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Composition of the edaphic mesofauna in three environments: *conserved, in transition and altered, Atlantic Forest, Brazil*

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A B S T R A C T

The mesofauna consists of organisms with a length between 0.2-2.0 mm, which play an important role in the ecosystem, such as the redistribution and mineralization of organic matter, enabling several benefits for the vegetation, besides being considered bioindicators of quality of the soil. In this context, the objective of this research was to quantify the soil mesofauna, in a Conservation Unit, in Maceió, Alagoas. For evaluating the mesofauna, soil + litter, samples with metal rings were collected. The samples were installed in the modified Berlese-Tullgren extractors battery. The captured mesofauna was identified and counted. Abundance, richness, diversity were evaluated using the Shannon index and uniformity was evuated by using the Pielou index. Soil samples were collected to determine the soil water content and soil temperature measurements were taken, as well as rainfall data to relate to the research data. The richness of the edaphic mesofauna is lower in the altered environment and similar in the conserved and transition environments; The Acarina and Collembola groups are the most dominant, regardless of environments, proven by the low values in the Shannon and Pielou indices; The soil temperature influences the richness and abundance of the edaphic mesofauna, favoring its occurrence in the environments.

Keywords: Atlantic Forest, edaphic organisms, ecological interaction

Composição da mesofauna edáfica em três ambientes: conservado, em transição e alterado, Mata Atlântica, Brasil.

R E S U M O

A mesofauna é constituída por organismos com comprimento entre 0,2-2,0 mm, que desempenham importante papel para o ecossistema, como a redistribuição e mineralização da matéria orgânica, possibilitando diversos benefícios para a vegetação, além de serem considerados bioindicadores de qualidade do solo. Diante deste contexto objetivou-se quantificar a mesofauna do solo, em Unidade de Conservação, em Maceió, Alagoas. Para avaliação da mesofauna foram coletadas amostras de solo+serapilheira com anéis metálicos. As amostras foram instaladas na bateria de extratores Berlese-Tullgren modificada. A mesofauna capturada foi identificada e contada. Foi avaliada a abundância, riqueza, diversidade pelo índice de Shannon e uniformidade pelo índice de Pielou. Foram coletadas amostras de solo para determinação do conteúdo de água do solo e realizadas medidas de temperatura do solo, bem como obtidos dados de precipitação pluvial para relacionar com os dados da pesquisa. A avaliação foi realizada no LabESA/IGDema/UFAL. A riqueza da mesofauna edáfica é menor no ambiente alterado e similar nos ambientes conservado e em transição; Os grupos Acarina e Collembola são os mais dominantes, independente dos ambientes, comprovado pelos baixos valores nos índices de Shannon e Pielou; A temperatura do solo influencia a riqueza e abundância da mesofauna edáfica, favorecendo sua ocorrência nos ambientes.

Palavras-chave: Mata Atlântica, organismos edáficos, interação ecológica.

Introduction

Atlantic Forest ("Mata Atlântica") biome is characterized by high species richness and endemism, and is one of the 34 biodiversity hotspots worldwide (Mittermeier et al., 2005; Moraes et al., 2007; Rasvailer et al., 2020; Santos et al., 2020). Among the ecosystems of this biome, the Secondary Ombrophilous Forest stands out (Fantini and Siminski, 2016), which has 29% of its original vegetation cover and is characterized by its great biodiversity of fauna and flora (Ministério do Meio Ambiente, 2019).

These forest remnants concentrate a large number of genera of plant species, including *Bromeliaceae*, whose tanks accumulate water and organic matter and serve as shelter and food source for a wide variety of organisms (Paula Júnior et al., 2017). Among these organisms, Arthropods stand out, which represent an extremely abundant and diverse group in terrestrial environments, and play key roles in ecosystems (Tinoco, 2006; Brusca et al., 2018). They are classified according to their size into: microfauna (≤0.2 mm), mesofauna (0.2-2.0 mm) and macrofauna (≥2.0 mm) (Melo et al., 2009; Swift et al., 1979). The microfauna is composed of organisms (≤0.2 mm) that participate in the cycling of nutrients, regulate the populations of bacteria and fungi and can affect the soil structure through interactions with the microflora (Correia and Oliveira, 2000).

The soil macrofauna consists of invertebrates with length ≥ 2.0 mm, are important components of the soil biota, acting in the ecosystem as litter fragmenters, litter transformers or predators. These organisms are affected by soil management and the density, diversity and presence of specific groups are criteria used in the assessment of soil quality (Souza et al., 2015; Silva et., 2021).

The mesofauna includes the organisms belonging to the classes Oligochaeta (family Enchytraeidae), Symphyla (Symphyls), Pauropoda (Paurópods), Protura (Proturs), Diplura (Diplurs), Collembola (Colêmbolo), Arachnida and Insecta. The Arachnida class is represented by the orders Pseudoscorpionida (Pseudoscorpions), Palpigradi (Palpigrades) and Acari (Mites). The Insecta class is represented by the orders Diptera (Mosquitoes), Coleoptera (Beetles) and Isoptera (Termites), Hymenoptera (Ants, Bees, Wasps) (Berude et al., 2015; Silva and Amaral, 2013; Barros et al., 2010; Melo et al., 2009). Acarina and Collembola, dominate in abundance and diversity in the mesofauna (Melo et al., 2009). Together, they constitute 72 to 97%, in proportion of individuals, of the total fauna of soil arthropods (Singh and Pillai, 1975), with mites being represented by more than 1,000 species in Brazil (Melo et al., 2009), the most numerous are the Oribatei (Acari: Cryptostigmata) and the Collembola (Hexapoda) (Singh and Pillai, 1975).

