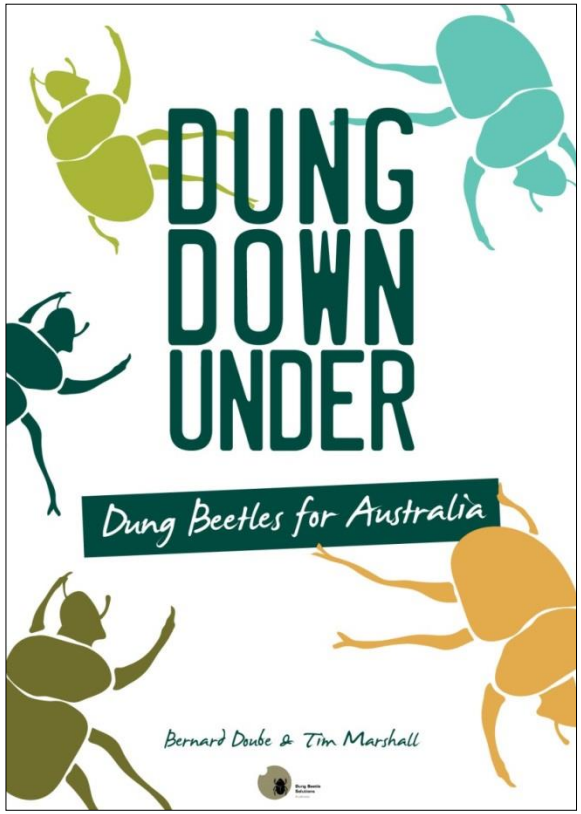
Dung Beetle Solutions

International

Harnessing the potential of soil biology:
Dung beetle benefits

Dr Bernard Doube

Dung beetle books



- *Dung Down Under*: **only $25 today**
- Horse Dung Down Under: coming soon
- Dung Beetle Field guide: buy from CSIRO**
- Lucky number 1-100

** https://www.publish.csiro.au/book/7207/

Today

1. Pre history
2. Benefits
3. Control of gut worms
4. Two new spring-active species
5. Biochar

Australian megafauna > 45 kg
26,000 – 15,000 years ago

1788: Governor Phillip

The past 200 years: A new pasture ecosystem

But only native dung beetles

- New mammals – cattle, horses etc.
- New gut parasites
- New grasses
- New legumes
- Cleared woodland = new grasslands
- New soil organisms
  - Earthworms
  - Microbes – rhizobia

Dung beetles in perspective

- Over 9,000 species worldwide
- Over 400 native species in Australia
- Only a few use domestic stock dung

