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Abundance and Diversity of Soil Macrofauna in Native Forest, Eucalyptus Plantations, Perennial Pasture, Integrated Crop-Livestock, and No-Tillage Cropping

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ABSTRACT: Intensive land use can affect macrofaunal biodiversity, which is a property that can be used as a soil quality indicator. This study evaluated the abundance and diversity of soil macrofauna and its relation to soil chemical and physical properties in five land use systems (LUS) in the eastern region of Santa Catarina. The following LUS were studied: native forest (NF), eucalyptus plantations (EP), perennial pasture (PP), integrated crop-livestock (ICL), and no-tillage cropping (NT). The macrofauna was quantified in 0.25 × 0.25 m monoliths and sampled in the 0.00-0.20 m layer in the summer (Jan/2012) and winter (Jul/2012). For each LUS, nine points were sampled, distributed in a 30 × 30 m sampling grid. After screening the edaphic macrofauna organisms, the individuals were counted and identified at the species level when possible, or in major taxonomic groups. The Shannon diversity indices were calculated and the macrofaunal groups together with the physical and chemical properties were subjected to principal component (PCA) and redundancy analysis (RDA). The abundance and diversity of macrofaunal groups are affected by the LUS. The properties of organic matter, macroporosity, bulk density, cation exchange capacity at pH 7.0, base saturation, potential acidity, and exchangeable Al were related to the abundance of soil macrofaunal groups. The stability and biodiversity of soil macrofauna were highest in the LUS of NF, PP, and EP.

Keywords: biodiversity, soil biology, soil quality.



INTRODUCTION

Biological properties can be used as soil quality indicators since they can reflect the effects of land use and management practices on the productive capacity of a soil (Baretta et al., 2011; Silva et al., 2011). In addition, the possibility of interdependence of soil physical, chemical, and biological properties must be taken into consideration since change in any one of the components can modify the fertility of the environment and influence plant development (Carneiro et al., 2009). In view of the sensitivity to changes resulting from land use and management, some edaphic properties are often used as indicators of soil quality (Baretta et al., 2010; Pereira et al., 2013). Thus, soil quality has been related to properties such as aggregation, texture, porosity, organic carbon, soil acidity, and diversity of soil fauna (Doran and Parkin, 1994).

In view of the importance of soil macrofauna for soil biodiversity and quality, further studies are needed on this topic, especially to expand the evaluation of land use systems in eastern Santa Catarina. This region is characterized by diversified farms, with predominance of family farms, under environmental conditions that indicate vulnerability of the soil in response to changes in land use. Furthermore, soil physical and chemical properties are affected by human activities, motivated by the need for management practices for agricultural production. These can significantly modify the structure of the biological communities, resulting in a reduction of the activity of important organisms for various processes, such as mineralization of organic matter, aggregate stability, porosity, and nutrient cycling. The objective of this study was to determine the abundance and diversity of soil macrofauna and its relation to the chemical and physical properties of land use systems in the eastern region of Santa Catarina and to detect physical and chemical properties that influence the distribution of groups of these soil organisms.

MATERIALS AND METHODS

The study was conducted in the eastern region of Santa Catarina, including the municipalities of Joinville, where the soil is a *Gleissolo Háplico* (Aquic Dystrudept) derived from Quaternary unconsolidated deposits; Blumenau, on an *Argissolo Vermelho-Amarelo* (Typic Hapludult), developed from Precambrian granitoid rocks; and Timbó, on a *Cambissolo Háplico* (Typic Dystrudept), developed from Quaternary unconsolidated deposits (Embrapa, 2004; USDA, 2014). The climate is humid mesothermal with hot summers, classified as Cfa by Köppen system (Embrapa, 2004).

The municipalities were selected for their geographical characteristics and land use systems (LUS). Five LUS were evaluated: native forest (NF), eucalyptus plantations (EP), perennial pasture (PP), crop-livestock integration (ICL), and no-tillage (NT). For statistical purposes, true replicates of the evaluated LUS were considered.

The NF areas were represented by Atlantic Forest fragments with original vegetation. The EP stands, with areas from 1 to 1.5 ha, were 3- to 7-year-old eucalyptus (*Eucalyptus* sp.) plantations. The PP areas, of 2 to 3 ha, were in pasture for 10 to 100 years. In all the ICL areas, maize (*Zea mays*) had been cropped in the summer and ryegrass (*Lolium multiflorum*) for grazing of domestic animals in the winter, for a period of 15 to 50 years. The areas under the no-tillage (NT) system, for 5 to 20 years, were from 1 to 7.5 ha. In the summer, maize was grown in all areas and in the winter, late-season maize was produced in Blumenau, ryegrass in Joinville, and in Timbo the area was left fallow. The farmers in these areas use no-tillage systems with chiseling every two years to reduce soil compaction. In some areas, incomplete soil cover and lack of adequate crop rotation planning were observed, which would be requirements for conservation soil management (Bartz et al., 2014; Baretta et al., 2014).

Quantification of soil macrofauna was performed by manual sorting of organisms collected in soil monoliths according to a method described by Anderson and Ingram (1993). Soil sampling was carried out in two contrasting seasons (summer, January 2012 and winter, July 2012). Samples were collected in the 0.00-0.20 m layer of a 1-ha area for each LUS in a sampling grid of 3×3 points at a spacing of 30 m, surrounded by a 20 m border, for a total of 270 sampling points (winter + summer) (Figure 1). In other words, nine monoliths of $0.25 \times 0.25 \times 0.20$ m per LUS per location per growing season were collected. The monoliths were wrapped, identified, and taken to the laboratory for manual sorting under artificial light. All organisms found were fixed in 80 % alcohol, except for earthworms, which were fixed in 92.8 % alcohol, and subsequently identified in large taxonomic groups and quantified. Abundance data were expressed in individuals per square meter (ind m^{-2}) and species richness expressed in numbers of the taxonomic groups represented.

