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Diversity of terrestrial Enchytraeidae (Oligochaeta) in Latin America: Current knowledge and future research potential

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ABSTRACT

This article reviews the current knowledge on terrestrial enchytraeid diversity in Latin America and it outlines the research potential that this group offers. Enchytraeids occur worldwide in all soils with sufficient moisture, oxygen and nutrient supply, but knowledge on their diversity and functioning in the tropics is practically non-existent, except in Latin America. Here, taxonomic efforts and research projects have led to the knowledge of currently 62 terrestrial or semi-aquatic species. Abundance of enchytraeids could be determined at the species level, and differences in the ecological behaviour of species were detected concerning factors such as soil type and land use. Especially South America harbours a rich and idiosyncratic enchytraeid fauna, dominated by genera or species absent or rare in other regions of the world, which is interesting from the phylogenetic point of view. However, only a minute fraction of the actual diversity is known to-date. Seventeen species are possibly peregrines. Densities appear to be comparable to those in temperate regions, from below 10,000 to 270,000 ind. m^{-2}, suggesting that enchytraeids may be as important for soil processes as in temperate regions. Site-specific species richness makes enchytraeids good biological indicators. Enchytraeids provide a widely open field for research in Latin America ranging from taxonomy and faunistics over biogeography, phylogenetics, comparative morphology, and developmental biology, to fundamental and applied ecology. The widespread ignorance concerning enchytraeids among scientists and naturalists as well as the current taxonomic impediment should be overcome by sound taxonomical and ecological work, training courses, identification manuals and popularization.

1. Introduction

Enchytraeids are small, whitish oligochaete worms that occur worldwide in all soils with sufficient moisture, oxygen and nutrient supply. They are also found in freshwater and marine sediments, but most species are terrestrial. A recent inventory lists 676 accepted species on a global scale (Schmelz and Collado, 2012). An identification guide is available for European species (Schmelz and Collado, 2010) although knowledge of the actual diversity in Europe is far from complete. However, all other regions of the earth are much less studied. This applies especially to tropical regions (Römbke, 2007). Due to the still fragmentary knowledge of enchytraeids in Latin America, inferences from the basic data (i.e. species descriptions and species records) about general diversity patterns must remain preliminary. Nevertheless, the Neotropics is the only world region apart from the Palearctic where such inferences can be made at all, due to a number of taxonomic studies and a recent inventory (Christoffersen, 2009). In other tropical regions (Africa, Asia, Northern Australia) practically nothing is known about the diversity of enchytraeids. In this article we briefly review the history of research into terrestrial enchytraeids in Latin America, we compare patterns of world distribution, and we argue against their presumed ecological insignificance in the Neotropics. Finally, we give an outlook into future research options, highlighting the importance of molecular methods for biodiversity studies.

2. History of enchytraeid diversity research in Latin America

"So far as we know, all Enchytraeids are of arctic or subarctic origin, none have been found endemic to the tropics" (Eisen, 1904). This picture changed when Černosvitov (1928, 1934, 1937a), collecting oligochaetes in Northern Argentina, discovered new species

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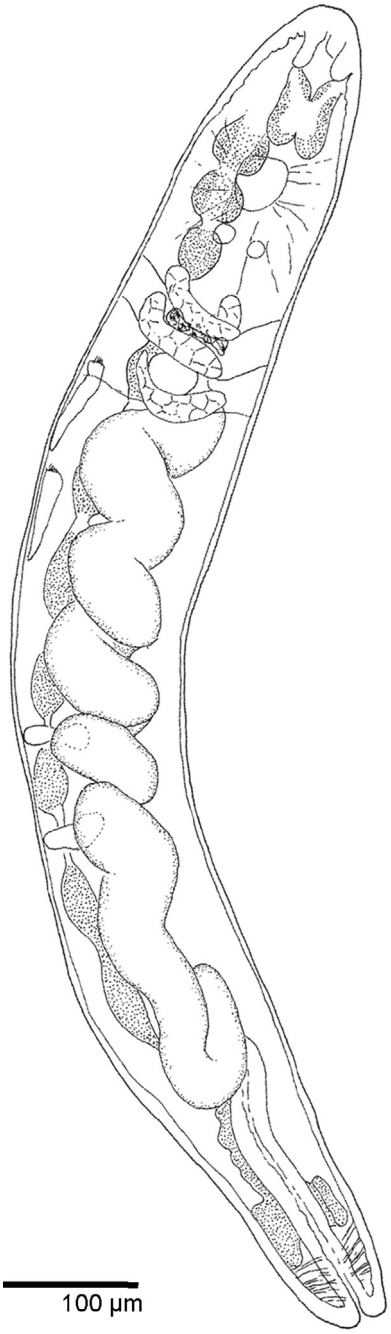

