Patricia Vit · Silvia R. M. Pedro
David Roubik *Editors*

Pot-Honey

A legacy of stingless bees

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ISBN 978-1-4614-4959-1 ISBN 978-1-4614-4960-7 (eBook)
DOI 10.1007/978-1-4614-4960-7
Springer New York Heidelberg Dordrecht London

Library of Congress Control Number: 2012952932

Printed on acid-free paper

Springer is part of Springer Science+Business Media (www.springer.com)

This book is dedicated to our families,
friends, colleagues—past, present, future–
observers of stingless bee life,
and stingless bee keepers

Foreword

The stingless bees are one of the most diverse, attractive, fascinating, conspicuous, and useful of all the insect groups of the tropical world. This is a formidable and contentious claim but I believe it can be backed up. They are 50 times more species rich than the honey bees, the other tribe of highly eusocial bees. They are ubiquitous in the tropics and thrive in tropical cities. In rural areas, they nest in a diversity of sites and are found on the flowers of a broad diversity of crop plants. Their role in natural systems is barely studied but they almost certainly deserve that hallowed title of keystone species. They are popular with the general public and are greatly appreciated in zoos and gardens. The chapters of this book provide abundant further evidence of the ecological and economic importance of stingless bees.

Given their extreme interest, then it follows that this group must have been the subject of a huge body of scientific research. Unfortunately, this is not the case. Although the stingless bees contain 50 times as many species as the honey bees, the latter have been the subject of perhaps 50 times as much research effort, as estimated by published papers. We have squandered this precious natural heritage by our lack of attention, and in our failure we have limited our use of this resource. But this book starts to address that failure.

The chapters of this book summarize much of the current knowledge of stingless bees and also provide new findings. The diversity of species, behaviors, and the wide geographic range is explored in the Part I. The close relationships between humans and stingless bees through history is the topic of the chapters of Part II. The importance of stingless bees in agricultural and natural ecosystems derives from their flower visitation behavior and resulting pollination; this is the focus of the third part. The final two parts provide reviews and original research on the use and properties of the products of the hives of stingless bees, in particular the honey.

Stingless bees are an ancient source of sweetness and medicine for many indigenous people in the tropics, from the nomadic hunters and gatherers of northern Australia to the mighty Mayan empire of Central America. But modern commercial exploitation of this product has been hampered partially by a lack of information on its properties and composition. A strength of this book is the focus on "pot-honey," honey derived from the pots of stingless bees, as opposed to the comb of honey bees. Perhaps now stingless bee honey will move from locally available and start to be seen in the global marketplace. Indigenous peoples may not have knowingly used stingless bees as pollinators of their crops, but certainly these industrious insects would have played an important role. Stingless bees also have an important role to play in education. These harmless and fascinating animals can be used in schools and universities, public gardens, and zoos, as case studies in ecological interactions. These bees may even have economical value as pets. Housing a colony of these bees in a city apartment provides an opportunity for urban dwellers to have some contact with nature.

This book is one of the few specifically devoted to stingless bees. Let us hope that it stimulates a generation of further research so that the enormous potential of this group can be realized.

Brisbane, Australia Tim A. Heard

Foreword

Yes, we can

We live in a time when bees seem to become scarce in relation to their former numbers engaged in pollination and honey production. Our time is also one of competition and upset between different kinds of bees. First, in the nineteenth century, *Apis mellifera* invaded the Americas and Australia. That was large-scale invasion. And in the twentieth century and afterwards, we saw the invasion, in a larger scale, of the African *A. mellifera scutellata* in the tropical and subtropical Americas, and there was also a strong decline in the numbers of the meliponine bees.

We, the friendly breeders of stingless bees, must in some way make them recover at least some parts of the areas already nearly lost. For doing so, we must improve and increase our breeding of stingless bees such as *Scaptotrigona* and *Melipona*, good for pollination. In other words we must as soon as possible improve MELIPONICULTURE and also increase the number of colonies engaged in different projects. We are not against any bee properly bred and cared for. However, we must also protect meliponiculture.

For doing so, we must improve our breeding experience in MELIPONICULTURE. This is quite possible, since in Nature, in Africa, in some places *A. mellifera* and the native meliponines are present after millions of years of coexistence. However, now in parts of tropical America, *A. mellifera scutellata* seems to be still gaining ground, becoming generally the dominant bees. In such a situation it is important to publish papers about the best ways of helping the Meliponini to survive and also to let people know more about their life history and their potential in pollination and in other fields.

I am glad to send my congratulations to the authors of the articles here published and for those who organized this initiative.

