Manaaki Whenua
Landcare Research

Rolling Out Dung Beetles in New Zealand

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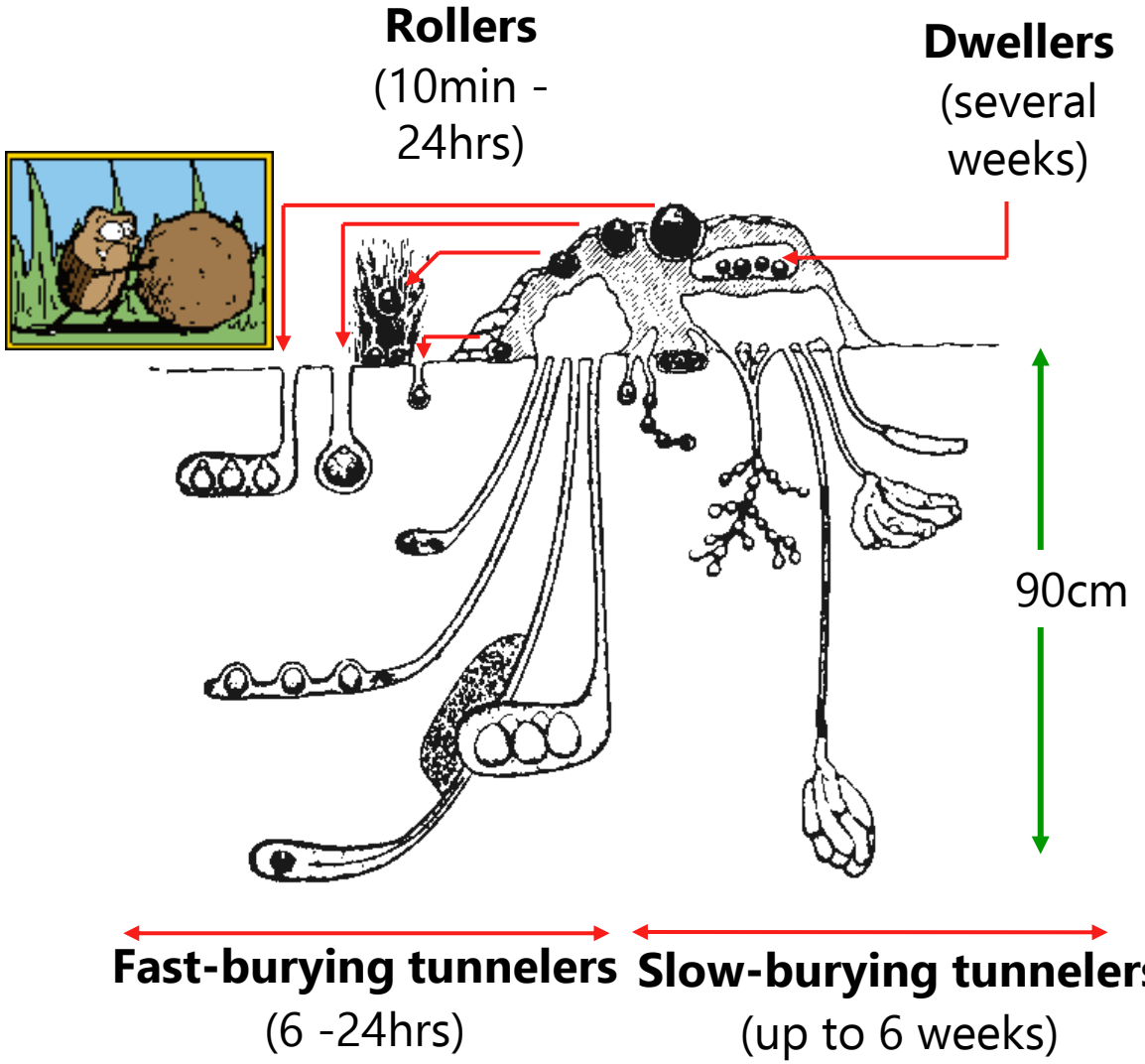
What am I going to talk about?

- Dung beetles: background, and situation in New Zealand
- Australia's pioneering and more recent programmes, but mostly;
- New Zealand activities associated with the recent Australian programme
- Summarise + where now?

Some Dung Beetle Basics

- Evolved to feed and breed in dung
- About 7000 species worldwide
- Family Scarabaeidae …. the scarabs
- Long interest from humans: the Egyptian solar deity *Khepri*
- Perhaps the best studied group of beetles
- Dung beetles bury fresh dung in pastures, providing valuable ecosystem services
- Permission to release eleven new dung beetle species in NZ, 2011

A well-colonized dung pat



Only tunnelers for NZ - why?

