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Impact of Anthropogenic Activities on the Zooplankton Community of Aba River in Aba, Abia State

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Abstract
The effect of anthropogenic activities on zooplankton community structure and abundance of the Aba River was studied in five sampling stations for a period of four (4) months. The study showed mean physicochemical parameter value range of temperature 26.7oC–27.7oC, pH 6.7-6.9, salinity 0.11o/o – 0.19o/o, turbidity 0.49–1.35NTU, nitrate 0.28–0.59mg/l, phosphate 0.05±0.01mg/l–0.09±0.06mg/l, dissolved oxygen 10.17–15.43mg/l, and biochemical oxygen demand 3.82 – 6.53mg/l. The biological analysis result showed a total of 14 zooplankton species belonging to 6 taxa. The family Rotifera had the highest number of zooplankton in total, with 1103 indiv/l (or 84.7%), followed by Cladocera and Protozoa with 62 indiv/l (4.8%), Copepod 57 indiv/l (4.4%), Insect 10 indiv/l (0.7%), and Crustacea 8 indiv/l (0.6%). The maximum Shannon-Weiner index of diversity per station per month was 1.730 in station 4 in July. The minimum (0.537) was at station 2 in September. The Megalef Richness Index varied from 1.91 to 2.85. The evenness index (E) ranged from 0.498 to 2.05. It was therefore concluded that anthropogenic activities and nutrient input into the water body influenced the species composition, distribution, and abundance of the plankton community of the Aba River.

Keywords: Toxic Effects, Raffia Palm (Raphia hookeri), Fruit Mesocarp, Oreochromis niloticus (Nile Tilapia), ~~Epebu Creek~~

Introduction

Zooplankton are mobile organisms that float freely in aquatic environments, playing a critical role in the ecosystem. According to Onwuteaka and Edoghotu (2017), zooplankton range in size from microscopic animals, such as protozoans, to larger creatures like jellyfish, which can sometimes be seen without magnification. Zooplankton are categorised into two groups: holoplankton, which spend their entire life cycle in the planktonic state, and meroplankton, which only remain in the planktonic state for part of their life cycle before transitioning to nektonic or benthic lifestyles. Many species of zooplankton possess locomotive appendages that allow them to move through water currents. These adaptations are crucial for predator evasion, particularly during diel vertical migration, and help increase their chances of encountering prey. Zooplankton are considered reliable indicators of changes in aquatic environments due to their sensitivity to variations in water quality (Edoghotu & Friday, 2018). They respond rapidly to factors such as elevated nutrient concentrations, low dissolved oxygen levels, harmful pollutants, poor food quality, and overpopulation (Ndour et al., 2018; Ismail & Adnan, 2016). The growth and abundance of zooplankton communities depend on various biological, chemical, and physical factors within their environment, along with their ability to withstand diverse conditions (Enerosisor et al., 2020). Climatic changes, physicochemical parameters, and vegetation cover all play a significant role in determining the distribution and number of zooplankton (Ekpo, 2013).
Research in tropical rivers of the Niger Delta has shown that zooplankton density increases in months with higher levels of phosphate and nitrates, as confirmed by studies from Onwuteaka and Edoghotu (2017), Oparaku et al. (2022), Puelles et al. (2019), and Josuah et al. (2021). Estuaries, which are nutrient-rich environments, provide strong support for zooplankton communities (Hastuti et al., 2018). In addition, dissolved oxygen levels, especially during the wet season when turbidity is high, influence zooplankton density (Mandu & Imaobong, 2015).

Water, essential for life, plays a fundamental role in ecosystems. Despite the abundance of water sources, their quality can vary significantly (Akagha et al., 2016). Water pollution has detrimental effects on individual species, populations, and entire ecosystems (Puelles et al., 2019). According to the World Health Organisation (WHO, 2007), over 14,000 people die daily due to water-related pollution. Pollution occurs when contaminants disrupt the natural use of water, and it can be caused by human, animal, agricultural, and industrial activities as well as natural processes. Polluted water becomes less suitable for human, animal, agricultural, and even industrial uses (Ndour et al., 2018). Water quality is determined by physical, chemical, and biological factors (Enerosisor et al., 2020), and contamination can alter these characteristics. Aquatic environments are exposed to various pollutants, including those that affect the taste and odour of water. Some contaminants may not directly affect humans but still have severe consequences on the ecosystem, while others pose significant health risks. Common water pollutants include oxygen-demanding wastes, pathogens, nutrients, synthetic organic compounds, oils, radioactive materials, heat, inorganic chemicals, and minerals. Heavy metals such as mercury, arsenic, lead, cadmium, and copper can bioaccumulate in organisms or settle in sediment. Aquatic species can transport these metals across ecosystems, as shown by Coria-Monter et al. (2020). Hydrodynamic action also contributes to the movement of metals within aquatic systems.