Some efforts like this one are needed from time to time, for promoting the survival of stingless bees. I would say: yes, we can save them. We really can.

São Paulo, Brazil Paulo Nogueira-Neto

Introduction

Just as variety is the spice of life, it is also the source of honey. It doesn't matter which kind of honey. There is surely variety, and that explains many of honey's attributes. An average honey taken from a bee colony living within tropical forest contains 50 plant products. Most are nectar or pollen, and some are from the storage containers or food pots, from which this volume takes its name. A few compounds, such as hydrogen peroxide, honey's valuable antibiotic, form within the honey itself, while others derive from plants or the bees themselves. Now, what is there to explain about pot-honey?

Here is a scholarly and lively collection of facts and important insights from people across the world to answer that question. It is explained, as it should be, by a journey across cultures, continents, scientific exploration, and time—a representative sample of knowledge, studies, and applications, some ancient and others nascent. For instance, as we develop analytical techniques both for sequencing honey-making bee genes and reliably defining and characterizing honey, we are exploring ways to market honey and protect the environment it comes from. This is only the beginning. Our human repertoire of honey uses and cultivation techniques can be matched with cultures from Australia to Argentina, from Mexico to Ivory Coast, and from India and Indonesia. This enterprise proffers revelations that few other culinary/linguistic/tribal/cultural/scientific studies can offer.

To begin with, honey from insects is a novel feat. As humans, we have a fondness for this food (and drink—as explained herein) that is deep. At the peak of social evolution in insects there is honey. It seems curious that certain bees, wasps, and ants, truly social with long-lived colonies of a queen and workers, are the sole manufacturers of honey on the planet. Yet we take them for granted. There is not long to study some of these unique and natural honeys, before their makers waver on the edge of extinction, and then are no more. Why? Because they are denizens of the tropics and the world's remaining wildlands.

Most honey comes from bees, but not the bumble bees or the honey bees. The tropical and stingless honey-making bees, the Meliponini, are the original and still the predominant makers of honey. Those stingless bees are not a close relative of *Apis*, the stinging honey-bee of wide renown. Biology of the two kinds of honey-making bees diverged some 100 million years ago, now revealed in biogeographic and molecular information that provides conclusive evidence.

The stingless bees invented honey. Not so many years ago, books on bee keeping would lay down the theme that there are only four honey bees on earth, then describe methods for bee keeping, and mead making, candlemaking and honey extraction, mostly in the temperate zone and since the Middle Ages. That pattern of presentation is now obsolete. We now contemplate there being a dozen living honey bee species. With the stingless bees, formerly "known" to contain about 200 species, we are surpassing 500 well-codified individual ways of being stingless bees—some actually larger than any honey bee—and many having powerful defense methods. With more exploration of tropical forests and other remote areas, such as the vast Australian "Outback," the number will soon eclipse that figure.

Stingless bee honey is unique not only for its origin in the rich vegetation of native environments but also for its unusual degree of sweetness, sourness, acidity, and a host of other qualities that we have studied. One of them is "medicinal value." Another feature is the resin or "propolis" that is a part of the entire nesting home of a stingless bee colony. It is definitely an important ingredient in biology and food. Some stingless bees protect and, in turn, are fed and nurtured by bugs. The bugs feed on plant phloem and provide sugars and sustenance to a few species of meliponine bees. Another factor is the microbes. The rainy tropical forests in which stingless bees thrive, as well as some of the dry and hostile regions they can exist in, challenge the procurement and storage of concentrated sugar in a nest. If the predators do not locate this rich resource, the microbes and micro-predators most certainly will. Yet stingless bees survive. We find they are protected in multiple ways, by behavior and nesting habits, and their health in the environment has a long history of compatibility, if not co-option, with other organisms and many plant materials.

How many kinds of honey exist in the world? Take the number of stingless bee species, multiply this by the number of seasons in the tropical or subtropical year (wet and dry, for the most basic), and then multiply this by a number including combinations of 20–50 pollen types. Of course, in an environment that has fewer flowering plant species, or where invasive honey bees are taking many of the flowers that the two bee groups compete for, that number is reduced. Indeed, a traditional scientific application of pollen study to the honey of bees has been in the identification of a single, predominant resource in a honey sample. Such "unifloral" honey is an economic standard, verified clearly by pollen identified in the honey, which permits commercialization and unquestionable legitimacy. Other kinds of honey are difficult to categorize in such a straightforward way. They are the flavor of the tropics. They come in too many varieties for superficial scrutiny, other than to state that they are diverse. A connoisseur would notice the difference. "Native honeys," as we find them, are a remarkable kaleidoscope of bouquet, aroma, flavors, aftertaste, and even texture. Such sensorial adventure begins with both botanical and entomological origin, often with an added benefit from their matrix of human cultural experience, in which they are embedded.

