

https://dspace.org/

Investigating the impact of herbivory and nitrogen-fixation on savanna plant and soil nutrient dynamics

Hattingh, Wesley Neil

2016-01-20
http://hdl.handle.net/10539/19346

Downloaded from a DSpace repository. https://dspace.org/

SUMMARY

Plant functional traits provide a means to investigate the diverse ecological strategies employed by plants and a tangible link to assess how the variability in these traits might influence ecosystem processes and functioning. The aim of this dissertation has been to determine how plant and soil nutrient dynamics in a savanna environment are affected by two primary drivers, one a top-down driver, being herbivory by large mammalian herbivores and the other a bottom-up driver, the variable N_2-fixation capacity of tree species. To the best of my knowledge this is the most comprehensive study to date to investigate the bioavailability of soil nutrients and the link between these availabilities and plant functional traits. Furthermore this study provides important insight into the use of a novel technology, ion exchange resin capsules in a South African savanna context.

By studying a selection of plant functional traits (nutrient concentrations, ratios as well as specific leaf area, relative chlorophyll content and leaf dry matter content) and soil nutrients (suite of macro- and micronutrients) associated with two species of savanna tree of contrasting N_2-fixation capacities, I went about investigating how herbivory differentially influences the nutrient dynamics of this system. Selecting individuals of the N_2-fixing *Acacia tortilis* and the non-N_2-fixing *Combretum hereroense* both inside an exclosure and on the adjacent land allowed me to determine the potential impacts by herbivores. These include both direct impacts from foraging and indirect impacts through the regulation of nutrient input pathways via deposition of dung and urine. The work compiled for this dissertation is based on the experimental work conducted in a mesic savanna system in the Marakele Park (PTY) Ltd. During the course of this dissertation, I investigated herbaceous and woody biomass in relation to protection from and exposure to herbivory, determining any differences in the functional leaf traits between individuals inside and outside the exclosure, if these differences were exhibited in the associated herbaceous biomass as well as a comprehensive assessment of the bioavailability of 15 important micro- and macronutrients using ion exchange resin capsules. These capsules were incubated in the soil over the entire summer rainfall period, providing a

cumulative view of nutrient bioavailability during the growing season. In this work I also demonstrated whether particular nutrients are associated with specific drivers (i.e. herbivory, canopy position or N_2-fixation). Furthermore, these results were then looked at together to suggest the mechanism by which herbivory and N_2-fixation drive nutrient dynamics and make recommendations on the use of these results in managing savanna systems in the future.

Between the two sites, aboveground herbaceous biomass was significantly greater when protected from herbivores than on the adjacent land. Both exposure to herbivory and N_2-fixation capacity were found to alter plant functional traits. Herbivore presence was associated with an increase in herbivore-resistant or structural traits such as C/N, C/P, foliar C and SLA as well as a reduction in N and P content. These less palatable leaves were accompanied by a significantly lower availability of a number of important soil elements, namely NO_3-N, inorganic N, P, K, Na, Cu, B, Mg, and S. This suggests a feedback loop between these two components of the ecosystem. N_2-fixation capacity is associated with greater concentrations of elements such as N and P and a reduction in traits that are illustrative of a greater structural investment into leaves. Soil nutrient bioavailability however, shows a reduction in certain nutrients when associated with *Acacia*. A number of nutrients which show a reduction in availability are those which are essential to N_2-fixation machinery, namely B and Fe but also lower bioavailabilities of Al and Mg. Finally, Ca, NO_3-N, B, Fe, Al and inorganic N were found in greater quantities below the tree canopy than beyond it.

In conclusion both herbivory by large mammalian herbivores and N_2-fixation have significant effects on tree health, through their regulation of limiting nutrients and alteration of leaf traits. Given the changes which these drivers are capable of exerting on plant and soil nutrient dynamics, this has important consequences for ecosystem processes and functioning and highlights potential considerations in the long-term sustainable management of savannas.