At the same points of fauna collection, 12 soil sub-samples around of each nine points were collected with a Dutch auger from the 0.00-0.10 m layer and ground to form a composite sample used for evaluation of the following properties: clay, water pH, pH SMP, P, K, organic matter (OM), Al, Ca, Mg, potential acidity (H+Al), cation exchange capacity at pH 7.0 (CEC pH7), base saturation, K/CEC, Ca/CEC, Mg/CEC, Ca/Mg, Ca/K, and Mg/K, according to methods described by Tedesco et al. (1995). Undisturbed soil clods were collected beside the macrofaunal sampling points. From these samples, 8.0-4.75 mm aggregates were separated for determination of stability by the wet sieving method, as described by Kemper and Chepil (1965). The aggregates were shaken vertically in water, and the apparatus consisted of four sieves (meshes of 4.75, 2.00, 1.00, and 0.25 mm). After weighing the dry soil mass retained in each sieve, the mean weight diameter (MWD) of the aggregates was calculated. Soil particle size was determined by the pipette method (Gee and Bauder, 1986) using sodium hydroxide solution as a chemical dispersant. The sand fraction was removed by sieving (0.053 mm mesh). The silt and clay fractions were separated by sedimentation and subsequent pipetting of the suspended clay. The clay and sand fractions were determined after drying at 105 °C and weighing, and the silt fraction was calculated as the difference between the total mass and the sum of the other two fractions.

Particle density (PD) was determined by the volumetric flask method (Claessen, 1997). Bulk density (BD) was determined by the steel cylinder method, in undisturbed soil samples. Biopore volume was determined using a tension table at a suction of 1 kPa (Ringrose

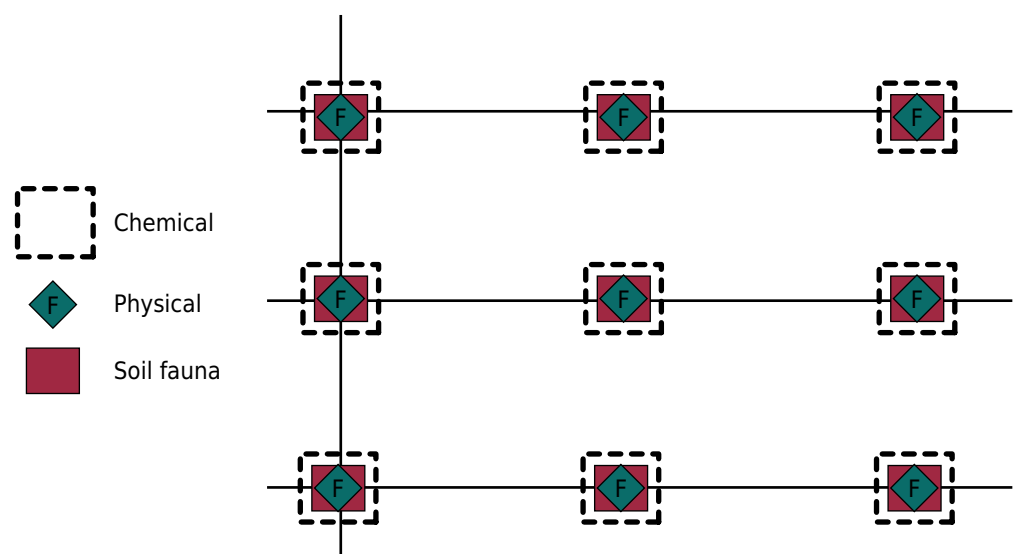


Figure 1. Sampling grid used in the collection of samples for chemical and physical analysis and quantification of soil macrofauna.

Voase, 1991). Micropore volume was determined by water retention after exposing saturated soil samples to a tension of 6 kPa on a tension table. Macropore volume was computed as the difference between the total pore and micropore volume. Total porosity (TP) was calculated by the ratio of bulk density to particle density (Claessen, 1997). Penetration resistance (PR) of the soil contained in the steel cylinders was determined, with moisture maintained at a tension corresponding to 10 kPa with a static penetrometer (Marconi, model MA-933) with a 4 mm cone set at an angle of 45° and a penetration speed of 1 mm s⁻¹.

The diversity of the soil macrofauna community was calculated by the Shannon diversity index (H) for each LUS. The diversity indices were estimated using the Vegan package for community ecology (Oksanen et al., 2009) of the statistical platform R (R Development Core Team, 2009). The relative frequency of the main groups in all LUS was also estimated.

The data regarding abundance (number of individuals per group) and group richness, resulting from identification of taxa of each LUS, were subjected to analysis of variance, using ASSISTAT (Silva, 1996) software.

The abundance data (ind m⁻²) were subjected to detrended correspondence analysis (DCA), to understand the gradient variation between LUS. When the length was less than three (linear response), principal component analyses (PCA) were performed for the seasons (winter and summer) with the statistical program Canoco, version 4.0 (ter Braak and Smilauer, 1998). Redundancy analysis (RDA) was also performed to evaluate the direct gradient of response variables in relation to the explanatory variables. For RDA, the most abundantly found taxa of macrofauna (response variables) were used: Pseudoscorpionidae, Opiliones, Formicidae, Hemiptera, Isoptera, Coleoptera, Larvae, Araneae, Chilopoda, Diplopoda, Orthoptera, Isopoda, Dermaptera, Blattodea, Mollusca, Diplura, Oligochaeta, and Diptera, and the less frequent groups were gathered under "Others". Soil physical and chemical properties were considered as environmental variables (explanatory variables). Physical properties were bulk density (BD), total porosity (TP), macroporosity (Macro), biopores (Bio), penetration resistance (PR), mean weight diameter of aggregates (MWD), and clay (Cla) and silt (silt) content. Chemical properties were pH in water [pH(H₂O)], base saturation (Bases), potential acidity (H+Al), phosphorus (P), potassium (K), organic matter (OM), aluminum (Al), calcium (Ca), and Ca-Mg ratio (Ca:Mg). The RDA analyses were performed as suggested by Baretta et al. (2014) with the statistical program Canoco, version 4.0 (ter Braak and Smilauer, 1998).

RESULTS AND DISCUSSION

Native forest had the highest group richness of all LUS, in the summer (Figure 2a) as well as winter (Figure 2b), which can be explained by the greater diversity and availability of food substrate for the soil fauna, fueled by high cycling of leaves and twigs in the forest litter (Moço et al., 2005; Bartz et al., 2014). Additionally, in the forest there is usually intense cycling of fine roots in the surface layer, which also contribute as a nutrient substrate for soil fauna (Hedde et al., 2015), favoring their multiplication. With regard to the other LUS, in the summer, the EP and PP systems were in an intermediate position in terms of richness of macrofauna, while ICL and NT had the lowest values. The lower fauna richness found in the ICL and NT systems can be explained by the lower supply and diversity of crop residues in the sampled areas, as also stated by Baretta et al. (2014), indicating the sensitivity of soil fauna to soil management practices.

