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The peregrine earthworm *Pontoscolex corethrurus* in the East coast of Costa Rica

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Summary

Sampling of earthworm communities was performed in the Caribbean coast of Costa Rica at 8 sites to assess the distribution of the peregrine pantropical species *Pontoscolex corethrurus* and its relationships with native species depending on the type of land use. *P. corethrurus* was largely dominant at each site and in almost all habitat types. Density was in the range of 143 to 182 ind.m^{-2}. *P. corethrurus* was absent from only one primary forest site where only native species could be found. In banana plantations, the density reached maximum of ca. 361 ind.m^{-2}. In all sites, an increase of this species corresponds significantly with a reduction of the rest of the earthworm fauna except for *Dichogaster* sp. Where *P. corethrurus* was absent, density of other species reached 34.4 ind.m^{-2}. In southern Costa Rica, human immigration and sustained activities probably favoured the establishment of *P. corethrurus*. This species became dominant, even in remaining plots of primary forests. In contrast, the species has not yet penetrated the large primary forest of the north-east of the country.

Key words: Earthworms, *Pontoscolex corethrurus*, peregrine species, exotic species introduction

Introduction

Peregrine species of earthworms comprise at least 100 species throughout the world. It is recognized that their characteristically wide distributions find their origin in a high degree of ecological plasticity that enables them to become established in a wide variety of habitats. It is also considered that, in the majority of cases, the establishment of introduced species is possible because of a previous absence of earthworms or because of an elimination of native species by human modifications of the environment. This is why the peregrine species can be preferentially encountered in the disturbed habitats (secondary forests, crop fields, etc.). There are very few reports of direct competition between previously established and newly introduced species. In the tropics, one of the best known is the glossoscolecid *Pontoscolex corethrurus* (Müller, 1857), an endogeic species which has a circumtropical distribution and whose geographical origin seems to be the North or north-east part of South America.

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Materials and Methods

In 1996, a stratified sampling of different areas of the Caribbean coast of Costa Rica, from North to South, was carried out. This sampling program included, for the southern part of the country, surroundings of Cahuita (25 samples), Puerto Viejo (18) and Bribri villages (17), banana plantations near Cahuita (25), remaining plots of primary forest in the Cahuita National Park (45) and the Manzanillo Wildlife Refuge (95), and for the northern part, periphery (65) and remote area (25) of the primary forest of the Tortuguero National Park, with a total of 315 samples. This program made an overview of the distribution of *P. corethrurus* in this area, according to the habitats and the relative abundance of other earthworm species. The samples were always a 25×25 cm area taken from in the 0–20 cm soil stratum.

Non-parametric analysis (Kruskall-Wallis tests) and a specific *a posteriori* test (Scherrer 1984) were performed to compare densities and biomasses (always obtained with earthworms preserved in formaldehyde) of *P. corethrurus* according to the sites and the habitat types, and to evaluate the effects of this species (by classes of abundance) on the other earthworms classified by ecological categories.

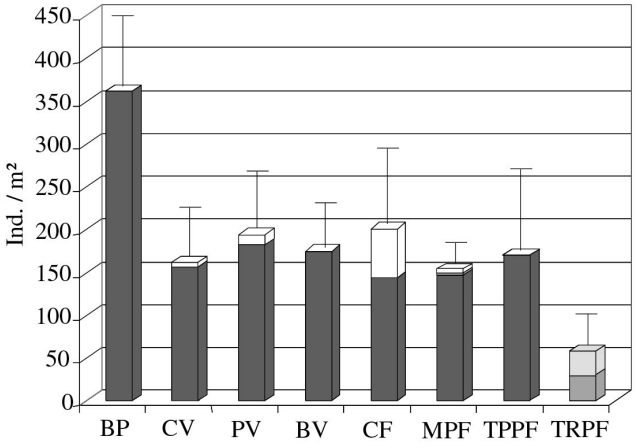

Fig. 1. Earthworm densities for the 8 studied plots. **BP**: Banana plantations near Cahuita, **CV**: Cahuita village, **PV**: Puerto Viejo village, **BV**: Bribri village, **CF**: Forest of the Cahuita National Park, **MPF**: Primary forest of the Manzanillo Wildlife Refuge, **TPPF**: Peripheric primary forest of the Tortuguero National Park, **TRPF**: Remote primary forest of the Tortuguero National Park
■ *Pontoscolex corethrurus,* ■ Other endogeic species, □ Other epigeic species, □ *Dichogaster* sp.

Results

P. corethrurus was largely dominant at each site and in almost all habitat types (Fig. 1). *Dichogaster* sp., an epigeic species and the second dominant exotic species in South-Eastern Costa Rica, was also often found, although the only significant population was localized in the forest of the Cahuita National Park. Densities of *P. corethrurus* were in the range of 143 to 182 ind.m^{-2} in most of habitats including forests, without significant differences. This species was absent from the remote primary forest of the Tortuguero National Park where only native species could be found. In banana plantations, the density of *P. corethrurus* was significantly higher than in the other sites and reached a