From a human point of view, stingless bees in Asia (Indonesia and Malaysia) are “the bees that remove sticky substances form their legs,” the “galo galo”, or the “flute bees” with the long, tubular nest entrance, or the “beer bees,” whose fermenting honey encourages the production of alcohol, in a container of bee nests and water. Much the same is true for Africa, and the Australian stingless bees have a multitude of uses and metaphors attached to them. In the American tropics, they are frequently the garden bees—those kept close at hand for a case of sore throat, or a home remedy conferring stamina or at very least, well-being. A remarkable dose of needed sweetness, with which to surrender all pessimism and doubt.

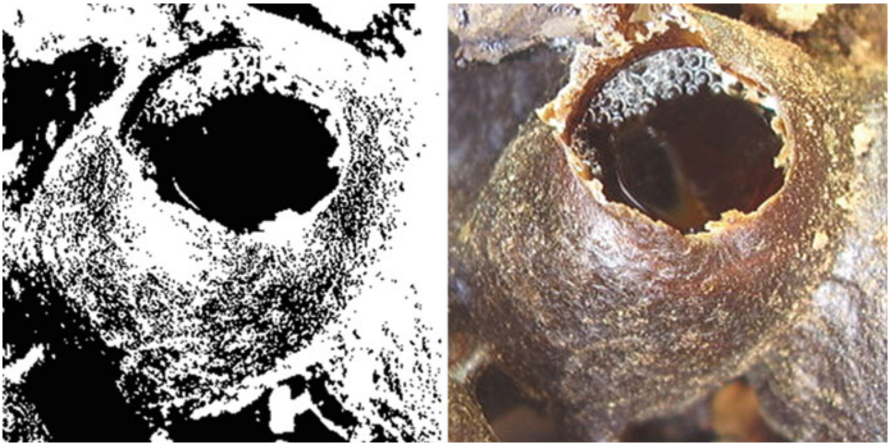
On the other hand, an astringent tang in the back of the throat and a near convulsion of shock with sweetness combined with something nearly its opposite is familiar to those of us who have consumed buckwheat honey. It is a monofloral honey that honey bees produce in Asia, where *Apis cerana* and *Fagopyrum* (Polygonaceae) are native. It is heavily laced with phenolic compounds. This general quality is perhaps the rule, rather than the exception, among the stingless bee honeys in our increasingly homogenized and monofloral world. However, the herbicide-treated and cleared plantations and orchards have given stingless bees, and other bees, a pasture that is more or less uniform, and it has flowers for only a part of the year. Its honey may be harvested, and appreciated, as something fairly novel. But it is far from natural.

Still basically unknown, despite multicultural and multigeographic recognition, are the honey and other so-called “hive products” of most stingless bees. Like the perfumed essences emitted by orchids and many flowers, they may soon vanish forever. They are, first and foremost, the most biodiverse products that nature has to offer. What are they worth, both scientifically and culturally? Further, how much have we, and the myriad other species that interact with them lost, if they are neglected, abused, and consigned to extinction? These are essential and pressing questions that we hope the reader will pursue with us.

