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Variation of Chironomidae (Insecta: Diptera) trophic guilds and their relation with trophic state in reservoirs in the semiarid

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ABSTRACT

The Chironomidae larvae are sensitive to variations in aquatic ecosystem conditions. We aim to analyze the variation of Chironomidae trophic guilds and their relation to the trophic state index in reservoirs in the semiarid. The study was conducted from 66 sites, distributed in the littoral zone of three reservoirs of Piranhas-Assu river, during June and December of 2014. The larvae were collected, and after identification, were classified in functional trophic groups. We applied the Trophic Status Index of Carlson, modified by Toledo for trophic classification. Sabugí reservoir was the only classified as mesotrophic (52,60±3,64) in June, where the greatest levels of diversity also occurred in the trophic guilds: gatherer-gollector (9 genera), predator (6 genera) and filterer-collector (1 genus). Higher levels of eutrophication occurred in Passagem das Traíras reservoir (84,99±6,19), the same with the smallest diversity in the guilds: gatherer-collector (3 genera) and 1 genus in the other categories. The variation of trophic guilds has been associated with trophy levels, because higher levels of degradation eliminate sensitive species, reducing the number of taxa. Thus, the Chironomidae trophic guilds demonstrate potential capacity for indicating the degree of impact to which the reservoirs are submitted.

Keywords: Benthic Macroinvertebrates; Eutrophication; Bioindicators; Feeding Trophic Groups

RESUMO

As Larvas de Chironomidae são sensíveis às variações nas condições de ecossistemas aquáticos. Objetivamos analisar a variação das guildas tróficas de Chironomidae e sua relação com o índice de estado trófico em reservatórios no semiárido. O estudo foi realizado a partir de 66 sites, distribuídos na zona litorânea de três reservatórios do rio Piranhas-Assu/ RN, durante Junho e Dezembro 2014. As larvas foram coletadas e, após identificação, foram classificadas em grupos tróficos funcionais. Aplicamos o índice de estado trófico de Carlson modificado por Toledo para classificação trófica. O reservatório Sabugí foi o único classificado como mesotrófico (52,60±3,64) em Junho, onde também ocorreu os maiores níveis de diversidade nas guildas tróficas: coletor-catador (9 gêneros), predador (6 gêneros) e catador-filtrador (1 gênero). Maiores níveis de eutrofização ocorreram em Passagem das Traíras (84,99±6,19), mesmo reservatório com a menor diversidade nas guildas: coletor-catador (3 gêneros) e 1 gênero nas demais categorias. A variação das guildas tróficas esteve associada aos níveis de trofia, pois maiores níveis de degradação eliminam espécies sensíveis, reduzindo o número de taxa. Deste modo, as guildas tróficas de Chironomidae mostraram capacidade potencial de indicação do grau de impacto a que os reservatórios estão submetidos.

Palavras-chave: Macroinvertebrados bentônicos; Eutrofização; Bioindicadores; Grupos Tróficos Alimentares

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1 INTRODUCTION

The Brazil semiarid region is characterized by presenting irregularities in its precipitation, what results in the formation of a wide network of intermittent rivers (CIRILO *et al*., 2010). On account of it, the construction of reservoirs became a feasible option to deal with water shortage problems, since these systems present great potential in water retention, and make it possible to supply the population, they provide a social and economic development in the region (CHELLAPPA *et al*., 2009; LIMA 2012).

The construction and use of these reservoirs of recreation activities, tourism, navigation, irrigation, agribusiness, fishing and agriculture have modified the natural aquatic ecosystems, causing changes in habitats and interfering with water runoff (TUNDISI, 2006). Furthermore, the reservoirs also contribute to a greater retention of organic matter, modifying the physical and chemical characteristics of water (PRADO; MORAIS-NOVO, 2007; TUNDISI, 2008; MELO *et al*., 2017). In many cases, these alterations promote the acceleration in the eutrophication process, which consists in the enrichment of water by organic substances, changing the balance condition and favoring the excessive increase of macrophytes and phytoplankton (CRUZ; FABRIZY, 1995; VIEIRA *et al*., 1998; BUZELLI *et al*., 2013). The eutrophication process may be generating as by punctual sources (ex. domestic and industrial effluents) as diffuses (ex. residues resulting from agricultural activities with multi-channel runoff) (LIMA *et al*., 2016).

