater contribution of phytoplankton to cladoceran biomass was identified (49.9%, 40.4%, and 35.3% in the Fechada, Ventura, and Garças Lagoons, respectively) (Fig. 3). POC was the second largest contributor to cladoceran biomass, followed by periphytic biofilm. In Lagoon das Garças, phytoplankton and POC presented similar contribution means (35.3% and 36.7%, respectively), as did the POC and periphytic biofilm in Lagoon Ventura (28.6% and 31.0 %, respectively). In Lagoon Fechada, there was a greater difference in contribution between the three food sources, 49.9% for phytoplankton, 32.9% for POC, and 17.2% for periphytic biofilm.

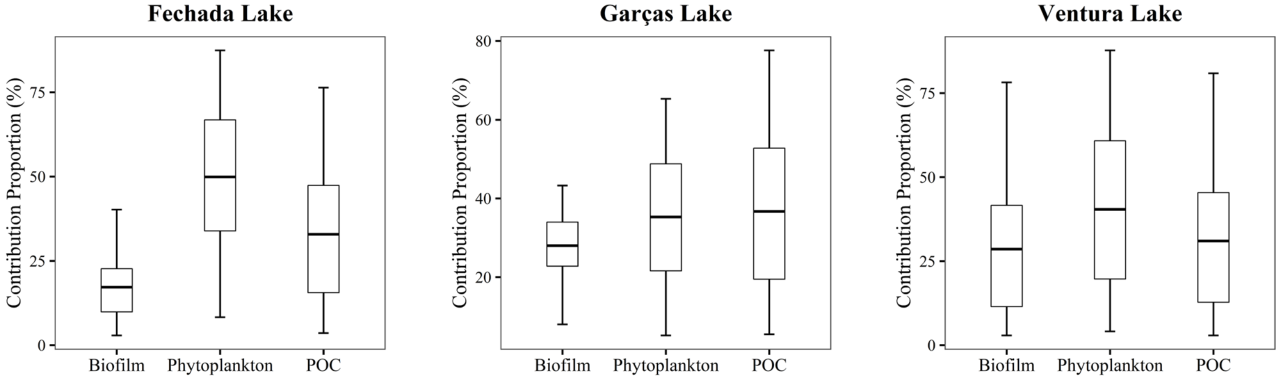

Fig. 3. The proportion of the contribution of POC, phytoplankton, and biofilm to cladoceran biomass in the three PIAP lagoons. Boxplots show the quartiles of 97.5%, 75%, 50%, 25%, and 2.5%. The lower and upper boxes indicate the 25% and 50% quartiles. Likewise, the lower and upper vertical lines indicate the 97.5% and 2.5% quartiles and the horizontal lines show the mode of contribution.

DISCUSSION

Isotopic values of δ^{13}C of phytoplankton presented very negative means as reported in the literature (Fry, 2006). The difference observed between the studied lakes may be due to the phytoplanktonic composition of these environments since some algae taxa, such as diatoms, tend to have a more depleted δ13C signature. The difference observed for the δ^{13}C of the biofilm may be due to the constitution of biofilm and the taxonomic composition of algae (Gearing *et al.*, 1984). The δ^{13}C of the POC, in general, represents the phytonomic composition surrounding the aquatic body (Martinelli *et al.*, 2005).

The POC had a characteristic signature of C$_3$ plants. So, POC may be constituted of plant material of arboreal origin, which can reach the water body by the leaching process, despite the fact that Ventura e Fechada Lagoon is surrounded by grass (Comunello, 2000). Furthermore, it is reported in the literature that POC with very negative values (-32‰ to -28‰), as observed in this study, is associated with the high presence of phytoplankton in its composition (Kendall *et al.*, 2001). The difference observed between the δ^{15}N in the Ventura Lagoon (conserved environment) and Garças Lagoon can indicate pollution from agriculture or livestock since these can cause δ^{15}N enrichment of the local biota (Chappuis *et al.*, 2017).

The cladocerans showed similarity in the signature of δ^{13}C and δ^{15}N in analyzed lakes, in line with the values in the literature for these organisms (Perga, 2011; Santana *et al.*, 2011). Their trophic position showed that they occupy the second place in the food web as observed in the literature and expected for primary consumer organisms. The higher trophic position in the Fechada Lagoon may be due to the presence of predators in the sample, increasing the average of δ^{15}N values interfering with the calculation of trophic position, performed with *Bosmina hagmanni* (Stingelin, 1904) and *Moina minuta* (Hansen, 1899), at PIAP (Santana *et al.*, 2011). The hypothesis that PIAP cladocerans have greater assimilation of algal carbon and less POC in their biomass was partially accepted since in the Lagoons the phytoplankton contributed more than 35% of cladoceran biomass, regardless of the chlorophyll concentrations in the ponds (Tab. I, Fig. 3). Phytoplankton is one of the most nutritious sources of energy in lake environments (Guo *et al.*, 2021). It is responsible for providing essential compounds for the upper levels of the food web, such as nitrogen compounds and fatty acids (Brett *et al.*, 2007). This may indicate that, in spite of their availability, more nutritious foods are preferentially used (Marcarelli *et al.*, 2011). Thus, this present study reinforces that this zooplankton community assimilates the carbon from this nutritional source.

