Why dung beetles are beneficial ecosystem engineers

There are no silver bullets in agriculture. To maximise the benefit of any natural input, complementary farming practices are needed.

Dung beetles have evolved with their host species. It took a Hungarian refugee, entomologist Dr George Bornemissza, who landed in Fremantle in 1951, to realise that our colonisers introduced ruminants but not their co-dependent dung beetles.

Australia has over 400 native dung beetle species but they evolved to use the dung resources of native animals. One species, for example, hangs on to the tails of wallabies to be on hand when the dung drops!

It was Dr Bornemissza who initiated the CSIRO exotic dung beetle introduction programme in the 1960's. *Initial funding in WA was through Health (flies) and Tourism (flies) departments. They were introduced as biosecurity agents – to remove fly breeding grounds.*

To get back to the question of why dung beetles are rightly called ecosystem engineers and are beneficial to livestock producers, it's necessary to go first to the dung pad.

Nature operates in closed systems – what exits the cow is intended to generate more pasture for consumption. So, what is in the dung is designed for that purpose. Obviously it contains a huge dollop of carbon and humic elements in the form of partially digested – or decomposed – cellulose, lignin, chitin and so on. It also contains mineral nutrients but these are dependent on those present in the forage. Here's where the complementary practices of multi-species pasture and appropriate mineral supplementation come into play.

Biological components of dung include seeds, fungal spores, enzymes, plant growth promoting hormones, microbes – predominantly anaerobic – that carry out multiple functions. *Bacillus subtilis* has a role in plant protection from fungal and bacterial pathogens, *Pseudomonas spp* have antifungal compounds, Proteobacteria are involved in degradation of pollutants, the solubilising of phosphate and nitrogen fixation. Anaerobic microbes dominate the lower intestine of cattle and it is these, on expulsion, continue the decomposition of complex polysaccharides.

Just as healthy soil needs to consider the chemical, biological and physical properties of soil, the benefit of the combination of the cow manure's chemical and biological properties is enhanced by the dung beetle's structural and ecosystem engineering functions.

The adult dung beetle's diet is the protein and nutrients in the liquid portion filtered from the dung pad. Adults have no teeth. The introduced species we are talking about today fall into three broad categories: rollers, tunnellers and dwellers. We don't have any roller species in WA – these are the ones that break off dung, mould into balls and roll away from the pad to be shallow buried or attached to vegetation. The dwellers are those that live in the interface between soil and dung and serve a useful purpose in

decomposing the pad and parasite control. The tunnellers is the group most associated with engineering. There is variation between the species but essentially tunnels are excavated with soil brought to the surface. Dung is used to line the tunnels and to form brood balls or brood sausages at the base of the tunnels or in branched tunnels in which eggs are laid.

These tunnels increase rainfall or irrigation infiltration capacity and reduce run-off, the carbon retains moisture and nutrients. Not only does the buried carbon retain moisture, the excavated tunnel-soil brings up leached nutrients, making them plant available - again.

Soil aeration is important for plant root respiration, aerobic microbial activity, nutrient cycling and reduction in soil bulk density. The tunnels provide easy access for plant roots to penetrate deeper into the soil profile and create pathways for macro-organisms like earthworms.

Microbial biofilms form at the interface of moisture and air. These adhere to plant roots, soil pores and mineral surfaces and assist in building soil aggregates. Plant available nutrients move in solution, so increased moisture retention and aeration have compounding benefits to plant growth.

And to finish off this section – developing larvae have teeth and a fermentation gut, reprocessing and re-inoculating the dung stored as their food source. The exoskeletons shed through multiple moults deposit chitin in the tunnels. Chitinase is a plant growth regulator, it also assists in plant protection from pathogens and biotic and abiotic stresses.

Key differences

We have one dweller *Aphodius fimitarius* a small orange and black dung beetle. It's fairly widespread across the south west. These beetles may make very shallow tunnels but they live, feed and breed within the dung pad. They are often found in older pads, forming part of the decomposition team. They can consume fly and parasite eggs.

The species that are present in the south west vary in population density by latitude and longitude

Summer-active species – a generalised term as there are peaks and troughs from the late spring to autumn period (could coincide with emergences of subsequent generations) – found in the south west and lower south west are:

- *Onthophagus taurus*
- *Onthophagus binodis*
- *Euoniticellus fulvus*
- *Euoniticellus pallipes*
- *Onitis aygulus*

O. taurus is by far the most widespread and numerous. It was released at many sites in the late 70's. In our recent southern Australia monitoring, Yoongarillup recorded the highest trap capture on 9th January 2021. Although this species may emerge in October, peak populations are generally in December and January when pads are rapidly demolished. Further south – Walpole and Northcliffe, for example, the period of heavier activity may begin earlier and extend into February. There is a second, smaller peak in mid-autumn. Multi-voltine.

O. binodis is a larger small black beetle and it was one of the earliest introductions – mid to late 70's. Its range is far more restricted with Walpole to Pemberton being the hot spots (loamy, high rainfall?). They are at Marbelup, through Manjimup, Nannup, Anniebrook but not north of Donnybrook or at Bridgetown.

Multi-voltine. Worth redistributing to Lower Blackwood if more extensive local monitoring demonstrates an absence.

E. fulvus is one of the three little golden beetles. Its release in the early 80's wasn't as widespread as *E. pallipes* but it has established a wide range across the south west though its population density is largest in the cooler, wetter areas from Tingledale to Anniebrook, though some were trapped at Harvey. Random trapping found them at Warner Glen, Forest Grove and Scott River. Multi-voltine. *E. intermedius* is more to the wheatbelt area, as is *Onitis alexis.*

E. pallipes, though they were released in many sites in the south west agricultural region, in our immediate south west the releases were more restricted in the original releases: Bridgetown and Busselton. It could be this species needs more targeted redistribution. Multi-voltine.

O. aygulus is a larger active in this timeframe, though only trapped in very low numbers including at Yoongarillup and Anniebrook sites. Univoltine Austumn fox bait!

The only *winter-active species* is *Bubas bison* which was first introduced to Kojonup in 1985 though other releases are known to have occurred at Brunswick and Dardanup area.

In our monitoring, larger numbers of this species were trapped in warmer, drier areas. Of our sites, Harvey was the most numerous, peaking in June, July. None were trapped at Tingledale whereas they were present a site at North Walpole, 20km away. They were recorded at Anniebrook but not Yoongarillup. Univoltine

Websites:

https://www.dungbeetles.com.au (homepage has the link to the Farmer's Guide)

https://dungbeetles.shinyapps.io/dungbeetlemaps/ (UWA mapping dashboard using analysed data collected during the DBEE monitoring of southern Australia) It takes a while to load.

https://www.dungbeetles.com.au/livestock-producers/buying-dung-beetles (dung beetle suppliers - Dr Forgie doesn't ship to Australia!)

https://www.dungbeetles.com.au/sites/default/files/2022-06/dbee_regional-guide_sw-wa_package.pdf (Some very general information – the nursery advice is *O. vacca* and may not be relevant for other species.

The project data has been uploaded to Atlas of Living Australia under the Dung Beetles Ecosystem Engineers collection. A little more complicated to navigate.

https://collections.ala.org.au/public/show/dr15584

Then there is our local Facebook page! https://www.facebook.com/dungbSW/

Our thanks to Kathy Dawson from Southern Forests Community Landcare for providing these notes. These notes are intended to read in conjunction with our Talkin' After Podcast - Talkin' Dung Beetles with Kathy Dawson & Kylie Cook.

TALKIN' After Hours

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with the Lower Blackwood LCDC