Studies, which aim to understand the environment patterns of aquatic ecosystems, before the degradation process has been developed, because the gradual loss of environmental quality affects the structure of biological communities, causing reduction of biodiversity and biotic homogenization (PRADO; MORAIS-NOVO, 2007; PEREIRA, 2011; JOVEM-AZEVÊDO *et al*., 2019). Many biological communities are used for monitoring the trophic state of aquatic ecosystems and, between them, benthic macroinvertebrates community has stood out. This is because, these organisms participate of nutrients cycling nutrients (CALLISTO; ESTEVES, 1995) and the energy flow of the ecosystem, being the link between producers and consumers and composing most of the food resources for other aquatic organisms (SANSEVERINO; NESSIMIAN, 2008).

The species that compose the benthic macroinvertebrates community exhibit a wide range of functional trophic classes, especially the Chironomidae (Insecta: Diptera) family (ROQUE *et al*., 2005; SAULINO *et al*., 2017), object of this study. This family is represented by a great variety of species and highlights itself among the others for its large distribution and ability to tolerate different environmental conditions (ROSIN *et al*., 2010; VIEIRA *et al*., 2012; SERRA *et al*., 2017). Due to the ecological importance of chironomids, studies, which consider their eating habits are increasingly significant (SANSEVERINO; NESSIMIAN, 1998; TRIVINHO-STRIXINO; STRIXINO, 1998; NESSIMIAN *et al*., 1999; ROQUE; TRIVINHO-STRIXINO, 2001; HENRIQUES-OLIVEIRA *et al*., 2003; ROQUE *et al*., 2005; SANSEVERINO; NESSIMIAN, 2008; BUTAKKA *et al*., 2014) and associate a set of trophic guilds.

The term trophic guild was proposed, firstly, by Root (1967) referring to a group of species that exploit the same category of food resources, similarly in a specific area. However, to arrive at a broader definition of trophic guild is necessary the use of taxonomic groups, feeding resources and functional feeding groups (Functional Feeding Groups – FFG) (SIMBERLOFF; DAYAN, 1991). Considering FFG refers to the sort of resource consumed and the morphological and behavioral mechanisms in order to obtain these resources (CUMMINS, 1973; CUMMINS *et al*., 2008).

Consequently, the understanding about the trophic guilds may constitute a useful and stable tool for the for environmental quality assessment, as it allows: i) showing which feeding resource stands out in the system; and ii) analyze how different groups of organisms behave in the face of environmental variations, since such changes modify the feeding resources available. For this reason, in this study, we had as the main goal, analyze the variation of trophic guilds from Chironomidae (Insecta: Diptera) family in reservoirs in the semiarid region under different trophy conditions. We expect the greatest diversity (number of genera/guilds) and trophic guild abundance occur in the places, which present better environmental condition bearing in mind that the distribution of the trophic guilds of the group studied will be related to the availability of feeding resources. In addition, that the trophic guilds variation occurs according to the local trophic quality, what may represent a potential tool for the monitoring of water quality in semiarid reservoirs.

2 MATERIALS AND METHODS

2.1 Study area and sample design

The study was performed in the Sabugí reservoirs, Cruzeta and Passagem das Traíras, all of them located in the Rio Piranhas-Assu watershed, Rio Grande do Norte state, Northeast Brazil (Figure 1; Table 1). This watershed is located in the central part of Rio Grande do Norte state, being its headwaters localized in the Serra do Piancó in Paraíba state and its mouth is next to Macau city, in Rio Grande do Norte state. The watershed embraces a territory of 42,900 km^2, where approximately 1,552,000 people live, residents in 147 municipalities, 102 in Paraíba and 45 in Rio Grande do Norte. (Instituto de Gestão de Águas do Rio Grande do Norte 2016).

A total of 66 sampling sites was selected in the littoral zone of the reservoirs (Figure 1) and sampling occurred in June (higher water volume) and December (lower water volume) 2014 (Table 1).

Table 1 - Characterization of Sabugí reservoirs, Passagem das Traíras e Cruzeta, located in the Piranhas-Assu river basin, in the state of Rio Grande do Norte (Instituto de Gestão de Águas do Rio Grande do Norte, 2016). Jun = June (1° period of sampling); Dec = December (2° period of sampling). *In percentage parenthesis of water volume. Data source: Secretaria de Meio Ambiente e Recursos Hídricos (SEMARH – Estado do Rio Grande do Norte).