However, the POC was the largest contributor in Lagoon das Garças and presented intermediate values of contribution to the biomass of cladocerans in the other two Lagoons. This may be due to the collections carried out in the rainy season, which was characterized by the flooding of water bodies in the floodplain and, consequently, by a greater contribution of allochthonous organic matter to these environments (Junk, 1989). Even though POC is characterized as a poor energy source for primary consumers (Brett *et al.*, 2007), greater availability of this food resource may have contributed to the high concentrations of cladoceran biomass as zooplankton can change their eating habits according to food availability (Kiørboe *et al.*, 2018). To confirm this hypothesis, it would be important that new studies be conducted during the dry season.

Thus, it is possible to infer the importance of these zooplanktonic organisms because they transfer energy from primary producers to higher levels of the food web and are fundamental in the cycling of organic matter in the ecosystem. Therefore, the zooplankton adds complexity to the detritivore web (Chambord *et al.*, 2017). They correspond to links between the decomposer web and higher trophic levels in carbon transfer (Chen & Wang, 2018). The POC, in all Lagoons, was responsible for at least 30% of the cladoceran energy source. This result demonstrates the importance of cladocerans in the coupling between the green and brown food web, often studied separately (Evans-White & Halvorson, 2017; Eckert *et al.*, 2020). Thus, this indicates the importance of carrying out studies interconnecting these two food webs (Mougi, 2020; Atkinson *et al.,* 2021).

The significant contribution of POC to cladoceran biomass indicates the relevance of this community in the upwelling of nutrients seized in organic matter suspended in the water column, especially nitrogen (Buchkowski *et al.*, 2019) and phosphorus that is available to the environment, resulting from residual processes of the metabolism of these animals (Atkinson *et al.*, 2021). These nutrients contribute to the growth of primary producers (Buchkowski, 2019; Mougi, 2020; Atkinson *et al.*, 2021). Organisms that feed on the organic matter can play a fundamental role in ascending control in green webs (Atkinson *et al.*, 2021). Thus, the multichannel feeding of cladocerans may contribute to the stability of the nutrient cycle in the studied lakes, establishing interaction with the green food web (Pauli *et al.*, 2019) as their diet includes organic material in suspension. Many studies that seek to elucidate the basis of the cladoceran-based food web focus only on observing the food dynamics of primary consumers based on diets related to phytoplankton and POC (Brett *et al.*, 2007, 2009), thus ignoring the periphytic biofilm, a food resource of high nutritional value (Guo *et al.*, 2021). The results obtained indicate that the biofilm is relevant for the biomass of cladocerans. This also demonstrates the importance of macrophytes in these environments where the biofilm develops, mainly on the petioles of these plants (Biolo *et al.*, 2015). In addition, macrophyte banks contribute to a high taxonomic diversity of the zooplankton community by adding environmental heterogeneity (Deosti *et al.*, 2021).

The isotopic signature of POC and biofilm indicates a food web originating in the coastal region of the lake and the isotopic signature of phytoplankton in consumers shows that the food web has its origin in the pelagic zone of the Lagoon (Post, 2002). Thus, these results can help to identify the source of energy in these Lagoons and show the broad ecological dynamics of this group of consumers (Rizo *et al.*, 2017). The results indicate that the coastal zone is responsible for sustaining most of their trophic relationships when we consider the contribution of POC and biofilm since all environments exist with a greater abundance of coastal zooplankton (Braghin *et al.*, 2018; Deosti *et al.*, 2021).

Cladocerans are a link for energy transfer from aquatic environments (Arunpandi *et al.*, 2020) and can also be considered a link between aquatics compartments due to abiotic factors, such as winds and microhabitats, in addition to other factor biotics, such as predation and horizontal migrations in the lake (Antón-Pardo *et al.*, 2021). Thus, when they feed in the coastal region and are preyed on in the pelagic zone, they transfer energy from one compartment to the other. This fact highlights the importance of preserving the environment surrounding the Lagoons since the coastal zones are the most affected by anthropic impacts (Abdelhady, 2021), which can interfere with the entire trophic web of the lacustrine environment.

We demonstrated that the PIAP cladocerans present greater assimilation of phytoplankton and a high assimilation of POC, which had a $\delta^{13}C$ isotopic signature similar to arboreal plants (Martinelli *et al.*, 2005), showing the importance of conservation from the riparian forest. The greater assimilation of phytoplankton to other food sources of cladocerans and in environments with different concentrations of chlorophyll in the water may be due to its higher nutritional value. Assimilation of the POC, however, could be due to its high availability in the rainy season of the floodplain.

Thus, cladocerans play a coupling role between the detritivore and herbivory web by serving as an energetic link between the aquatic compartments (coastal and pelagic). Therefore, the study highlights the importance of conserving the environment around the Lagoons. Cladocerans directly influence the coastal region of the Lagoons, which is essential for this community and serves as the basis for the trophic relationships between both webs.

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