ISRAEL JOURNAL OF ENTOMOLOGY, Vol. 50 (1), pp. 147–162 (31 December 2020)

Stingless bee *Meliponula* Cockerell (Hymenoptera: Apidae: Meliponini) ground nest architecture and traditional knowledge on the use of honey in the Amhara Region, Northwest Ethiopia

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ABSTRACT

Stingless bees constitute an important component of tropical ecosystems. The present study reports on the ground nest architecture of the *Meliponula* stingless bees, impact of agricultural activities on the stingless bee population and traditional use of stingless bee honey in three districts—Wegera, Libo Kemkem and Alepha—of the Amhara Region, Ethiopia. The ground nests were located with the help of indigenous knowledge. The parameters of the *Meliponula* ground nests were measured and compared with published data. The impact of agricultural activities and the use of stingless bee honey (locally known as *tazima* or *tazma mar*) in ethnomedicine were documented through interviewing local communities and briefly discussed. It has been noted that stingless bee honey is used locally as a treatment for both infectious and non-infectious conditions and as an effective pain-relief measure. However, the stingless bee populations in the Amhara Region are endangered by traditional agricultural practices and habitat destruction. It has been suggested that development of appropriate meliponiculture technology is most essential to conserve the stingless bee diversity in Ethiopia and to effectively utilize their honey for human benefit.

KEYWORDS: Hymenoptera, Apidae, Meliponini, stingless bees, meliponiculture, Afrotropical, Ethiopia, ethnomedicine, honey, indigenous knowledge.

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DOI: 10.5281/zenodo.4588315; ISSN (online) 2224-6304
urn:lsid:zoobank.org:pub:0F4D41F3-79E4-4E14-AAA2-33A1F05994FB

INTRODUCTION

Stingless bees (Hymenoptera: Apidae: Meliponini) are the largest group of eusocial bees, especially abundant in tropical and subtropical regions of the world. Today, the vast majority of stingless bee species is found in the Neotropics, where they represent a large taxonomic diversity and an impressive variety of life histories (Camargo & Roubik 2005; Camargo 2013). Taxonomy of African Meliponini is still insufficiently known (Eardley 2004; Eardley & Kwapong 2013; Fabre Anguilet *et al*. 2015; Ndungu *et al*. 2017), with only one species of the Afrotropical genus *Meliponula*—*M. beccarii* (Gribodo, 1879)—being recorded in Ethiopia (Pauly & Hora 2013). Stingless bees are ecologically, economically and culturally important, and are considered among the major pollinators of many native and cultivated plants (e.g. Slaa *et al.* 2006; Michener 2007; Athayde *et al.* 2016).

Stingless bees form perennial colonies ranging from a few dozens to thousands of individuals. They evolved adaptive nest construction strategies, which have resulted in complex nest architectures. Stingless bees construct nests in a variety of substrates, including subterranean cavities, tree trunks, branches of living trees, rock crevices, brick walls, active or abandoned termite nests, arboreal ant nests, abandoned subterranean chambers of ants (Roubik 2006). A study of stingless bee genus *Trigona* Jurine found the materials used for nest construction were mainly pure wax or cerumen (a mixture of wax and propolis), plant fibres and clay (Rasmussen & Camargo 2008). Certain species developed architectures that help control nest temperatures; the nests in large trunks or in soil are particularly well insulated. However, descriptions of nest architecture are currently lacking for many stingless bee species. This is particularly true for equatorial Africa, where very little research has been done on stingless bees in general (Portugal Araujo 1963; Fletcher & Crewe 1981; Namu & Wittmann 2017; Njoya *et al*. 2016; Ndungu *et al*. 2019), and particularly on the genus *Meliponula* Cockerell (Portugal Araujo 1963; Njoya *et al*. 2017, 2018, 2019). In Ethiopia, the nests structure, chemical composition of the honey and other ecological aspects of stingless bees are virtually unknown. The present study aims to fill this gap by describing the subterranean nest architecture of the *Meliponula* stingless bees in the Amhara Region, NW Ethiopia.

Africa's economy depends on agriculture, which rapidly intensifies to meet human increasing demands for arable land, urbanization and other practices that put pressure on ecosystems. These activities, as well as harvesting wild stingless bee honey, influence distribution, density and nests of stingless bee populations (Kwapong *et al.* 2010; Otieno *et al.* 2011; Sahle *et al.* 2018).