Reservoirs	**Localization**	**Muncipalities**	**Altitude (m)**	**Maximum capacity (m^3)**	**Water volume/period ($106m^3$)***
Sabugí	6° 46’ 46” S 36° 47’ 47”W	São João de Sabugí	335m	65,334,880.00	18 (27.7%) / Jun 9 (13.8%) / Dec
P. Traíras	6° 27’ 16” S 36° 52’ 29” W	São José do Seridó	196m	49,702,393.65	3 (8.0%) / Jun 1 (2.0%) / Dec
Cruzeta	06° 24’ 32” S 36° 48’ 01”W	Cruzeta	217m	23,545,745.33	5 (20.8%) / Jun 2 (8.3%) / Dec

2.2 Physical and chemical water variables

In situ parameters were analyzed: temperature (ºC), pH and dissolved oxygen (DO - mg/L), using multi-parametric probe Horiba (U-50). The transparency of water (WT – m) was measured by means of disappearance of Secchi's disc in the water column (POMPÊO, 1999).

At each site, one liter of water was collected in the subsurface to estimate the concentration of: total phosphorus (TP - µg/L), reactive soluble phosphate (PO_4^- - µg/L), total nitrogen (TN - µg/L), following methodologies described in “Standard Methods for the Examination of Water and Wastewater” (APHA, 2005). The concentrations of chlorophyll-a (Chlo-a - µg/L) were determined after water filtration and acetone pigment extraction 90% (LORENZEN, 1966).

Figure 1 - Map of the location of the reservoirs belonging to the Piranhas-RN watershed, in the state of Rio Grande do Norte, Northeast Brazil. The black points in the figure represent the sampling sites.

2.3 Trophic state index (TSI)

The evaluation of the trophic state of the reservoirs was performed in agreement with Carlson index (1977), modified by Toledo *et al*. (1983). The result of the index is composed by a sub index of trophic state to total phosphorus TSI (TP) orthophosphate TSI (PO_4^{-3}), Chlorophyll-a TSI (Cla-*a*) and water transparency TSI (SD).

The final values allow classifying the environments in: Oligotrophic (TSI ≤ 44), Mesotrophics (TSI ≥ 54) and Eutrophics (54< TSI). Here, we have selected the Trophic State Index of Carlson (1977), because it has been considered the index more indicted to trophic level of reservoirs (for equation details see AZEVÊDO *et al*., 2015).

2.4 Chironomidae Community

To inventory the biodiversity of the Chironomidae family, sediment samples were collected with the aid of Ekman-Birge dredger (area 225cm²). The material collected was transferred to plastic bags and fixed in the field with formaldehyde at 10%. In the laboratory, samples were washed on 0.5mm mesh sieves for organism retention. Thereafter, the material was sorted and subsequently the individuals found were preserved in 70% alcohol. The identification was carried out at genus level, with the aid of a stereomicroscope and microscope according with specialized identification key (TRIVINHO-STRIXINO, 2011).

2.5 Classification of trophic groups

After identifying and counting the collected individuals, trophic classification was conducted according Coffman and Ferrigton (1996), in the following categories: gatherer-collector, filterer-collector, shredder, predator and scraper. Knowing that: (I) gatherer-collector: includes organisms that use as feeding resource small fragments of organic matter disposed in the sediment; (II) filterer- collector: organisms which feed by filtration of suspended material in the water column; (III) shredder: shred parts of vegetables like macroalgae, wood and submerged leaves; (IV) predator: they feed of other alive organisms or their tissues and body fluids and (V) scraper: are adapted to remove algae stuck on the surface.

2.6 Data analysis

Verifying if there is significant variation in the abundance of trophic groups of Chironomidae was performed “Permutational Multivariate Analysis of Variance” (PERMANOVA) (ANDERSON *et al*., 2008). Three factors were selected: sampling period (two levels: June and December), reservoirs (three levels: Sabugí, Passagem das Traíras e Cruzeta) and trophic classification (three levels: oligotrophic, mesotrophic and eutrophic). The abundance data of the trophic guilds were transformed into square root and Bray Curtis was selected as similarity matrix. The significance tests were considered from 9999 permutations (ANDERSON *et al*., 2008).

