

No-Tillage Improves Earthworm Species Richness in Southern Brazil⁽¹⁾

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Background, Results, Application and Implications for Conservation Agriculture

No-tillage (NT) is the most widely adopted conservation farming practice in Brazil, where it currently covers more than 30 million hectares (Febrapdp, 2012). According to Brazilian farmers and researchers (Bartz, 2010), this soil management system is based on three principles: 1) minimal soil movement, sufficient only for the placement of seeds and fertilizers in the soil; 2) maintenance of a permanent organic soil cover (usually crop residues), and 3) the adoption of crop rotations and green manures. The use of NT results in an ecosystem with a lower degree of disturbance or disorder when compared to other management practices that include intense soil mobilization. In particular there is a significant recovery of soil biodiversity, and improvement of the soil as a biotic environment, as a result of lower human impacts on the system (Derpsch, 1991). Among the organisms most promoted by the adoption of NT are the earthworms (Brown et al., 2003). The diversity, density and biomass of earthworms are strongly influenced by soil cultivation (Lavelle et al., 1989) and the earthworm populations can be used as soil quality indicators in agroecosystems (Paoletti, 1999). Several studies and surveys on earthworm populations have been conducted in Brazil, but very few of them identified the species collected. So the aim of this work was to evaluate the earthworm species richness in no-till, integrated crop-livestock and native forest in the State of Santa Catarina, Brazil.

Experimental Approach

A total of 72 sites in 23 counties were sampled. At each site, earthworms were sampled following two complementary approaches: qualitative and quantitative sampling.

Quantitative sampling was carried out on a square grid with 9 points or a transect with 5 points 30m away from each other. The grid was centered in a 1ha plot so that sampling points were at least 20m away from the plot boundaries. At each point earthworms were sampled using the TSBF (Tropical Soil Biology and Fertility) method (Anderson and Ingram, 1993), i.e., hand sorting of a 25x25 cm x 20 cm deep soil monolith. The qualitative sampling consisted in digging at least 10 randomly selected holes in each site. Usually, the holes were dug randomly within the 1 ha area, but in some cases, especially in NF, selected microhabitats (in bromeliads, in and under decaying trunks, under stones, and in wet areas) were also sampled.

Sampling was carried out Jul., Aug. and Dec. 2011, Jan., Jun. and Nov. 2012). Earthworms were fixed and preserved in 92.8% ethanol, counted and identified at family, genus or species level using keys and original descriptions found in Michaelsen (1900), Righi (1990, 1995) and Blakemore (2002).

Results and Discussion

A total of 46 species of earthworms was identified (table 1) in the three land use systems. The fragments of native forest had the lowest richness (24 species), while the agricultural sites (NT and ICL) showed similar species richness (29 and 31 species, respectively). Many juvenile specimens were only identified to one of the four families: Glossoscolecidae, Megascolecidae, Onerodrilidae and Acanthodrilidae. There were six species newly recorded for the State of Santa Catarina in this study: *Andiorrhinus duseni*, *Amythas corticis*, *Amythas morrissi*, *Octolasion tyrtaeum*, *Bimastos parvus* and *Dichogaster gracilis*. The

first is a native species and the others are exotic (introduced). Of the 46 identified species, 70% are native and 30% are exotic species (table 1). Considering the sampled sites the percentage of native/exotic was: 83/17, 61/39 and 62/38 respectively in the NF, ICL and NT sites. The results show that, despite the lower total species richness in the forest sites, these areas are important for conserving native populations. However, while the higher richness in the agricultural sites is mainly due to the presence of exotic earthworms (table 1), they are also maintaining an important number of native species. Nevertheless, the quantitative data must still be analysed to verify the abundance of each species (native and exotic) in the sampled sites. Both natural and agricultural sites may be dominated by one or a few species, either exotic and/or native. It is noteworthy that almost all the encountered species of the native genera *Glossoscolex* and *Fimoscolex* are new species that must still be described and named (\cong 24 species).

Table 1. Earthworm species in forest (FN), integrated crop-livestock (ICL) and no-till (NT) sites in the State of Santa Catarina, Brazil. (e = exotic, n = native species).

Family, genus and specie	Origin	FN	ICL	NT	Family, genus and specie	Origin	FN	ICL	NT
Rhinodrilidae					Ocnerodrilidae continuation...				
<i>Pontoscolex corethrurus</i>	e	+	+	+	Ocnerodrilidae sp.2	n	+	+	+
<i>Urobenus brasiliensis</i>	n	+	+	+	Ocnerodrilidae sp.3	n	+	+	+
Glossoscolecidae					Ocnerodrilidae sp.4	n	-	+	+
<i>Glossoscolex</i> sp.1	n	+	+	+	Ocnerodrilidae sp.5	n	+	+	+
<i>Glossoscolex</i> sp.2	n	+	-	-	Ocnerodrilidae sp.6	n	-	+	+
<i>Glossoscolex</i> sp.3	n	+	+	-	Ocnerodrilidae sp.7	n	-	+	-
<i>Glossoscolex</i> sp.4	n	-	-	+	Megascolecidae				
<i>Glossoscolex</i> sp.6	n	+	-	-	<i>Amyntas gracilis</i>	e	+	+	+
<i>Glossoscolex</i> sp.7	n	+	-	-	<i>Amyntas corticis</i>	e	-	+	+
<i>Glossoscolex</i> sp.8	n	+	-	-	<i>Amyntahas morrissi</i>	e	-	+	+
<i>Glossoscolex</i> sp.9	n	+	-	-	<i>Metaphire californica</i>	e	-	+	+
<i>Glossoscolex</i> sp.10	n	-	-	+	<i>Metaphire</i> sp.1	e	-	-	+
<i>Glossoscolex</i> sp.11	n	-	-	+	<i>Megascolecidae</i> sp.2	e	-	+	-
<i>Glossoscolex</i> sp.12	n	+	-	-	Lumbricidae				
<i>Glossoscolex</i> subadult sp.1	n	-	-	+	<i>Octolasion tyrtaeum</i>	e	-	+	+
<i>Fimoscolex</i> sp.1	n	-	+	-	<i>Bimastus parvus</i>	e	-	+	+
<i>Fimoscolex</i> sp.2	n	-	-	+	Lumbricidae sp.1	e	+	+	+
<i>Fimoscolex</i> sp.3	n	+	+	+	Lumbricidae sp.2	e	+	+	-
<i>Fimoscolex</i> sp.4	n	-	-	-	Acanthodrilidae				
<i>Fimoscolex</i> sp.5	n	+	+	-	<i>Dichogaster gracilis</i>	e	-	+	-
<i>Fimoscolex</i> sp.6	n	+	+	+	<i>Dichogaster bolau</i>	e	-	+	+
<i>Fimoscolex</i> sp.7	n	+	+	+	<i>Dichogaster saliens</i>	e	-	-	+
<i>Fimoscolex</i> sp.8	n	+	+	-	<i>Microscolex</i> sp.1	n?	-	+	+
<i>Fimoscolex</i> sp.9	n	-	+	+	NI* sp.1	n?	+	+	-
<i>Andiorrhinus duseni</i>	n	+	-	-	Species richness		24	31	29
Ocnerodrilidae					Total of native species		20	19	18
Ocnerodrilidae sp.1	n	+	+	+	Total of exotic species		4	12	11

* Not identified specie.

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