The effect of ecosystem engineers on N cycling in an arid agroecosystem

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Snapshot

- Ecosystem engineers—such as earthworms, termites and ants—are important to ecosystem functions, including aboveground productivity.
- Their contribution to soil nutrient cycling is not well understood, particularly in arid systems where termites and ants are the dominant ecosystem engineers.
- We explored the effect of termite and ant reduction on nitrogen (N) biogeochemistry in soils from the northeasternmost wheat growing region in W. Australia.
- Many soil N pools were up to 2.5 x larger with native populations, but the rate of transformations was lower relative to the reduced termite plots.
- Conservation of soil macrofauna, particularly those that translocate N through the soil profile, may be important in sustainable management of cropped lands.

Background

- Ecosystem engineers are beneficial to soil health and ecosystem productivity\textsuperscript{1,2,3}.
- Their presence can lead to substantially higher crop yields\textsuperscript{4}.
- Despite their importance, little is known about how they alter soil biogeochemistry.
- Soils with native termites and ants have higher mineral N, likely due, at least in part, to N-fixing bacteria in the termite hindgut\textsuperscript{5}.
- But, whether N transformations mediated by free-living soil microorganisms contributes to these differences is unknown.

Objectives and Hypothesis

- Objective: to assess the size of soil N pools and fluxes between pools, in order to determine the effect of termites and ants on soil processes.
- Hypothesis: ecosystem engineers alter the soil N cycle by increasing the amount of N-containing compounds (i.e. fixed mineral N) and by stimulating the activity of free-living microbes.

Approach

- Soils obtained from two-way factorial field experiment to assess the effect of soil macroinvertebrate reduction and shallow tillage on wheat yield\textsuperscript{6}.
- We measured soil N pools—combustible soil N, total dissolved N (TDN), including dissolved organic N (DON) and mineral N (ammonium (NH\textsubscript{4}) and nitrate (NO\textsubscript{3})), and potentially mineralizable nitrogen (PMN).
- and soil N fluxes—proteolysis, N mineralization, and amino acid turnover.

Results

Soil N pools

- Pools were generally larger for soils with native rather than reduced termite populations. Soil N declined with depth, but TDN pools stayed constant.
- A termite x tillage interaction was apparent for many soil N pools.

Soil N fluxes

- Fluxes were often greatest in soils with reduced termite populations with tillage. Termite x tillage interaction was also observed.
- High rates in the top 10 cm, and sometimes also at 20-30 cm. This may be due to N movement by termites and/or higher microbial biomass at that depth.

Conclusions

- Ecosystem engineers enhanced soil N pools, but fluxes into the pools were largest when termites were reduced.
- The latter is potentially an artefact of field accessibility caused by differences in mixing (by termites or tillage).
- Potential N transformation rates were enhanced by tillage when the termites were reduced, but were hindered by tillage when termites were abundant.
- Managing soils to promote biodiversity can have environmental and economic benefits by reducing external N fertilizer demand without yield trade-offs.