Ethiopia hosts over 6000 species of flowering plants (Friis 2009), with many supporting local bee colonies (Awraris Getachew Shenkute *et al*. 2012; Tura Bareke & Admassu Addi 2018; Tariku Olana & Zerihun Demrew 2019). In Ethiopia, distinct seasonal variations influence the abundance and phenology the source plants, and hence honey production (Tura Bareke & Admassu Addi 2018). The transition to modern agricultural practices, decline of native vegetation, and traditional methods for the collection of honey have all led to the decline of stingless bee colonies (Winfree *et al*. 2009).

Beekeeping and harvesting honey of wild stingless bees play a major role in socio-economic development in Ethiopia and may contribute up to 50 % of household income (Awraris Getachew Shenkute *et al*. 2012). The stingless bee honey (known locally as *tazima* (*tazma*) *mar*), pollen and wax have long been reported to have strong antibacterial, immunostimulatory, anti-inflammatory, antioxidant and wound healing properties (e.g. Mogessie Ashenafi 1994; Duarte *et al.* 2012; Alem Getaneh *et al.* 2013; Berhanu Andualem 2013; Yalemwork Ewnetu *et al.* 2013; Borsato *et al.* 2014; Medeiros *et al.* 2016; Yazan *et al.* 2016), and are broadly used in ethno- and modern medicine (e.g. Vit *et al.* 2004; Temaru *et al*. 2007; Lopez-Maldonado 2010; Alvarez-Suarez *et al.* 2013; Vandamme *et al.* 2013; Reyes-González *et al.* 2014; Medeiros *et al.* 2016; Biswa *et al*. 2017; Rosli *et al*. 2020).

The present study was designed to elucidate stingless bee nests architecture, honey production season, the impact of agricultural activities, and indigenous use of honey in traditional medicine in the Amhara Region. Further to this, the research was focused on good practices in traditional use of honey, in meliponiculture and in conservation of stingless bee species.

MATERIALS AND METHODS

Description of the study area

Ground nest structure, agricultural activities, honey collection season, traditional knowledge use of honey were recorded from November 2016 to October 2018 at three sites, Libo Kemkem, Wegera and Alepha woredas, of the Amhara Region in north-western Ethiopia. The mean annual maximum and minimum temperatures of the study area were 31.8 °C and 10 °C, respectively. The average annual rainfall was approximately 1300 mm and showed a uni-modal distribution in the summer season (June–August). The vegetation in the study area was represented by dry evergreen montane forest with admixture of bushes, shrubs, and plantations of exotic plants interspersed with stands of natural forest (Zegeye *et al*. 2011). Natural vegetation was found along the river and at orthodox church sites, but most of the remained areas were cultivated land with cereal crops such as maize, wheat, sorghum, millet and teff. Major farming activities included traditional ploughing, application of pesticides and chemical fertilizers and excavating ground nests of wild stingless bees for honey for food and medicinal purposes.

Ground nest architecture

The stingless bee nest sites were indicated by local experts, who possess indigenous knowledge about environmental adaptation, visiting flowering plants and foraging time of stingless bees. Researchers and local experts found 36 ground nest entrances using two traditional techniques (cf. Amenay Assefa Kidane *et al*. 2021). The first one utilizes observation of a hover fly (Diptera: Syrphidae), locally called *molecho*, that flies to the ground nest entrance. The syrphids are easily visible due to their large body size and bright orange-yellow colour with black markings and are frequently observed approaching the ground nest entrance for honey. Local experts catch a hover fly from its own nest, tie a red thread around the fly waist, and follow the syrphid while it flies to the ground nest entrance. The second technique employs observations of movements of worker bees from and to the ground nest. Local experts notice the worker bees as they leave continuously the ground nest for foraging site at the specific time from 8–10 am. Thus, local experts and researchers demarcate ground nests of stingless bees for excavation.