These organisms play important roles in the ecosystem, contributing to the humification, redistribution of organic matter and stimulating microbial activity. Thus, they bring benefits to vegetation through the availability of nutrients in the processes of mineralization of organic matter (Santos et al., 2017; Martins et al., 2020; Andrade, 2021). Mites act as micro predators, feeding on fungi, bacteria and other soil organisms (Franco, 2016). They represent the main source of food for the herpetofauna communities, being part of the diet of amphibians (anurans) and reptiles (lizards) (Lopes et al., 2017; Tinoco, 2006), among other animals. In addition, soil quality indicators are considered due to their sensitivity to environmental changes, with rapid responses to changes in vegetation cover, edaphoclimatic conditions (humidity and temperature), which can reduce and/or disappear in very degraded areas (Barros et al., 2010; Franco, 2016; Casaril et al., 2019; Martins et al., 2020; Pessotto et al., 2020; Góes et al., 2021). The mite population varies according to various aspects such as organic matter, soil protection, plant species and microclimate, among others. Collembols, on the other hand, require soil moisture between 40 and 70% (Silva et al., 2007).

The Municipal Parque of Maceió, in Alagoas, is part of a Conservation Unit, and is open to visitors. In the Parque it is possible to observe a diversification of landscapes with patches of conserved vegetation, in transition and altered. The last two environments are more vulnerable due to the proximity to the community surrounding the Parque. Even the edges of forest fragments presenting altered landscapes and exposed to extreme conditions, plant species are still of great importance in maintaining the richness and diversity of invertebrates present in the ecosystem (Paula Júnior et al., 2017). According with this context, the following questions arose: 1) does the composition of the edaphic mesofauna change between conserved, transitionand altered environments? 2) do edaphoclimatic variables (rainfall, humidity and soil temperature) interfere with the composition of the soil mesofauna? In order to answer the questions, the following hypotheses were elaborated: H1) the composition of the soil mesofauna varies depending on the state/condition of the vegetation cover, so that the greatest diversity, richness and abundance of organisms are found in the conserved area; H2) the edaphoclimatic variables interfere in the composition of the mesofauna, so that the humidity and the temperature of the soil are the variables that most influence the organisms of the edaphic mesofauna. Since in the conserved area, the more humid the soil and with lower temperatures, the more abundant and more diverse the environment will be; in areas in transition and altered, the higher the temperature, the lower the humidity and rainfall, the less diverse and less abundant the areas are.

The results point to the need to maintain forest ecosystems in urban spaces, notably in the Municipal Parque of Maceió, since natural environments provide important ecological services, such as disease control, pest control and climate maintenance (Morais et al., 2010; Silva et al., 2019). According to Laurance et al. (2002) one of the great current challenges is to contain the growing fragmentation of forest ecosystems with harmful effects on biotic communities, reducing plant and animal species, including edaphic mesofauna. In addition, fragmentation poses a risk of genetic change and even species extinction, especially in tropical biomes (Pinto et al., 2004).

Material and methods

Study area

The survey was conducted in the municipality of Maceió, geographical coordinates 09°21'31"/09°42'49" S and 35°33'56"/35°38'36" W, with altitude oscillating between 7 and 300 m. The municipality is inserted in the "Mesorregião Geográfica do Leste Alagoano" (Geographical Mesoregion of East Alagoas) and Microregion of Maceió. It has an As' - Hot tropical climate with rainfall from autumn to winter, according to Köppen's classification. The average annual precipitation is 1,867.4 mm/year, the average annual air temperature is 25.1 °C and the relative humidity is 78.5% (INMET, 2018). The soils were classified by Parahyba et al. (2008), and according to the Soil Taxonomy nomenclature (USDA, 2014) the predominant soils are Oxisols and "Argissolos" (Ultisols) which make up an area that represents 74.8% of the total area of the municipality. The remaining soils are equivalent to 21.6% of the area, identified as Gleissoils (Entisols Aquents) and "Neossolos Quartzarênicos" (Entisols Quartzipsamments), inserted under sedimentary terrains: the plateau that corresponds to the Barreiras formation and the coastal and lagoon plains, with relief (lowered 3 to 5 m; Pleistocene terrace 8 to 10 m; Sedimentary Plateau of Tabuleiros 40 to 100 m), with predominant vegetation.

The experimental areas are inserted in the Municipal Parque of Maceió (Figure 1), which is a Conservation Unit (geographical coordinates 9º36'47.4" S and 35º45'36.9" W) with an area of 82.4 ha, located in the Bebedouro neighborhood. Within the Parque, three areas were selected according to the size and conservation of vegetation: conserved (Figure 2A), in transition (Figure 2B) and altered (Figure 2C). It presents irregular topography, with variations in altitude, covering the slope of a structural estuary, fluvial lagoon terraces, flat relief of tertiary lithologies, and a remnant Atlantic Forest type biome (Secondary Rainforest) (Lima, 2009).

