Stingless bees process honey and pollen in cerumen pots

Patricia Vit & David W Roubik, editors

Fotografías: *Dr. Cristiano Menezes*
Abeja fotografiada: *Leurotrigona muelleri (Friese, 1900)*

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Editors

Stingless bees process honey and pollen in cerumen pots

Las abejas sin aguijón procesan miel y polen en potes de cerumen

As abelhas sem ferrão processam mel e pólen em potes de cerúmen

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María Eugenia Hernández
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Foreword

It is with some trepidation that I put pen to paper in an effort to produce a suitable prologue for this collection of works. As a relative newcomer to stingless bee research I felt I did not qualify for such a privilege. However, upon reflection, I may be just the right representative to complete this task and it is my honor to do so.

The information contained within these pages, albeit in very modern, electronic pages, has been put together by some of the most respected, experienced, knowledgeable and devoted stingless bee keepers and researchers in the world. It is only through their dedication that new researchers, such as myself, are able to access information pertaining to these wondrous creatures.

Of the 21 chapters in this book, seven are written in Spanish, and two in Portuguese, the native language of the author(s). This, in itself, demonstrates the value of this e-book. Through the wonders of modern technology we are able to receive information written in foreign languages by simply copying and pasting sections of text into online translators. Previously unattainable knowledge, acquired by those who work intimately with stingless bees, is now available to all those who have access to a computer. One chapter, written in Spanish, is a tribute to the late Professor João Maria Franco de Camargo, and tells of the meticulous and unerring work carried out on 88 species of bees, collected over a twenty-year period. The author gives insights into the reasons behind the names assigned to some of the species and portrays Camargo's love for the study and illustration of these remarkable bees.

The authors of the chapters within this book share the product of their love for and dedication to stingless bees in their respective fields of expertise. This includes the geological and cultural histories of stingless bees, their use in education, and the importance of stingless bee farming (meliponiculture) to rural communities and to bee conservation. In South America, the production of pot-honey, through meliponiculture, is growing; however, regulation of the quality of the end product is lacking. Here, a draft proposal is put forward as a guide for legislation of quality and safety standards in commercial *Melipona* honey. Pot-honey analysis is providing information on the geographical location of important floral sources, as well as resource preferences by foragers and the behavioral traits associated with these resources. Pot-honey can also be used as a bio-indicator of environmental health and levels of air pollution. The medicinal properties of pot-honey have become apparent with the development of honey therapies for wound management, antioxidant therapy and in oncology. The vagaries and complexities associated with taxonomic practices in stingless bee classification are also addressed. That was a good academic underpinning of some very complex phenomena.

I hope you enjoy sharing the information within these pages as much as I have.

Megan Halcroft
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Prologue

Stingless bees now and in the future

Bee keeping with honey bees (*Apis mellifera*) has played an important role in tropical, more sustainable development programs during recent years, mainly because the net profits from labor in conventional honey production are high compared to other agricultural activities. However, honey bee keeping is not always advisable in protected areas, and of course in the New World tropics, where honey bees are introduced, a long history and unique tradition surrounds the keeping of the native stingless bees (Meliponini). The latter cultural practice is also known from the Old World where it has existed for centuries, in parallel with the more common keeping of honey bees.

Stingless bees include a large number of different tropical and some subtropical species. As in honey bees, they form social colonies and provision their nests with honey and pollen, which are stored in pots made of beewax or cerumen. Although more species are expected to be found and described, the known worldwide diversity is presently 526 species: 411 in the New World and 115 in the Old World distributed as follows: 19 in Africa, 7 in Madagascar, and 89 in southeast Asia and Australia. Camargo and Pedro (2007) and Rasmussen (2008) provide all published references available on the taxonomy and biology of the stingless bees from those regions, thus making it relatively easy to acquire an overview, or background information, of what is already known and what needs to be studied and reported for each species. When it comes to evolutionary or comparative studies, stingless bees are also an excellent study organism for understanding advanced sociality, feeding specialization, and adaptive value of different nesting strategies. Both higher-level and some species-level molecular phylogenies are available for some groups (Ramírez et al., 2010; Rasmussen and Camargo, 2008; Rasmussen and Cameron, 2007; Rasmussen and Cameron, 2010) as are morphology-based phylogenies (e.g., Camargo and Pedro, 2003, Camargo and Pedro 2004, Gonzalez and Roubik, 2008).

