




Background

Insects & The Taxonomic Impediment

The **global shortage** of important taxonomic information, taxonomists and curators **disproportionately affects insects**.

Why Dung Beetles?

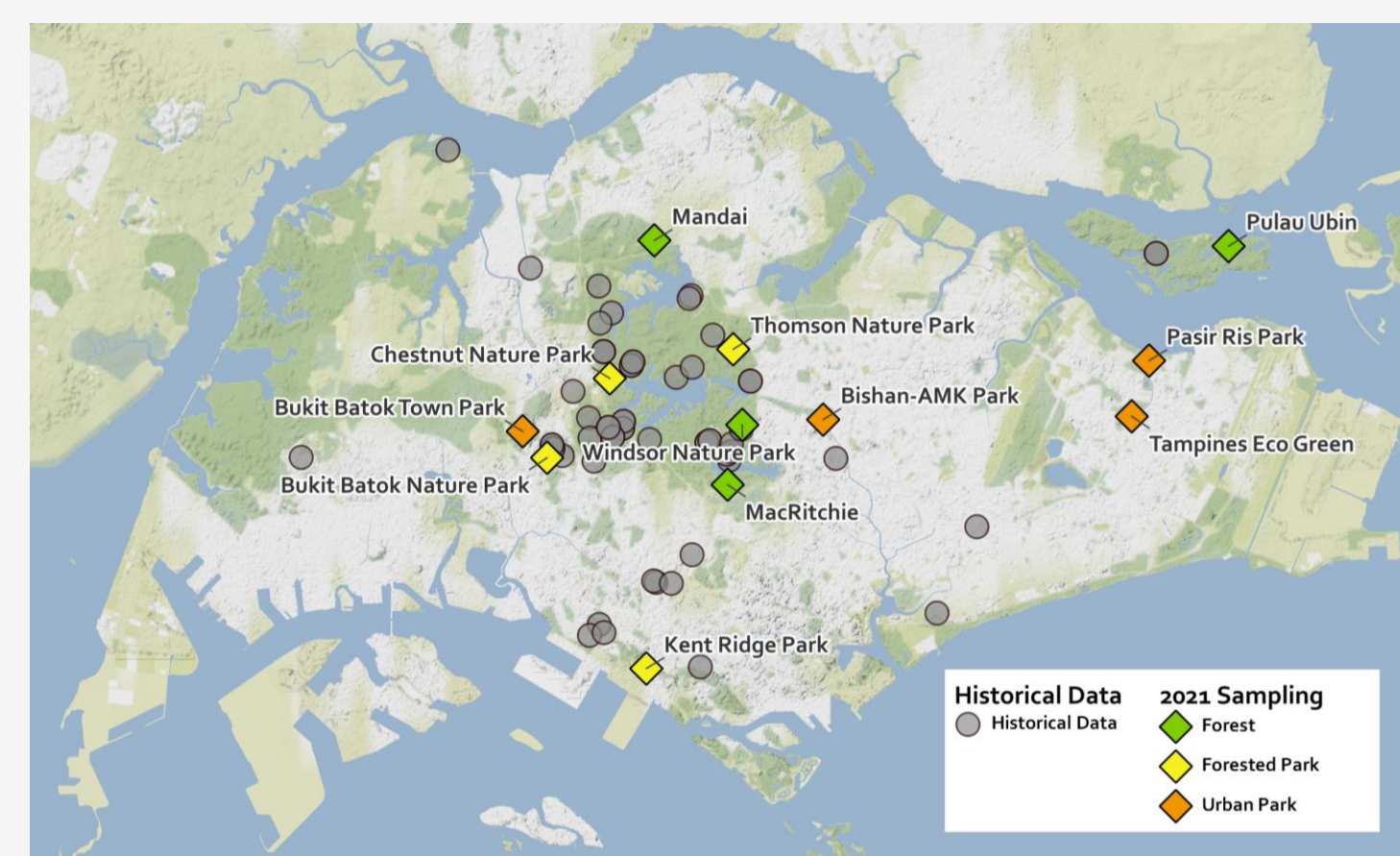
-  Provision of **ecosystem services** [1]
-  Excellent **proxy** for monitoring **ecosystem health** [2]
-  **Surrogate indicator** for elusive mammals [3]

Knowledge Gap in Singapore

Information on **local dung beetle distribution** in **urban parks and green spaces** is currently **lacking**: Sampling efforts were previously concentrated in the Central Catchment and Pulau Ubin.