Materials and Methods

The Aba River, located in southern Nigeria, originates from the Imo River and flows in a north-south direction before reaching Cross Rivers State, where it discharges into the Atlantic Ocean along the Nigerian coastline (Onwuteaka & Edoghotu, 2017). The Ada Creek area's economic activities include vehicle washing, fishing, industrial water sourcing, and the operation of an abattoir. Residents in upstream areas also rely on the river for drinking water and household uses (Oparaku et al., 2022). The river is geographically positioned between Longitude 7°19' to 7°23'E and Latitude 5°05' to 5°10'N, near Aba in Abia State, Nigeria. For this investigation, five sampling sites were selected along the creek. These sites were chosen based on their accessibility and ease of sample collection. Water samples were collected monthly from July to October over a period of four months, using clearly labelled plastic containers that had been thoroughly cleaned with strong nitric acid and rinsed with distilled water. The collected water samples were used for water chemistry analysis. Surface water samples were gathered in plastic containers at each site, while salinity, pH, and dissolved oxygen (DO) samples were collected in specialised bottles. The DO samples were placed in 250-ml narrow-necked bottles, which were first rinsed and then fully submerged to fill them without trapping air. To avoid air bubbles, the bottles were stopped underwater and treated with 2 ml of Winkler reagents 1 and 2. Biochemical oxygen demand (BOD) samples were collected simultaneously, stored in loosely covered containers, and transported to the laboratory for incubation and analysis. All laboratory procedures followed protocols established by the American Public Health Association (APHA, 2005). In the laboratory, pH levels were measured using a pH meter (Jenway model No. 2010). The concentration of phosphate (PO_4^{3-}) was determined through the ascorbic acid method, and nitrate concentration was analysed using the brucine method (Alpha 419). For zooplankton collection, a plankton net with a 200-micrometre mesh size was employed. The samples, obtained through a 10-minute tow, were preserved in specimen vials with 10% formalin for further analysis. In the laboratory, these samples were homogenised and subsampled into a Neubauer hemacytometer counting chamber for microscopic identification and enumeration of organisms. The identified zooplankton were classified by family, genus, and species.

Results

Throughout the study, the water temperature remained consistent across all sampling locations. Average temperatures at each station ranged from 26.75±1.26°C to 27.75±1.71°C, which is consistent with findings by Wokoma (2016) but differs slightly from the range of 27°C–32°C reported by Josuah et al. (2021) in Elechi Creek. Similarly, the 26.1°C–32.8°C temperature range observed by Ismail and Adnan (2016) in the lower Bonny River and the 25°C–32°C range in Lagos Lagoon (Puelles et al., 2019) showed variation compared to the present findings. The accumulation of nutrients from industrial and agricultural activities may contribute to temperature variations across different locations. However, these fluctuations in the Aba River's temperature had no significant impact on the zooplankton community's abundance. For example, high temperatures corresponded with months of low plankton abundance, while zooplankton populations were abundant in cooler months. Notably, at Station 5, where the mean temperature was 27.75°C±1.71, zooplankton abundance was lower than at Stations 1 and 2, which had mean temperatures of 26.75±1.26°C and 27°C±1.63, respectively. Conversely, Station 3, with a mean temperature of 27.75°C±1.26, saw a higher zooplankton abundance compared to Station 5. This disparity may be due to additional environmental factors, underscoring the fact that temperature alone does not conclusively correlate with zooplankton abundance. Turbidity levels in the study ranged from 0.49±0.32 NTU to 1.35±1.33 NTU, significantly lower than the 67.35–76.81 NTU range reported by Puelles et al. (2019) in the Ogun River and below the WHO recommended threshold of 50 NTU. Human activities, such as vehicle washing, likely contributed to the elevated turbidity levels in some stations during specific months.