- **Tunnelers are by far the most abundant**

- **Least exposed to predation**

Dung Beetles in NZ: the Endemic Species

- 15 species, mostly small, flightless

- Often abundant in native forest – important native decomposers (dung, carcasses etc)
- Rarely in pasture – no useful role in breaking down dung in pasture systems

Exotic pasture dwelling dung beetles frequent in dung in NZ

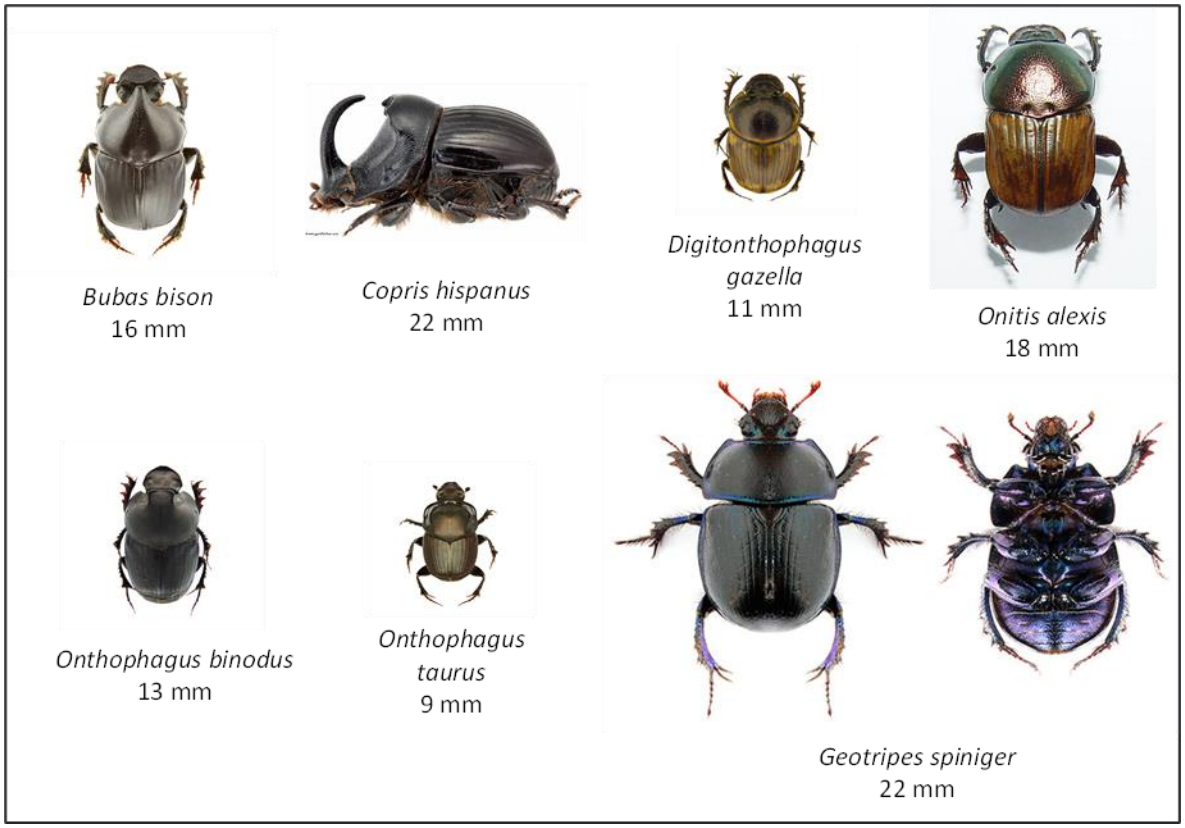
- Several self-introduced dung dwellers

- Two self-introduced Australian tunnelers

- Mexican dung beetle
- Larger - 17 mm, introduced 1956
- Good species for warm areas

- NZ needs more dung beetle species to bury dung

New Dung Beetle Species being Reared in NZ



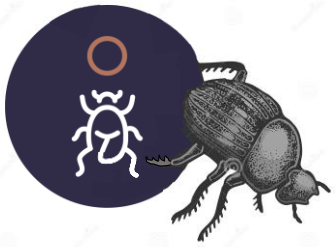
- Dung Beetle Innovations bringing in a further four species
- Need species for different climates, soils, seasons …… even times of day & different types of dung

Australian Dung Beetle Programme

- Australia pioneered introducing dung beetles with a major programme 1965-85: 23 species established

- Smaller developments in Australia since 1980s: https://www.dungbeetles.com.au/dung-beetles/history
- New Australian programme: Dung Beetle Ecosystem Engineers – A$25m 2018-2022

Dung Beetle Ecosystem Engineers Project



- Aims:
- Extensive surveys – find geographic/seasonal gaps (southern Australian focus)
- Rearing and releases; existing + new species
- Quantify ecosystem services – in $$
- Big emphasis on education, training and information delivery
- https://www.dungbeetles.com.au/about/project-objectives
- Meat & Livestock Australia, Federal Govt, Charles Sturt Uni, Uni Western Australia, Uni New England + stakeholder groups

