Mygalomorphae Spider Hot Spot Report

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Executive Summary

This is an Invertebrates Australia Research Report.

Authors:

1 Introduction

Invertebrates are an often overlooked but vital component of healthy ecosystems. They perform a variety of critical ecological functions and ecosystem services, including pollination, soil modification, organic matter decomposition, nutrient cycling, pest control, and food provisioning to other animals and humans Lavelle et al. (2006), Macadam and Stockan (2015), Griffiths et al. (2021), Porto et al. (2021). They are ubiquitous across land and seascapes, constituting the vast majority of Earth's biodiversity. Over 1.25 million invertebrate species have been documented, representing around 95% of animal species Eisenhauer and Hines (2021). However, many invertebrate species and populations around the globe are under threat, as are the services they provide and the ecosystems they support Hallmann et al. (2017), Ulrich et al. (2020), Wagner et al. (2021), Eisenhauer et al. (2023).

Invertebrates face a multitude of anthropogenic and environmental threats, including habitat loss, climate change (and associated events such as fires, floods, and droughts), pollution, pesticides, and introduced species Wagner et al. (2021), Marsh et al. (2021), Reddin et al. (2022). While there is an urgent need for further research on invertebrate biodiversity and conservation in relation to these threats, conservation measures can help to mitigate their effects, protect and restore biodiversity, and prevent extinctions.

Biological conservation is hampered by limited resources, and identifying priority areas to focus conservation efforts can help to maximise their effectiveness Myers et al. (2000). Species richness and endemism are key indices of biodiversity that reflect biological complexity and uniqueness, and can be used to identify 'biodiversity hotspots' to prioritise for conservation Myers (1988) Caldecott et al. (1996), Reid (1998). **Species richness refers to the number of species in an area**. Numerous definitions of **endemism exist but generally a taxon is considered endemic to a particular area if it occurs only in that area Anderson (1994)**. By these definitions, species richness and endemism are dependent on spatial scale Townsend Peterson and Watson (1998). Quantifying endemism and identifying areas of high endemism is important in conservation because narrowly endemic taxa have small ranges by definition and are therefore more vulnerable to threats such as environmental change and habitat loss (). Designation of protected areas and other landscape management practices can be informed by spatial quantification of endemism. Identifying hotspots helps to focus limited resources and improve the efficiency of biodiversity conservation efforts.

Identifying hotspots for all invertebrates is not logistically feasible at present, so as a proof of concept we focussed on spiders in the infraorder *Mygalomorphae*, using spatial analyses

to identify hotspots of species richness and endemism across Australia… Our methods can be applied to other taxonomic groups…

Quantification of endemism depends on the spatial scale being considered, and numerous calculation methods exist (). Endemism can be quantified on a continuous scale across a spatial grid with reference to the constituent grid cells, based on how many cells taxa occupy.

2 Methods and Statistical Analyses

2.1 Data retrieval

We used data from Atlas of Living Australia (ALA) for this study. We downloaded occurrence records using the `galah` R package using the following criterion:

1. Found in Australian mainland and Tasmania.
2. Identified to a taxon rank of species.
3. Basis of record of either:
    i) Preserved specimen
    ii) Material sample
    iii) Machine observation
    iv) Human observation
4. Coordinate uncertainty of less than 1000 meters or has a value of NA (citizen science records or human observations are typically entered as NA)

We downloaded data for this report on the **20 January 2024** and it contained **XXXXX records**

We also used ALA's data quality assertions to further refine our download. We excluded occurrence records using the following criterion:

1. Coordinates are equal to 0
2. Coordinates are presumed swapped e.g. when latitude is entered as longitude
3. Latitude and longitude values are presumed negated
4. Coordinates our out of range
5. Taxon excluded by the ALA
6. Taxon considered as a questionable species

The above assertions excluded XXXX records, a break down of records for each assertion is **summarised in Table. 1**

2.2 Data overview

2.3 Data cleaning

2.4 Generation of α hulls

2.5 Quantifying species richness and endemism

2.5.1 Sample redundancy

2.5.2 Sample window and moving window

2.5.3 Endemism metrics

2.6 Data and code availability

All data and code to reproduce the R portion of our analyses can be found at our Github repository.

3 Results

4 Discussion

5 Summary

In summary, this book has no content whatsoever.

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References

Anderson, Sydney. 1994. "Area and Endemism." *The Quarterly Review of Biology* 69 (4): 451–71. https://doi.org/10.1086/418743.

Caldecott, J. O., M. D. Jenkins, T. H. Johnson, and B. Groombridge. 1996. "Priorities for Conserving Global Species Richness and Endemism." Journal Article. *Biodiversity & Conservation* 5 (6): 699–727. https://doi.org/10.1007/BF00051782.