In the winter, the NF maintained the highest richness of soil macrofaunal groups, while the other LUS did not differ from each other (Figure 2), showing that in addition to the effect of land use, soil fauna may be affected by seasonal variations.

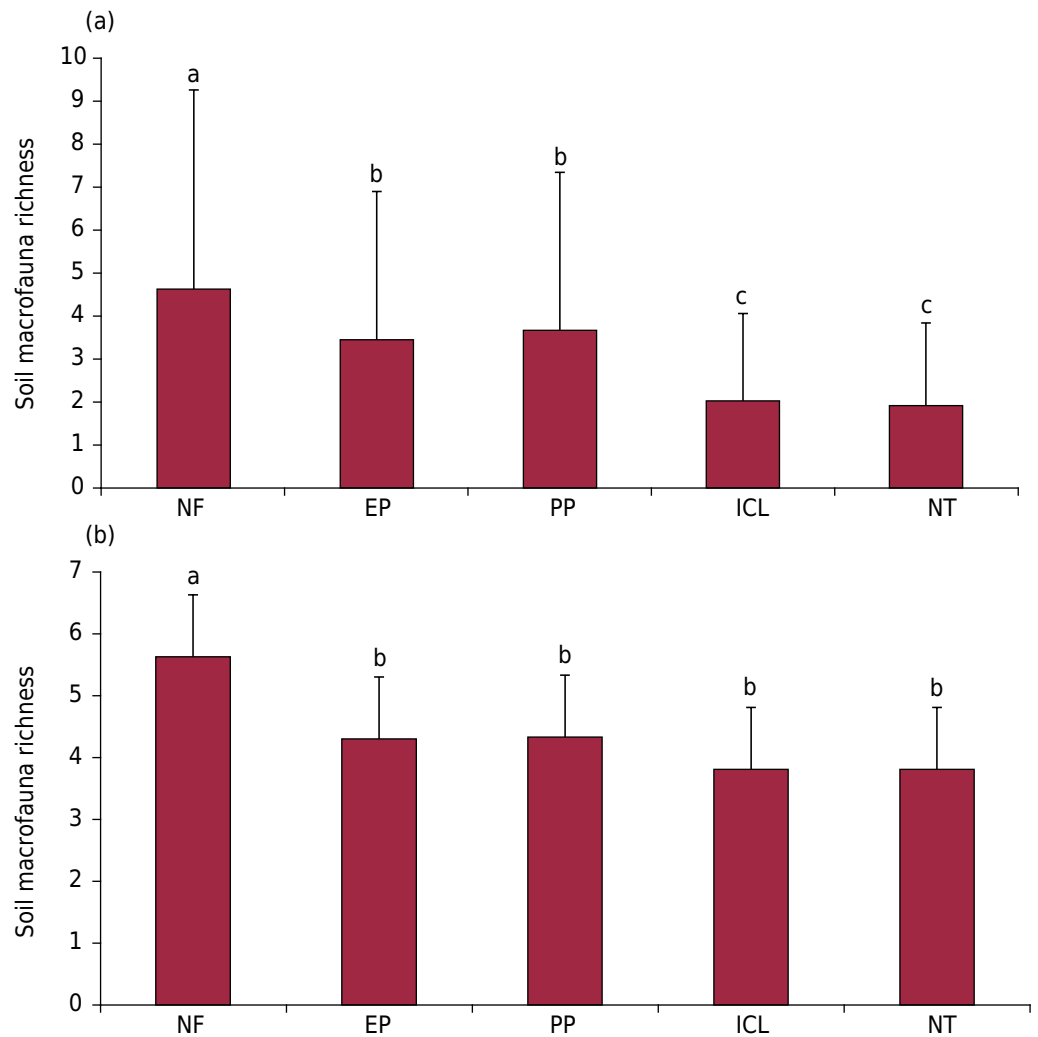


Figure 2. Richness of soil macrofaunal groups in the land use systems: native forest (NF), eucalyptus plantations (EP), perennial pasture (PP), integrated crop-livestock (ICL), and no-tillage (NT) in the summer (a) and winter (b), in the eastern region of Santa Catarina, Brazil. Different letters above the bars reflect statistical difference using the t test ($p < 0.05$) and line bars are standard deviation.

The total abundance (ind m^{-2}) of soil macroinvertebrates was also different between the LUS ($p < 0.05$) in summer (Figure 3a) and in winter (Figure 3b). In the summer, the highest abundance of macrofauna was found in PP, similar to NF (Figure 3a), while EP, ICL, and NT did not differ from each other. In contrast, in winter, the abundance was highest in PP and EP, followed by NF and NT (Figure 3b). The ICL system had the lowest abundance among the LUS. The same behavior was also observed by Rosa et al. (2015), who evaluated the same LUS in the West and highlands of Santa Catarina and found greater abundance of soil macrofauna in PP, with no differences between summer and winter.

In the ICL, NT, and EP systems, the abundance of macrofaunal assemblages was lower, with identification of only the taxonomic groups Orthoptera, Larvae, and Diptera and the category of total of other less common groups. These results may indicate that the intensity and degree of interference of management practices alter the soil structure and thus influence the presence and activity of soil macrofauna, due to resource constraints for these organisms (Bartz et al., 2011, 2014; Baretta et al., 2014).

In the summer, the Shannon diversity index (H) decreased in the following sequence: NF > EP > PP > NT > ICL (Figure 4a), following a trend that is the inverse of the gradient of intensification of land use. In the winter, diversity was highest in NF, followed by ICL, NT, PP, and EP (Figure 4b).