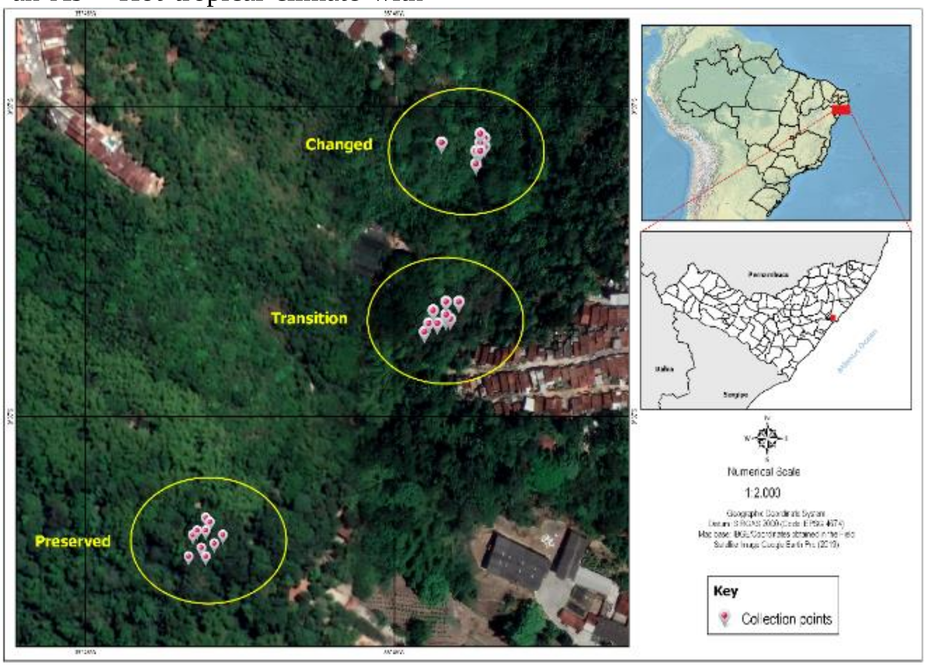


Figure 1. Location of the researched environments preserved, in transition and altered, in the Municipal Parque, Maceió, Alagoas.

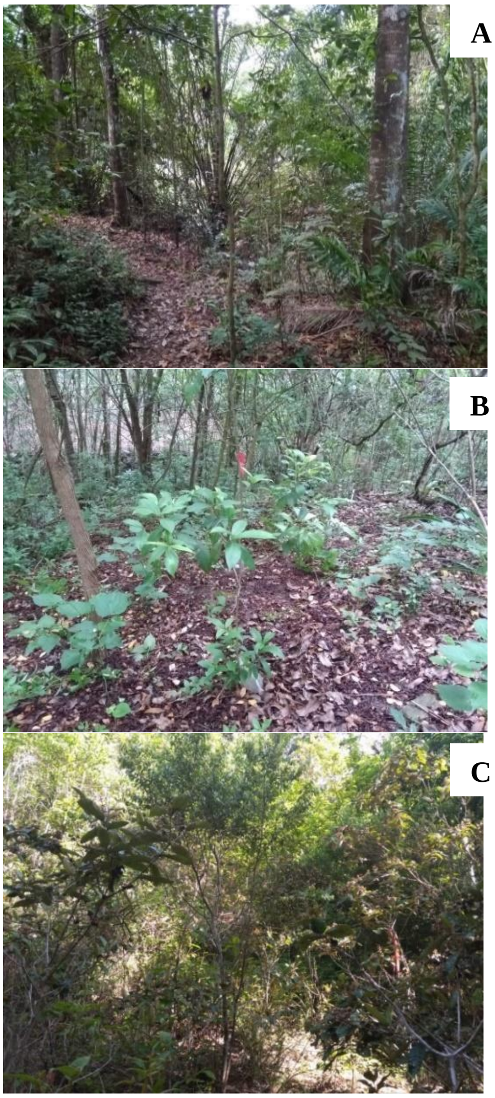


Figure 2. Conserved environments (A), in transition (B) and altered (C), at Parque Municipal, Maceió, Alagoas

Soil mesofauna - field and laboratory works

Mesofauna was assessed bimonthly (Aug/Oct/Dec 2018 and Feb/Apr/Jun 2019) at 10 points. Samples of soil + litter were collected using metal rings (diameter = 4.8 cm and height = 5 cm) at 0-5 cm depth (Figure 3A). In the laboratory, the mesofauna was extracted using the modified Berlese-Tullgren extractors method (Figure 3B) in which the samples were kept in the extractor for 96 hours. Due to the heating produced by incandescent lamps installed on the soil samples (Araujo, 2010), the organisms migrate to the bottom of the soil, thus passing through the funnel and falling into the glass container containing 70% alcohol. The captured organisms with a length between 0.2-2.0 mm (Swift et al., 1979) were identified and counted using a binocular loupe and identification key by Triplehorn and Jonhson (2011) (Figure 3C).

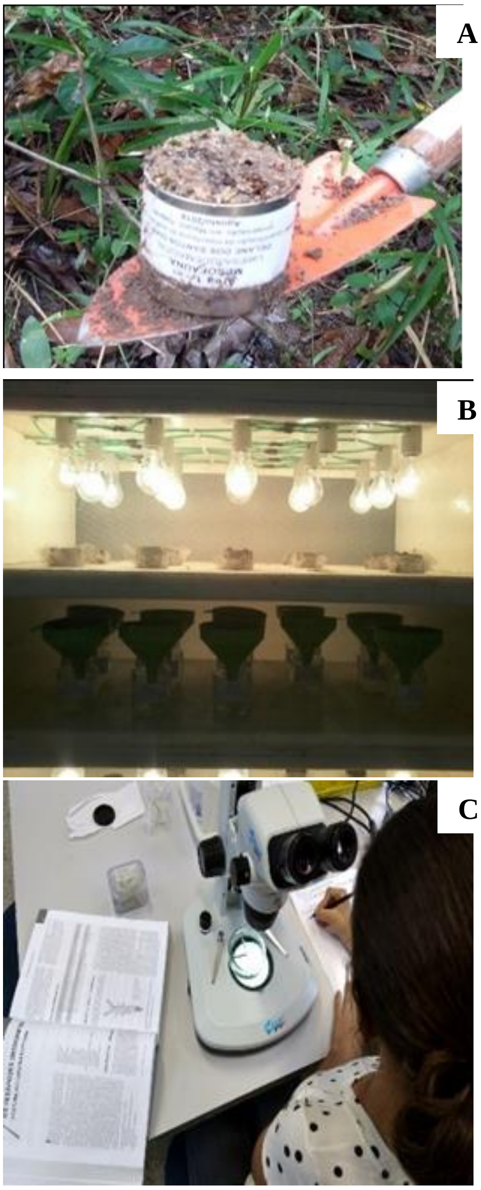


Figure 3. Rings with soil samples (A) modified Berlese-Tullgren extractor battery (B) and identification of organisms in binocular loupe (C).