To assess significant differences in the environmental variables analyzed, also were performed PERMANOVA's series, considering the same factors selected for trophic guilds. The data environmental distribution was previously evaluated since the correlation of Spearman (Draftsman's Plot). The environmental data with distorted distribution were transformed in log (x+1) and normalized later (Euclidean distance was considered as a similarity matrix).

To analyze the trophic quality variation, we applied the Euclidian distance matrix about the data of TSI and then we employ ANOVA tests, taking into account the same factors previously selected for analysis of trophic guild variation and environment variable.

For viewing results referring to trophic state and the abundance of trophic guild, it was used Box-plots graphics. All the statistical analysis was performed in statistical program PRIMER 6+PERMANOVA (2006). The construction of Box-plots graphics was carried out in the statistical program R (The R Development Core Team, 2016), using the vegan package (OKSANEN, 2016).

3 RESULTS

3.1 Environment variables

Significant differences were found for environment variables as among the reservoirs (PERMANOVA: Pseudo-$F_{2.112}$ = 37.1; p = 0.0001), sampling periods (PERMANOVA: Pseudo-$F_{1.112}$ = 34; p = 0.0001), and trophy of study reservoirs (PERMANOVA: Pseudo-$F_{1.112}$ = 10.89; p = 0.0001).

In the data set of environment variables, we observed that the waters of reservoirs were hot and with neutral to alkaline pH. During June and December the higher concentrations of dissolved oxygen occurred in Passagem das Traíras reservoir (9.81 mg/L ± 6.18; 11.3 ± 5.63, respectively) (Table 2 and Figure 2A-B). In this reservoir, we noted less water transparency in both months (38 cm ± 18 June e 31 cm ± 17 December) (Table 2 e Figure 2 C-D).

During the study period, the higher concentration of total phosphorus occurred in Jun in Cruzeta reservoir (279 µg/L ± 207). Furthermore, the last sampling period (December), the level of concentration of that nutrient was higher in Passagem das Traíras reservoir (1192.66 µg/L ± 349.33) (Table 2 and Figure 2E-F).

In relation to total nitrogen concentrations, in both June and December, the highest concentrations were registered for Passagem das Traíras reservoir (210.76 µg/L ± 68.15; 460.86 µg/L ± 45.97, respectively) (Table 2 e Figure 2G-H). As well as for total nitrogen, the concentrations of chlorophyll- a in both studied months were higher in that same reservoir, being: June 56.62µg/L ± 27.41 and December 281.79µg/L ± 74.6 (Table2 e Figure 2I-J).

3.2 Trophic Classification

From classification of trophic state in reservoirs was possible to watch that in the period of June Sabugí reservoir was the only one classified as mesotrophic (52.60 ± 3.64), and the other reservoirs were classified as eutrophic: Passagem das Traíras – 63.79 ± 4.49 and Cruzeta – 74.30 ± 1.80. In December, unlike June, Sabugí reservoir achieved an average for eutrophic classification (65.38 ± 9.14) and the other reservoirs remained as eutrophic: Passagem das Traíras – 84.99 ± 6.19 e Cruzeta 70.10 ± 10.34. Highlighting, in Passagem das Traíras reservoir was registered the highest level of eutrophication during all the study period (Figure 3). Despite the numeric differences, no significant differences were found in the trophy level between the reservoirs (ANOVA: Pseudo-$F_{2.112}$ = 1.56; p = 0.54) and sampling periods amostrais (ANOVA: Pseudo-$F_{1.112}$ = 2.52; p = 0.33). However, significant differences have occurred between the trophic classification (ANOVA: Pseudo-$F_{1.112}$ = 20.19; p = 0.0001).

Table 2 - Environmental variables of Sabugí, Passagem das Traíras and Cruzeta reservoirs, located in the Piranhas-Assu/RN watershed, in the state of Rio Grande do Norte, in June and December 2014.

