The role of dung beetle assemblages in dung removal/decomposition, secondary seed dispersal, and seed germination along a biogeographical / climatological gradient

Maurice Hoffmann, Tanja Milotic, Bram D’hondt
INBO – Ghent University

ALTER-Net Conference
Multi-Site Experiment side event
Dung beetle assemblages, dung removal/decomposition, secondary seed dispersal and seed germination along a biogeographical / climatological gradient

The main issues, we want to address in this multi-site experimental set-up are:

1. Does dung fauna assemblage and more specifically dung beetle assemblage composition differ between biogeographical / climatological regions (and between different herbivore types) we are interested primarily in the functional group level

   → This hypothesis is highly probable to be true, given the differentiation in dung beetle assemblage, described of tropical, subtropical, semi-desert rangeland, warm temperate, cold temperate and boreal ecosystems, wet versus dry conditions (see e.g. Hanski & Cambefort 1991; Scholtz et al., 2009)

2. And, hence can it be expected to change with climate change?

   → See e.g. Menendez & Gutierrez (2004)

3. If so, what’s the impact of dung beetle assemblage on dung removal and decomposition rate (of prime ecological importance in the C- and nutrient cycle in grazed ecosystems)?

   → See e.g. O’Hea et al. (2010)

4. If so, what’s the impact of dung beetle assemblage on secondary seed dispersal (of prime ecological importance in plant ecology)?

   → See e.g. Slade et al. (2007)

5. If so, what’s the impact of dung beetle assemblage on seed germination (of prime ecological interest in the functioning of endozoochory)?

   → See e.g. D’hondt et al. (2008)
Hot topic?

- e.g. Braga et al., 2013. Dung Beetle Community and Functions along a Habitat-Disturbance Gradient in the Amazon: A Rapid Assessment of Ecological Functions Associated to Biodiversity. PLOS-one 8(2): e57786. doi:10.1371/journal.pone.0057786

• Abstract - Although there is increasing interest in the effects of habitat disturbance on community attributes and the potential consequences for ecosystem functioning, objective approaches linking biodiversity loss to functional loss are uncommon.

• The objectives of their study were to implement simultaneous assessment of community attributes (richness, abundance and biomass, each calculated for total-beetle assemblages as well as small- and large-beetle assemblages) and three ecological functions of dung beetles (dung removal, soil perturbation and secondary seed dispersal), to compare the effects of habitat disturbance on both sets of response variables, and their relations.

• They studied dung beetle community attributes and functions in five land-use systems representing a disturbance gradient in the Brazilian Amazon: primary forest, secondary forest, agroforestry, agriculture and pasture.

• All response variables were affected negatively by the intensification of habitat disturbance regimes, but community attributes and ecological functions did not follow the same pattern of decline. A hierarchical partitioning analysis showed that, although all community attributes had a significant effect on the three ecological functions (except the abundance of small beetles on all three ecological functions and the biomass of small beetles on secondary dispersal of large seed mimics), species richness and abundance of large beetles were the community attributes with the highest explanatory value.

• Their results show the importance of measuring ecological function empirically instead of deducing it from community metrics.
What it this all about?
Coprophagous and coprophilous fauna

Fig. 1.2. A simplified food web of the insect community inhabiting cattle dung in Europe (modified from Skidmore 1985).
Dung beetle functional groups

Roller

Tunneler

Dweller
Dung beetle functional groups: tunnelers

Fig. 3.4. Seven nest types (1–7) and their variations among the tunnelers.

Plate 3.3. Vertical section under a dung pat to which pairs of Onitis viridulus, O. folgidus, O. alexis, O. caffer, and O. uncinatus had been added two weeks earlier.
Dung beetle assemblages
an example from the Westhoek (Belgium) (D’hondt et al., 2008)

**Westhoek:**
- **dwellers**
  - *Aphodius*, 12 spp.
- **tunnelers**
  - *Geotrupes*, 2 spp.
  - *Onthophagus*, 1 spp.
  - *Oxyomus*, 1 spp.
Zoochorous seed dispersal: potential and reality

... and non-adapted (?) diaspores

D’hondt et al., 2011
Zoochorous Seed Dispersal

- Most 'likely' zoochorous seed dispersal
- Large initial population
- Small population

1997
2007

Helianthemum nummularium
Common Rockrose

1982-84
Effect of dung beetle activity on seed germination
D’hondt et al., 2008: model species: Agrostis capillaris and Poa pratensis
Experimental set-up

Need to discriminate between

1. Effect of different dung types
2. Effect of biogeographical region / climate
3. Effect of dung beetle assemblage
4. Effect of different dung beetle functional groups
5. Effect of climate change

other large herbivores?
Biogeographical gradient

Europe’s biogeographical regions
Climatological gradient

Koppen climate map
1. Dung beetle assemblages
1. Dung beetle assemblages
1. Description of dung beetle assemblages

- Randomized block design
- (Dung beetle) pitfalls
- Identify functional group composition
- Identify species composition
- Identify cophrophagous/coprophilous fauna
2. Effects:
dung removal/decomposition and dung beetle assemblage
Experimental set-up
all about fencing in and fencing out ...

Any combination of fencing: D+  

Braga et al., 2013
Experimental set-up, basics

horse

sheep

cattle

Control All+

D+/Tt-/Rr+

D+/T-/t+/Rr+

D+/Tt+/Rr-

D+/Tt+/R-/-r+
Experimental set-up

horse

sheep

cattle

Control

All+

D+/Tt-/Rr-

D+/T-/t+/R-/r+

D+/T-/t+/R-/r+

D+/T-/t+/Rr-
Experimental set-up

- horse
- sheep
- cattle

Control
All+
2. Dung removal/decomposition and dung beetle assemblage
3. Effects: Secondary seed dispersal and dung beetle assemblages
3. Effects: Secondary seed dispersal and dung beetle assemblages

Seed dummies

- horse
- sheep
- cattle
3. Effects: Secondary seed dispersal and dung beetle assemblages

- **horse**
- **sheep**
- **cattle**

Control: D+/Tt-/Rr+
D+/T-/t+/Rr+
D+/Tt+/Rr-
D+/Tt+/R-/r+

→ Etc.
4. Effects: Seed germination and dung beetle assemblages

- Helianthemum nummularium
- Poa pratensis
- Agrostis capillaris
- Trifolium repens

- horse
- sheep
- cattle
4. Effects: Seed germination and dung beetle assemblages
4. Effects: Seed germination and dung beetle assemblages

- horse
- sheep
- cattle
MSE needs

1. (Long-) Grazed ecosystem
2. Preferably with the herbivores present whose dung is to be tested
3. Herbivore exclosure fence
4. Standardization !!!
   1. Dung material
   2. Fencing material
   3. Seed dummy material
   4. Seed material
   5. Set-up
   6. Timing
   7. ...
5. Entomological expertise
6. Field work willingness
7. Mobility funding
8. Material funding
9. Scientific interest
10. Cooperation
11. Lots of patience, adrenaline, ...
(Some) References

- Several anonymous dung beetle cartoonists.
Interested to participate?

Contact tanja.milotic@ugent.be; maurice.hoffmann@inbo.be