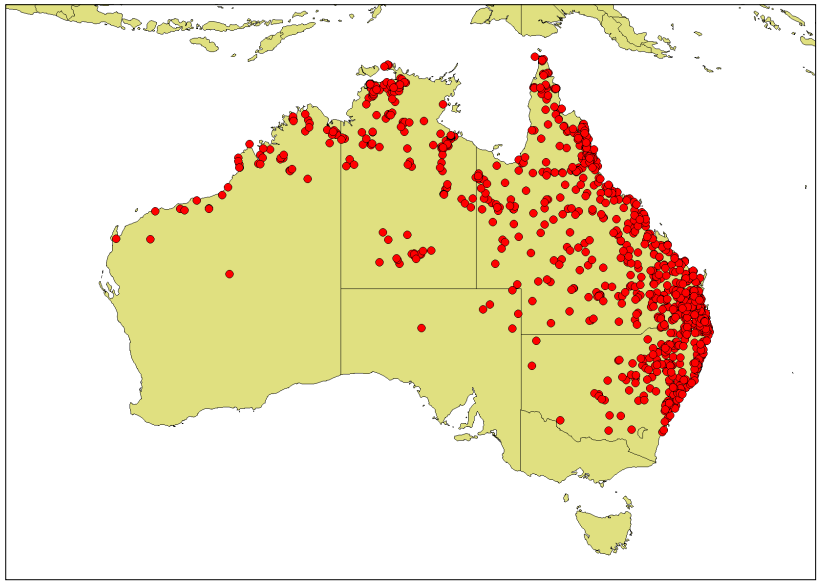
Exotic dung beetles

CSIRO Dung Beetle Programs

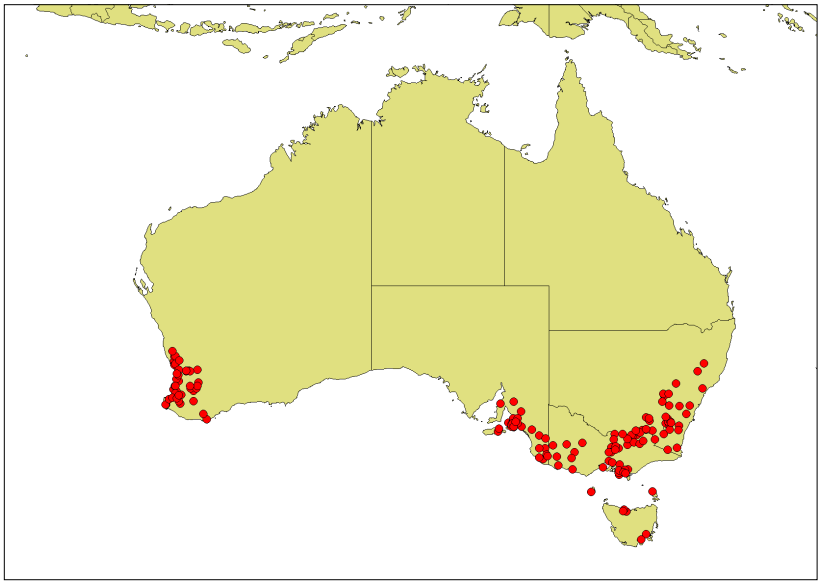
	No. of species
1968-1989	
Released and established	23
Released not established	20 (incl. *O. vacca*)
Never released	12
1992-1995	
Released not established	1
Never released	3 (incl. *B. bubalus*)
2012-2019	
Released	2 (*B. bubalus*, *O. vacca*)

CSIRO introduced exotic dung beetles to Australia

Species distribution



Onthophagus gazella
(summer rainfall sp.)



Onthophagus taurus
(Mediterranean climate sp.)

CSIRO dung programs: outcomes

Australia inturd by beetles

After 5 days: subsoil at surface

After 2 weeks: much dung burial

Dung beetles in Australia

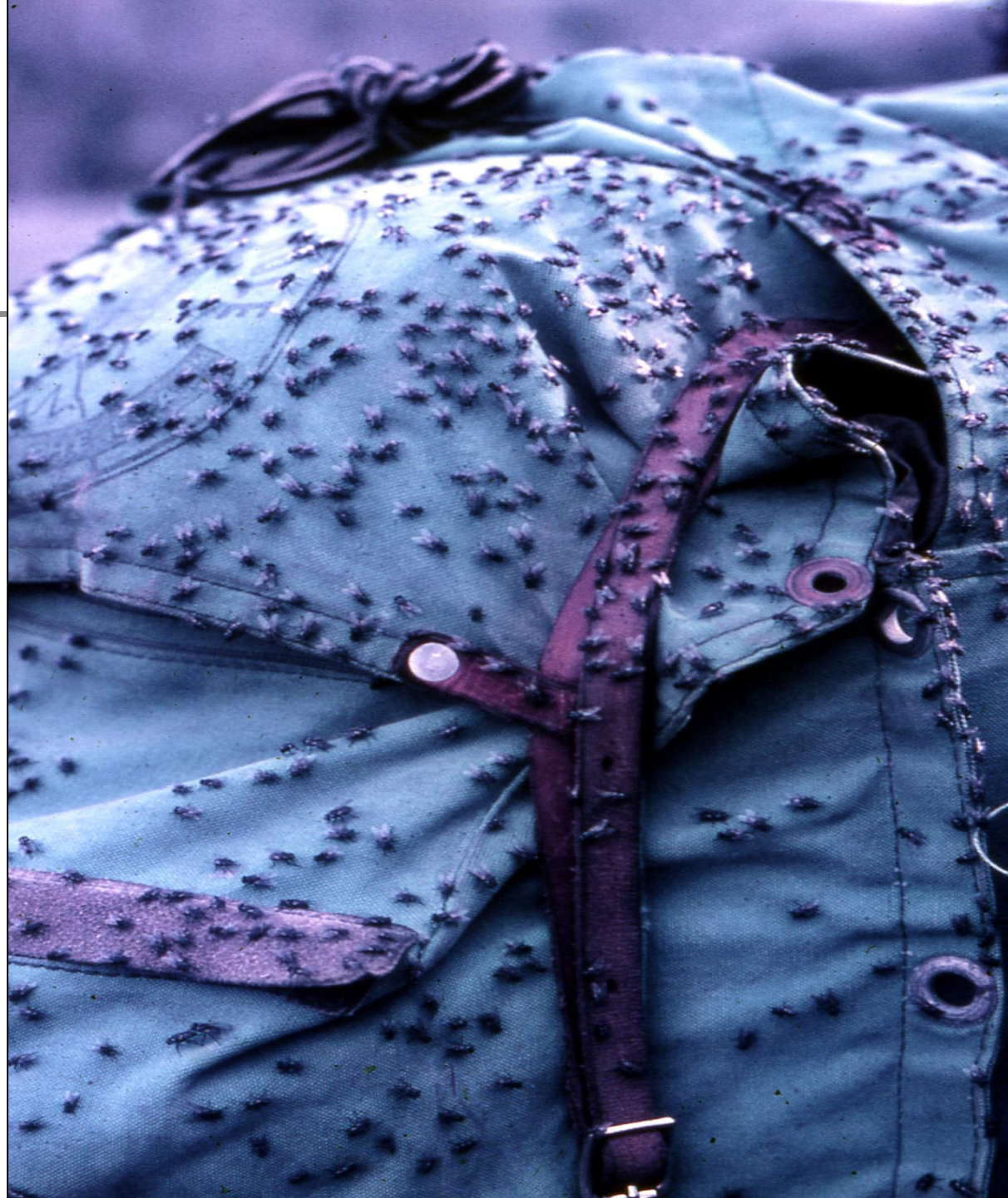
- Pest control
  - Fly control
  - Gut parasite control
- Production benefits
  - Earthworms & soil structure
  - Plant roots
  - Plant nutrients
  - Water
  - C-storage in soils