Station 3 recorded the highest average turbidity at 1.35±1.33 NTU, followed by Station 4 at 1.28±1.12 NTU. The higher turbidity levels in these stations were linked to a reduced presence of phytoplankton.

The average pH values observed in this study ranged from 6.7±0.58 to 6.9±0.89, which falls within the acceptable range for biological productivity. These values align with the pH of 6.5–9.5 specified by the World Health Organisation (WHO, 2010) and the 6.5–8.5 range outlined by NESREA (2011) for water suitable for aquatic life and recreational activities. The pH values also correspond to freshwater systems in the Niger Delta, which typically range from 5.5 to 7.0, indicating slight acidity (Imoobe, 2011). Salinity levels in the study varied from 0.11±0.08 o/oo to 0.19±0.18 o/oo, with a decline observed during September and October due to increased water volume from heavy rainfall. Nitrate concentrations ranged from 0.28±0.11 mg/l to 0.59±0.30 mg/l, which is consistent with the findings of Karmakar et al. (2022) on River Lavun, but below the WHO (2010) threshold of 5.0 mg/l. Phosphate levels ranged from 0.05±0.01 mg/l to 0.09±0.06 mg/l, similar to Eli's (2008) results but lower than those reported by Wokoma (2016) and Anthony et al. (2018). The study recorded dissolved oxygen (DO) values between 10.17±4.42 mg/l and 15.43±10.72 mg/l, which are higher than the NESREA (2011) standard of ≥6.00 mg/l and align with the findings of Karmakar et al. (2022). Biochemical oxygen demand (BOD) values ranged from 3.82±2.63 mg/l to 6.53±3.98 mg/l, reflecting similar trends in previous studies on the Aba River by Wei et al. (2019) and River Lavun by Karmakar et al. (2022).

A total of 14 zooplankton species were identified, comprising 1302 individuals from six taxa. Rotifera was the dominant class with 1103 individuals (84.7%), followed by Cladocera and Protozoa with 62 individuals each (4.8%), Copepoda with 57 (4.4%), Insecta with 10 (0.7%), and Crustacea with 8 (0.6%). This lower species count contrasts with the 27 species reported in the Orashi River (Edoghotu & Friday, 2018), but it also aligns with findings in the Echara River (Edoghotu & Wokoma, 2015). Human activities, particularly at Stations 4 and 5, were linked to lower zooplankton populations due to disturbances like car washing and household waste discharge. The study confirms findings by Abbai and Sunkad (2013), who noted that zooplankton distribution is influenced by pollutants introduced by human activities. The diversity indices (Megalef, Shannon-Weiner, and evenness) indicated that zooplankton species were distributed across all stations, with light intensity and water transparency affecting their abundance. The Shannon-Weiner diversity index ranged from 0.537 to 0.900, while the evenness index varied between 0.441 and 0.983.

Conclusion

The study revealed that various physicochemical parameters, such as temperature, pH, salinity, dissolved oxygen, and nutrient levels, along with human activities, significantly influence water quality and the abundance of aquatic organisms, particularly zooplankton. While the water temperature remained relatively stable across the study area, its correlation with zooplankton abundance was inconclusive, suggesting that other factors, such as light availability and turbidity, play a crucial role in shaping aquatic populations. The water quality, as indicated by pH, nitrate, phosphate, and dissolved oxygen levels, was generally conducive to supporting aquatic life and fell within acceptable standards set by organisations such as the World Health Organisation (WHO) and NESREA. Zooplankton diversity, dominated by the Rotifera class, reflected the impact of environmental conditions and human disturbances, with lower abundance observed in areas of higher turbidity and human activity. The findings underscore the importance of monitoring water quality and managing human activities around water bodies to preserve aquatic biodiversity and ecosystem health. Further research into the specific interactions between physicochemical factors and zooplankton populations would provide deeper insights into the dynamics of freshwater ecosystems in the region.