Environmental Variable	**Reservoir/Period**					
	Sabugí		**P. Traíras**		**Cruzeta**	
	June	December	June	December	June	December
°C	27.82±0.50	28.55±1.46	25.94±0.79	26.32±0.70	26.24±1.40	26.62±0.93
pH	8.45±0.23	7.12±0.35	8.36±0.22	8.57±0.17	7.67±0.25	7.71±0.18
DO (mg/L)	2.35±0.81	7.15±1.22	7.99±1.24	8.26±1.83	7.14±1.09	6.11±1.57
WT (m)	0.68±0.13	0.39±0.13	0.25±0.05	0.25±0.05	0.45±0.17	0.44±0.15
TP (µg/L)	68.85±12.68	255.25±305.96	187.25±18.72	656.89±282.26	321.12±41.46	400.44±296.73
PO_4^- (µg/L)	7.47±4.55	145.53±176.83	13.00±7.84	252.83±168.06	238.73±19.27	222.82±268.20
TN (µg/L)	85.70±7.77	124.87±35.77	118.51±57.20	276.82±121.77	57.63±8.07	109.04±21.60
Chlo-*a* (µg/L)	16.75±9.66	8.71±7.27	41.35±8.88	189.62±55.14	10.89±4.24	12.63±6.56

3.3 Chironomidae Assembly

In the study were identified 9,625 larvae of Chironomidae, distributed in 16 genera: *Ablabesmyia, Aedokritus, Asheum, Cladopelma, Coelotanypus, Chironomus, Dicrotendipes, Djalmabatista, Fissimentum, Goeldichironomus, Larsia, Parachironomus, Pelomus, Polypedilum, Procladius*, *Tanytarsus* (Table 3).

Among the trophic guilds were identified: gatherer-collector (GC); filterer-collector (FC) and predator (P). The guild GC was the most abundant with 6,281 larvae identified (65.26% of representation), being *Goeldichironomus* the most representative genus (3,261 individuals) in this trophic category (Table 3). In FC category, *Tanytarsus* was the only one constituent genus, being registered 2,927 larvae (30.41% of representation). The guild P was represented by 417 individuals (4.33% of representation) during the period of study, with *Coelotanypus* being the most representative genus (309 individuals) (Table 3).

Analyzing the distribution of guilds per reservoir, we observed that in Sabugí reservoir the category GC was represented by 9 genera, P by 6 genera, and FC by 1 genus. In Cruzeta reservoir, the category GC was represented by 7 genera, FC by 1 genus and P by 4 genera. In Passagem das Traíras the category GC was represented by 3 genera, FC and P per only 1 genus (Table 3). Significant differences in the abundance of trophic guilds were found between the reservoirs (PERMANOVA: Pseudo-F2.96 = 8.7; p = 0.0001), sampling periods (PERMANOVA: Pseud- F1.96 = 3.1; p = 0.02) and trophy (PERMANOVA: Pseud- F1.96 = 3.15; p = 0.01).

When we analyze, specifically, the distribution of trophic guilds between the study periods, it was possible to observe that different from what occurred in the period of higher water volume registered (June). In the period of lower water volume (December), in Sabugí there was an increase in the abundance of individuals in the category FC and decrease in abundance of GC. In relation to Passagem das Traíras reservoir in the period of June, in all categories only one individual was found, already in December the category of GC had an increase in the number of individuals. However, the other trophic guilds the other trophic guilds were not registered in this reservoir for the period of December. In Cruzeta reservoir, we found similar representation between trophic guilds obtained in both periods, but with an increase in abundance of individuals of all categories in the period of December. (Table 3).

Figure 2 - Environment variable from Sabugí reservoirs (R1), Passagem das Traíras (R2) and Cruzeta (R3), the hydrographic basin of Piranhas-Assu river, state of Rio Grande do Norte, Northeast Brazil. Vertical lines correspond to the standard deviation and the horizontal line to the mean values of concentration of the variables. Where: DO = dissolved oxygen; WT = water transparency; TP = total phosphorus; TN = total nitrogen; Chlo-a = chlorophyll-a. On the left concentrations during the June period and on the right concentrations during the December period.