Honey is a rare element of science and nature. What components or synergisms explain each mechanism of action? Is the greater water content of stingless bee honey a defect in quality, as would be recognized in *A. mellifera* honey, or an important medicinal factor? Sugar and water hold the invisible (and visible, with pollen grains) structure of honey—to arrange metals, secondary metabolites, microbes, chemical residues and final products, after processing by the bees in their nests. Genuine and false honey are simple comparisons, seen immediately by what is present and what is lacking. Honey is used as food, and as our cosmetics and medicines. The little bubbles in pot-honey suggest that ethanol is in the stingless bee storage pots, but in very low concentration. Modern technology has a wide range of applications to discern whether chemical compounds such as unique flavonoids, organic acids, or oxidative reactions in honey influence the immune system or interfere with cancer onset and progress. The Meliponini introduce the reader to a fascinating world of the woodland bees and their cerumen pots, in which honey and pollen are kept. Our well-known 94-year-old mentor—admiring the first stingless bee he saw alive *Trigona (Tetragonisca) angustula* Latreille—said that this bee was special “because it is small, gentle, pretty, in Panama often nests in cavities in buildings in towns, makes excellent honey and does not visit filth.” Dr. Michener was correct. Biodiversity and similar admiration for the local species of meliponines are found in the following chapters describing stingless bees from Australia, Venezuela, French Guiana, Guatemala, Costa Rica, Argentina, and Mexico. Two chapters examine the possible roles of microorganisms living with stingless bees, and consider whether fermentation is a mutualistic interaction between yeasts and bees. Strategies in communication by stingless bees to locate, collect and process food in competitive niches are developed in two chapters. Historical views communicate the high valuation of stingless bees and their pot-honey, medicinal uses by Mayans, entomological descriptions in the oldest Brazilian report, and melittology and *Melipona* bee scientific heritage, which has a legacy of at least 4000 years. Afrotropical stingless bees are treated from a taxonomic perspective used by traditional healers, naturalists and systematists. Conservation of stingless bees is presented as a challenge in Africa and Mexico, where human disturbance and habitat fragmentation propel Meliponini and many organisms toward depletion or extinction. Pollen spectra and plant use by stingless bees for food and nesting are surveyed, with new details and analytical techniques. The sensory descriptions of pot-honey are accompanied with chapters on physicochemical analysis of pot-honey from bees in Australia, Bolivia, Brazil, Colombia, Guatemala, Mexico, and Venezuela—including microbial, nutritional, and metal composition—an electronic nose, non-aromatic organic acid profiles, and Nuclear Magnetic Resonance. The flavonoid studies show that meliponine pot-honey from Venezuela, Australia, Brazil, and Bolivia is richer in flavonoid glycosides than *A. mellifera* honey. Bioactivity of pot-honey considers antioxidant value, cancer prevention and therapy, and antibacterial properties of Latin American and Thai pot-honey, and a review on immunological properties of bee products. Propolis collected by stingless bees from Bolivia, Philippines, Thailand, and Venezuela also is characterized. A closing chapter on major initiatives of production, and marketing in some parts of Brazil, moves our attention toward sustainable economics and principles that would benefit with increased commercial availability and consumption of pot-honey.

Human emotion and reaction to pot-honey indicate the evolution of natural contact between bees and our species. Sensory attributes of color, taste, texture, odor, and aroma are explored in detail. Pot-honey, as a healthy product, may someday follow millennia-old Traditional Chinese Medicine in the patterns of human response, ecology and cultural use.

The inimitable Professor Camargo left a generous contribution placed here as a seminal chapter of this book. His authentic respect for the local names and cultural uses of the bees were instrumental in producing that which authors heard as a call to offer their insights and research findings.



Future generations may have more ideas than time to further develop the science of pot-honey and decipher the messages carried, in monastic silence, by the bee chefs within their cerumen alchemist cauldrons.

Mérida, Venezuela; Sydney, Australia — Patricia Vit
Ribeirão Preto, Brazil — Silvia R.M. Pedro
Balboa, Panama — David W. Roubik

Acknowledgments

To the stingless bees and the stingless bee-keepers of the world, and for the pot-honey and meliponiculture that have evolved.

In addition to contributing to inspiring several chapters, Charles D. Michener helped with additional editing and suggestions. Carlos Augusto Rosa and Paula São Thiago Calaça kindly contributed the list of microorganisms associated with bees. Various authors updated plants listed in their chapters. All botanical scientific names were checked and family names updated by Jorge Enrique Moreno Patiño in the lists of plants, according to the Missouri Botanical Garden (Tropics) database. The chapter reviewers provided timely and detailed comments and criticisms: Maria Lúcia Absy, Ingrid Aguilar, Ligia Almeida-Muradian, Monika O Barth, Alfred Botha, Susanna Buratti, José Camina, João Pedro Cappas e Sousa, José Ángel Cova, David De Jong, Rosires Deliza, Michael Engel, Wolf Engels, Miguel Ángel Fernández Muiño, Mabel Gil-Izquierdo, Cynthia FP Luz, Walter Farina, Daniela Freitas, Klaus Hartfelder, John-Erick Haugen, Tim Heard, Robert Kajobe, Gina Meccia, Charles D Michener, Gabriel AR Melo, Guiomar Nates-Parra, César Pérez, James Nieh, Auro Nomizo, Livia Persano Oddo, Silvia RM Pedro, Gabor Peter, Claus Rasmussen, Martyn Robinson, David W Roubik, Gianni Sacchetti, María Teresa Sancho Ortiz, Judith Slaa, Bruno A Souza, Marta Regina Verruma-Bernardi, Rogel Villanueva, Patricia Vit, and Alfredo Usubillaga. We acknowledge our institutions and authorities for the academic support.

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Part I
Origin, Biodiversity and Behavior of the Stingless Bees (Meliponini)