Food and Agriculture Organization of the United Nations

Proceedings

Keep soil alive, protect soil biodiversity

GLOBAL SYMPOSIUM ON SOIL BIODIVERSITY

19–22 April 2021

GLOBAL SOIL PARTNERSHIP

itps INTERGOVERNMENTAL TECHNICAL PANEL ON SOILS

Convention on Biological Diversity

GLOBAL SOIL BIODIVERSITY INITIATIVE

UNCCD SPI Science - Policy Interface

Enchytraeids in two phytophysiognomies of Brazilian Cerrado

Cintia Carla Niva [1], Robélio Leandro Marchão [1], Karina Pulrolnik [1], Douglas Alexandre [2], Juaci Vitoria Malaquias[1], Dgessica Rayanne Francis de O. Alcantara[3], André Elias Cavalcanti Bezerra Guedes[4], Natalia Durães[5], Rüdiger Maria Schmelz[6]*

[1]Embrapa, Brasilia-DF, Brazil. cintia.niva@embrapa.br
[2]Universidade do Estado de Santa Catarina, UDESC, Lages-SC, Brazil
[3]União Pioneira da Integração Social - UPIS, Brasilia-DF, Brazil
[4]Instituto Federal de Brasilia - IFB, Brasilia-DF, Brazil
[5]CNPq and Universidade de Brasilia - UnB, Brasilia-DF, Brazil
[6]IFAB, Institut for Applied Soil Biology, Hamburg, Germany

Abstract summary

This is the first study on enchytraeid diversity in phytophysiognomies of the Brazilian Cerrado Biome carried out with standard sampling and extraction methods. Shrubby woodland (Cerrado sensu stricto, CSR) and gallery forest (MG) was sampled in the Brasilia Botanical Garden Ecological Station and the Brasilia National Park, respectively, with samplings performed at the end of the rainy season in 2017 and 2018. Enchytraeid population density in MG was higher than in CSR, reaching more than 30 thousand individuals/ m^2 in MG and 5 thousand in CSR. Enchytraeid abundance was influenced by soil organic matter and moisture. So far, six genera and six potentially new species taxa were identified. Dominant genera were *Guaranidrilus* and *Hemienchytraeus*.

Keywords: Enchytraeidae, tropics, Oligochaeta, Clitellata, savana, diversity

Introduction, scope and main objectives

Enchytraeids are small oligochaetes living in soil, freshwater and marine environment. Soil enchytraeids have potential as soil quality indicators as they occur worldwide, play a key role in belowground ecosystems and are sensitive to changes in the environment (Pelosi and Römbke, 2016). They play roles similar to earthworms in soil functioning, such as on soil nutrient cycling and soil structure, however at a smaller scale because of their small body size.

Most of the knowledge on enchytraeids is concentrated in the temperate regions, especially Europe. In the tropics, Brazil is the place with more information available, although taxonomic and ecological knowledge is still very scarce and restricted to few locations in the Amazonian and Atlantic Forests (Römbke and Meller, 1999; Römbke *et al.*, 2015). In the Cerrado ecoregion, for instance, genera and species of enchytraeids are practically unknown, although there is some information on population densities in native and cultivated areas. These data, however, were obtained with inappropriate methods (e.g. Silva *et al.*, 2006).

The Cerrado, a tropical savanna considered a hotspot of biodiversity. The 2 million square kilometres of savanna (23 percent of Brazilian territory) have been increasingly taken by the expanding agriculture and livestock activities over the last 40 years, with remaining 56 percent of the area still covered with natural vegetation in 2018 (Mapbiomas, 2019). The Cerrado occupies mainly the central region of Brazil where seasonality is marked by a rainy season from October to March and a dry season during the rest of the year. The loss of biodiversity in the Cerrado biome has been a matter of concern, because endemic species are abundant.

Regarding soil invertebrates in the Cerrado biome, faunistic and ecological information at lower taxonomic levels is scarce, so that studies on enchytraeids are urgently needed considering current threats. We will present the results on enchytraeid population and generic composition in two different phytophysiognomies of the Cerrado. This information will supplement studies that focus on the use of enchytraeids for monitoring soil biological quality, soil biodiversity loss and sustainability of production systems in Brazil.

Methodology

Sampling sites

The study areas included the Brasilia Botanical Garden Ecological Station (JBB) with a total area of 4,518 hectares and the Brasilia National Park (PNB), a Federal Conservation Unit of 43,000 hectares. Both locations were chosen because of their good state of conservation and low anthropogenic influence. Two phytophysiognomies were sampled in each site: Woody Savanna (Cerrado Sensu Stricto, CSR) and Gallery Forest (MG). The climate in this region is tropical savanna climate, *Aw*, according to the Köppen classification), with distinct rainy and dry season. The sampling was carried out in May 2017 and April 2018, at the end of the rainy season. Soil type in CSR areas is a latosol and in MG a gleysol.

