

Large Herbivores Benefit Plant Growth via Diverse and Indirect Pathways in a Temperate Grassland

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Abstract : Large herbivores affect plant growth not only through their direct, consumptive effects, but also through indirect effects that alter species interactions. Indirect effects can be either positive or negative, therefore having the potential to mitigate or enhance the direct impacts of herbivores. However, until recently, we know considerably less about the indirect effects than the direct effects of large herbivores on plants, and few studies have explored multiple indirect pathways simultaneously. Here, we investigated how large domestic herbivores, cattle (*Bos taurus*), can shape population growth of an intermediately preferred forb species, *Artemisia scoparia*, through diverse pathways in a temperate grassland of northeast China. We found that, although exposure to direct consumption of cattle, *A. scoparia* growth was not inhibited, but rather showed a significant increase in the grazed than ungrazed areas. This unexpected result was due to grazing-induced multiple indirect, positive effects overwhelmed the direct, negative consumption effects of cattle on plant growth. The much more intensive consumption on the dominant *Leymus chinensis* grass, ground litter removal, and increases in ant nest abundance induced by cattle, exerted significant indirect, positive effects on *A. scoparia* growth. These pathways benefited *A. scoparia* growth by lessening interspecific competition, mitigating negative effects of litter accumulation, and increasing soil nutrient availability, respectively. Our results highlight the need to integrate indirect effects into the traditional food web theory, which is based primary on direct, trophic linkages, to fully understand community organization and dynamics. Large herbivores are important conservation and management targets, our results suggest that these mammals should be managed with the understanding that they can affect primary producers through diverse paths.

Keywords : grasslands, large herbivores, plant growth, indirect effects

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