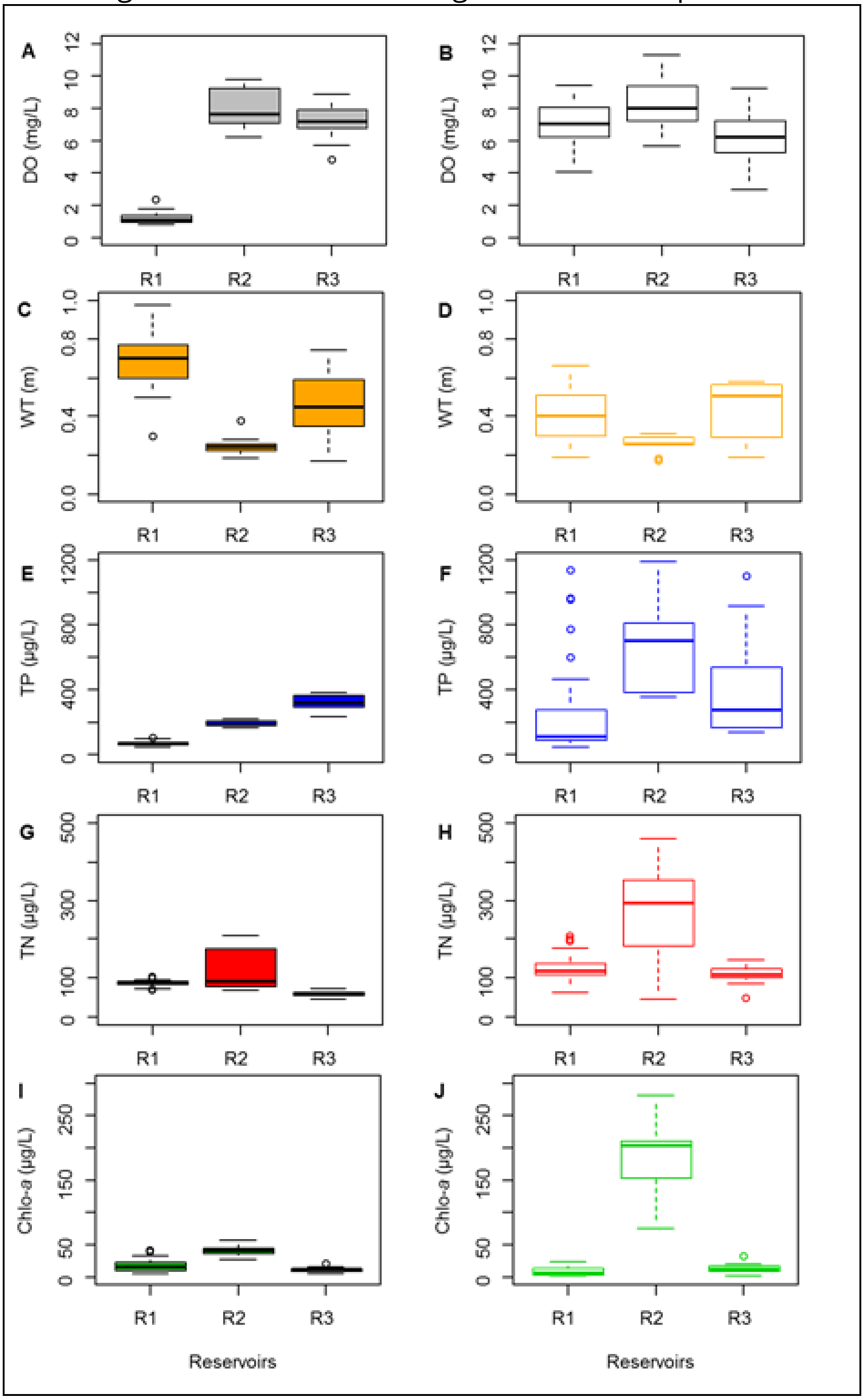

Figure 3 - Index of the trophic status from the Sabugí, Passagem das Traíras and Cruzeta reservoirs, located in the Piranhas-Assu hydrographic basin, Northeast Brazil. Where: Eutro = eutrophic; Meso = Mesotrophic; and Oligo = Oligotrophic.