Dung beetles in Australia

- **Pest control**
  - **Fly control**
  - Gut parasite control
- Production benefits
  - Earthworms & soil structure
  - Plant roots
  - Plant nutrients
  - Water
  - C-storage in soils

The 1970s:

Many bush flies, no effective dung beetles



Dung beetles in Australia

- **Pest control**
  - Fly control
  - **Gut parasite control**
- Production benefits
  - Earthworms & soil structure
  - Plant roots
  - Plant nutrients
  - Water
  - Carbon storage in soils

Pre-war agriculture

Modern stock management: 1950 to 2010

The post-war revolution: Ag-vet chemicals

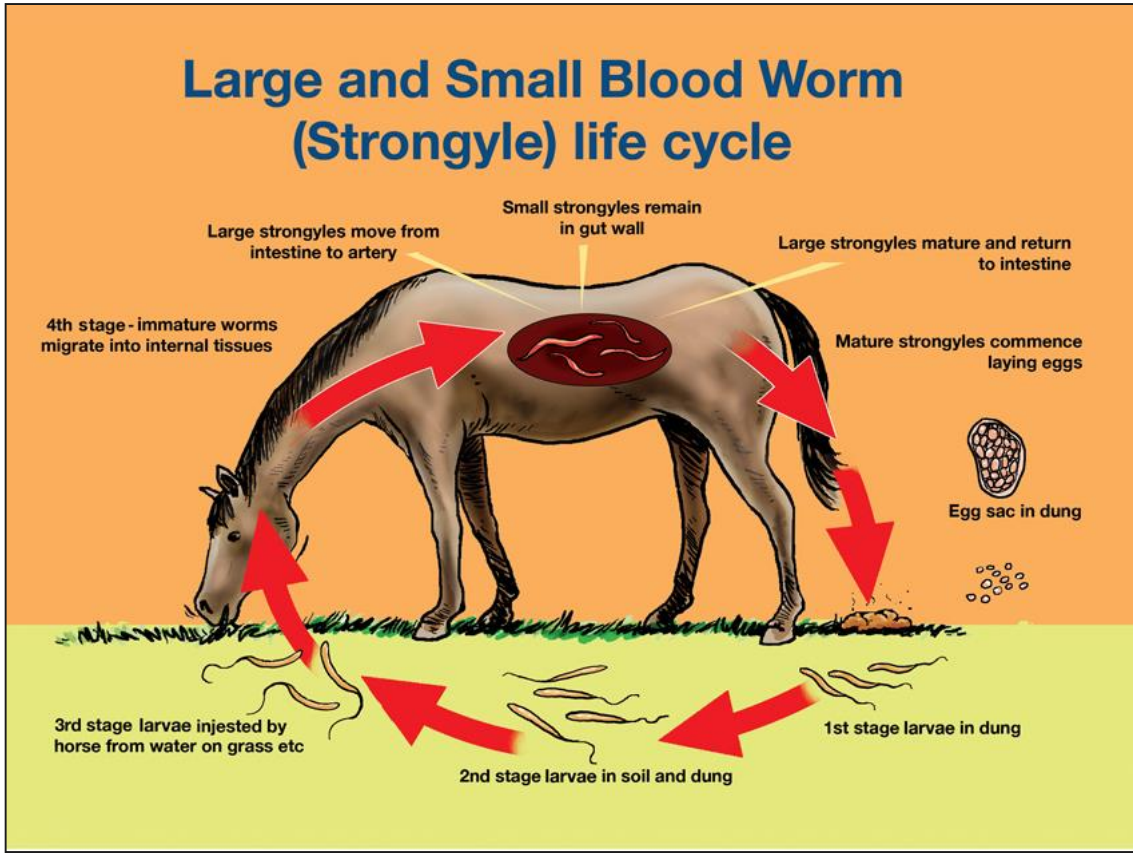
- Antibiotics to control bacterial disease
- Vaccines to control viral diseases
- Chemicals to control gut parasites
- Chemicals to control lice and other pests
- Chemicals to control pasture pests

Professor Julian Cribb's 2014 book

Not all stock get de-wormed

Gut worm life cycle

- Adults live in the gut
- Eggs are shed in dung
- Eggs hatch into larvae
- Three larval stages
- 3LL stage is the infective stage



Controlling gut worms

- Drenches and pastes
- Natural immunity
- Pasture spelling
- Cross-grazing
- Dung beetles
- Pathogens