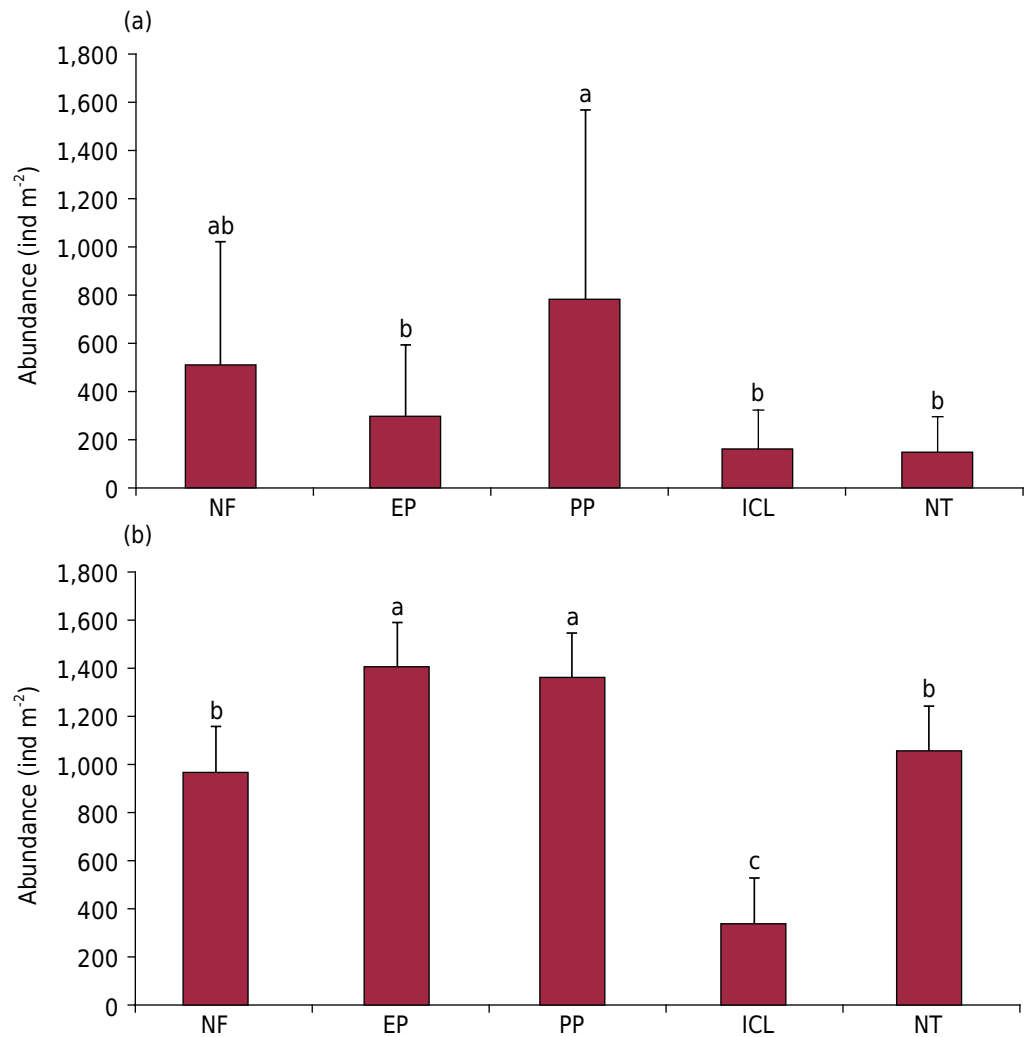


Figure 3. Abundance of soil macrofaunal groups in the land use systems: native forest (NF), eucalyptus plantations (EP), perennial pasture (PP), integrated crop-livestock (ICL), and no-tillage (NT), in the summer (a) and winter (b), in the eastern region of Santa Catarina, Brazil. Different letters above the bars reflect statistical difference using the t test ($p < 0.05$) and line bars are standard deviation.

The result of highest diversity in NF was also reported by Silva et al. (2006) in a study in the *Cerrado* region, indicating that native forests, where low anthropogenic activity favors the occurrence of soil macrofauna, have a more diversified and stable ecosystem. The high diversity index in EP in the summer, compared to the agricultural systems, can be ascribed to the higher amounts of crop residues deposited in this system, along with the milder and more stable microclimate within the forest environment, favoring the activity of soil organisms. In a study of a eucalyptus plantation in Alegrete, RS, Brazil, Rovedder et al. (2004) obtained results similar to this study ($H=1.14$), indicating that soil fauna responds positively to accumulated litter on the forest floor.

Similarly, in a study involving P and K fertilization of *Acacia auriculiformis* (A. Cunn) plantations in the state of Rio de Janeiro, Ribeiro et al. (2014) found a positive relationship between diversity and abundance of soil fauna and nutrient availability. The authors suggested that this response was related to the greater amount of litter input in the fertilized systems.

Although diversity was lowest in the NT and ICL agricultural systems, these systems clearly favored the occurrence of soil macrofaunal groups, corroborating results of Portilho et al. (2011) and Baretta et al. (2014). According to Alves et al. (2006), leaving crop residues