Soil mesofauna – quantitative and qualitative

The soil mesofauna was quantitatively evaluated by measuring the total number of organisms (abundance of specimens) and richness (number of taxonomic groups). And qualitatively through diversity, calculated using the Shannon Index (H) defined by:

$$H = -\Sigma pi.\log pi$$

where: pi = ni/; ni = Number of individuals in each group; N = Σ of the number of individuals in all groups.

Equability was assessed by the Pielou Index (e) using the equation:

$$e = H/ \log S$$

where: H = Shannon index; S = Number of species or groups.

The Shannon index (H) varies from 0 to 5, indicating that the decline in its values is the result of a greater dominance of groups at the expense of others (Begon et al., 1996). The Pielou Equability Index (e) varies from 0 (minimum uniformity) to 1 (maximum uniformity) and allows to represent the uniformity of the distribution of individuals among the existing species and / or groups (Pielou, 1977).

Edaphoclimatic variables

Determinations of Soil Water Content (SWC) were carried out at a depth of 0-10 cm, on the same dates and collection points as the mesofauna. The samples were stored in aluminum cans previously identified and with recognized weight. The soil was taken to the laboratory for the determination of the sample wet weights on an analytical balance. Subsequently, the soil was dried in an oven at 105 °C, for 24 hours, and after that period it was weighed again to check the final weight and determine the percentage of existing water. For this analysis we follow the methodology of Tedesco et al. (1995), according to the equation:

SWC% = ((ws-ds)/ds) x100

where: SWC = Soil water content; ws= Weight of wet soil (g); ds = Weight of dry soil (g).

Due to the greater activity of the edaphic organisms being in the superficial layer of the soil and also as a form of standardization, soil temperature measurements were taken at a depth of 0-10 cm. For that, we used a HI 98501-1 HANNA skewer digital thermometer.

Rainfall data were also obtained from INMET (National Institute of Meteorology). The collection of rainfall was performed monthly, and it was used the accumulated total of each month during the evaluation period.

Data analysis

The data of the edaphic mesofauna were analyzed by descriptive statistics and submitted to analysis of variance and the means compared by the Tukey test at 5% probability, in order to verify if there is a statistically significant difference between the areas.

Pearson correlation estimates were made, for each of the three areas, between the abundance and richness data of the edaphic macrofauna (dependent variables, or responses), and the rainfall variables, soil temperature and soil water content (variables independent, or explanatory). Their significance was verified by the Student's t test at 5% probability. The correlation test was performed in order to test the influence of independent variables on dependent ones. Both tests were performed using software R version 3.6.1 (R Core Team, 2019).

The data from the correlation estimates were interpreted based on the significance and classification proposed by Dancey and Reidy (2006). The authors point out that a correlation can be: weak ($\rho \leq 0.399$), moderate ($\rho \geq 0.400 \leq 0.700$) or strong ($\rho \geq 0.701$). The correlation varies between -1 and 1, the sign indicates a positive or negative direction of the relationship and the value suggests the strength of the relationship between the variables, the closer to 1 (or -1) the stronger the level of linear association between the variables (Figueiredo Filho et al., 2014).

Results

Composition of edaphic mesofauna throughout the year in different areas

The occurrence of edaphic mesofauna organisms varied according to the time of collection. The groups Acarina, Collembola, Diplura and Symphyla were verified in all the evaluated months. The highest frequency of Diplura and Symphyla started to appear in December, and in February they intensified, reaching an intense population peak (Figure 4).

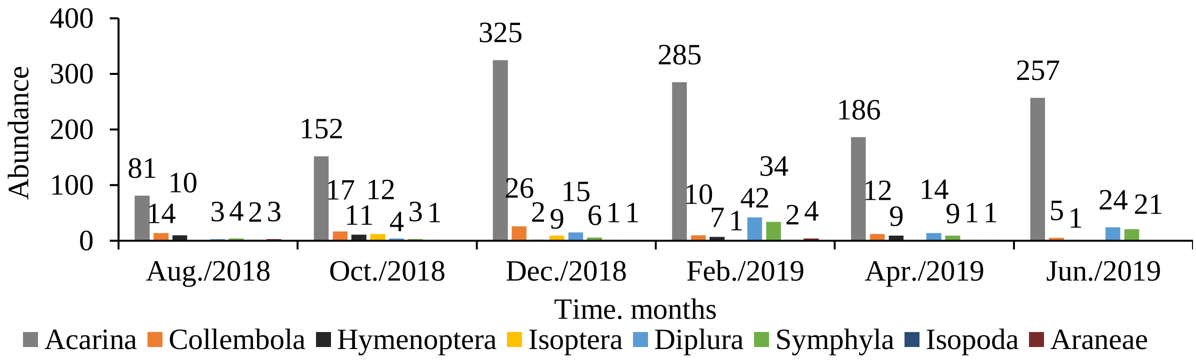


Figure 4. Abundance of mesofauna over the months (Aug/Oct/Dec/2018 and Feb/Apr/Jun/2019), at Parque Municipal, Maceió, Alagoas.

December and February were the months in which the taxon richness reached its peak, totaling 8 taxonomic groups, in the other months they remained with 7 taxonomic groups. In June there was a reduction in the abundance and richness of groups, with only Acarina, Collembola, Diplura and Symphyla being registered (Figure 4).