Sampling and sample processing

Soil cores of 5 cm diameter and 5 cm depth (including organic and mineral layer) were taken at 10 points distant 10-15 m along a transect at each sampling site in two consecutive years, at the end of rainy season. In MG, because of varying depths of the organic matter layer, two cores were sampled vertically at a greater depth to assure that the mineral soil layer was included in the sample. For comparisons, the average values of the two cores were used. The worms were extracted with a wet funnel device based on methods described in ISO 23611-3/2007 (ISO, 2007) with heating for 2.5 h as described in Niva *et al.* (2015). The enchytraeids were separated from other organisms and counted under a stereomicroscope. Identification of genera was carried out with living worms under a microscope. Soil fertility attributes and moisture (%) were determined for each sampling point.

Results

The enchytraeid population density found in MG was generally higher than in CSR, but there was a marked difference in JBB from the first to the second sampling date, where mean density in MG reached more than 30 thousand individuals/ m^2 (ind/m^2) in the second year, contrasting with only 637 ind/m^2 in the first year. In PNB, on the other hand, there was no significant difference in density between the two years (Figure 1). Generally, the enchytraeid abundance correlated positively with soil moisture and organic matter.

Soil moisture kept the range of 27 to 33 percent in CSR in both locations at both collection dates, while in MG-JBB it raised from 43 to 65 percent from one year to the other and, in MG-PNB, did not change (64-66 percent). The organic matter content in MG was 18 and 16 percent in PNB and JBB respectively, while in CSR it was 3.6 and 5.4 percent. Soil moisture and organic matter were always higher in MG than in CSR.

Eight different genera were recorded. One of them, named spR in the following, is probably new and undescribed. *Hemienchytraeus* was present in all locations and *Guaranidrilus* and spR were dominant in most of the cases (Figure 2). *Achaeta* and *Enchytraeus* occurred at very low abundances, the first was mostly present in samples collected in 2017 and the second, in 2018.

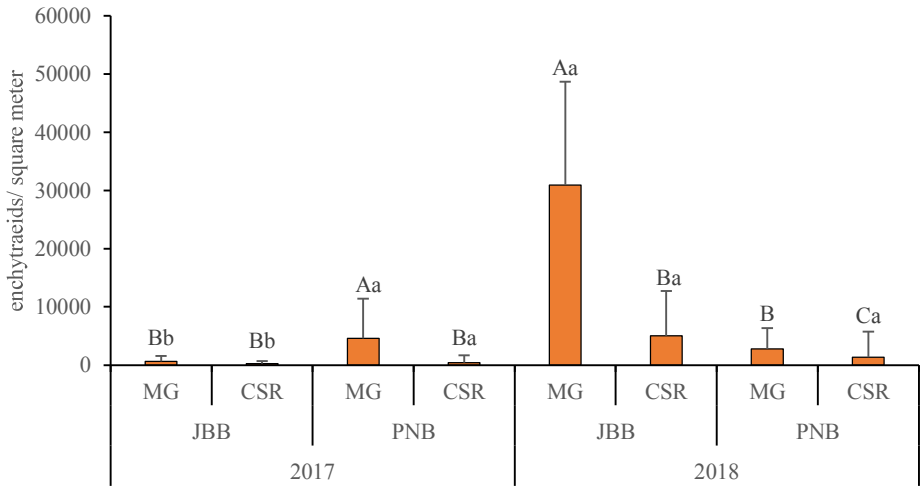

Figure 1: Enchytraeid mean density (individuals/ m^2) and standard deviation in two phytophysiognomies of Cerrado Biome, Brazil, in two collection years

Phytophysiognomies: MG- Gallery forest; CSR- Cerrado Sensu Stricto. Locations: JBB – Brazilian Botanical Garden; PNB: Brasilia National Park. Different capital letters indicate significant difference between years in the same phytophysiognomy and location. Different small letters indicate significant difference between the phytophysiognomies within a year and location (n= 10; non-parametric Kruskal-Wallis test; alpha= 0,05)