Dung Beetle Ecosystem Engineers Project

- Manaaki Whenua – Landcare Research is a partner/$$ contributor
- Two key areas where DBEE wanted NZ dung beetle expertise:
- 1/ Effect on leachate through soil cores
- 2/ Interaction with gastro-intestinal nematodes
- Also added in 4 NZ field sites to the larger southern Australian survey, and;
- Plus field cage experiments (mesocosms) to quantify ecosystem services
- Details on these four topics in the remainder of this talk

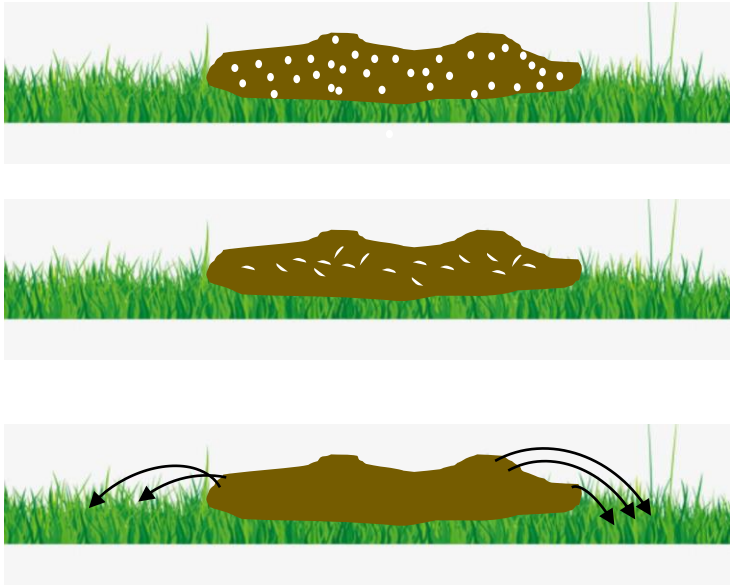
Leachate studies

- Do contaminants in leachate increase after dung beetle burrowing?
- Intact soil cores (lysimeters) ‘carved’ out; encased; edge-sealed; collection apparatus below core
- Dung-only cf dung+beetles
- Several soil types NZ/Australia

- First NZ trials show no increase in N, P, *E. coli* in leachate through an allophanic soil in NZ after dung beetle activity

Gastro-intestinal nematodes

- Basic life history:
- Eggs in fresh dung (≤ lots!)
- First and second stage larvae feed on bacteria in dung
- 3rd stage larva is non-feeding, mobile and infective. 7-day development, 12-week lifespan



- What affects the numbers going through this lifecycle, and how can dung beetle activity influence this?
- Dung disturbance e.g. by pre-reproductive adults
- Dung burial/processing into brood balls