Analyzing the taxon richness of the edaphic mesofauna community in the environments, it was observed that there was a statistical difference between the conserved environment and the transition and altered environments. Comparing the environment in transition with the conserved one, there was a statistical difference at the level of 5% probability (Table 1).

The number of groups of mesofauna in the 0-5 cm deep layer was similar in the conserved and transition environments, both with 8 taxonomic groups and in the altered environment the organisms were distributed in 7 taxonomic groups (Figure 4).

Table 1. Average of the abundance and richness of the edaphic mesofauna, in the conserved, transition and altered environments, in the Municipal Parque, Maceió, Alagoas

Variables	Conserved	Transition	Altered
Richness	9,60 b	13,30 a	13,10 a
Abundance	6,53 b	11,18 a	9,55 ab

Equal letters, there is no statistical difference; different letters there is statistical difference by the Tukey test, at the level of 5% probability.

The total number of organisms reached 1,601, distributed in the conserved environment (387 individuals), in transition (650 individuals) and altered (564 individuals) (Figure 5).

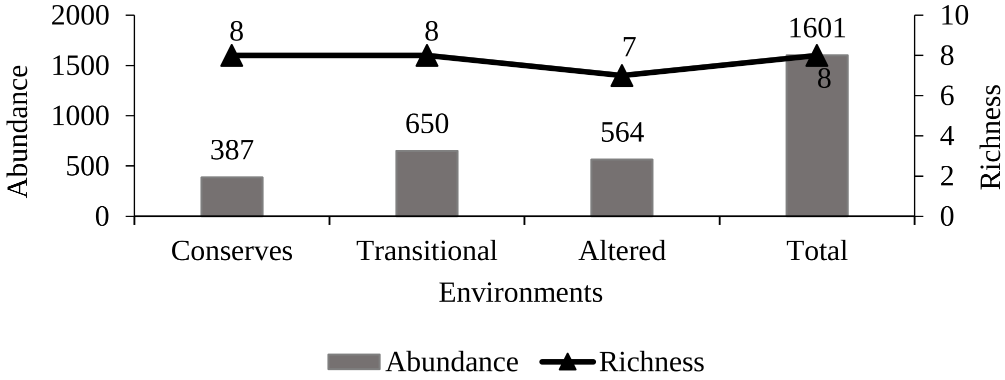


Figure 5. Abundance and richness of the edaphic mesofauna in the conserved, in transition and altered environments, in the Municipal Parque, Maceió, Alagoas.

In the altered environment, for example, the presence of the Isopoda group was not observed in the material collected (Figure 4).

Regardless of the environments, the Acarina group had greater abundance (conserved = 320; transition = 527; altered = 426) (Figure 6).

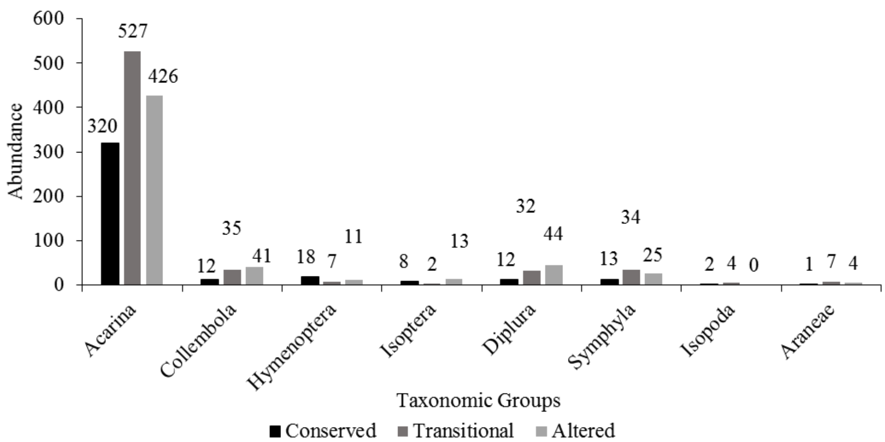


Figure 6. Abundance of mesofauna in conserved, transition and altered environments, in the Municipal Parque, Maceió, Alagoas.

Regardless of the months, the Acarina group was the one with the highest number of individuals (1,286 = 79.04%) in relation to the others (Graph 6). The Collembola group also stood out in the areas of collection in the conserved (12 ind.), Transition (35 ind.) And altered (41 ind.) Environments (Graph 6).

The lowest diversity (H) and uniformity (e) is directed to the Acarina group in the environments (conserved: H = 0.08; e = 0.03; transition: H = 0.09; e = 0.03; altered: H = 0.12; e = 0.04) reflecting the high dominance in these environments (Table 2).

Table 2. Shannon diversity index (H) and Pielou uniformity index (e) for the taxonomic groups registered

Taxonomic Groups	Areas					
	Conserved		Transition		Altered	
	H	*e*	H	*e*	H	*e*
Acarina	0,08	0,03	0,09	0,03	0,12	0,04
Collembola	1,50	0,58	1,26	0,45	1,13	0,41
Hymenoptera	1,33	0,51	1,96	0,69	1,70	0,62
Isoptera	1,68	0,65	2,51	0,89	1,63	0,59
Diplura	1,50	0,58	1,30	0,46	1,10	0,40
Symphyla	1,47	0,56	1,28	0,45	1,35	0,49
Isopoda	2,28	0,88	2,21	0,78	-	-
Araneae	2,58	1	1,96	0,69	2,14	0,78

Edaphoclimatic variables that influence the composition of mesofauna

Throughout the experiment, bimonthly data were collected regarding rainfall, soil water content and soil temperature, which are shown in Figure 7.