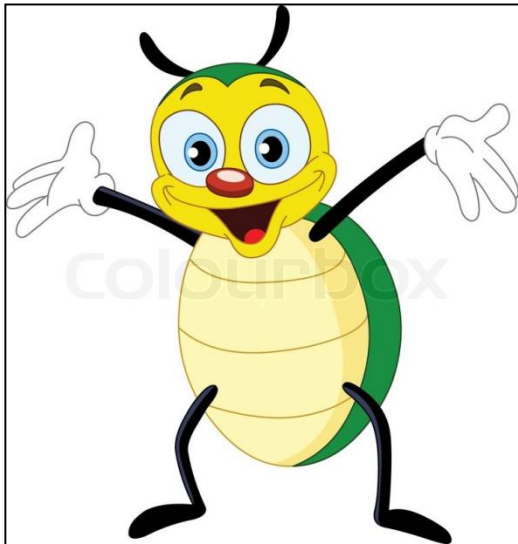
Drenches and pastes:

Consider your dung beetles when using parasiticides

- Mectins – most kill dung beetles
- 'White' drenches: BZ or benzimidazole
- 'Clear' drenches: LV eg levamisole
- Many others

Toxic mectins: Ivermectin
Doramectin
Eprinomectin

Beetle-friendly: Moxidectin: EQUEST
CYDECTIN, MOXIMAX



Natural immunity

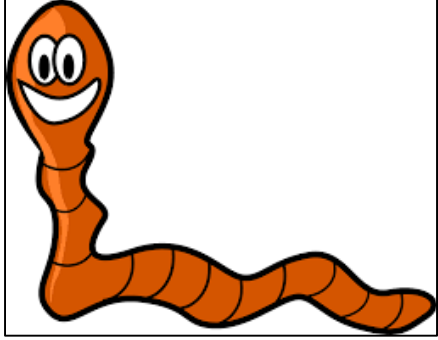
- Millennia of co-evolution
- Effective immunity to gut worms
- Little or no animal damage
- Low parasite numbers stimulate resistance
- No parasites == no resistance
- Exceptions – young, the sick and the old

Integrated Parasite Management

Which horses need treatment?

- Faecal egg counts
- Coat and general condition
- Foals, the sick and the old
- Reduced cost of chemicals
- Slows development of resistance

Pasture spelling



Infective parasite larvae crawl up a grass stem

- Summer
  - One week before infective 3LL leave the dung pad
- Winter
  - Some to many weeks before 3LL leave the dung pad

Pasture spelling intervals

- Summer: a few weeks
- Winter: many weeks

Cross-grazing

Dung beetles control gut worms

Dung burial kills the infective stages

- dung beetle activity
  - kills worms when pads dry out
  - kills worms that are buried with the dung

Dung beetles control gut worms

- Sheep: — No. of infective 3LL
  - Surface dung — many
  - Manual burial — many more
  - Burial by beetles — none

Research by Dung Beetle Express N-NSW

Dung beetles in Australia

- Pest control
  - Fly control
  - Gut parasite control
- **Production benefits**
  - **Earthworms & soil structure**
  - **Plant roots**
  - **Plant nutrients**
  - **Water**
  - **C-storage in soils**