Fig. 1. *Achaeta singularis* Schmelz, 2008, possibly an endemic species and a remnant of the old autochthonous soil fauna of the Mata Atlântica.
From Schmelz et al. (2008), Fig. 6A.

of terrestrial enchytraeids and erected two genera that, judging from our present knowledge, dominate the native enchytraeid fauna of the continent: *Hemienchytraeus* and *Guaranidrilus*. He further described a new species of the cosmopolitan genus *Achaeta*. *A. neotropica* would later turn out to be widely distributed in the Neotropics but not found elsewhere (Schmelz et al., 2008). Černosvitov laid the foundations for biodiversity knowledge of terrestrial enchytraeids in Latin America; previous contributions (Giard, 1894; Cognetti, 1900; Eisen, 1904; Michaelsen, 1912) had been sporadic and species identities cannot be reconstructed in most cases (see Schmelz, 2003). With Černosvitov's untimely death in 1945, research into Latin American enchytraeids came to a halt. The influential taxonomic revision of Enchytraeidae by Nielsen and Christensen (1959) dealt only with European species. Research on terrestrial enchytraeid diversity started again with Righi and his students, Christoffersen and Bittencourt. From 1973 to 1988 they described in 13 articles (cited in Christoffersen, 2009) altogether 22 new species, mostly from Brazil, and most of them belonging to *Guaranidrilus* and *Hemienchytraeus.* They also recorded or redescribed several other species. Righi erected a new genus, *Tupidrilus*, for species closely related to *Guaranidrilus*. Descriptions were up to modern standards and well-documented with reference or type specimens – most of them extant and accessible at the Zoological Museum of the University of São Paulo – but sampling was not quantitative and did not cover all taxa. Dózsa-Farkas (1989) described four species of enchytraeids from Ecuador, three of them new to science. Further diversity studies did not get down to the species level (e.g. Botea, 1983; Coates and Stacey, 1994; Stacey and Coates, 1996), or they produced unreliable results (Botea, 1987).

Some of the soil ecological studies carried out in South America included counting of enchytraeids. Exceptionally high abundances were found in organic soils of high mountain regions: Sturm (1978) reported a mean of 179,500 ind. m^{-2} and Vaçulik et al. (2004) found up to 270,000 ind. m^{-2}, but species were not identified.

Basic ecological studies with enchytraeids at the species level began with two international projects, focusing on improved use of degraded forest areas in the Brazilian Amazon (SHIFT ENV-52) (Römbke and Meller, 1999; Schmelz and Römbke, 2005), and on regeneration and protection of secondary forests in the Mata Atlântica in the state of Paraná (SOLOBIOMA, 2003–2009) (Römbke et al., 2005; Schmelz et al., 2009), respectively. Here the combination of quantitative sampling and taxonomic scrutiny allowed the first estimates of species abundance and area-related diversity of enchytraeids in the Neotropics. Although abundance was low (mean 2000–6000 ind. m^{-2}), species number of enchytraeids per area (5–20) approached those known for temperate regions (Römbke, 2007; Römbke et al., 2007). Taxa responded differently to soil type and land use, but influence of vegetation (state of succession of the Atlantic Forest) was less evident. Most of the roughly 50 species found in the Mata Atlântica are new to science, and taxonomic and revisionary work is in progress (e.g., Schmelz and Collado, 2007; Schmelz et al., 2008, 2011), as well as analyses of the quantitative data (e.g., Römbke et al., 2007).

Lists of tropical and South American enchytraeid species and species records have been compiled by Römbke (2007) and Christoffersen (2009). Römbke (2007) also gives a detailed review of terrestrial enchytraeid research in the tropics, while Christoffersen (2009) lists all species records, specified by country and, in the case of Brazil, also at individual State level. A guide for field studies with enchytraeids under tropical conditions (sampling, extraction, identification) can be found in Niva et al. (2010).

3. Enchytraeid diversity, current state of knowledge

3.1. Taxonomic composition

So far, 62 terrestrial or semi-aquatic species of enchytraeids have been recorded from Latin America (Table 1), together with two freshwater aquatic species, totalling 64 species. Whereas practically nothing is known about the enchytraeid fauna of Central America, the Caribbean Islands and Mexico, over 75% of the South American species are exclusively known from this subcontinent (Fig. 1). However, not all of them may be endemic because the enchytraeid fauna of other tropical and subtropical regions is practically unknown. It is beyond doubt, however, that tropical and subtropical South America harbours a rich enchytraeid fauna that is not derived from Holarctic pools. Dominant genera in terms of abundance and species richness are *Guaranidrilus* and *Hemienchytraeus* (Römbke, 2007; Schmelz and Niva, unpubl. obs.); these taxa