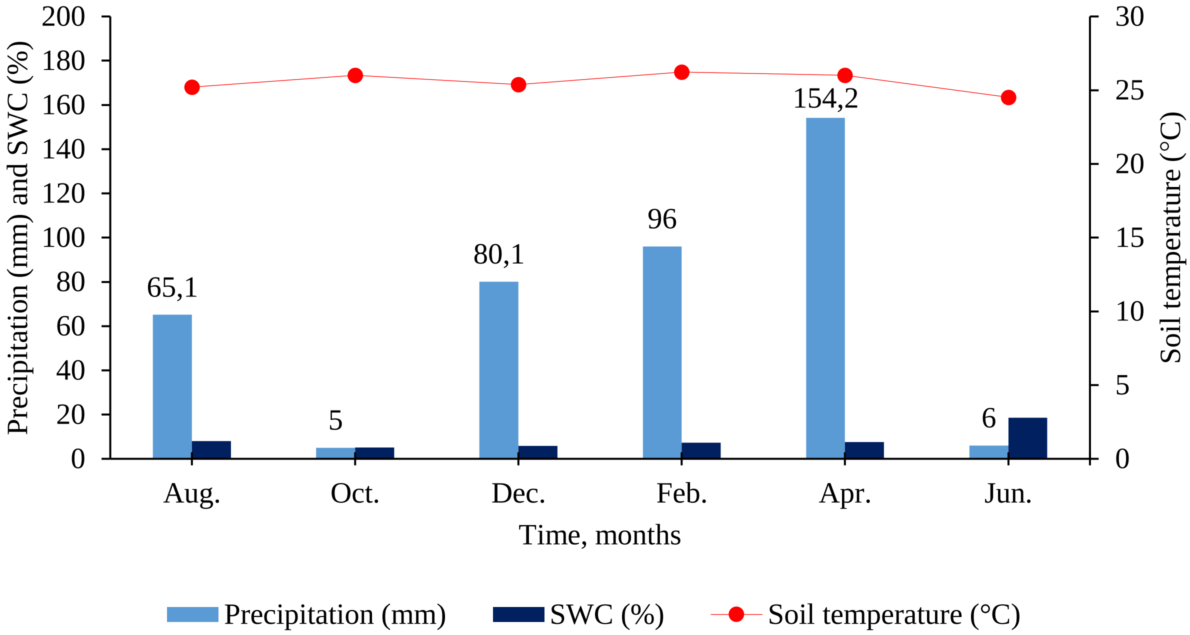


Figure 7. Rainfall (mm), soil water content (%) and soil temperature (ºC), between August/2018 to Jun/2019.

The occurrence of the organisms of the edaphic mesofauana varied according to the time of collection, being observed in the months with increments in the rainfall record, greater differences in the number of organisms, among the different vegetation cover studied, in relation to the months with less water volume (Figure 7).

In June, the reduction in the wealth of groups was attributed to the high rainfall that occurred in the days before the collection, which limited the sampling, also impacting the abundance that had a decrease in the values (Figure 4).

In the conserved environment the thick litter layer intercepted part of the rainfall, influencing the data of the soil water content by presenting a lower percentage (SWC% = 7.86%) when compared to the altered environments (SWC% = 9.81%) and in transition (SWC% = 8.62) (Figure 8).

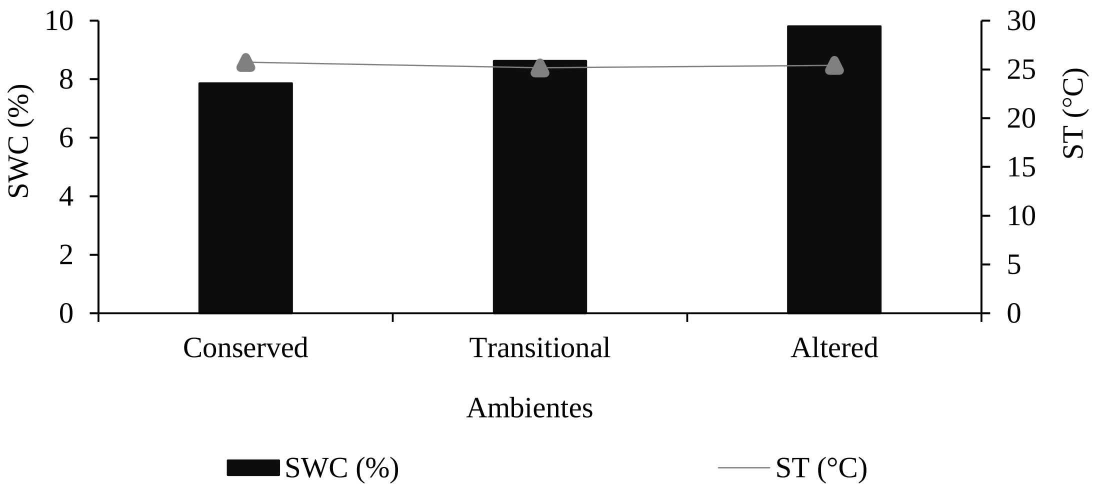
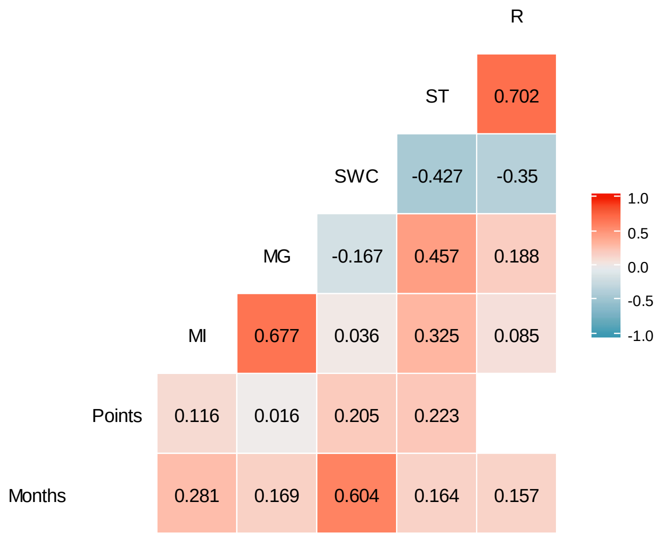