Soil health: earthworms

Earthworm followed the tunnel down

Earthworm casts deep in the soil

Soil health: roots into the subsoil

Benefits: water infiltration into soil

Feeding tunnels of *Bubas bison* at Bool Lagoon, SA

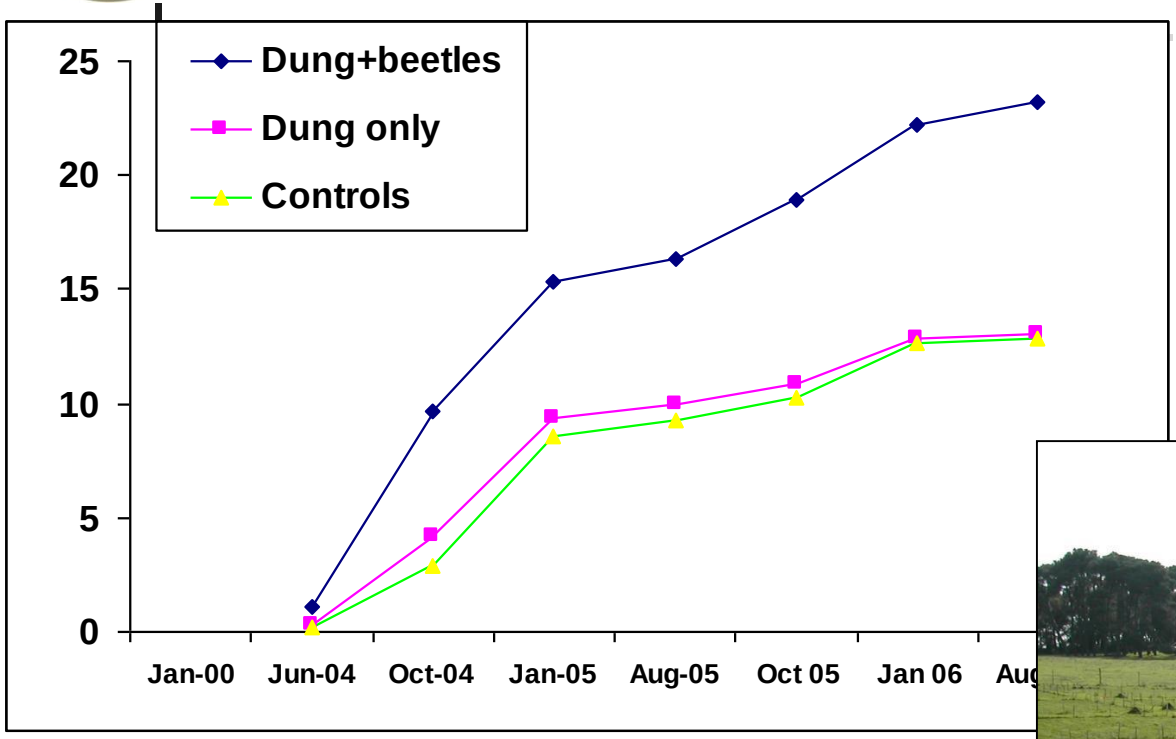
640 exit tunnels

Water infiltration into soil

Measuring time for 50 mm to soak in

Pasture production

Kuitpo, South Australia



Cumulative pasture production (tonnes DM/ha)

Recent national projects

- **CSIRO-MLA Project 2012-2017**
  Introduced 2 new spring-active species

- **New DBEE program 2017-2021**
  Will introduce 3+ new species

mla MEAT & LIVESTOCK AUSTRALIA

Australian Government
Department of Agriculture and Water Resources

une University of New England

Charles Sturt University

THE UNIVERSITY OF WESTERN AUSTRALIA

Department of Primary Industries and Regional Development
GOVERNMENT OF WESTERN AUSTRALIA

CSIRO

Dung Beetles for Landcare Farming

WARREN CATCHMENTS COUNCIL

MINGENEW-IRWIN GROUP

Leschenault Catchment Council

Manaaki Whenua Landcare Research

Dung Beetle Solutions Australia

DBEE program: 2017-2021

- $23 m over 5 years
- 10 partners
- Breed and redistribute spring species
- Define gaps in dung burial
- Import three new species
- Extensive outreach program
- $ value on dung beetle benefits

Dung Beetle Ecosystem Engineers
New national program

Theme 3: Beetle distribution

- 300 new releases across southern Australia
- Mass rearing of beetles for release
- Selection of release sites:
  - CLIMEX
  - Habitat suitability
- Release and monitoring **on-farm nurseries**

CSIRO-MLA Projects 2012-2022

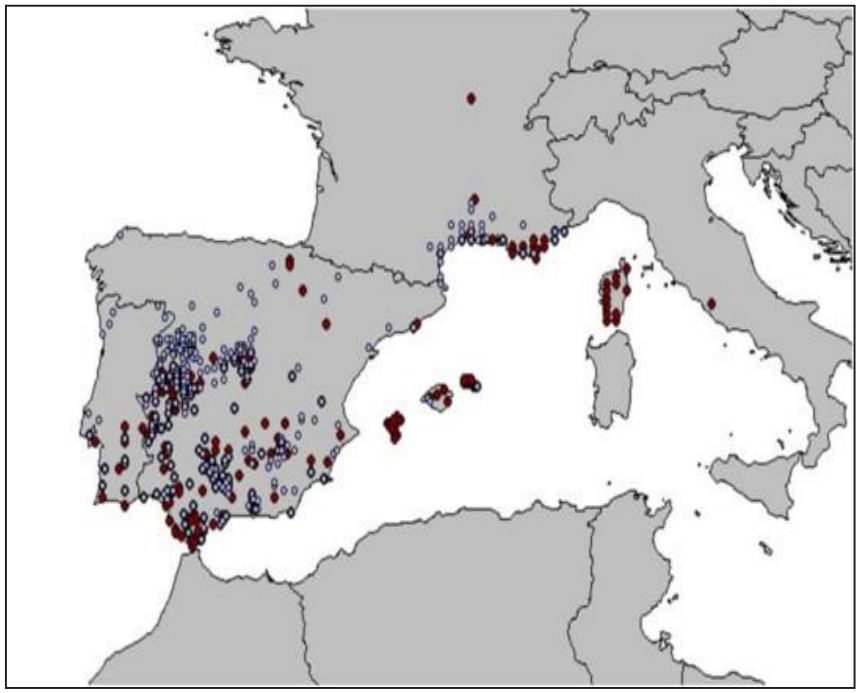
Onthophagus vacca and *Bubas bubalus*

Why choose these species?