Methods

Increased Sampling in Parks and Urban Areas



Pitfall Traps

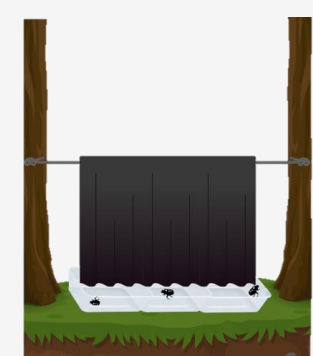
Baited: Carrion, Fruit, Dung



Total: 216 trap nights

Flight Intercept Traps

Unbaited



Total: 39 trap nights

Dung beetles are identified in the lab with reference to existing specimen collections and the Biodiversity of Singapore digital reference collection.

Historical Records Data Set

- Museum collections
- Collections of local laboratories
- Published datasets from journal articles and GBIF
- Unpublished datasets of local research projects

The Checklist of Dung Beetles of Singapore

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Species Checklist: 27 Species across 6 Genera

- | | | |
|-------------------------------------|-------------------------------------|--------------------------------------|
| 1. <i>Caccobius unicornis</i> | 10. <i>Onthophagus deliensis</i> | 19. <i>Onthophagus phanaeides</i> |
| 2. <i>Catharsius renaudpauliani</i> | 11. <i>Onthophagus leusermontis</i> | 20. <i>Onthophagus proletarius</i> |
| 3. <i>Heliocopris tyrannus</i> | 12. <i>Onthophagus limbatus</i> | 21. <i>Onthophagus rutilans</i> |
| 4. <i>Ochicanthon peninsularis</i> | 13. <i>Onthophagus luridipennis</i> | 22. <i>Onthophagus semicupreus</i> |
| 5. <i>Onthophagus angustatus</i> | 14. <i>Onthophagus neofurcatus</i> | 23. <i>Onthophagus semifex</i> |
| 6. <i>Onthophagus babirusa</i> | 15. <i>Onthophagus orientalis</i> | 24. <i>Onthophagus trituber</i> |
| 7. <i>Onthophagus cervus</i> | 16. <i>Onthophagus pacificus</i> | 25. <i>Onthophagus waterstradti</i> |
| 8. <i>Onthophagus crassicolis</i> | 17. <i>Onthophagus papulatus</i> | 26. <i>Paragymnopleurus maurus</i> |
| 9. <i>Onthophagus deflexicollis</i> | 18. <i>Onthophagus pedator</i> | 27. <i>Paragymnopleurus striatus</i> |



Relative sizes are approximated. Species in red were not re-sampled in 2022.

Morphological Identification Key

- Dichotomous key based on morphological traits
- Traits identifiable by eye (without the need of a microscope)
- Based on specimens collected in Singapore

Check out the morphological key for yourself here!



We have presented the **first species checklist and morphological key** of dung beetles in Singapore. The species checklist **supports future conservation assessments** by providing information on dung beetle distribution, and the morphological key encourages more **consistent identification records** and potentially citizen science.

Discussion

12 Species Absent in 2021 Sampling

- **Potential extinction** of vulnerable larger species (e.g. *H. tyrannus*) due to **forest fragmentation** [4]
- **Specialist species** not caught with our trap set ups:
 - **Bait types** (e.g. *O. leusermontis*, historically sampled with cattle or pig dung)
 - **Habitat types** (e.g. forest specialist *O. angustatus* & arboreal specialist *O. deliensis* [5])
- **Misidentification** of historical specimens (e.g. *P. striatus*)

Limitation of Morphological Traits: Species Complexes

Species Complex: Two or more **closely related species** that are **morphologically similar**

Example: *O. limbatus* & *O. proletarius*



O. limbatus: Curved horns



O. proletarius: Straight horns

Males identifiable by **horn shape**;
Females are otherwise **nearly identical**

Future Work

Integrative Taxonomic Approaches

Morphology-based taxonomy:
Identification by taxonomists

Genomic-based taxonomy:
DNA barcoding to confirm species identity

More accurate and robust species checklist & morphological key

Increase Sampling Intensity

Confirm species presence or potential extinction by sampling with a wider variety of **bait type and trap type**, and in **more sites across Singapore**.

References

- [1] Nichols, E. S., et al. (2008). *Biol. Conserv.* **141**(6):1461-1474.
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- [3] Raine, E. H., et al. (2019). *Proc. R. Soc. B.* **286**: 20182002
- [4] Klein, B. C. (1989). *Ecology.* **70**(6): 1715-1725.
- [5] Abdul Rahman, I. L., et al. (2021). *Biotropica.* **53**(6): 1522-1534.

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