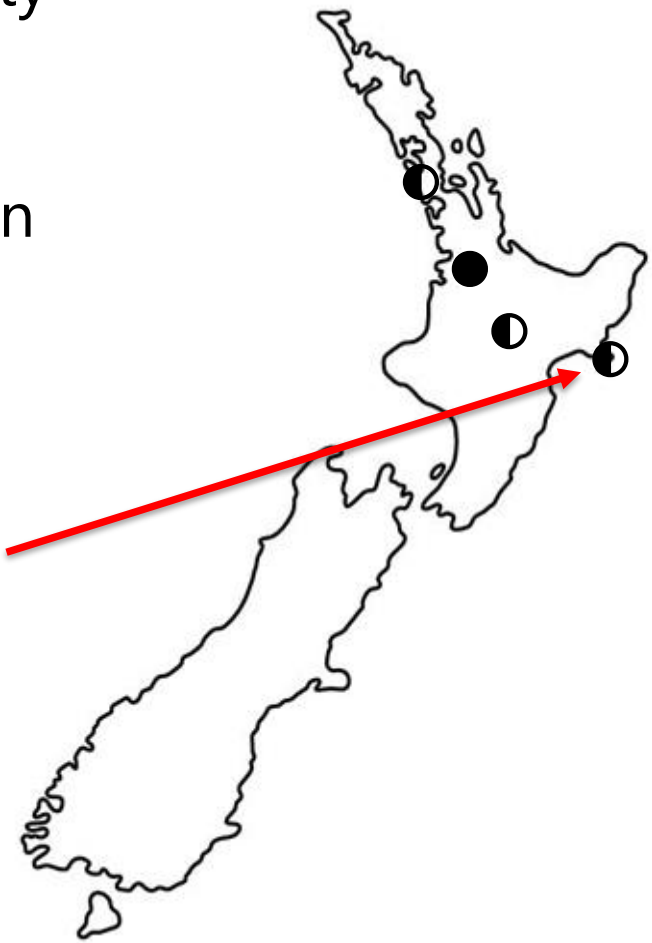
Gastro-intestinal nematodes

	Dung disturbance	Dung burial/brood balls
Egg hatch	Aerobic conditions can *greatly* increase hatch rate	Aerobic conditions increase egg hatch but processing into brood balls destroys most eggs
Survival of L1/L2	*Greatly* reduced survival if dung dries out	Burial could increase survival of L1/L2 by preventing drying out, but processing into brood balls likely to kill larvae
L3	Resistant to drying out. Can migrate onto foliage in moist conditions	Migration from buried dung possible from <10cm depending on moisture and soil type (e.g. lower survival in sandy soils but able to migrate from deeper than in clay soils)

- Simulation modelling to tackle the complexity
- Existing data suggests dung beetles are usually highly beneficial - but there are gaps/uncertainties
- Develop decision-making tool – “to drench or not to drench”?

Field surveys – NZ sites

- 4 selected: 1 intensive (●), 3 low-intensity
- All sites: pitfall trapping; dung removal rate expts
- Intensive site : more detailed research on ecosystem services

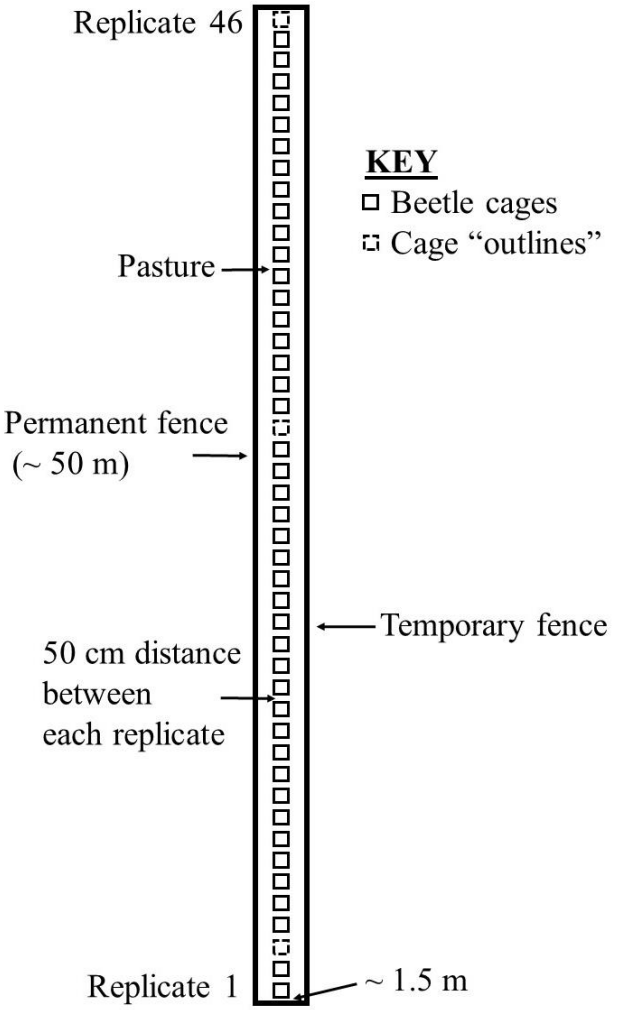


- Established dung beetles at three sites, but none at Mahia Peninsula

- Mass released four species at Mahia last summer – 20,000 beetles
- Hopefully a boost that Rocket Lab would be proud of….


Dung beetle releases

Cage experiments to quantify ecosystem services



- Beetles/dung added at 0 and 6 months – 10 reps/treatment
- Measuring dung removal, soil nutrients, pasture productivity

Summary/where now?

- NZ pastures need dung beetles – 'catch up' with Australia
- Joined latest Australian project: Dung Beetle Ecosystem Engineers (DBEE)
- Parallel research on beetle impacts but also mass-releases
- Use DBEE project, and other NZ research efforts (UoW, Otago Uni etc), to springboard further NZ developments
- Application to MPI SLMACC Freshwater Mitigation Fund to quantify dung beetle benefits to freshwater by reducing pollution in runoff and leachate
- Include dung beetles in nutrient management models like OverseerFM – real $$ value to farmers

Final points

- We want to catch-up fast – not wait decades for dung beetle impacts (like many areas of Australia)
- Key issues – show $$ benefits to farmers, but likely to still need some initial local/national government incentives

Acknowledgements:
Dung Beetle Ecosystem Engineers – all organisations and individuals who have helped us. Lots of MWLCR, EPA, Regional Council staff, farmers and international dung beetle enthusiasts. MPI for support including from the Sustainable Farming Fund. Envirolink/MWLCR core funding (both MBIE). The people and organisations I've missed.

A modern take on Khepri – the NZ model?

Thanks

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