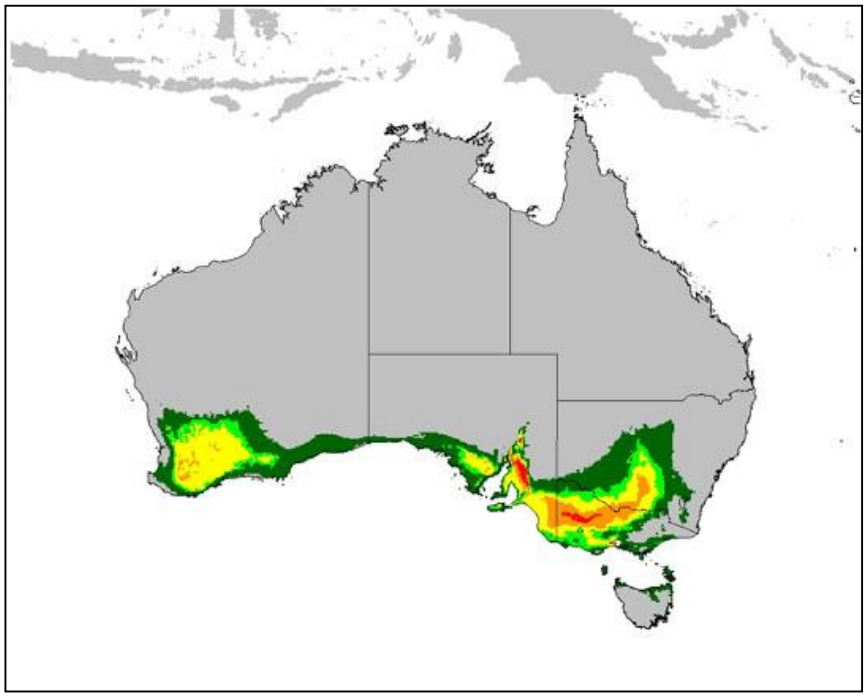
They are spring-active

- Bushfly control
- Improved soil health
- Improved pasture growth
- Biological control of gut parasites

Bubas bubalus distribution
(with *Bubas bison*)



