Exclusion of small mammals and lagomorphs invasion interact with human-trampling to drive changes in topsoil microbial community structure and function in semiarid Chile

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Abstract

Species losses and additions can disrupt the relationship between resident species and the structure and functioning of ecosystems. Persistent human-trampling, on the other hand, can have similar effects through the disruption of biocrusts on surface soils of semiarid systems, affecting soil stability and fixation of carbon and nitrogen. Here, we tested the interactive and synergistic impacts of the exclusion of native mammalian herbivores and the effects of introduced lagomorphs in a semiarid thorn scrub ecosystem, where soils were subjected to two different trampling intensities (i.e., trampled and non-trampled). We postulated that because of their differential habitat use and fossorial activities, with respect to native small mammals, lagomorphs would have strong negative effects on soil structure, biocrust cover, and biocrust bacterial community structure. Our expectations were that changes in biocrust cover in response to trampling where native mammals were excluded, but exotic lagomorphs were present, will spread their impacts on soil chemical and physical features. To test our hypotheses, we measured changes in soil biogeochemical properties in four experimental plots where lagomorphs (L)/small mammals (SM) were experimentally manipulated to exclude them from the plots (–), or let them be present (+). The experimental combinations monitored were: -L/+SM, -L/-SM, +L/+SM, and +L/-SM. Results showed that human-trampling disturbance interacted with the loss of native small mammals and the presence of non-native lagomorphs to cause large changes on biological (i.e., biocrust cover, bacterial and nifH genes abundance), physical (i.e., soil moisture and soil stability) and chemical (i.e., TC and TN) soil features. The relative impacts of trampling disturbance on biological and physicochemical features were strongly influenced by the presence of non-native lagomorphs. For example, larger decreases in biocrust cover and bacterial abundance were observed in treatments without lagomorphs (-L/+SM; -L/-SM). In turn, losses of biocrust cover, in addition to trampling, determined decreases in soil stability in all treatments. These results suggest that non-native lagomorphs surpass the effects of the loss of native small mammals in reducing soil quality and productivity. Therefore, human-trampling has the potential to convert low disturbed soils, as those observed in non-trampled soils in treatments -L/+SM, -L/-SM into poor soils with low biocrusts cover and concomitant low stability, as observed in +L/+SM; +L/-SM treatments. These findings agree with previous observations that different components of global change act in synergic ways in fragile, water-limited environments. Because biological invasions and soil surface disturbance are becoming widespread in dryland regions globally, understanding the long-term consequences of these interactions is essential..

Keywords

Biocrusts, Nitrogen, Semi-arid ecosystem, Biodiversity loss, Soil stability.