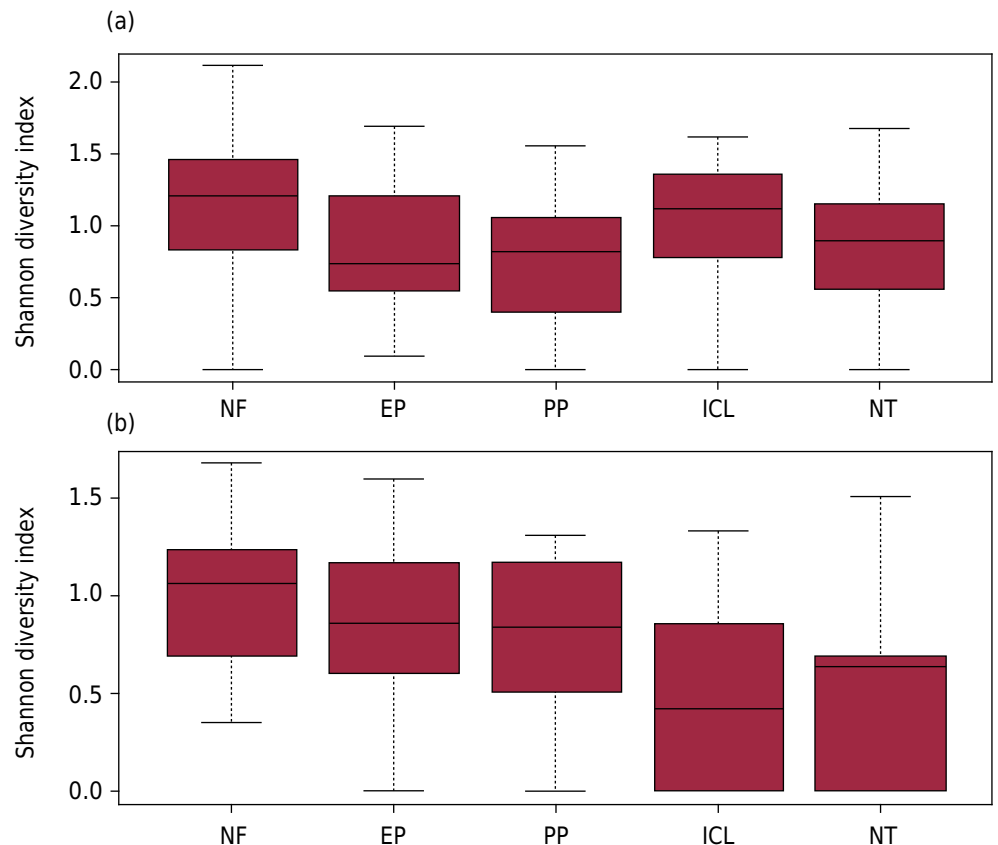


Figure 4. Shannon diversity index in box-plots for the land use systems: native forest (NF), eucalyptus plantations (EP), perennial pasture (PP), integrated crop-livestock (ICL), and no-tillage (NT) in the summer (a) and winter (b), in the eastern region of Santa Catarina, Brazil.

on the soil surface and the absence of tillage in soil conservation management systems can benefit certain soil macrofaunal groups in comparison to conventional systems.

For the summer, principal component analysis (PCA) indicated a differentiation in the abundance of functional macrofaunal groups among the LUS. The first principal component axis (PC1) explained 40 % and the second axis (CP2) only 16.2 % of the variability of the systems, i.e., together they explained 56.2 % of the total variability (Figure 5). A separation of the ICL, NT, and EP systems from NF and PP could be observed. The ICL, NT, and EP areas were on the left side of the diagram and were associated with the presence of Diplura, Pseudoscorpionidae, and the Others category, the total of the less frequent groups.

In contrast, NF and PP, on the right side of the diagram, were more related to the orders: Isoptera, Opiliones, Larvae, Chilopoda, Diplopoda, Hemiptera, Dermaptera, Araneae, Isopoda, Amphipoda, Orthoptera, Blattodea, Oligochaeta, Formicidae, and Coleoptera. This greater diversity of edaphic macrofaunal groups in NF may reflect more limited anthropogenic influence in a more protected and favorable environment for macrofaunal activity, growth, and development, mainly related to the diversity of ecological niches in this ecosystem. According to Carneiro et al. (2009), pastures, as systems without soil tillage, also tend to have better protection of OM, which may be one of the major reasons for the high abundance and richness of macrofauna in PP, since many of these organisms are sensitive to changes in soil structure.

For the winter, the first axis of the principal component (PC1) explains 22.5 % and PC2 explains only 9.3 % of the variability among the systems studied, or 31.8 % of the total variability together (Figure 6). In general, the summer results indicate a greater abundance of macrofaunal groups in the NF and PP systems. The orders Isopoda, Chilopoda, Diplopoda,