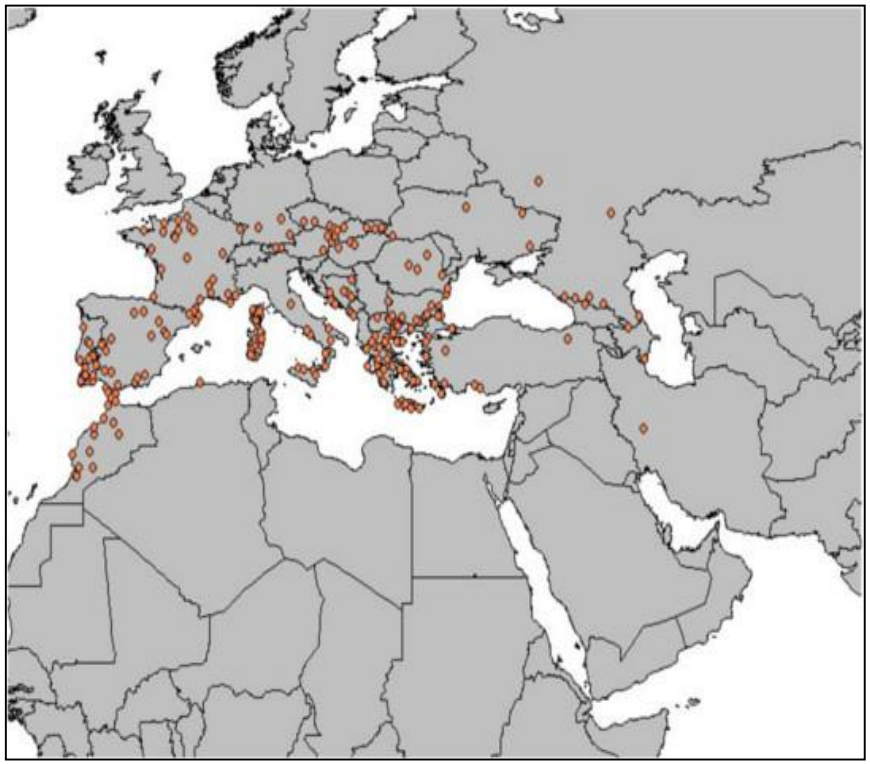
Europe



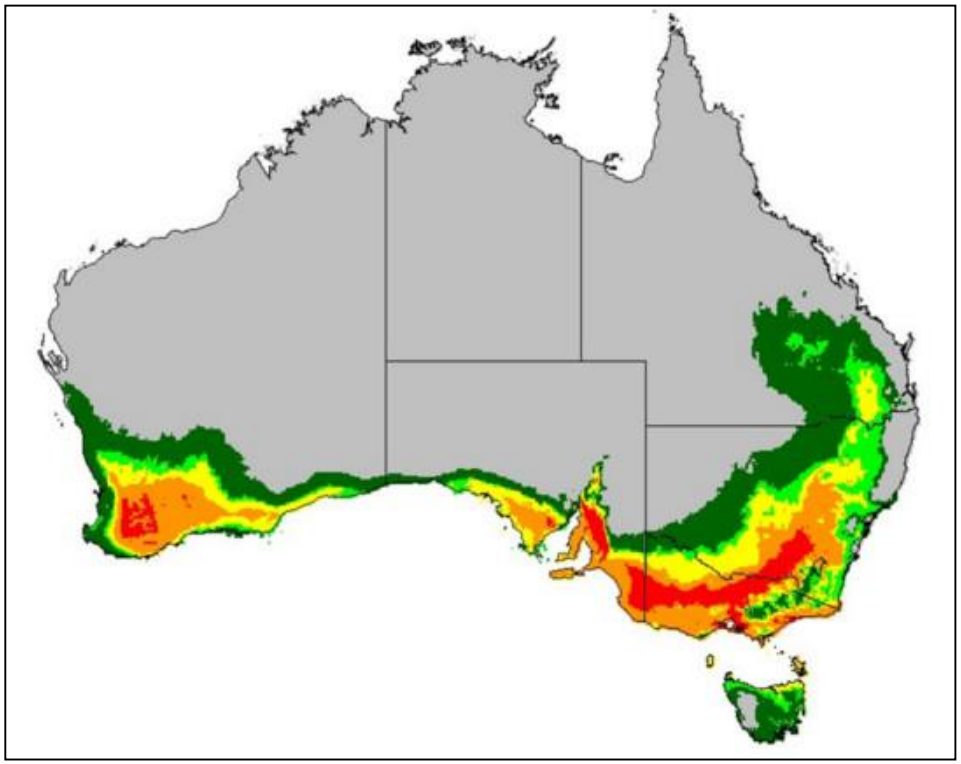
Australia

Source: Wright et al. 2015, Importation of 2 winter-spring active dung beetles for southern Australia, Final report of Project B.ERM.0213, Meat and Livestock Australia, Sydney.

Onthophagus vacca distribution



Europe



Australia

Source: Wright et al. 2015, Importation of 2 winter-spring active dung beetles for southern Australia, Final report of Project B.ERM.0213, Meat and Livestock Australia, Sydney.

Boasting

O.vacca 2014-2018

Strathalbyn SA

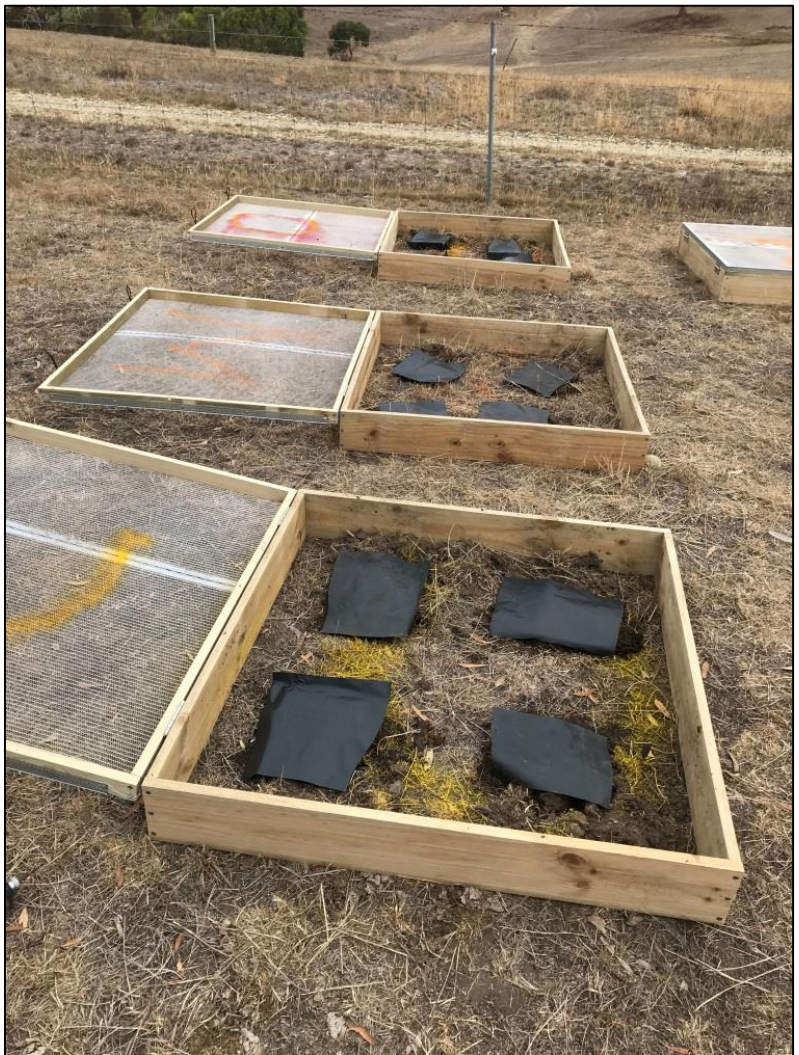
- 2014 65 beetles
- 2015 440 beetles
- 2016 5,600 beetles
- **2017 13,000 beetles**
- 2018 large numbers

- 2017 national releases (n = 9)
  - 2,000 WA field
  - 1,400 Vic field
  - 1,750 SA field (Mark Higgins)
  - 2,700 NSW field nursery
  - 2,300 WA field nursery

Onthophagus vacca 2017

Field + cage releases Mitta Valley Vic

Field trials
On farm-nurseries for *O. vacca*



Field trials
On farm-nurseries for *O. vacca*

Fleurieu dung beetles

A model of Barossa Valley LCG

Winter-active beetles: *Bubas bison*

Before 2002	none
Winter 2002 and 2003	30 colonies
Winter 2007	survey
Winter 2015	**survey**
Winter 2017	20 colonies
Spring 2017	survey
Winter 2018	survey
Winter 2019	re-survey?