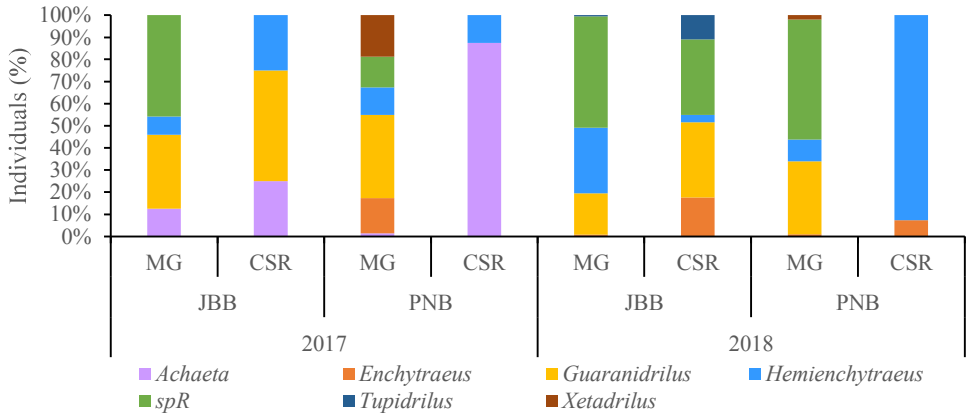

Figure 2: Distribution (%) of enchytraeid genera in each phytophysiognomy of Cerrado Biome, Brazil, in two collection years

Phytophysiognomies: MG- Gallery forest; CSR- Cerrado Sensu Stricto. Locations: JBB – Brazilian Botanical Garden; PNB: Brasilia National Park. spR is a potential new taxon.

The principal component analysis (PCA) performed with population density of each genus, richness, soil chemical and texture variables of the four sampling sites showed that the first and second axis accounted for 62.8 percent of the total variability of the data (Figure 3). The axis 1 mainly separated the phytophysiognomies, and axis 2 separated the locations, suggesting that distribution of soil attributes and enchytraeids were influenced by the sites (JBB and PNB) (Figure 3). The variables which contributed to axis 1 (> 90 percent), shown by the longer arrows, were total N, MO, Sand, H+Al and, negatively, clay (Figure 3). The enchytraeid density (indiv.m) and spR contributed positively to axis 2 (>70 percent), while V, negatively. Genus richness correlated with organic matter and soil fertility attributes.

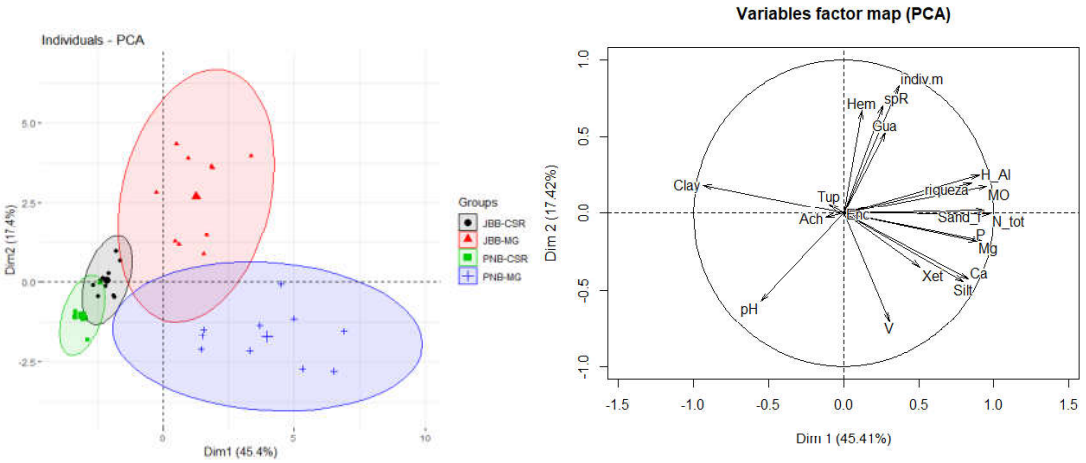

Figure 3: Principal component analysis (PCA) of the variables potentially affecting enchytraeid populations in the phytophysiognomies in each location (A)

Graph (B) shows the correlation of soil variables and enchytraeid data. Phytophysiognomies: MG- Gallery forest; CSR- Cerrado Sensu Stricto. Locations: JBB

– Brazilian Botanical Garden; PNB: Brasilia National Park. Enchytraeidae genera: *Achaeta* (Ach), *Enchytraeus* (Enc), *Guaranidrilus* (Gua), *Hemienchytraeus* (Hem), *Tupidrilus* (Tup), *Xetadrilus* (Xet), spR (potentially new taxon). Other variables: Density (indiv.m), riqueza (Richness), pH, potencial acidity (H_Al), Calcium (Ca), organic matter (MO), magnesium (Mg), total nitrogen (N_tot), phosphorus (P), base saturation (V), fine sand (Sand_f), clay and silt.