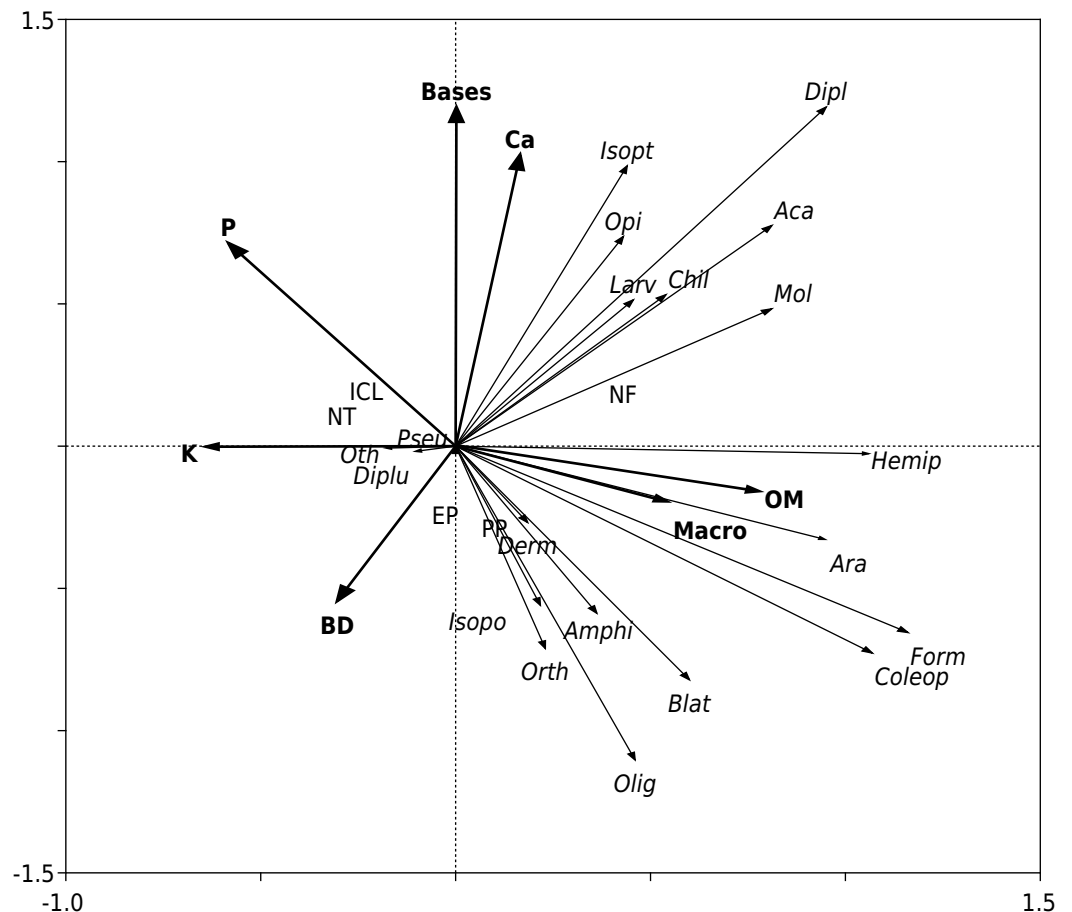


Figure 5. Principal component analysis (PCA) to differentiate native forest (NF), eucalyptus plantations (EP), perennial pasture (PP), integrated crop-livestock (ICL), and no-tillage systems (NT) based on samples collected in the summer, in the eastern region of Santa Catarina, Brazil. Vectors in bold represent the soil physical (BD: bulk density, Macro: macroporosity) and chemical properties (Ca: calcium, K: potassium, P: phosphorus, Bases: base saturation, OM: organic matter). In italics are the main macrofaunal groups: Oligochaeta (*Olig*), Opiliones (*Opi*), Formicidae (*Form*), Amphipoda (*Amphi*), Coleoptera (*Coleop*), total of other larvae (*Larv*), Molusca (*Mol*), Diplopoda (*Dipl*), Chilopoda (*Chil*), Isopoda (*Isopo*), Araneae (*Ara*), Isoptera (*Isopt*), Orthoptera (*Orth*), Hemiptera (*Hemip*), Dermaptera (*Derm*), Pseudoscorpionidae (*Pseu*), Diplura (*Diplu*), and total of other less frequent groups (*Oth*).

Araneae, Amphipoda, Mollusca, Formicidae, Coleoptera, Opiliones, Hemiptera, Isoptera, Dermaptera, and Oligochaeta were most abundant in NF and PP, indicating a lower level of disturbance in these areas. Several studies have demonstrated the negative effect on the structure of soil communities caused by intensification of land use (Portilho et al., 2011; Baretta et al., 2014). In a mesocosm experiment, Collison et al. (2013) showed that monocrops affect the macrofaunal groups, leading to lower decomposition rates of crop residues than in polyculture cropping.

In the ICL, NT, and EP systems, the abundance of macrofaunal groups was lower in the winter, at which time only the taxonomic groups Orthoptera, Larvae, and Diptera and the category of total of other less common groups were found. These results reinforce how strongly management practices alter the soil structure and consequently influence the presence and activity of soil macrofauna (Bartz et al., 2011; Baretta et al., 2014; Hedde et al., 2015).

Based on the results obtained in redundancy analysis (RDA) in the summer, statistical differences ($p < 0.10$) were detected for the soil physical and chemical properties of OM, macroporosity (Macro), Ca, base saturation (Bases), P, and K, which were thus included in the model (Figure 7). Relationships between some physical and chemical properties and the abundance of soil macrofaunal groups were observed. For example, the soil

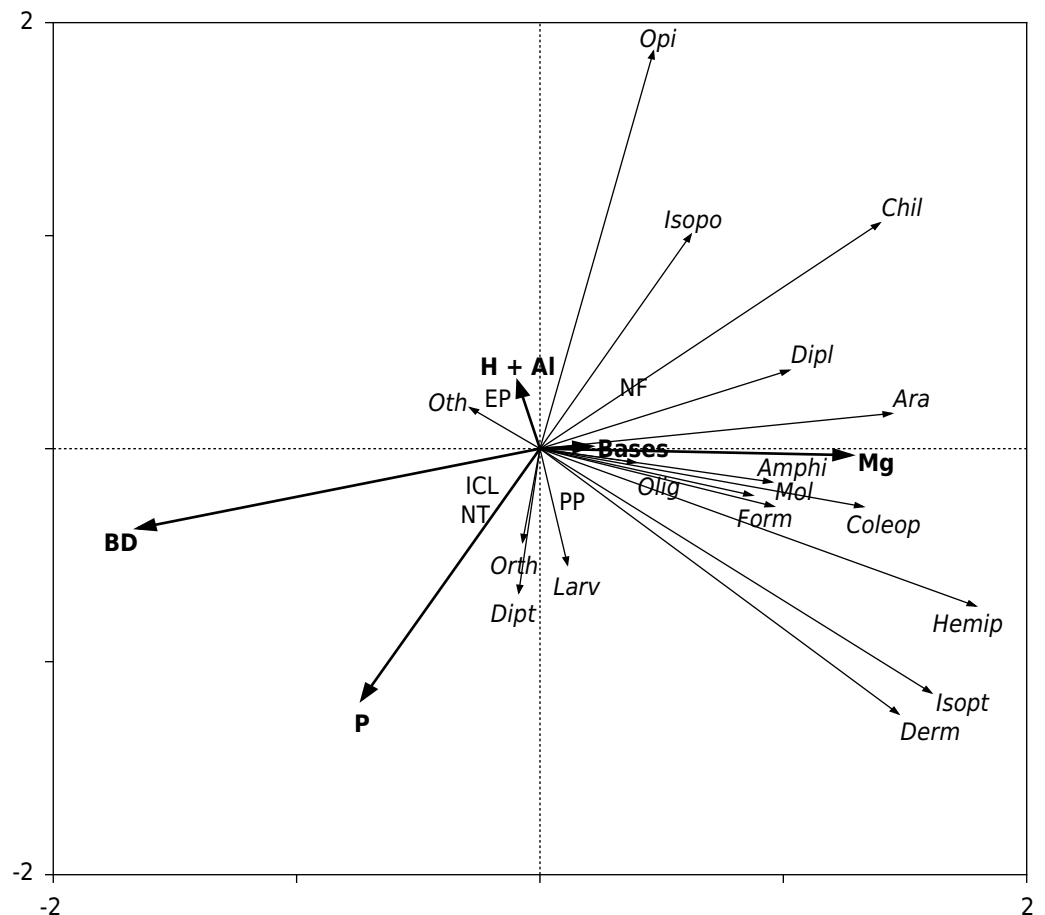


Figure 6. Principal component analysis (PCA) to differentiate native forest (NF), eucalypt plantations (EP), perennial pasture (PP), integrated crop-livestock system (ICL), and no-tillage (NT) based on samples collected in the winter, in the eastern region of Santa Catarina, Brazil. Vectors in bold represent the soil physical (BD: bulk density) and chemical properties (Mg: magnesium, P: phosphorus, H+Al: potential acidity, base saturation (Bases)). In italics are the main macrofaunal groups: Oligochaeta (*Olig*), Opiliones (*Opi*), Formicidae (*Form*), Coleoptera (*Coleop*), total of other larvae (*Larv*), Molusca (*Mol*), Diplopoda (*Dipl*), Chilopoda (*Chil*), Isopoda (*Isopo*), Araneae (*Ara*), Amphipoda (*Amphi*), Isoptera (*Isopt*), Orthoptera (*Orth*), Hemiptera (*Hemip*), Dermaptera (*Derm*), Diptera (*Dipt*), and total of other less frequent groups (*Oth*).

macrofaunal groups Formicidae, Coleoptera, Araneae, Blattodea, and Pseudoscorpionidae were strongly correlated with OM, indicating that environments with better conditions for this property may favor the activity and stability of these organisms. According to Begon et al. (2008), an abundant amount of OM in a soil can create suitable microhabitats for a variety of organisms, mainly due to stabilization of the soil moisture regime.

