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Cyanobacterial crusts linked to soil productivity under different grazing management practices in Northern Australia

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In arid and semi-arid Australia, the central role of healthy soil ecosystems in broad-acre grazing lands may be attributed to the widespread presence of cyanobacterial crusts. In terms of soil nutrient cycling and stability their role is particularly crucial in a climate dominated by annual dry seasons and variable wet seasons. In this study, we aimed to measure the contribution of cyanobacteria to soil nutrient cycling under contrasting levels of disturbance associated with grazing management. Field sampling was carried out on six paired sites (twelve properties) located across an east-west 3,000 km transect that covered different rangeland types on grazing properties in northern Australia (Queensland, Northern Territory and Western Australia). At each location paired sites were established and two different management systems were assessed, cell-paddock rotations (25–400 ha) and continuous grazing (200–2,000 ha).

Cyanobacterial soil crusts were recorded from all of the twelve sites and cyanobacteria with the capacity to fix nitrogen were found at ten of the twelve sites. The overall diversity of cyanobacteria varied from three to ten species under any type of grazing system. As field work was conducted in the dry season, it is likely that the diversity may be greater in the wet season than the initial data may indicate.

The average cyanobacterial soil crust cover across soil surfaces, between grass tussocks, during the dry season was estimated to be 50.9% and, 42.6% in the early wet season. This reflected longer established crust cover (dry season) versus newly established crusts. There was a high level of variability in the biomass of cyanobacteria however; the grazing system did not have any marked effect on the biomass for any one rangeland type. The grazing system differences did not appear to significantly influence the diversity at any location except on a floodplain in the Pilbara (WA).

Biological nitrogen fixation by cyanobacteria was recorded at all sites. Nitrogen fixation rates were significantly higher in the wet season samples compared to the dry season. Rates of nitrogen fixation, mineralisable nitrogen and cyanobacterial biomass were comparative to other studies both in Australia and globally.

Eleven of the twelve sites had higher plant-available (mineralisable) nitrogen in the 0–1 cm depth compared to the 1–5 cm depth. Nitrogen isotopes showed that the nitrogen concentration found in the surface soils (0–1 cm) from five sites originated from cyanobacterial nitrogen fixation. At the remaining sites the isotopic signatures were slightly more positive, indicative of fractionation. The results have substantiated the link between cyanobacteria and their contribution to carbon and nitrogen cycling across the northern Australian rangelands. The data also highlights the variability between sites and management practices that influence biogeochemical processes that affect soil productivity.