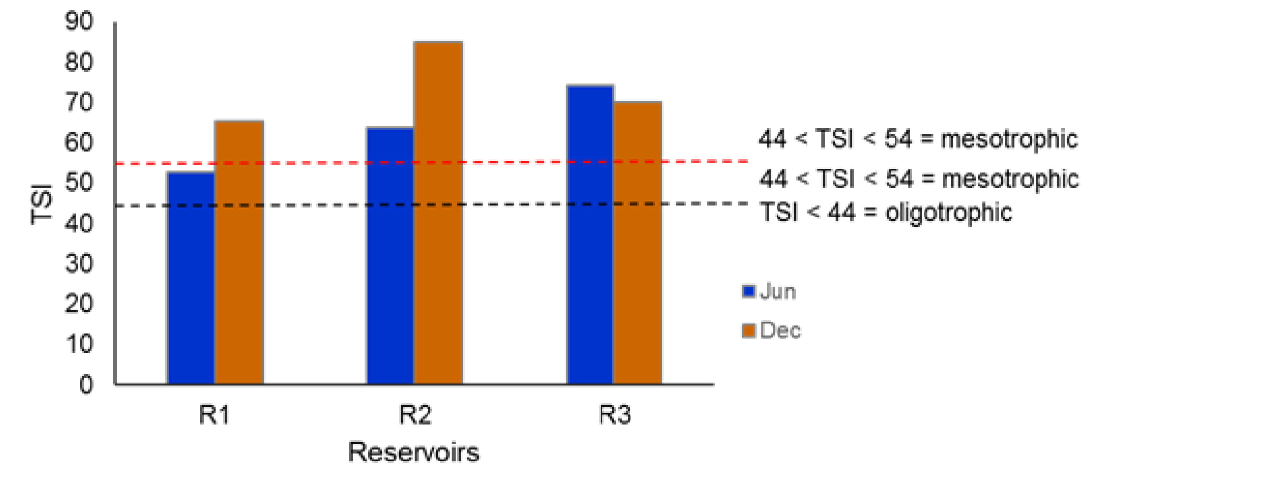

Table 3 - Abundance of Chironomidae (Insecta: Diptera) genera in Sabugí, Passagem das Traíras and Cruzeta reservoirs, located in the Piranhas-Assu watershed, Rio Grande do Norte state, Northeast Brazil, during the months of June and December 2014. Trophic categorization of the identified genera, where: GC = Gatherer-collector; CF = Filterer-collector and P = Predator.

Genus	**Reservoir/Period**						
	June			**December**			
	Sabugí	Cruzeta	P. Traíras	Sabugí	Cruzeta	P. Traíras	Trophic Guild
Aedokritus (Trivinho-Strixino, 1996)	12	0	0	667	224	27	GC
Asheum (Sublette, 1964)	1.026	0	0	25	25	0	GC
Cladopelma (Keiffer, 1921)	0	0	0	2	0	0	GC
Chironomus (Meigen, 1803)	239	35	0	2	13	0	GC
Dicrotendipes (Keiffer, 1913)	15	5	0	35	30	0	GC
Fissimentum (Cranston & Nolte 1996)	1	0	0	256	0	0	GC
Goeldichironomus (Fittkau, 1965)	2.591	429	1	97	143	0	GC
Polypedilum (Keiffer, 1912)	155	1	0	32	127	1	GC
Pelomus (Reis, 1989)	56	3	0	3	0	0	GC
Tanytarsus (Van der Wulp, 1874)	262	30	1	2.430	204	0	CF
Ablabesmyia (Johannser, 1905)	0	0	0	4	0	0	P
Coelotanypus (Kieffer, 1913)	15	1	0	213	80	0	P
Djalmabatista (Fittkau, 1968)	0	0	0	4	1	0	P
Larsia (Fittkau,1962)	6	0	0	1	0	0	P
Parachironomus (Lenz, 1921)	11	5	1	0	0	0	P
Procladius (Skuse, 1889)	0	0	0	9	66	0	P

4 DISCUSSION

The data set of the present study indicates important results on the indicator role of the Chironomidae trophic guilds. We expected that the higher diversity of trophic guilds (nº of genera/guilds) and levels of abundance was founded in places with lower trophy levels (lower values of TSI). This is because, the variation in the trophic guild sets in communities can be determined by the differences in environmental conditions and of available local resources (GRÖNROOS; HEINO, 2012). Sites under levels of anthropogenic pressures present alterations in natural conditions, which act as filters in the selection of species with different requirements (MASESE *et al*., 2014). Our data set indicates that the higher diversity of trophic guilds and abundance occurred in Sabugí reservoir, the same ecosystem in which the lowest trophic level was recorded, confirming what we expected. The best quality of Sabugí's water can be confirmed by the presence of the genus *Fissimentum*, since it is a genus considered as an indicator of good environmental quality (LEAL *et al*., 2004; MORAIS *et al*., 2010; MOLOZZI *et al*., 2011) and it was restricted to that reservoir.