Eisenhauer, Nico, and Jes Hines. 2021. "Invertebrate Biodiversity and Conservation." *Current Biology* 31 (19): R1214–18.

Eisenhauer, Nico, Raúl Ochoa-Hueso, Yuanyuan Huang, Kathryn E Barry, Alban Gebler, Carlos A Guerra, Jes Hines, Malte Jochum, Karl Andraczek, and Solveig Franziska Bucher. 2023. "Ecosystem Consequences of Invertebrate Decline." Journal Article. *Current Biology* 33 (20): 4538–4547. e5.

Griffiths, Hannah M., Louise A. Ashton, Catherine L. Parr, and Paul Eggleton. 2021. "The Impact of Invertebrate Decomposers on Plants and Soil." *New Phytologist* 231 (6): 2142–49. https://doi.org/https://doi.org/10.1111/nph.17553.

Hallmann, Caspar A., Martin Sorg, Eelke Jongejans, Henk Siepel, Nick Hofland, Heinz Schwan, Werner Stenmans, et al. 2017. "More Than 75 Percent Decline over 27 Years in Total Flying Insect Biomass in Protected Areas." Journal Article. *PLOS ONE* 12 (10): e0185809. https://doi.org/10.1371/journal.pone.0185809.

Lavelle, P., T. Decaëns, M. Aubert, S. Barot, M. Blouin, F. Bureau, P. Margerie, P. Mora, and J.-P. Rossi. 2006. "Soil Invertebrates and Ecosystem Services." *European Journal of Soil Biology* 42: S3–15. https://doi.org/https://doi.org/10.1016/j.ejsobi.2006.10.002.

Macadam, Craig R., and Jenni A. Stockan. 2015. "More Than Just Fish Food: Ecosystem Services Provided by Freshwater Insects." *Ecological Entomology* 40 (S1): 113–23. https://doi.org/https://doi.org/10.1111/een.12245.

Marsh, Jess, Payal Bal, Hannah Fraser, Kate Umbers, Aaron Greenville, Libby Rumpff, and John Woinarski. 2021. "Assessment of the Impacts of the 2019-20 Wildfires of Southern and Eastern Australia on Invertebrate Species Final Report." Journal Article. *National Environmental Science Program*.

Myers, Norman. 1988. "Threatened Biotas: "Hot Spots" in Tropical Forests." Journal Article. *Environmentalist* 8 (3): 187–208. https://doi.org/10.1007/BF02240252.

Myers, Norman, Russell A. Mittermeier, Cristina G. Mittermeier, Gustavo A. B. da Fonseca, and Jennifer Kent. 2000. "Biodiversity Hotspots for Conservation Priorities." Journal Article. *Nature* 403 (6772): 853–58. https://doi.org/10.1038/35002501.

Porto, Rafaella Guimarães, Oswaldo Cruz-Neto, Marcelo Tabarelli, Blandina Felipe Viana, Carlos A. Peres, and Ariadna Valentina Lopes. 2021. "Pollinator-Dependent Crops in

Brazil Yield Nearly Half of Nutrients for Humans and Livestock Feed." *Global Food Security* 31: 100587. https://doi.org/https://doi.org/10.1016/j.gfs.2021.100587.

Reddin, Carl J., Martin Aberhan, Nussaïbah B. Raja, and Ádám T. Kocsis. 2022. "Global Warming Generates Predictable Extinctions of Warm- and Cold-Water Marine Benthic Invertebrates via Thermal Habitat Loss." Journal Article. *Global Change Biology* 28 (19): 5793–5807. https://doi.org/https://doi.org/10.1111/gcb.16333.

Reid, Walter V. 1998. "Biodiversity Hotspots." Journal Article. *Trends in Ecology & Evolution* 13 (7): 275–80. https://doi.org/10.1016/S0169-5347(98)01363-9.

Townsend Peterson, A., and David M. Watson. 1998. "Problems with Areal Definitions of Endemism: The Effects of Spatial Scaling." *Diversity and Distributions* 4 (4): 189–94. https://doi.org/https://doi.org/10.1046/j.1472-4642.1998.00021.x.

Ulrich, Josephine, Solveig Franziska Bucher, Nico Eisenhauer, Anja Schmidt, Manfred Türke, Alban Gebler, Kathryn Barry, Markus Lange, and Christine Römermann. 2020. "Invertebrate Decline Leads to Shifts in Plant Species Abundance and Phenology." Journal Article. *Frontiers in Plant Science* 11. https://doi.org/10.3389/fpls.2020.542125.

Wagner, David L., Eliza M. Grames, Matthew L. Forister, May R. Berenbaum, and David Stopak. 2021. "Insect Decline in the Anthropocene: Death by a Thousand Cuts." Journal Article. *Proceedings of the National Academy of Sciences* 118 (2): e2023989118. https://doi.org/10.1073/pnas.2023989118.