The orders Amphipoda, Dermaptera, Orthoptera, Oligochaeta, Diplura, and Isopoda, in contrast, correlated more strongly with BD and K. Similar results were reported by Carneiro et al. (2009), in which different management systems led to changes in soil physical properties (bulk density, macroporosity, total pore volume, etc), affecting the composition and distribution of soil biota. Thus, changes in soil physical and chemical properties can trigger changes in the composition of the soil macrofaunal assemblages. This behavior was confirmed by other authors in analyses of the relationships of soil chemical and physical properties with biological properties (Baretta et al., 2008; Pereira et al., 2013; Hedde et al., 2015).

In the winter, statistical differences ($p < 0.10$) were observed for the following soil chemical and physical properties: P, Bases, Mg, H+Al, and BD (Figure 8). As in the summer, the physical and chemical properties and the abundance of soil macrofaunal groups were also correlated in the winter. Most groups of organisms (Coleoptera, Chilopoda, Larvae, Araneae, Pseudoscorpionidae, Molusca, Diplopoda, Hemiptera, Blattodea, Isopoda,

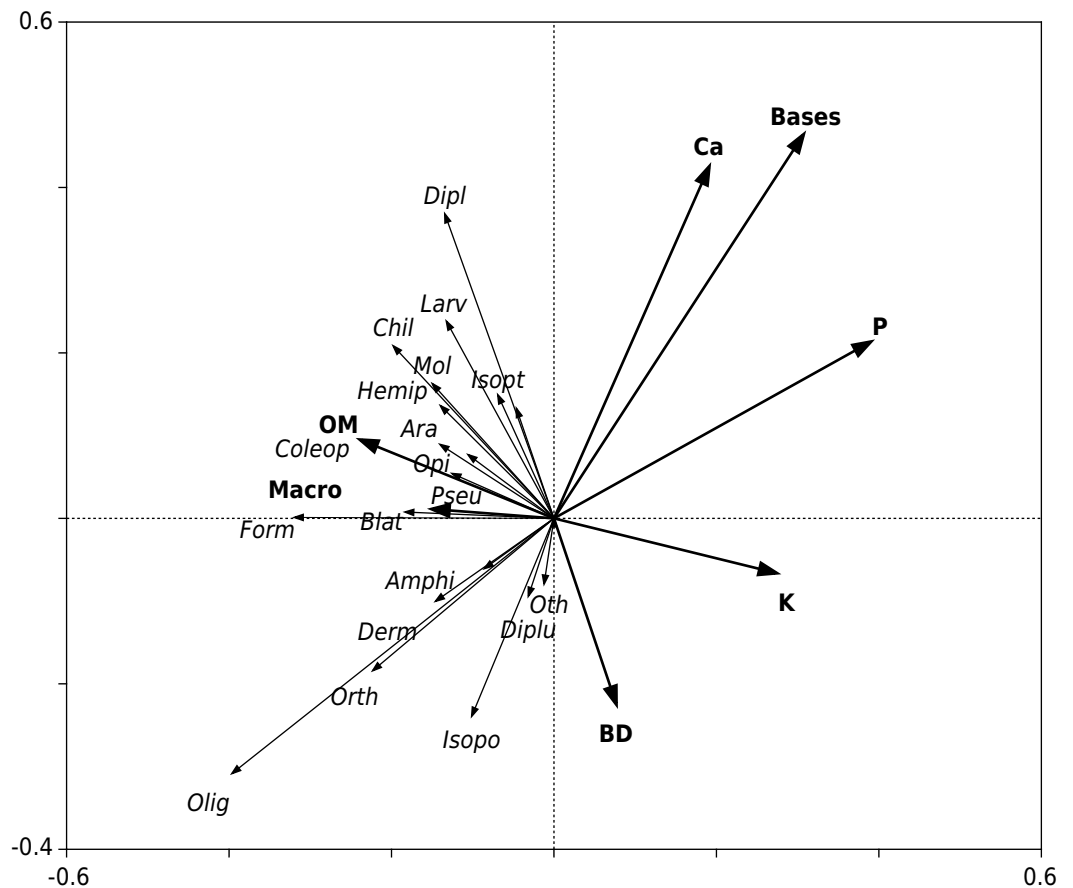


Figure 7. Redundancy analysis (RDA) for macrofaunal groups (in italics) and soil physical and chemical properties (in bold) in the summer sampling in the eastern region of Santa Catarina, Brazil. Oligochaeta (*Olig*), Formicidae (*Form*), Coleoptera (*Coleop*), Opiliones (*Opi*), Dermaptera (*Derm*), total of other larvae (*Larv*), Molusca (*Mol*), Pseudoscorpionidae (*Pseu*), Diplopoda (*Dipl*), Chilopoda (*Chil*), Isopoda (*Isopo*), Araneae (*Ara*), Blattodea (*Blat*), Diplura (*Diplu*), Isoptera (*Isopt*), Orthoptera (*Orth*), Amphipoda (*Amphi*), total of other less frequent groups (*Oth*). Chemical properties: phosphorus (P), calcium (Ca), potassium (K), base saturation (Bases), organic matter (OM), and physical properties: macroporosity (Macro) and bulk density (BD).

Dermaptera, Orthoptera, and Formicidae) correlated with the chemical properties of Mg and Bases. In the summer there was a strong correlation between the levels of OM and soil macroporosity with macrofaunal groups (Figure 7), mainly because OM is one of the main resources exploited by soil fauna organisms. In a study in Marambaia, state of Rio de Janeiro, in flooded *restinga* areas, Silva et al. (2013) found that accumulated OM served as food for fauna organisms, particularly saprophages, due to soil moisture at the study sites. Likewise, in NF areas, the relationship of macrofauna with OM contents was strong, possibly due to the diversity of plant residues accumulated on the soil surface.