Discussion

Very little quantitative and qualitative information about tropical enchytraeids is currently available. Studies in Mata Atlantica and Amazon in Brazil suggest that abundance of enchytraeids in tropical regions might be similar or smaller than in temperate regions (Schmelz *et al.*, 2013). Considering that 10-140 thousand ind/m^2 are expected to be found in temperate forest soils, the mean density of 30 thousand ind/m^2 recorded in MG supports the aforementioned hypothesis. In CSR, however, the density was much smaller (maximum of 5 thousand) (Figure 1). The higher moisture and organic matter content of the gleysol in MG may have favoured the maintenance of enchytraeids compared to the latosol in CSR. The lower abundance of enchytraeids found in 2017 may also have been caused by the lower moisture, due to a severe reduction in rainfall in that year, which agrees with the abundance results. Worms may have moved down vertically to moister strata. In the future, sampling at greater depths may be necessary. The PCA showed a strong association of MO with enchytraeid richness (Fig 3) suggesting a strong correlation of organic matter with enchytraeid abundance.

The genera found in MG and CSR were not different from Mata Atlantica or Amazon (Römbke and Meller, 1999; Römbke, Collado and Schmelz, 2007) except for spR (Fig 2). Similarly, to the forests of other biomes studied so far, *Guaranidrilus* and *Hemienchytraeus* were also abundant genera in these two phytophysiognomies (Figure 2; Fig 3). A preliminary species-level analysis of the specimens, however, revealed six potentially new species, among which, spR may be a new genus with some traits resembling *Guaranidrilus*.

Conclusions

The Cerrado biome harbors enchytraeids at mean densities of up to 30 thousand ind/m^2. So far, this study revealed six genera. Together with a potentially new genus, *Guaranidrilus* and *Hemienchytraeus* were the three most abundant enchytraeid genera in the Gallery Forest and the Cerrado Sensu Stricto. Six species, however, are distinct from the ones known from other biomes and are probably new to science.

Acknowledgements

FAPDF and Embrapa for financial support. William M. Araújo, Celso Y. H. Ussuki and students from UnB, UDESC and IFB helped in the field and processing of samples.

References

International Standard Organisation (ISO). 2007. Soil quality - Sampling of soil invertebrates - Part 3: Sampling and soil extraction of enchytraeids (ISO 23611-3) [online]. Geneve, Switzerland. [Cited 30 January 2020] https://www.iso.org/obp/ui/es/#iso:std:iso:23611:-3:ed-1:v1:en

Mapbiomas. 2019. *Cerrado. Evolução anual da cobertura e uso da terra (1989-2018)* [image]. [Cited 30 January 2020]. https://mapbiomas-br-site.s3.amazonaws.com/mbi_colecao4_cerrado_la_rev.jpg

Niva, C.C., Cezar, R.M., Fonseca, P.M., Zagatto, M.R.G., Oliveira, E.M., Bush E.F., Clasen, L.A., Brown G.G. 2015. Enchytraeid abundance in Araucaria Mixed Forest determined by cold and hot wet extraction. *Brazilian Journal of Biology,* 75(4): 169-175.

Pelosi, C. & Römbke, J. 2016. Are Enchytraeidae (Oligochaeta, Annelida) good indicators of agricultural management practices? *Soil Biology and Biochemistry*, 100, 255-263.

Römbke, J. & Meller, M. 1999. Applied research on Enchytraeidae in Central Amazonia: project approach, methodology and first results. *In* R.M. Schmelz & K. Sühlo, eds. Newsletter on Enchytraeidae No. 6. Proceedings of the 3rd International Symposium on Enchytraeidae, pp 69–75. Osnabrück, Germany, Universitatsverlag Rasch.

Römbke, J., Collado R. & Schmelz, R.M. 2007. Abundance, distribution and indicator potential of enchytraeid (Enchytraeidae, Clitellata) in secondary forests and pastures of the Mata Atlântica (Paraná, Brazil). *Acta Hydrobiologica Sinica,* 31: 139–150.

Römbke, J., Collado, R., Höfer, H., Ottermanns, R., Raub, F., Ross-Nickoll, M. & Schmelz, R. M. 2015. Species diversity of Enchytraeidae (Oligochaeta) in pastures, regenerating secondary forests, and old-growth forests in the southern Mata Atlântica (Brazil). *Soil Organisms*, 87(2), 101-120.

Silva, R.F.D., Aquino, A.M.D., Mercante, F.M. & Guimarães, M.D.F. 2006. Populações de oligoquetos (Annelida: Oligochaeta) em um Latossolo Vermelho submetido a sistemas de uso do solo. *Ciência Rural*, 36(2): 673-677.

Schmelz, R. M., Niva, C.C., Römbke J. & Collado, R. 2013. Diversity of terrestrial Enchytraeidae (Oligochaeta) in South America: current knowledge and their potential for future research. *Applied Soil Ecology*, 69: 13–20.