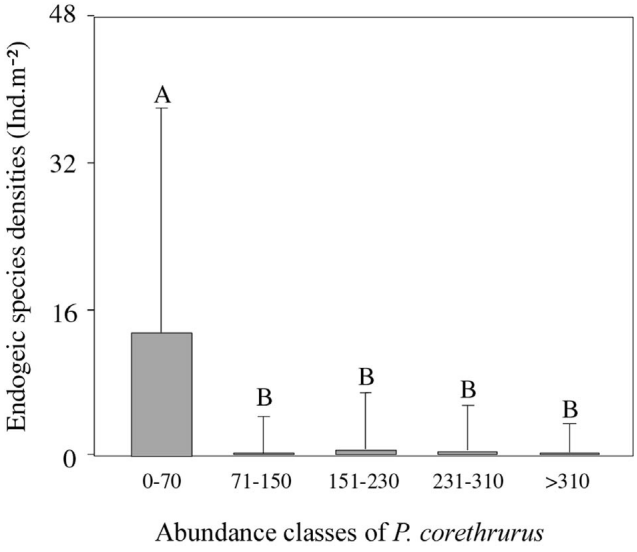

Fig. 2. Endogeic earthworm densities according to abundance classes of *P. corethrurus* (ind.m^{-2})

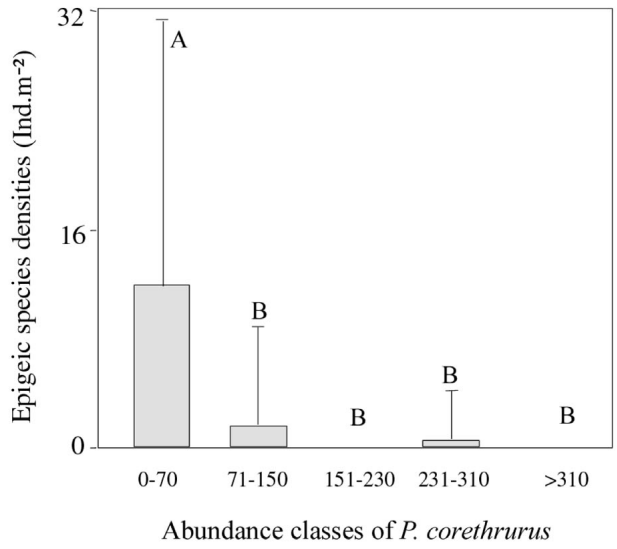

Fig. 3. Epigeic earthworm densities according to abundance classes of *P. corethrurus* (ind.m^{-2})

maximum of ca. 361 ind.m^{-2}. The same trends were obtained with the biomass measurements. A range of 53.6 to 77.4 g.m^{-2} was observed in all habitats except for the banana plantations where the biomass of *P. corethrurus* was significantly higher than in the other sites and reached a maximum of 144.6 g.m^{-2} and for the remote primary forest of Tortuguero where this species was absent (native earthworms reached then 28.96 g.m^{2}).

At all sites, an increase in *P. corethrurus* corresponded significantly with a reduction in the rest of the earthworm fauna except for *Dichogaster* sp. (Figs. 2 and 3). Following the same pattern, endogeic and epigeic species densities dramatically fell from 12–13 to 0.5–2 ind.m^{-2} when the density of *P. corethrurus* reached 70 ind.m^{-2}. The earthworm community became then almost monospecific.

Discussion

Extensive movements of human populations and land colonization are often associated with importation and introduction of exotic species which can, according to their capacities of adaptation, become established and alter habitats under favourable environmental conditions. *P. corethrurus* , a species probably native to the Guayana shield, has a pan tropical distribution and can be encountered even in islands such as Hawaii, far from continents (Nakamura 1990) or in subtropical areas such as Florida (Reynolds 1994). Southeastern Costa Rica has had a large human immigration and agricultural expansion during the last decades. This study underlines the presence of *P. corethrurus* in the major part of the Caribbean coast of the country, particularly in the southern part of this area which is probably linked to human immigration and sustained activities. In a large variety of habitats *P. corethrurus* became dominant, even in remaining plots of primary forests (Manzanillo Wildlife Refuge). On the other hand, the species did not penetrate the large primary forest of the north-east of the country. However, this strong colonization noises the question of whether *P. corethrurus* enters directly into competition with native populations to their detriment, or just benefits from environmental disturbances generated by human activities. Furthermore, has it the capacity to penetrate large pristine tropical forests? More generally, can an exotic earthworm species displace native populations? This question has been a concern for a long time (Eisen 1900; Smith 1928; Stebbings 1962). Fragoso (1993) found little evidence that this is occuring, even in small reserves. For Kalisz & Wood (1995), direct competition between native and exotic earthworms could conceivably occur in a fragmented habitat due to a large population of exotic species in an encompassing disturbed landscape and to the greatly increased perimeter across which exotic earthworms could invade the remnant. The primary forest of the Manzanillo Wildlife Refuge, in the south-east of Costa Rica, follows this pattern. The relative small size of this forest, its geographical insulation, the disappearance of native endogeic earthworms without visible habitat disturbance suggests that *P. corethrurus* could have penetrated the forest and replaced the native fauna after direct competition. Possible axis of human disturbances along old penetrating ways could have supported this process.

Many studies have shown significant modifications caused by the activity of *P. corethrurus* in a soil where it was newly introduced. In particular, its soil compacting capacity appears to be very pronounced, sometimes more than that of a bulldozer (Chauvel et al. 1999). This study has shown a relation between increasing densities of *P. corethrurus* and a reduction of the other species, whatever the habitat. The activities of this exotic species and its effects on soil properties could be a direct source of displacement, rarefaction or disappearance of native species populations (Fragoso et al. 1995).

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