For each nest, we recorded its location and the following characteristics: nest entrance size (length, diameter, and height from ground surface), shape (funnel, mount-like, or round-ringed), colour (brown, black, or light brown), and rigidity. The temperature and relative humidity inside the ground nest were recorded. After the opening, the cavity layer was measured from the outer to inner part of the ground nest. The entire colony was dug out from underground, placed into wooden box and transferred to Entomology Laboratory, Maraki Campus, University of Gondar for further observation and for counting the number of brood combs, brood cells and stingless bees.

Impact of agricultural activities on the stingless bees

Data were collected from October 2016 to September 2018, and three study sites were selected to assess the influence of agricultural practices on the stingless bee populations. Semi-structured interviews were considered an effective method for data collection. The interviewer developed and used an interview guide with a list of questions and topics that needed to be covered during the conversation. The questions were prepared in English and simultaneously translated into Amharic. The interviewer recorded respondents' socio-demographic status including sex, occupation, educational background, and duration of time respondents lived in the study area during the last 50 years. The questions focussed on the indigenous knowledge on the stingless bees, main agricultural practices affecting the natural habitat, application of chemical fertilizers and pesticides, traditional ploughing, direct digging of stingless bee ground nests for honey harvesting, and also on the expansion of urbanization.

Indigenous use of honey in ethnomedicine

These semi-structured interviews were conducted with local experts (healers and elders), who have traditional knowledge on predators of stingless bees, distribution, location of nests, pollen harvesting time, honey excavation technique from the ground nest, the quantity of honey production in a particular season, and medicinal value of honey with respect to different ailments. An interviewer and 60 respondents were selected from the three study sites; the reviewer discussed with individual respondents the quantity of honey in four seasons and availability of honey on local markets. In addition to this, traditional healers and senior citizens were interviewed with regard to the indigenous use of honey combined with different spices for treatment of different ailments.

Data analysis

The ground nest structure, impact of agricultural activities and traditional knowledge on the use of stingless bee honey data were analysed using MS Office 2007 Excel and SPSS version 20 software. The SPSS was used to run one-way ANOVA to compare any significant difference in the internal and external structure of the ground nest, temperature and relative humidity inside the nest, traditional use of honey and quantity of honey production in four seasons among the three studied site. Further, individual mean significant difference was calculated by using post-hoc Least Significant Difference test (LSD, $p<0.05$).

RESULTS

Physical properties and internal structure of the ground nest

Field observations show that most of the stingless bee nests are located in the shaded areas covered with grass and surrounded by shrubs, far from anthropogenic activities, along the edges of cultivated land and pastures. The nest entrances are protected by guard bees (Fig. 1A–C) and the number of the guards range from 3–7. The shape of the nest varies from spherical to elongated (Fig. 1D–F), and the mean size of stingless bee colony is 4573±1546 individuals (Table 1).

Fig. 1: Ground nest shapes and entrances of stingless bees: (A, B, C) ground nest entrances protected by guard bees; (D, E, F) various shapes of underground nests; (G) depth of the underground nest cavity.

Table 1. Data on stingless bee ground nests in the Amhara Region (N=36).

Characteristics	Range	Mean±SD
Number of entrance guards	3–7	4.8±1.7
Colony size (no. of bees)	2480–5895	4573±1546
Entrance tube diameter	1.8–2.3 cm	2.0±0.2 cm
Entrance tube length	23.4–35.4 cm	27.8±5.3 cm
Nest cavity diameter	25–32 cm	28.7±3.3 cm
Nest cavity height	23–29 cm	25.8±2.8 cm
Number of honey pots	75–105	94.7±13.6
Honey pot diameter	1.6–2.4 cm	2.0±0.3 cm
Honey pot height	1.3–2.9 cm	2.3±0.8 cm
Number of pollen pots	96–115	104.5±7.9
Number of brood combs	8–12	10.0±1.8
Brood comb diameter	8.1–12.3 cm	10.3±1.8 cm
Number of brood cells	3680–7624	5767.3±1626.7
Brood cell diameter	0.5–0.8 cm	0.7±0.1 cm
Brood cell height	0.7–1.2 cm	0.9±0.2 cm
Drainage tube diameter	0.3–0.7 cm	0.5±0.2 cm
Drainage tube depth	165–205 cm	188.3±17.2 cm
Volume of honey per pot	15–25 cm^3	19.8±4.3 cm^3
Total volume of honey	190–1750 cm^3	965.3±710.4 cm^3