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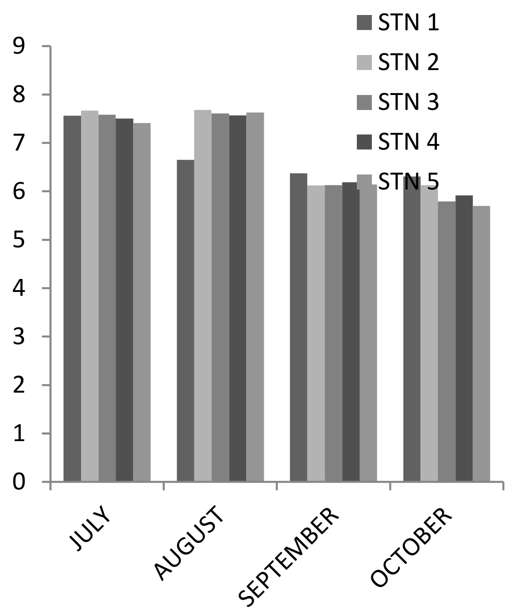

Fig. 2: Values of pH across the Stations from July to October 2018.

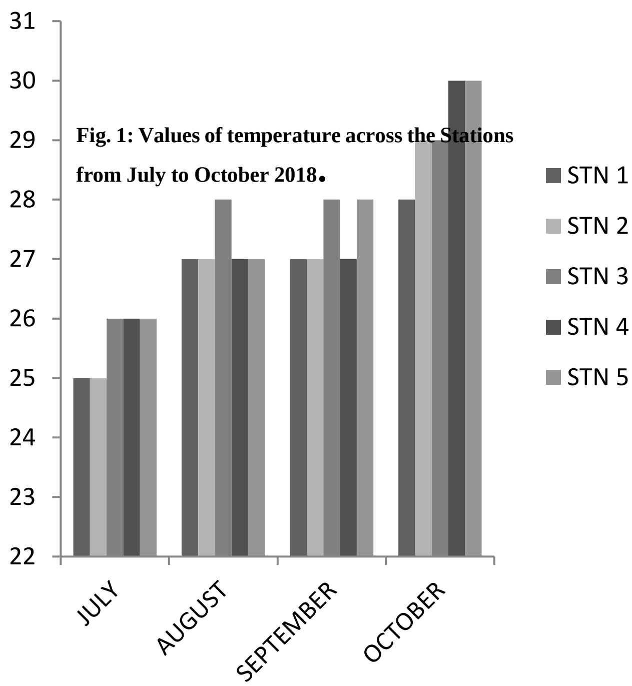

Fig. 1: Values of temperature across the Stations from July to October 2018.

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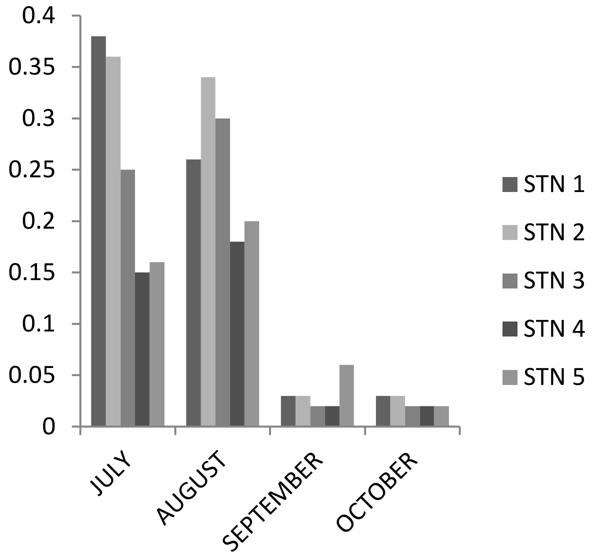


Fig. 3: Values of salinity across the Stations from July to October 2018.

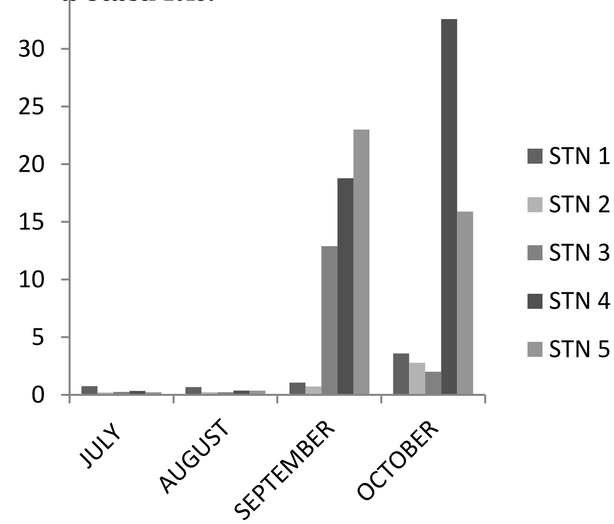


Fig. 4: Values of turbidity(NTU) across the Stations from July to October 2018.