The taxonomic knowledge of stingless bees is still limited in various groups and regions. Even for genera that have been subject to taxonomic study in recent years, there is always a chance of encountering undescribed species, because the melittofauna in many regions is still poorly sampled or known. Furthermore, some commonly encountered genera have never been revised and their species-level identification is, unfortunately, impossible without the careful examination of museum specimens, which are often located in many different countries. Even the species status, or species concept, of some remain to be clarified, including that of a few common species that are heavily used by rural communities and widely studied across the Neotropics. For example, the bee called *Tetragonisca angustula* (Latreille) is a common bee kept in hives, which ranges from Mexico to Argentina. It is probably composed of several undescribed species (Camargo and Pedro, 2007). Such taxonomic problems for a diverse and culturally and economic important group of bees translates into nomenclatural instability, which becomes an annoyance for non-taxonomists and confounds any comparative evolutionary or behavioral study. Chapter 11 discusses some of these issues.

Most of the stingless bee fauna of Central America can be identified with the taxonomic keys to species of Mexico (Ayala, 1999) and Panama (Roubik, 1992). The higher diversity in South America is more difficult to identify correctly, but many species can be identified using the available taxonomic revisions, and following the assignment to genus (an excellent generic key is Silveira et al., 2002), with keys such as those by JMF Camargo, JS Moure, SRM Pedro, and even the older keys by HF Schwarz. Afrotropical stingless bees can be identified with the taxonomic key of Eardley (2004), except for those from

Madagascar that can be recognized using Pauly et al. (2001). For the Indo-Malayan and Australasian region, the only genus-group key currently available is that of Moure (1961), although Deborah Smith (personal communication) is preparing a new exhaustive taxonomic key. Keys to the species of that region are presently only available for some areas (Rasmussen, 2013; Sakagami et al., 1990; Schwarz, 1937, Schwarz, 1939), with additional literature needed for poorly characterized genera, such as *Tetragonula*. For this genus, keys to the species of continental Asia (Sakagami, 1978) and Australia (Dollin et al., 1997) are better used. No workable key exists for *Austroplebeia* although a revision is near completion (A Dollin, personal communication). Thus, despite many advances, a significant amount of work remains to be done to fully understand the diversity of stingless bees worldwide. This is necessary to assure that such a taxonomic knowledge is available to the broad group of biologists working with these bees (Gonzalez et al., in press).

The increasing interest in stingless bees during recent years is evident just by looking at the publication rate of scientific papers related to these bees. Figure 1 was prepared by searching during June 2013 in the Thomson Reuters "Web of Science" database of scholarly literature for any topics related to "meliponi*", "*Trigona*", "stingless bee", or "trigonin*" from 1980 and until 2012. The asterisk retrieves searches of all derivations of a word, e.g., "meliponi*" will locate citations related to Meliponina, Meliponini, Meliponinae, Meliponidae, and *Melipona*. As observed in the figure, the rise in recorded publications is exponential, with less than 10 papers per year 30 years ago to now close to 120 publications per year. With such an amount of new research being made available almost on a daily basis, it is doubtless important to compile books such as the present one, which will serve as a starting point for all those entering stingless bee research.

