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USE OF PLANAR OPTODE TECHNOLOGY TO ASSESS OXYGEN AND PH DYNAMICS IN SOILS BIOTURBATED BY DUNG BEETLES

Dung beetles through the manipulation of livestock faeces provide a diversified range of ecosystem services. They contribute to dung redistribution in the soil, and organic matter mineralization and nutrient recycling. This, in turn, facilitate nutrient uptake from plants, and reduction of greenhouse gas emissions. Dung beetles are key organisms in maintaining the functionality of pasture ecosystems, secondary seed dispersal, and parasite control and suppression.
Here we use as a model *Onthophagus nuchicornis* (Linnaeus, 1758), a dung beetle which digs tunnels beneath the dung pat where it builds brood balls for larvae nutrition. We evaluated soil bioturbation and dung removal activity by investigating oxygen and pH dynamics with planar optode technology (MERL and KOREN, 2020; MERL *et al.*, 2023). The optodes were integrated into a thin (7 mm) soil sandwich (*i.e.*, microcosm) and by using a single-lens reflex camera we acquired two dimensional (2D) images (25x15 cm) over a > 24h period. A 405 nm UV LED was used to excite the optodes.
The results show that dung beetles strongly affect the amount of oxygen in the soil by tunnelling and transporting the dung, which is highly anoxic, deep into the soil. In addition, dung beetles, through bioturbation, increase the oxygenation of the dung still on the soil surface by allowing aeration and thus favouring aerobic decomposition processes. Soil pH also changes due to bioturbation and dung removal. The results show that dung beetles action produces an alkalinising effect on the soil (approx. from pH 6 to pH 8), especially in areas where dung has been buried. In addition, even the dung left on the surface shows an increase in pH due to bioturbation. With this technology, we were able to assess both the differences in the soil before and after the action of the dung beetles, as well as the actual way in which the dung beetles move underground by mixing the dung with the soil and building their nests.
In conclusion, this is an entirely new approach to understanding and quantifying some of the ecosystem services provided by these beetles, as planar optodes have, to our knowledge, never been used on dung beetles. Our pilot study well demonstrates the high potential of planar optode technology for application in this field.