Fig. 2: Values of pH across the Stations from July to October 2018.

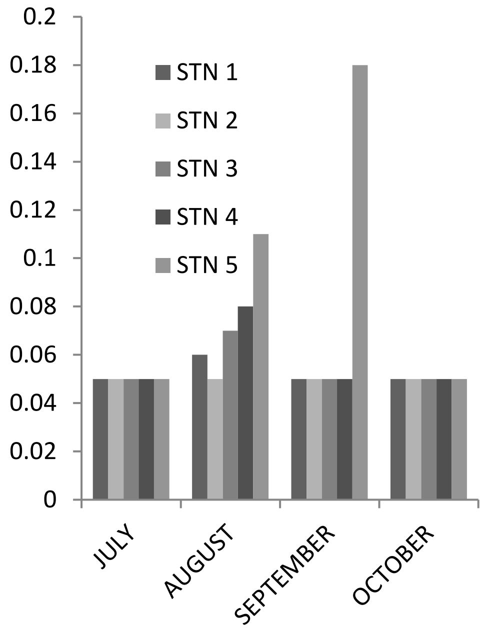


Fig. 5: Values of nitrate across the Stations from July to October 2018.

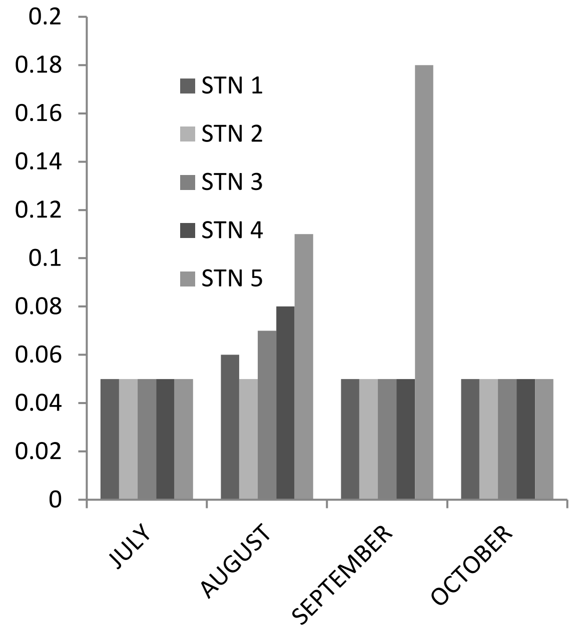


Fig. 6: Values of phosphate across the Stations from July to October 2018.

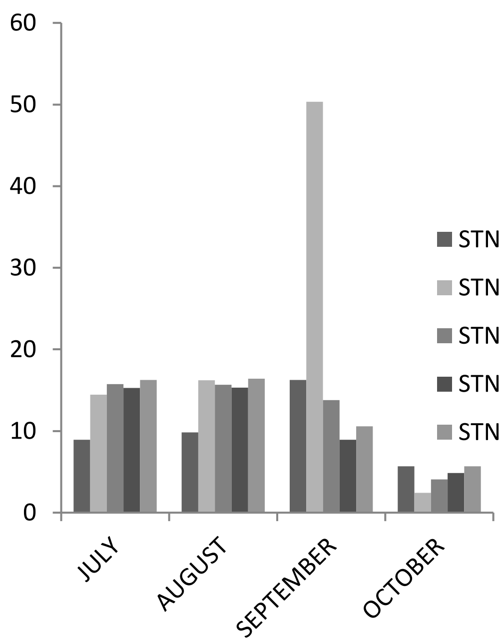


Fig. 7: Values of Dissolved Oxygen(mg/l) across the Stations from July to October 2018.

