Earthworms and Amazonian Dark Earths: improving understanding of the relationships between soil management, biodiversity and function*

Luis Cunha*[1], Marie Bartz[2], Wilian Demetrio[3], Telma Silva[4], Samuel James[5], Elodie Da Silva[6], David Stanton[1], Ana Caroline Conrado[3], Thibaud Decaens[7], Patrick Lavelle[8], Alessandra Santos[3], Herlon Nadolny[3], Elena Velásquez[9], Anne Zangerlé[10], Sandra Tapia Coral , Talita Ferreira[3], Lilianne Maia[3], Rodrigo Segalla[3], Charles Clement[4], Aleksander Muniz[11], Peter Kille[1], George Brown†[6], and Tpi Network

[1]Cardiff University – United Kingdom
[2]Positivo University – Brazil
[3]Federal University of Paraná – Brazil
[4]Instituto Nacional de Pesquisas da Amazônia – Brazil
[5]University of Iowa – United States
[6]Embrapa Forestry – Brazil
[7]Centre d'Ecologie Fonctionnelle et Evolutive (CEFE) – Campus CNRS, UMR 5175 – 1919 route de Mende;34293;Montpellier Cedex 5, France
[8]Institut de Recherche pour le Développement (IRD) – Colombia
[9]Universidad nacional de Colombia – Colombia
[10]Technische Universität Braunschweig – Germany
[11]Embrapa Amazônia Ocidental – Brazil

Abstract

Amazonian Dark Earths (ADEs) are highly fertile soils created by human activities over millennia and found throughout Amazonia. The distinguishing dark color and high nutrient content (particularly for available Ca and P) make these soils prime areas for agricultural activities. In fact, many ADEs have been used for this purpose to varying degrees for decades, but little is known about the effects of ADE formation and management on soil biodiversity. Therefore, 9 sites with ADE and adjacent soils (reference soil) were sampled for soil fauna, including the assessment of earthworm populations (species composition and abundance) using the ISO standard method (n= five 25x25 cm x 30 cm deep soil monoliths per site). Additionally, qualitative sampling using 50x50 cm formalin extraction and hand-sorting from various niches such as within and under litter & decaying wood and under stones was also used. Soil chemical parameters and micromorphology assessment was performed on samples from the 0-30 cm layer, in order to evaluate the relationship of animals to bioturbation and soil fertility. Study sites included three old-growth forests, three young (secondary & regenerating) forests, and three agricultural systems (pasture, maize & soybean) in the regions of Belterra (PA), Manaus (AM) and Porto Velho (RO). A total of 37 species were

*Corresponding author: luisnevescunha@gmail.com
†Speaker

found, many of them species that are new to science. The worms belonged to five families (Acanthodrilidae, Octochaetidae, Ocnerodrilidae, Rhinodrilidae and Glossoscolecidae), and included the genera *Pontoscolex* (at least 2 spp.), *Diachaeta* (at least 3 spp.), *Atatina* (at least 5 spp.), as well as *Rhinodrilus*, *Urobenus*, *Righiodrilus* and *Glossodrilus*. Formalin extraction was efficient for obtaining surface-dwelling epigeic and epi-endogeic species but generally resulted in lower abundance values when compared to hand-sorting. Abundance ranged from a mean of 86 indiv. m-2 in adjacent soils up to 216 indiv. m-2 in ADEs. Species richness ranged from a minimum of 1 to a maximum of 7 species at each site, and young and old forests had higher richness (4-4.5 spp.) than agricultural systems (2.2 spp.). ADEs had slightly higher overall species richness (24 spp.) than adjacent soils (22 spp.), and species composition was conspicuously different, with 15 unique ADE species and 13 unique adjacent soil species. Earthworm biomass ranged from 10.4 g m-2 in adjacent soils to 17.4 g m-2 in ADEs. The higher earthworm abundance associated with ADEs was tightly related to the presence of biogenic aggregates as well pottery shards. Furthermore, the sampled areas represent only a fraction of the ADEs present in Amazonia, however, the results suggest that earthworms are an important component of ADEs, representing 28% of the total macrofauna abundance and 58% of the overall biomass . Therefore, we expect that they may contribute significantly to the functioning and engineering of these human-modified ecosystem. *Funded by CNPq, Newton-CONFAP, NERC, EU and CAPES