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Tetragonula (Hymenoptera: Meliponini): morphology, behavior, genomics and the citizen scientist

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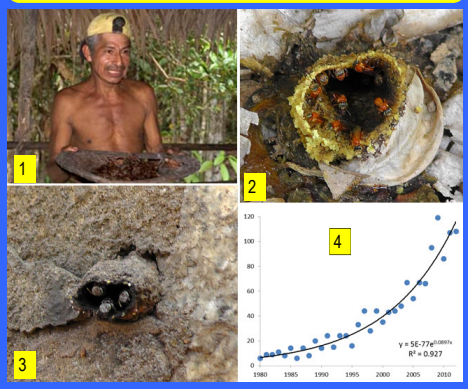
Introduction

Stingless bees are restricted to the tropical and subtropical areas of the world, where they are ecologically, economically and culturally important (Fig. 1). Nesting habits and nest architecture vary greatly not only among genera, but also among species within a genus (Figs 2, 3). The increasing interest in meliponines during recent years has grown almost exponentially, as indicated by the number of scientific publications each year (Fig. 4).



Figures 1-4. 1, farmer showing recently extracted honey pots from a nest. 2, 3, nest entrances of two species of *Tetragonula* from Borneo (2) and India (3). 4, number of scientific papers on meliponines published each year since 1980 to the present (Rasmussen & Gonzalez 2013).

Tetragonula Moure is the most common, widely distributed, and economically important group of Old World stingless bees. This monophyletic genus comprises 32 nominal species of small to very small bees found in the Indian subcontinent, Southeast Asia, and Australia (Rasmussen 2008). Though some species are readily recognizable based on morphology, taxonomic boundaries of most *Tetragonula* are poorly defined and many are exceedingly difficult to distinguish, even for specialists. Several are suspected to contain cryptic species, given their broad, discontinuous distributions and morphological variation. There is no identification key encompassing all *Tetragonula* species

Research Approach

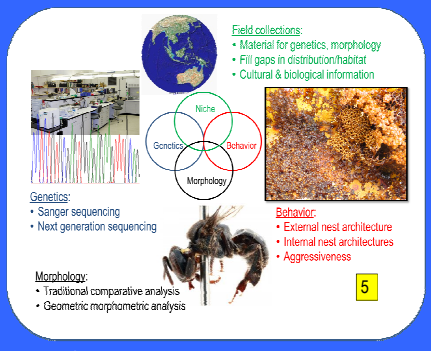


Fig. 5. Combined approach to assess cryptic diversity in *Tetragonula*.

This project uses a holistic approach to assess the cryptic diversity of *Tetragonula* Moure (Fig. 5). Using data from morphology, behavior, geographic distribution, Sanger sequencing, and Next Generation sequencing, the species status of all *Tetragonula* will be revised to define and determine practical species boundaries, to reveal the existence of cryptic species, and to develop a robust phylogeny aimed to examine the evolution of selected ethological traits and possible biogeographic patterns (Fig. 6).

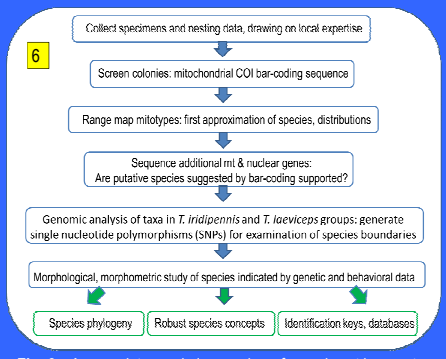


Fig. 6. Approach to maximize number of samples at low cost

Products & Preliminary Results

Public participation is key to the success of this project. First, many species of *Tetragonula* are already being used in many regions. Second, a few examples indicate that local or traditional knowledge may also be valuable in detecting cryptic species by providing additional diagnostic ethological features rarely available to systematists.

For example, an active Facebook group of Indo-Malayan stingless bee enthusiasts consisting of beekeepers, farmers, and scientists already exists (Fig. 7). Members regularly exchange observations, pictures, videos, and other information on native bees.

Fig. 7. Facebook group on Indo-Malayan Stingless Bees with more than 2000 members

The following digital outputs and web-based products will be developed:

- Geo-referenced specimen database;
- Fully illustrated species pages with maps of known and predicted distributions, information on nesting habits and nest architecture, local names and uses of species;
- Gallery of high quality images of name-bearing types and diagnostic characters of species;
- Interactive online key in multiple languages that combines morphological and nesting features.

Literature Cited

1. Rasmussen, C. 2008. Catalog of the Indo-Malayan/Australasian stingless bees (Hymenoptera: Apidae: Meliponini). Zootaxa 1935: 1–80.
2. Rasmussen, C. & V.H. Gonzalez. 2013. Prologue: Stingless bees now and in the future. In: P. Vit & D.W. Roubik (Eds.), Stingless Bees Process Honey and Pollen in Cerumen Pots,, pp. vi–ix. Literature Cited

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