SOIL CHEMICAL FACTORS AND GRASSLAND SPECIES DENSITY IN EMAS NATIONAL PARK (CENTRAL BRAZIL)

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INTRODUCTION

In herbaceous communities, the number of species and biomass appear to present a humped-back relationship (Al-Mufti *et al*., 1977; Grime, 1979). Biomass, on its turn, depends on the production of the community and, thus, on the fertility of the soil (Janssens *et al*., 1998). Nutrient limitation is, indeed, one of the most important factors affecting the structure of plant communities

Individual studies of grasslands on specific soil types suggest that different nutrients can limit biomass production and, hence, species composition and number. Whereas phosphorus influences grassland biodiversity (Janssens *et al*., 1998), the role of potassium is less clear. Similarly, the role of pH is also unclear: on the one hand, pH was the variable most highly correlated with species richness and diversity in the Netherlands, but, on the other hand, in some temperate regions of western and central Europe, it was not correlated with them at all (Janssens *et al*., 1998).

Several explanations for the occurrence of savannas, in general, and of the cerrado, in particular, involve soil either as a primary cause or as an indirect factor. As long as soil chemical factors are important in the distribution of the vegetation forms within the Cerrado Domain and may influence the number of species, we analyzed some soil characteristics in three herbaceous vegetation forms - hyperseasonal cerrado, seasonal cerrado, and wet grassland - in ENP, a core cerrado site. In ENP, number of species is higher in the wet grassland and lower in the hyperseasonal cerrado. But, is this pattern related to soil characteristics? That is, regardless of the vegetation form, are there relationships between soil factors and the number of species in those herbaceous communities? Which soil factors are important in explaining variation in number of species in those grasslands?

MATERIAL AND METHODS

We established three 1 ha areas in the southwestern portion of the reserve, one composed of hyperseasonal cerrado, one composed of seasonal cerrado and one composed of wet grassland. Physiognomically, these three vegetation forms are grasslands. In each vegetation form, we placed randomly ten 1 m^2 quadrats, at mid-rainy season, and counted the number of individuals of each vascular plant species. In each point, we also collected soil samples at four depths (0-0.05, 0.05-0.25, 0.4-0.6, and 0.8-1.0 m) for chemical analyses

For each quadrat, we counted the number of species, which gave us the species density. Thus, we had a matrix with the number of species and soil chemical factors for each one of the 30 quadrats and for each one of the four depths. To test the relationships between species density and soil chemical factors at each depth, we used linear multiple regressions. In these analyses, species density was the response variable and the soil chemical factors - pH, organic matter, phosphorus, aluminium, and potassium - were the explanatory variables.

RESULTS AND DISCUSSION

Contrary to the expected, we did not find humped-back relationships for none of the analyzed soil chemical factors. Species density varied from three to 24 spp m^{-2} .We found significant relationships between the number of species and soil chemical factors for all depths. The depth with the highest coefficient of determination was the superficial one (R^2 = 0.68, F = 10.179, P < 0.001). In this depth, aluminium and pH were the best predictors of species density, the former positively related to species density and the latter negatively related)

Humped-back relationships between species density and soil factors may be expected, at least for major soil nutrients, such as phosphorus and potassium (Janssens *et al*., 1998). Contrary to temperate grasslands, relationships between species density and major soil nutrients may be more complex in tropical grasslands, as those grasslands within the Cerrado Domain. Since we did not find humped-back relationships between species density and soil factors, we cannot expect humped-back relationships between species density and biomass in the grasslands we studied as well.

In the grasslands we studied, aluminium and pH were the best predictors of species density, as The Netherlands (Venterink *et al*., 2003). In Europe, there is a positive relationship between pH and species density. Low pH reduces the mineralization of soil organic matter and other nutrient reserves. In tropical grasslands, such as in Australia, on the other hand, plant species density is negatively correlated with soil pH, corroborating our results. Local relationships between plant species number and soil pH are related to evolutionary history, thus, the relationship between them should be positive in those floristic regions where the evolutionary center is on high pH soil and negative where the evolutionary center is on low pH soil (Pärtel, 2002).

Exchangeable aluminium decreases the nutrient availability to the plants. Thus, we could expect a negative relationship between aluminium and species density. However, we found a positive relationship in the grasslands we studied. Tilman (1982) suggested that species number is greater in sites where plant growth is limited by several nutrients. Since aluminium decreases nutrient availability, plant growth would be limited by several nutrients in aluminium-rich soils. Thus, we may postulate that the positive relationship aluminium and species density we found is because the grassland species in ENP are limited by several nutrients. This positive relationship between aluminium and species density does not mean that high concentration of aluminium in soil implies in high species density, since this high concentration of aluminium can be toxic to the plants and decrease the species density.

Our study is limited in time and there may be variations in soil characteristics and number of species in the three environments throughout the year due to the seasonal variations, such as the temporary waterlogging in the hyperseasonal cerrado that would result in changes of chemical soil features. These changes may imply differences in species density during the waterlogging when compared to the other seasons of the year. Nevertheless, even taking into account these limitations, species density in ENP's grasslands may be predicted by two soil factors: pH and aluminium. Since the predictable variation in species density is important to determining areas of conservation (Pärtel, 2002), we may postulate that these two soil factors are indicators of high species density areas in tropical grasslands, which could be used for assigning priority sites for conservation.

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