GLOBAL SOIL BIODIVERSITY INITIATIVE

Scratching below the surface with Australia's digging mammals

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From badgers, sea birds and gopher tortoises to

burrowing frogs and goby fish, the world has a wealth of diversity in the vertebrate animals that dig through sediments and soils. By creating burrows for shelter, ploughing through soil or digging foraging pits when searching for food, many animals move and manipulate soils through bioturbation. Prolifically digging animals are often considered ecosystem engineers as their bioturbating actions, which mix sediments and rework soils, can alter resource availability for other species.

Figure 1. The quenda is a marsupial bandicoot, endemic to south-western Australia that digs prolifically while searching for subterranean food.

Australia has many digging mammals, such as bettongs and bandicoots, who substantially disrupt and modify the topsoil and organic layer while searching for subterranean food. When foraging for food, these digging mammals

often create shallow pits with an associated spoil heap of ejected soil. This combination of digging and discarding soil disrupts the microhabitat layer by exposing soil and burying organic matter under the spoil heap. Although digging activities appear small at a local scale, their cumulative impacts can be important for broader-scale ecosystem processes, influencing soil turnover, water infiltration and nutrient cycling.

Figure 2. A foraging pit created by a quenda while searching for food.

Tragically, many of Australia's digging mammals are threatened, with several species suffering substantial population declines and range contractions due to habitat loss and predation by introduced foxes and cats. One of the digging mammals that does persist in south-western Australia is the quenda (*Isoodon fusciventer*), a medium-sized (800 – 1200 g) marsupial bandicoot (Figure 1). When food resources are plentiful, but introduced predators are few, these

solitary mammals often have over-lapping home ranges and can occur at high densities. Each night, they create about 45 foraging pits (Figure 2) with their well-developed forelimbs as they search for underground invertebrates, fungi and tubers. It has been estimated that an individual quenda can turn over nearly four tonnes of soil annually. The digging actions of quenda change soil moisture and hydrophobicity, alter the surface litter composition and influence seedling recruitment at a local scale (Valentine et al, 2017). Given this, the foraging activity of quenda could play a role in changes to the chemical and biological characteristics of soils, and we wanted to investigate how these changes might influence seedling growth. That is, do quenda influence the growth of seedlings, and, if so, how?

In our recent study (Valentine et al, 2018), we collected soil from the base of 20 recently dug (within 2 months) quenda foraging pits (pit soil), the associated spoil heaps (spoil soil) and adjacent undisturbed soil (undug soil) and analysed the soils for nutrients (phosphorus, potassium, sulphur, organic carbon and conductivity) and microbial activity. Topsoil cores were collected from the same locations, transferred to pots and seeds of a local tree species, tuart (*Eucalyptus gomphocephala*), were added to the soil under glasshouse conditions (Figure 3). Seedling growth was measured over four-months, and seedling shoot and root biomass were measured upon harvesting.

Figure 3. Glasshouse with tuart gum seedlings grown in soil collected from quenda foraging pits, spoil heaps and adjacent undisturbed ground.

Our research showed that foraging by quenda altered soil nutrients and microbial activity, and subsequently facilitated seedling growth (Figure 4). The soil properties potassium and electrical conductivity occurred in greater levels in the spoil soil. In addition, both the spoil and undug soil had greater amounts of organic carbon and microbial activity. In contrast, the pit soil had the lowest levels of nutrients and microbial activity. Seedlings grown in spoil soil created by quenda grew quicker than other seedlings and, upon harvesting, were taller, heavier, with thicker stems and a bigger root biomass than seedlings in the pit or undug soil. The best predictors of seedling growth were greater amounts of potassium, electrical conductivity and microbial activity.

The way quenda forage for food involves excavating soil and discarding it on top of organic matter. This potentially creates an environment that is conducive for decomposition of the organic matter in the spoil heap, and subsequently, returns nutrients to the soil. In the nutrient-poor soils typical of south-western Australia, these extra nutrients may be crucial for facilitating seedling growth. The widespread decline of Australia's previously common digging mammals may have flow-on effects for other biodiversity elements. We believe that the persistence of native digging animals, like quenda, is important for maintaining the health, function and biodiversity of ecosystems.

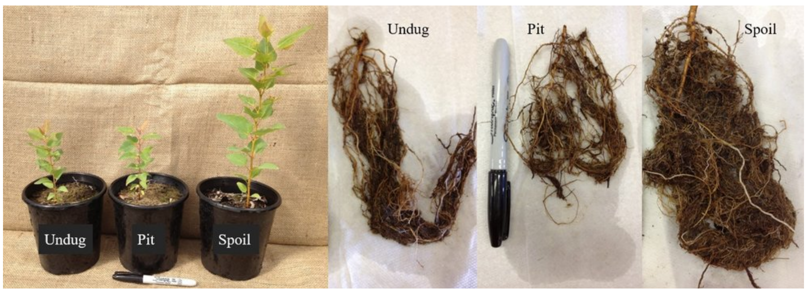

Figure 4. Seedling height and root biomass of tuart gum trees grown in soil collected from different locations

(undug, pit and spoil) of a quenda foraging pit.

References

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