Fleurieu dung beetles
Role of AML NRM: *Bubas bison*

- Winter 2007 — 3-4 years
  - *B. bison* established but had not spread
- Winter 2015 — 11-12 years
  - Complete coverage except Echunga + Birdwood
- Winter 2017 — beetles released into gaps
- Winter 2018 — 1 year established

Winter survey

Fleurieu dung beetles

Bubas bison release strategy

- **1,000** beetles per release 2017
  - **6-fold increase in 2018**
- **2,000** beetles per release 2017
  - **19-fold increase in 2018**

Biochar

Amazonian *Terra preta*

Terra preta (dark earth) soils
- High plant productivity
- High organic carbon
  – stable char (black carbon)

Source: www.biochar-international.org

Making the best biochar for productivity and remediation.

The transportable Green Flame operates cleanly in front of piles of waste feedstock.

- Wide range of feed stocks.
- Biochar recipes with underlying science
- Thermal energy options.
- Waste management solution.

GREEN FLAME

CleanCarbo

Kontiki biochar kiln

The Continuous Biomass Converter (CBC)

A unique thermo-chemical profile for production of char, gas and water products

Four functions in one reactor:

1. dewatering
2. char making
3. tar cracking
4. gas scrubbing

Continuous, automatic operations

Consistent products

High efficiency

Modular design

Patented

The Crucible Group's Continuous Biomass Converter (CBC) Vales Point, NSW

Building-frame waste for CBC processing

Summerhill Waste Management Centre

Biochar fed to cattle

increases weight gain

reduces methane production

increases soil carbon

Cattle love eating biochar

Thank you for listening

Questions?

Dung Beetle Solutions

Australia

Dr Bernard Doube

Worst types of gut worm

- Large blood worms
- Small blood worms
- Strongyles
- Tapeworms

Seasonal cyst cycle -- small blood worms

Larvae form cyst in the gut wall

- Australia, dry summer - Armidale
  - Encyst in spring, emerge autumn
- Australia, even rainfall - Coffs Harbour
  - Remain active throughout the year

Release of larvae from cysts

Mediterranean dry summers

- Cysts – autumn release

Implications for

- Chemical control
- Pasture spelling
- Dung beetles

Integrated Parasite Management

- **How to control gut parasites**
- Drenches and pastes
- Natural immunity to parasites
- Pasture spelling
- Dung beetles
- Cross grazing

Natural immunity

- millennia of co-evolution
- effective immunity to gut worms
- little or no damage
- low parasite numbers stimulate resistance
- no parasites == no resistance
- Exceptions- foals, the sick and the old

Integrated Parasite management

- **Natural control**
- What kills infective larvae?
- Pasture spelling – seasonal
- Dung beetles- seasonal activity
- Cross grazing

Integrated Parasite Management

long term sustainability

- Quality food, water, shelter exercise
- Controlling parasites and pathogens
- Managing chemical resistance
- Managing pastures
- Managing dung beetles

Integrated Parasite Management

- **Benefits**
- Healthy horses: few chemicals
- Natural control of parasites
- Reduced cost of chemicals
- Slows development of resistance
- Stops poisoning the environment
- Dung beetles improve pastures

New Fact Sheets
New Website
Go to HorseSA Website

Fact Sheet 1: Pests & parasites, horse health and soil health
Fact Sheet 2: Horses on small properties
Fact Sheet 3: Dung beetles, gut parasites and vet chemicals
Fact Sheet 4: Gut parasites and the threat of resistance
Fact Sheet 5: Managing pasture pests
Fact Sheet 6: Pests of horses: integrated management
Fact Sheet 7: Manure management
Fact Sheet 8: Threats to dung beetles

Controlling gut worms

- Drenches and pastes
- Natural immunity
- Pasture spelling
- Cross-grazing
- Dung beetles
- Pathogens

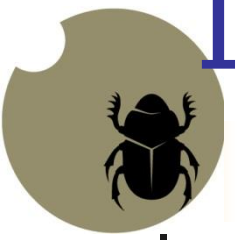
Integrated Holistic Management
Back to gut parasites

- **Gut parasites of horses**
- 9 main groups
- Drenches and pastes – how often
- Are chemicals really necessary?

Integrated Holistic Management Message

- Reduce reliance on chemicals
  - for control of gut worms
  - for control of pasture pests
  - for pasture production
- Increase reliance on natural processes
  - natural immunity to parasites
  - biocontrol of pasture pests
  - dung beetles

Integrated Holistic Management Message



- Reduced reliance on chemicals
- Increased reliance on natural processes
- Benefits
  - save money on chemicals
  - don't poison the environment
  - natural control of pests and disease
  - increased biodiversity

Challenge:

Maintain stock horse health

Maintain good horse health

- Quality food, water, shelter, exercise
- 1. Control parasites
- 2. Manage chemical resistance
- 3. Manage pastures
- 4. Manage dung beetles