Living logs: Tree trait effects on decomposition and associated invertebrate diversity

Zuo, J.

2016

Summary

Forests are known for their high biodiversity, both above- and belowground. One profound characteristic of natural forest ecosystems is the large amount of dead trees on the soil, which is a key determinant of biodiversity and important ecosystem functions. The decomposition of dead tree material has a substantial influence on biogeochemical cycling. Besides, tree logs also host a large number of organisms that need wood tissue as a key resource. Recent research has improved our understanding of decomposition processes and habitat relationships for many species associated with dead wood. However, how the various abiotic and biotic factors of trees together drive variation in organic matter decomposition among tree species and their different organs is still far from resolved. Also, we do not have much knowledge about how (1) abiotic factors, (2) available invertebrate species pools and (3) the wood and bark traits of tree trunks and branches of different species and decay stages, together drive variation in invertebrate fauna diversity.

The main aim of this thesis is to investigate the decomposition of different organs of diverse recently logged tree species and the faunal communities associated with them during early decomposition in temperate forest ecosystems. Trait-based approaches have been used to compare the dead plant matter quality across tree species and organs to understand the mechanisms of trait afterlife effects on decomposition and associated fauna biodiversity.

Chapter 2 focused on decomposition *per se,* highlighting the importance of considering the afterlife effects of functional traits of different organs of tree species in their local environmental context. First, there was some evidence of a Tree Economic Spectrum (TES) that had important trait afterlife effects driving coordinated decomposability of different organs across the tree species. Second, leaves were consistently more decomposable than twigs and twigs more than coarse branches across all species. Third, the relative effects of this TES on decomposition rates interacted with organ and local environment. In the nutrient-rich site, those effects on decay rates were consistent for leaf litter and twigs, while in the nutrient-poor environment the effect of resource economics traits on decomposition rate was only significant for leaf litter.

Chapters 3, 4 and 5 have together demonstrated how invertebrate abundances and community composition associated with decaying logs and coarse branches depend on some of the same (a)biotic drivers, and their interactions, that affect decomposition. Moreover, invertebrate species interacted between themselves and with bark traits, thereby adding further complexity to their community composition. The results of Chapters 3 showed strong interspecific differences in bark traits and a suite of bark traits together had fundamental afterlife effects on invertebrate community assembly, and acted as an environmental filter for the colonizing invertebrates in early decomposing logs. A combination of bark traits, acting as a potential 'bark economics spectrum', was a highly significant positive predictor of the abundance of each of the key invertebrate clades. Pairs of tree species supported more dissimilar faunal community composition and greater family richness when they differed more in bark traits overall. Thus bark trait dissimilarity among tree species in forest stands is likely a better indicator of early-phase trunk fauna diversity than tree species diversity *per se*. The results of Chapters 4 showed facilitation had significant effects on the community composition. As it was demonstrated that especially the density of bark holes (but to some degree also surface area of their inner bark galleries) made by early-colonizing bark beetles had strong positive effects on the presence of later-colonizing invertebrates with a body width smaller than those of the bark beetles. Bark beetles can alter the accessibility of bark resource availability to other organisms, by modifying the structural properties of bark tissues, thereby speeding up dead tree associated community assembly. In Chapter 5, diversity of macro-detritivores in senesced coarse branches was found to be influenced by tree species, tree growing site, decay stage, decomposition environment and interactions of those multiple factors. There was a curvilinear relationship between wood decay stage and abundance of macro-detritivores, by using wood density as a measure for the decay stage. Macro-detritivore community composition on different tree species converged during the decay process. Consequently, tree species identity is more important in the substrate selection of macro-detritivores at the early stage of decomposition. Tree species, the growing environment of the trees and the decomposition environment of the logs strongly determined macro-detritivore community composition in dead wood, moreover these drivers interacted with each other and with the decay stage in complex ways.

This thesis focused on the mechanisms controlling the logged tree decomposition across organs and the associated invertebrate diversity in two contrasting temperate forests. It has provided considerable insight into the decomposition process and associated biodiversity. However, further research is needed on the remaining knowledge gaps, related to trait afterlife effects, decomposition processes, interactions within detrital communities and environmental factors. Especially further research on how these factors and their interactions may change from early to later wood decay stages, is needed to enlarge our understanding of how biodiversity dynamics during wood decay, soil ecosystem processes and (a)biotic factors that drive them interact in forests.