Orthoptera in Singapore: diversity, new species and the predatory katydids

Tan Ming Kai (A0087366R)
Supervisors: Prof. Rudolf Meier and Dr. Hwang Wei Song
Department of Biological Sciences, Faculty of Science, National University of Singapore

Introduction

- Orthoptera include grasshoppers, crickets and katydids
- Diverse taxa: ~27000 species worldwide
- Master of deception and known for “singing” abilities
- Knowledge gaps on Orthoptera diversity in Singapore still to be filled
- More new species still awaiting discovering
- Diet of orthopterans poorly known with traditional diet analysis laborious, incomplete and low resolution

Part 1: Diversity of Orthoptera in Singapore

Material and Methods
- First checklist for Singapore compiled:
  2. Active field collection (2010-2015)
- 240 research articles on taxonomy of Orthoptera and global database Orthoptera Species File
- ~240 high resolution images taken using Visionary Digital System and uploaded online (http://lkcnhm.nus.edu.sg/APS)
- Synonym lists, identifying features and biological notes added

Results
- 245 species
- 50 Caelifera (grasshoppers)
- 195 Ensifera (crickets, katydids and allies)
- All major lineages of Orthoptera found in Singapore

Part 2: Species discovery: cryptic grasshoppers and scaly crickets

Material and Methods
- Hennigian Species Concept applied for species hypothesis
- Morphology, DNA and ecology used for testing species boundaries
  1. Morphometric analyses using PCA
  2. Male genitalia dissection
  3. Phylogenetic analysis of COI and ITS2 datasets
- Microhabitat analysis using PCA

Cryptic pygmy grasshopper from Nee Soon
- No distinct morphological differences
- Morphometric analysis: no clear groupings

Part 3: Molecular ecology: diet analysis via metabarcoding

Material and Methods
- 30 Hexacentrus unicolor dissected to remove mid- and hindguts → gut lining removed to obtain gut content
- DNA extraction of gut content
- Amplify COI (313bp) using tagged primers
- 3-8 PCR replicates per specimen to reduce PCR bias and amplify cryptic prey → multiplexed and SureCleaned
- COI sequenced using Illumina MiSeq
- Sequences blasted against GenBank database for prey identification

Preliminary results
- Metabarcoding revealed newly documented prey items from gut content:
  - Grasshopper Xenocatantops humilis (98%)
  - Flesh fly Rovinia pusiolae (89%)
- Metabarcoding findings support field observation: Grasshopper Oxya sp. (100%)
- Unknown prey identified via metabarcoding: Moth Hypna spp. (Erebidae) (94%)
- Potential for prey identification at higher resolution
- Field observation + metabarcoding gut content = comprehensive diet breadth

Conclusion

- Most comprehensive understanding of the diversity of Orthoptera in Singapore available
- 4 new species described: 3 scaly crickets and 1 pygmy grasshopper
- Diet breadth of Hexacentrus unicolor potentially more comprehensively documented than before

Acknowledgements

I am thankful of Yeo Huiqing for field assistance; Darren Yeo, Amrita Srivatsan, Wong Wing Hing, Zhang Yafei and Supatha Solvi for help with bioinformatics; Ang Yuchen for help with APS; Chong Kwok Yan for help with statistics; Sigfrid Eades for the review of manuscript 1 and Sergey Storozenko for help on Tetrigidae. Research permit: NP/RP10-073.

References