The association of selected soil properties with soil macrofauna diversity occurs indirectly through increased plant root and shoot production and residue deposition on the surface, forming plant litter, which is fragmented and decomposed by different groups of soil macrofauna. Thus, a complex chain is formed, which is essential for the soil structure. For example, the Chilopoda group strongly depends on the quantity and quality of the soil cover (Almeida et al., 2007). In contrast, fragmenting agents such as Isopoda are scavengers that consume coarser organic matter particles (Begon et al., 2008). Consequently, litter composition and quantity may be decisive for the diversity and survival of different soil organisms.

Among the physical properties, only BD correlated with macrofauna in the winter and, together with H+Al, was positively related with the groups Amphipoda, Isoptera, Oligochaeta, and Opiliones (Figure 8). The correlation between soil Ca with macrofauna

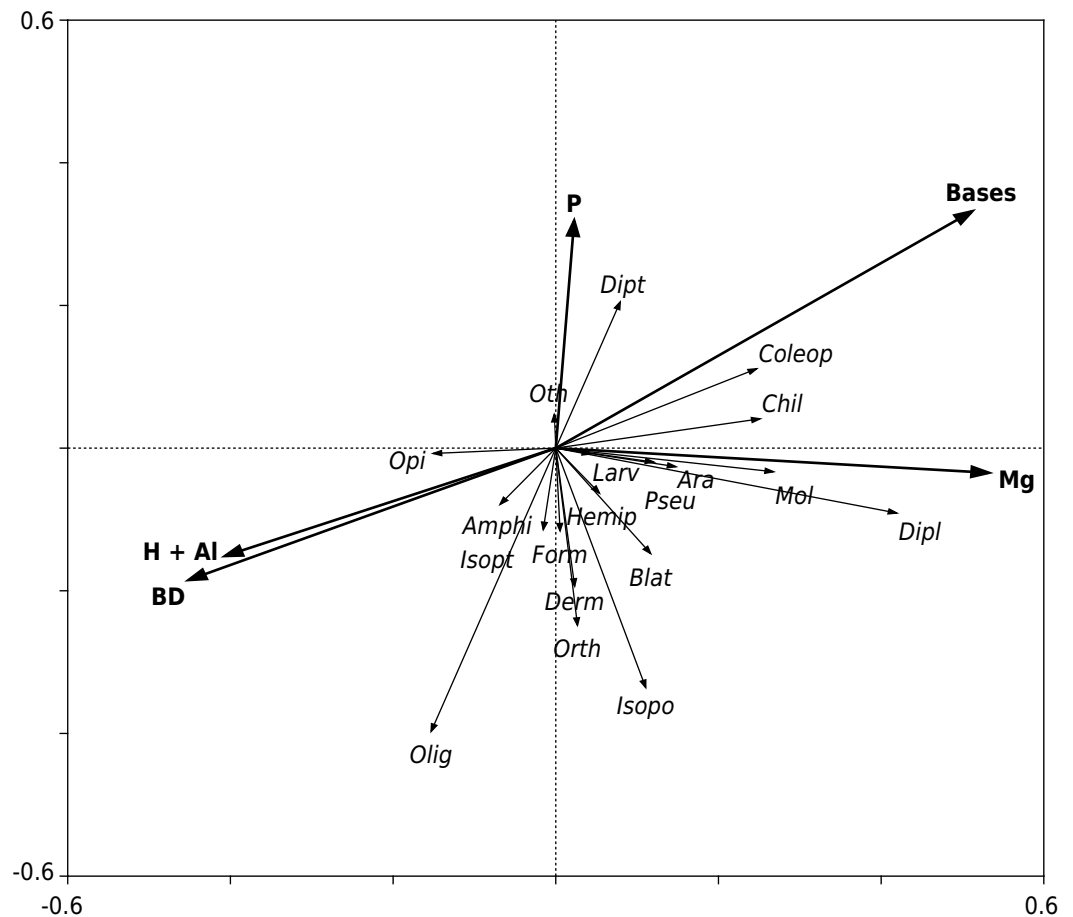


Figure 8. Redundancy analysis (RDA) for macrofaunal groups (in italics) and soil physical and chemical properties (in bold) in the winter sampling in the eastern region of Santa Catarina, Brazil. Oligochaeta (*Olig*), Formicidae (*Form*), Coleoptera (*Coleop*), Opiliones (*Opi*), Dermaptera (*Derm*), total of other larvae (*Larv*), Molusca (*Mol*), Pseudoscorpionidae (*Pseu*), Diplopoda (*Dipl*), Chilopoda (*Chil*), Isopoda (*Isopo*), Araneae (*Ara*), Blattodea (*Blat*), Isoptera (*Isopt*), Orthoptera (*Orth*), Amphipoda (*Amph*), Hemiptera (*Hemip*), Diptera (*Dipt*), and total of other less frequent groups (*Oth*). Chemical properties: phosphorus (P), magnesium (Mg), base saturation (Bases), potential acidity (H+Al), and physical properties: bulk density (BD).

was probably due to the high physiological requirement for Ca of some arthropods to maintain the exoskeleton (molting process) (Schoefield et al., 2003; Luquet, 2012). Lower BD can be ascribed to advantages resulting from the presence of other organisms in the soil structure, mainly by increasing soil particle movement, mixing this material with OM, with direct and indirect participation in processes of aeration, formation of macro and microaggregates, and mineralization of OM, as well as benefitting the edaphic biota, thus enhancing plant development and growth (Bartz et al., 2011; Hedde et al., 2015).

CONCLUSIONS

Land use systems alter the composition of soil macrofauna, following a gradient of intensification of land use where systems with stronger anthropogenic influence have lower soil fauna diversity and abundance, regardless of the season (winter and summer).

The different land use and management systems determine soil physical and chemical properties, especially macroporosity and bulk density (physical) and organic matter, calcium, phosphorus, and potassium (chemical), which, in turn, are highly correlated with the most frequent soil macrofaunal groups (Formicidae, Coleoptera, and Oligochaeta) in the eastern region of Santa Catarina.

Among the macrofaunal groups, the most relevant in differentiating land use systems were Formicidae (ants), Coleoptera (beetles), and Oligochaeta (worms).

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