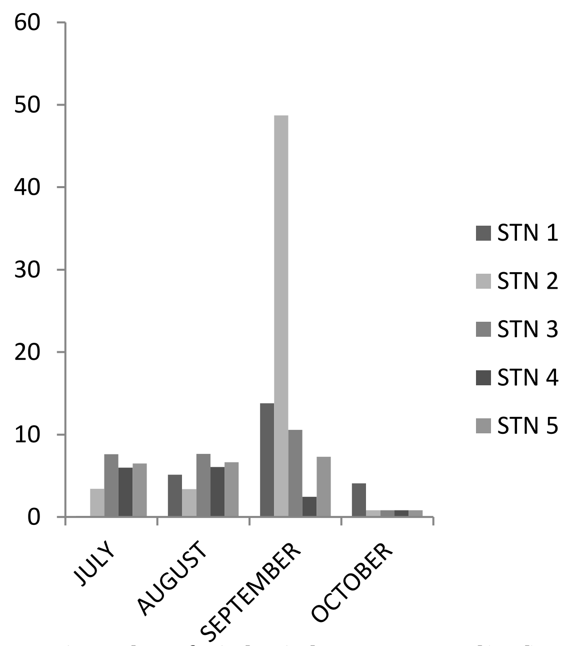


Fig.8:Values of Biochemical Oxygen Demand(mg/l) across the Stations from July to October 2018.

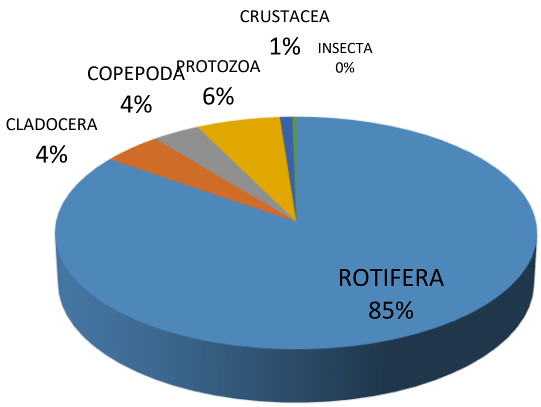


Fig. 6: Chart showing zooplankton abundance in July 2018.

Fig. 6: Chart showing zooplankton abundance in August 2018.

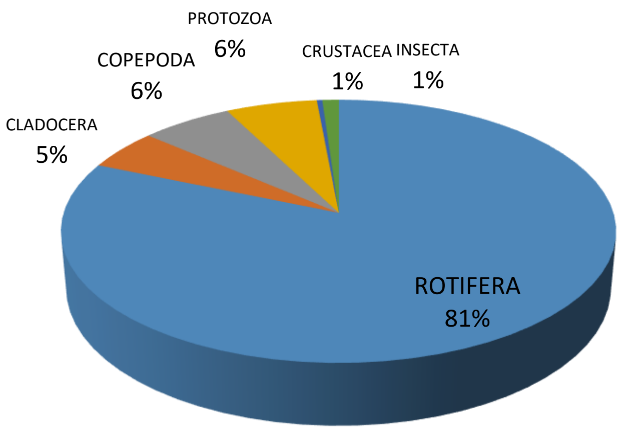
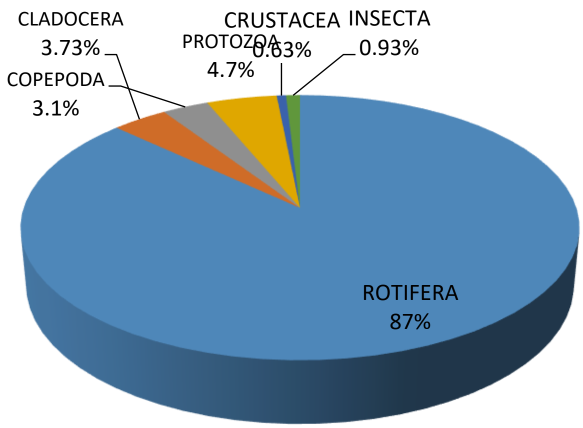
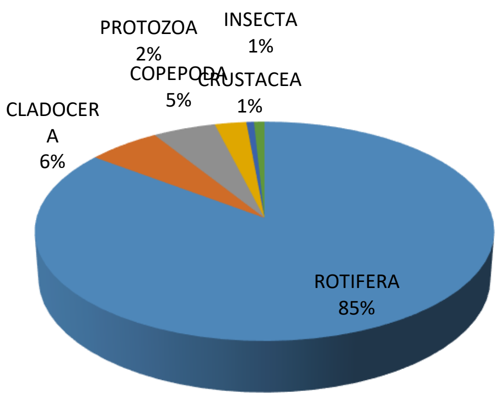


Fig. 6: Chart showing zooplankton abundance in September 2018.

Fig. 6: Chart showing zooplankton abundance in October 2018.





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