In the present study, the guild gatherer-collector was the most diverse (larger number of genera associated) and more abundant, being found in all reservoirs. The organisms belong to this guild, often use as a food resource small fragments of organic matter found in the sediment (COFFMAN; FERRIGTON, 1996). Moreover, the wide distribution of this trophic category can be attributed the great plasticity of organisms which compose it. In addition to biological attributes that favor its permanence in environments with different conditions, for example: presence of respiratory pigment (hemoglobin) and body movement, which makes oxygen uptake more efficient even at very low concentrations (KRAWCZYK *et al*., 2013).

The Filterer-collector was the second guild more abundant and it’s also found in all reservoirs. The filterer-collectors feed on thin particulate organic matter in suspension. The presence of individuals of this guild indicates that thin particulate organic matter is in constant processing, which can be more abundant in intermediate turbidity waters. (LOPES *et al*., 2011; JOVEM-AZEVÊDO *et al*., 2019). Similar results in relation to the trophic groups predominance of gatherer-collector and filterer-collector were registered in previous studies in tropical ecosystems (LOPES *et al*., 2011; CHAGAS *et al*., 2017), corroborating our discoveries.

During the last study period (December) there was an increase of phosphorus and total nitrogen levels, as well as dissolved oxygen levels in all reservoirs. In the same period, we registered an increase in the trophic level of the waters, indicating that the degradation level was higher. The process of eutrophication is one of the main causes of changes in the distribution of nutrients in the aquatic environment, as well as the changes in water quality and in biodiversity, especially in shallow bodies of water (ROSSET *et al*., 2014; MELO *et al*., 2017). This process, mostly, reflects an imbalance environment, in which opportunistic species spotlight, increasing their population, while sensitive species tend to population decline (CARDOSO; MOTTA-MARQUES, 2004). We found that the predominance of trophic group gatherer-collector can be due to higher genera abundance as *Goeldichironomus* and *Asheum*, and trophic group filterer-collector the gender abundance *Tanytarsus*, genera commonly related to high levels of impacts (AZEVÊDO *et al*., 2017, 2018; JOVEM-AZEVÊDO, 2019). Thus, an increase of collector number can indicate larger quantity of organic matter available in the environment, what can be directly related to the increase in nutrient concentrations in the ecosystem.

In contravention of all, Passagem das Traíras was the reservoir with higher trophy level when compared with the other studied reservoirs. In it was registered lower abundance of trophic guilds. Over the course of the study there was also the exclusion of some species and guilds, as gatherer-collector and predator. The patterns noted confirm our hypothesis: larger abundance of trophic guilds of Chironomidae occurs in ecosystems with the best trophic conditions, while a lower abundance and diversity of Chironomidae trophic guilds are supported in sites with low trophic condition, indicating the guilds change according with the local environmental conditions also in artificial ecosystems (as the reservoirs). Gandini *et al*. (2012) emphasize that changes in the proportion of available food resources, may lead to the loss or diminution of some species and trophic guilds.

5 CONCLUSION

This study has shown that the trophic guilds suffer from variation, about diversity (nº of the genera/guild) and abundance according to the trophic state of reservoirs. Reservoirs of highest trophic quality, present a greater diversity of trophic guilds and greater abundance of the occurring taxon. On the contrary, reservoirs with greater status of degradation present lower species abundance, thus as the trophic guilds, indicating the conditions of degradation limit the diversity of species with different requirements.

Furthermore, our findings demonstrate that the Chironomidae trophic guilds represent tools with potential for the assessment of trophic state in reservoirs, allowing the monitoring of the health of these ecosystems.

Finally, water improvement measures of reservoirs should consider the best level of environment quality, giving special priority to maintaining the concentration of nutrients associated with the trophic state of the waters. Such rehabilitation measures can guarantee favorable conditions for the colonization of a variety set of species and trophic groups, which help in preserving the dynamic balance and ecosystem services.

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