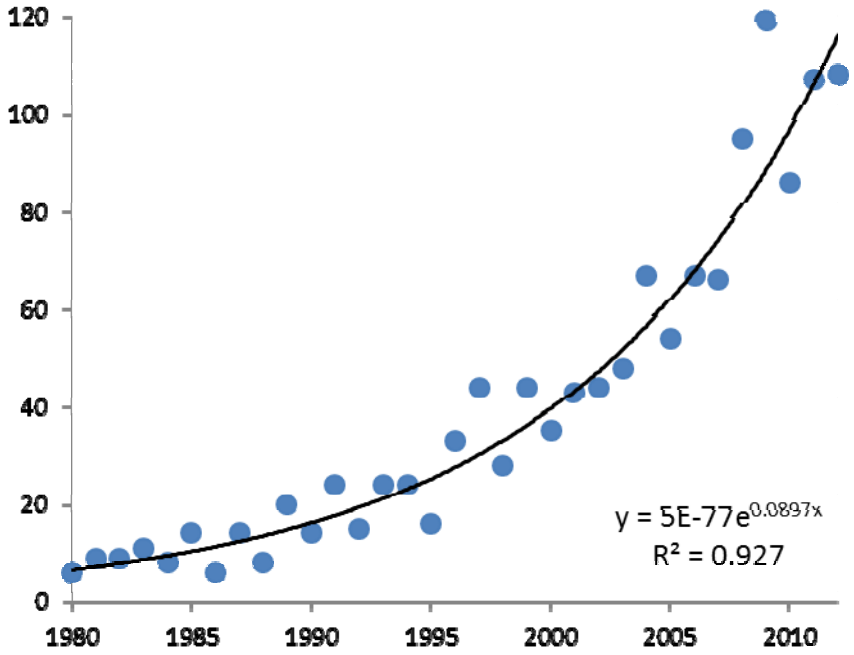

Figure 1. Number of scientific papers on stingless bees published each year since 1980 to the present, as recorded by Web of Science.

This edited book consists of 21 chapters, nearly of all them in English but with some in Spanish and Portuguese. The subjects treated in the book are as diverse, as the stingless bees themselves. The book includes contributions on meliponine cultural, medicinal, and educational values, palynology, systematics, foraging behavior, and fossil history. The nutritional, curative and gastronomical values of honey are

particularly interesting aspects covered in this book (chapters 3, 5, 7, 8, 10, 19), as are new recommendations outlining a quality standard for honey and related products which includes that of stingless bees (chapters 16, 17), as well as new methods for honey appreciation through a sensory evaluation (chapter 21)". The importance of this product, the honey and the book, might be much higher than expected. The honey gives stingless bees an important added value besides both crop pollination and ecosystem pollination service. Stingless bee honey is the key product that might contribute to the conservation and preservation of traditional knowledge of stingless bee keeping (and folk medicine), as reported in this volume from Quintana Roo in Mexico (chapter 1) and Brazil (chapter 2). That ancient appreciation of honey as a remedy and the art of keeping colonies required in-depth knowledge of the ecosystem service provided by the bees, *i.e.*, the necessity of pollen and nectar resources from tropical wildlands. Such knowledge is now transformed and modernly presented in environmental education programs, such as from Australia and Brazil, in chapters 6 and 12. In the past, long-term studies of flower visitation were a common practice to identify key plant species for stingless bee foraging. As documented here, this now can be done routinely, by sampling honey and pollen directly from the nest. The diversity and floral preferences of stingless bees can be quantified as proposed in chapter 3, 4 and 9, with chapter 13 explaining the different means of forager recruitment found among these bees. Modern techniques, such as an electronic nose (chapter 18), is a new way to categorize or identify stingless bee honey, thus providing a useful tool in the development and control of quality standards. In addition, the many names proposed for new species by the late JMF Camargo are explained in chapter 14, as well as the geological history of stingless bees, in chapter 15.

We are excited to introduce this new book on stingless bees, which provides an overview of the group and the current status of our knowledge of little-known details with tremendous importance to science and society. The editors and contributors of this book have done a terrific job putting this piece together. We hope that new students and researchers find it stimulating.

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Introduction

The cost of stingless bee keeping is minimal, yet the cost of training persons who know their science and management is considerable, as is that of locating wild nests or communicating with traditional or tribal stingless bee keeping experts. We consider some of these themes in a recent edited book "Pot-honey. A legacy of stingless bees" with many contributors from many countries. Now we have to ask: How far can the exploitation of stingless bees go? For the Western hive bee, *Apis mellifera*, commercial exploitation is clearly a trade-off. We may watch the documentary “More than Honey” shown in Europe and America in 2013, directed by Marcus Imhoof, and come away with the idea that the honey bee industry is not going to protect bees any more than industries protect cattle, chickens, pigs or sheep. Many are the bees and colonies available, and many die due to management, pesticide and pasturage situations. Yet, they are deemed adequate or “sustainable” to pollinate many crops, in many parts of the world. Sustainable here merely means that the losses are tolerable to humans. Does this serve as a model for stingless bees? No.