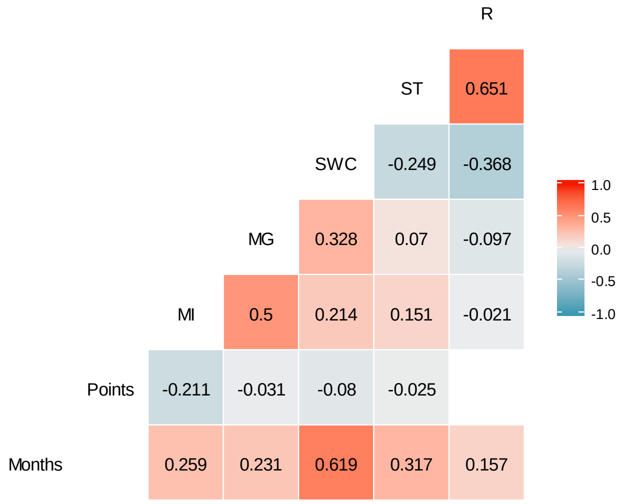
Figure 8. Soil water content (%) and soil temperature (° C) in conserved, transition and altered environments, at Parque Municipal, Maceió, Alagoas.

The soil temperature showed little variation between the conserved environments (25.42 °C), transition (25.14 ° C) and lower in the altered environment (23.87 °C) (Figure 8). Larger populations of mites were obtained in the December and February collections (Figure 4).

Pearson's correlation

Pearson's correlation estimates were low (Figure 9A-9C). Of the three explanatory variables analyzed (rainfall, soil temperature and soil moisture), soil temperature and humidity demonstrated to have an influence on the response variables (number of groups and number of individuals in the edaphic mesofauna). Soil temperature influenced positively and significantly both the number of individuals (p-value: 0.01133) being a weak correlation and the number of groups of the edaphic mesofauna (moderate correlation, p-value: 0.0002443) (Figure 9A), in the conserved environment (area 1). In the transition environment (area 2), the soil water content was the variable that had some positive and significant influence (weak correlation) on the number of groups of the edaphic mesofauna (p-value: 0.01045) (Figure 9B). In the altered environment (area 3), there was no relationship between the variables rainfall, humidity and soil temperature, with the number of groups and individuals of the mesofauna (Figure 9C).





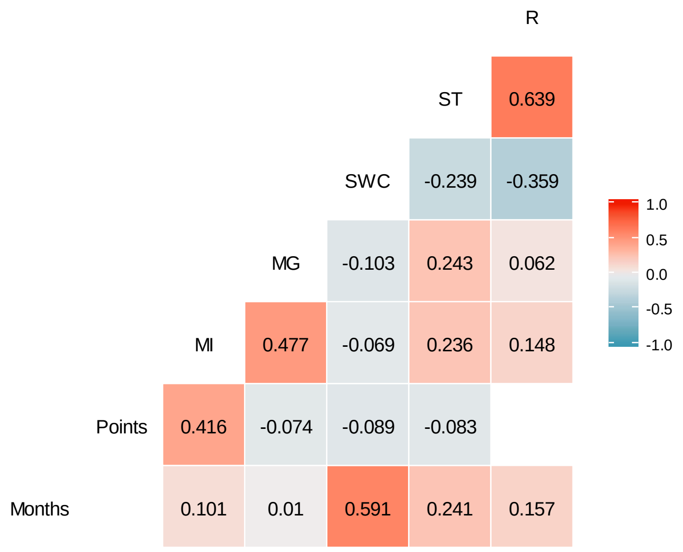


Figure 9. Pearson's correlation estimates for the three environments: conserved (A), in transition (B) and altered (C). MI: Mesofauna Individuals; MG: Mesofauna Groups; SWC: Soil Water Content; ST: Soil Temperature; A: Rainfall.

Discussion

Composition of edaphic mesofauna throughout the year in different áreas

It was observed that regardless of the environment, there was variation in the composition of the mesofauna throughout the experimental period (Figure 4), which demonstrates greater stability of the abundance of mesofauna in the conserved environment, due to the better distribution of the organisms by taxonomic group, confirmed by the richness of groups (Figure 5).

Mite populations were high in all areas, regardless of months, with an increase notably in December and February (Figure 4). Silva et al. (2017) mention that the Acarina group is the most abundant because it adapts to habitat diversity. It plays an important role in controlling microbial individuals, in the process of humifying organic compounds and renewing nutrients (Rieff, 2014).

This percentage increase in mites is attributed to the low total population density of the other taxonomic groups, regardless of environments. Confirming what Morais et al. (2013) that the Acarina group has an abundant population, reaching more than 70% in preserved forests. Showing to be adapted to local microclimate conditions (Moço et al., 2005), regardless of environments.

However, the number of individuals can vary according to the presence of soil cover, organic matter, vegetation and microclimate (Machado et al., 2015). For this reason, they are found in practically all terrestrial environments and have different feeding habits, they are important due to the damage that some species cause to man, animals and plants. As well as the positive aspects that other species present, such as the predation of agricultural pests and the aid in the process of decomposition of organic materials (Morais et al., 2013), since they are shredders of plant residues (Franco, 2016).

Expressiveness was also observed in the abundance of organisms in the Symphyla and Diplura groups (Figure 4). These are found in litter, under decaying logs and in humid environments, rich in humus. They feed on fungi or vegetal matter in the end of decomposition (Berude et al., 2015). The Diplura group organisms live in colonies, under logs or stones, in litter and in the topsoil (Morais et al., 2013). They feed on vegetables and fungi, or are predators (Berude et al., 2015).

The organisms showed a better distribution among the fauna groups, in the conserved environment, as verified in the values of richness (Figure 5). This result is attributed to the diversified conditions provided by areas of native forests and forests that allow greater biodiversity, due to the variety of plant species and organic compounds present in the litter (Rieff et al., 2010) which serves as shelter and food resources for the edaphic mesofauna.

Thus, diversity is related to the wide variety of resources and microhabitats that the soil-litter system offers. The process of fragmentation of forest ecosystems, with anthropogenic disturbances, is an important threat to biodiversity, as highlighted by Berude et al. (2015). During field surveys the occurrence of the Isopoda group was not observed in the altered environment (Figure 4), reflecting their preference for environments that are more protected from the incidence of sunlight, generally prefer environments with trees, shrubs, humidity and organic debris where populations are observed expressive, which does not happen in open places in drier environments. Thus, the distribution of mesofauna organisms by group being worse in transition and altered environments is a reflection of changes in vegetation. It is worth mentioning that different species of isopods live in gregariousness (Silva and Coraiola, 1999), that is, they are grouped in populations aiming at protection and are easily found in forest environments, when lifting a piece of wood or removing the litter.

The taxonomic group Collembola also stood out in abundance (Figure 4). It is worth mentioning that in the literature, collembola are among the most abundant invertebrates in the soil and litter. They are also found near the soil surface, in places with decomposing organic matter. They can also be found in fallen leaves, in the sheath of live leaves and in moss plants (Triplehorn and Johnson, 2011).

Edaphoclimatic variables that influence the composition of mesofauna

The decrease in the number of individuals of the edaphic mesofauna and the variety of taxonomic groups in June was related to the high precipitation that occurred in the days before the collection, which limited the sampling (Figure 4). Araujo (2010) also observed a sharp drop in the number of edaphic organisms shortly after the torrential rain. In this same context Souto (2006) also found a reduction in the number of individuals when the increases in monthly precipitation were quite expressive.

In all collections, a low oscillation of the soil temperature was observed in the investigated environments, being slightly higher in the conserved> transition> altered environments (Figure 8) due to the presence of the litter. Araujo

(2005), highlights that the superficial layers of the soil receive greater solar radiation, presenting high temperatures, especially if the litter supply is dense, as this allows the storage of heat by the biomass layer.

This thick layer of litter in the conserved environment intercepted part of the precipitation, which was absorbed by the litter and reduced the infiltration, with a lower percentage accumulated in this area (Figure 8). The more fragmented the litter is, the greater the moisture retention, which allows less rain impacts on the soil (Magalhães, 2015).

The temperature and humidity conditions recorded in December and February favored the record of a high quantity of the Acarina group (Figure 4). According to Ducatti (2002) the samples collected in the hot and humid period, is a satisfactory condition for the presence of mites in the topsoil, since this group is adapted to favorable conditions of humidity and temperature.

Regardless of the environments, the Collembola group also stood out in the sampling (Figure 4). These organisms are sensitive to low moisture content (Pollierer and Scheu, 2017). Collembola populations vary with the seasons and are more abundant in the hot and rainy seasons (Barros et al., 2010). Collembola help to control the fungi biomass in the soil, also acting as dispersers of these fungi (Berude et al., 2015).

Despite having a weak (number of individuals) and moderate (number of groups) correlation, these results show that when the temperature increases, the greater the abundance and richness of the edaphic mesofauna in this conserved environment (Figure 9A). In the transition environment (Figure 9B), although the intensity of the correlation was weak, we can infer that the more humid the soil, the greater the diversity of the edaphic mesofauna in this type of environment. Berude et al. (2015) mention that factors such as soil temperature directly influence the organisms of the edaphic mesofauna, interfering in the diversity of its population. In a complementary way, Dionísio and Signor (2016) state that the presence of mesofauna organisms in the places depends on factors such as soil humidity and temperature.

In general, these results demonstrate that other factors, not evaluated in this research, may be more influencing the number of groups and individuals than the variables analyzed here. Above all, with regard to the altered environment, since there was no significant correlation of any edaphoclimatic variable with the data of the edaphic mesofauna (Figure 9 C).

The results point to the need to keep forest ecosystems in urban spaces, notably in the Municipal Parque of Maceió, since natural environments provide important ecological services, such as disease control, pest control and climate maintenance (Morais et al., 2010). According to Laurance et al. (2002) one of the great current challenges is to contain the growing fragmentation of forest ecosystems with harmful effects on biotic communities, reducing plant and animal species, including edaphic mesofauna. In addition, fragmentation poses a risk of genetic change and even species extinction, especially in tropical biomes (Pinto et al., 2004).

Conclusions

The variations in the composition of soil mesofauna in the different ecosystems of the Municipal Parque vary according to the time of collection;

The richness of the edaphic mesofauna is smoler in the environment altered by the effects resulting from the modification of the landscape and similar in the conserved and transition environments;

Among the edaphoclimatic variables, the soil temperature influences the richness and abundance of the edaphic mesofauna, favoring its occurrence in the environments;

The diversity of the edaphic mesofauna in the Municipal Parque of Maceió, is distributed among eight groups: Acarina, Collembola, Araneae, Hymenoptera, Isopoda, Diplura, Symphyla and Isoptera, with the Acarina group being the most dominant, independent of the environments, proven by the low values in the Shannon and Pielou indices;

The conservation of the invertebrates of the edaphic mesofauna in the Municipal Parque of Maceió, is directly linked to the maintenance of forest remnants, responsible for maintaining the diversity of ecological processes, and the preservation of forest environments in this and other urban Parques is recommended.

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