We know very well there are still many facets of the bees and their biology that need more. More what? More raw data and information, and more thoughtful, complete syntheses of recent knowledge and tribal practice, belief and application. More sense of the marketability and *real* sustainability of having certain of the stingless bees become commercially in vogue. More biogeographic information— the result of having a reliable source of taxonomic data—connected to certain environments and native plants, animals, fungi, microbes, etc. We are beginning to appreciate the Meliponini and the all-encompassing story of the largest group of honey-making creatures on earth. They may catch up to and ultimately surpass the legacy and renown of *Apis mellifera*. Our ‘stinger-less’ honey bees boast over 50 times as many species, and tropical, subtropical and even a few temperate-zone honeys.

The present volume contains 21 chapters with diverse topics written in English, Portuguese and Spanish. It is to be hoped that they clarify stingless bee origins, names, taxonomy, culture, composition, properties, conservation, education and regulation. Several complementary topics found their place in this e-book. Meliponiculture is discussed for Brazil, Mexico and Argentina. Local names of stingless bees inserted in Brazilian songs and poems express a cultural message in the rediscovery of pot-honey. Palynological studies of honey, geopropolis and propolis are tools for approaching the botanical and geographical origin of meliponine products. The need of post-harvest processing for pot-honey is revealed in a detailed chapter on honey maturation practices in Maranhão State, Brazil. Stingless bees also have a place in Australian education, as told to us by a teacher from Alstonville High School, in New South Wales. Systematic reviews on honey treatments for cancer in general, and for the Thai *Tetragonula laeviceps* pot-honey in cultured cells, are presented. The widespread industrial contaminants of lead and mercury (Pb and Hg) are discussed for pot-honeys from Argentina, Australia, Brazil and Venezuela. Finally, antioxidant activity is evaluated, for the first time, in different components of a stingless bee nest, in a chapter based upon *Tetragonisca angustula*. An important interphase chapter between stingless bee taxonomists and pot-honey analysts illustrates reasons for shifting or overturning previous classification and identification, with examples from Neotropical bees. The cover images from a scientist fully in awe of *Leurotrigona muelleri* are presented in a comprehensive chapter named ‘the little pearl’. Foraging specializations carefully condensed as "the fast *versus* the furious" outline morphological foraging traits and foraging strategies guiding meliponine colony decisions in the choice of food sources, and for making their honey in cerumen pots. The significance of a binary system in the life of a taxonomist who devoted his own life to study Meliponini and name 3 genera and 88 species of stingless bees, connects JMF Camargo with his colleagues forever. Inspiration found in fossils recount the evolutionary history of Meliponini with the ancient *Cretotrigona prisca* from the Late Cretaceous of New Jersey, USA, contributing to the continuing stingless bee information we are pleased to receive from professor Charles Michener, currently 94 years young. Two benchmark proposals are given for quality standards of *Melipona* pot-honey in Bahia,

Brazil, and Venezuela, to move forward towards an official regulation for honey produced in cerumen pots, previously designed only for *Apis mellifera* in its beeswax combs. The inclusion of pot-honey in cosmetic formulations, its characterization with an electronic nose and the emotional perceptions, which are quantifiable, open new avenues to investigate human interactions with this ancient honey.

Actions to showcase the value of pot-honey are given in the final chapter of this e-book as an interactive exercise between Costa Rica and Venezuela, that could embrace tropical initiatives to promote meliponiculture, research and education: 1. VIII Mesoamerican Congress of Native Bees. 2. Route of Meliponini Museums in the World. 3. Sensory evaluation of pot-honey. 4. Evaluation of emotions elicited after consuming pot-honey. 5. A project "One meliponary in each school". 6. Thinking on the volume of the honey reactor –the cerumen pot–. 7. A book for the most abundant honeys in the forest but less frequent in the market.

We hope that this brief extension of meliponine knowledge will keep the flames burning bright, because the theme is one that will, we believe, illuminate our world on many timely and interesting subjects.

Mérida, Venezuela; Sydney, Australia ***Patricia Vit***

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Contents

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