The entrance diameter ranges from 1.8–2.3 cm; entrance tube length, 23.4–35.4 cm; nest cavity diameter, 25–32 cm; and the nest cavity height, 23–29 cm (Table 1). There is no significant difference in the length of the nest entrance among the three sites ($F=3.42$; $df=2,11$; $p>0.05$). The mean temperature and relative humidity recorded in the nest cavities are 34±2 °C and 42±1 %, and both physical properties of the nest show no significant difference. The average volume of the nest cavity is 8,935.3 cm^3, recorded for 4–7-year-old colonies. The drainage tube at the bottom of the ground nest cavity (Fig. 1G) has the length and diameter of 188.3±17.2 cm and 0.5±0.2 cm respectively (Table 1).

The entire nest cavity is enclosed with 1-mm thick black and brittle batumen (Fig. 2A) consisting of 2–3 layers, from which short pillars protrude to the unlined walls of the cavity. The brood chamber is surrounded by 6–8 layers of involucrum (Fig. 2B), each spaced by a distance less than 0.5 cm. The involucrum is made of a substance containing propolis, resin and occasionally plant debris, and is attached to the batumen by tiny pillars. The involucrum sheets are brown, shiny and arranged in several layers that allow the bees to move in-between and into the brood area; the inner involucrum layers are tighter and soft. The nest cavity has two compartments. The peripheral compartment contains pollen and honey storage pots (Fig. 2C), which are normally arranged in more than one compact cluster. Honey and pollen pots are of the same size but different colour. The pollen pots are black, and the honey pots are dark brown with white or yellow honey. The storage pots are irregular in shape,

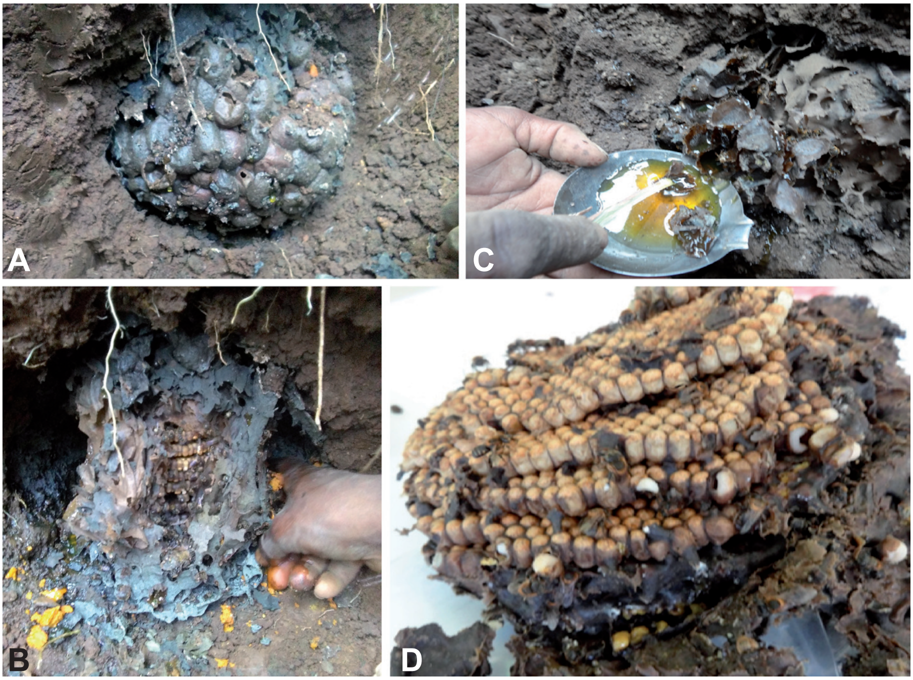

Fig. 2: Internal structure of the underground nest cavity: (A) batumen on the outside of the nest; (B) traditional extraction of stingless bee honey; (C) involucrum layers between storage pots and brood comb cells; (D) brood comb cells arrangement.

being spherical, oblong and conical (Fig 2). The mean number of honey storage pots is 94.7±13.6; the average honey storage pot diameter and height are 2.0±0.3 and 2.3±0.8 cm, respectively. The average volume of honey per pot and the total volume of honey per nest are 19.8±4.3 and 965.3±710.4 cm^3, respectively (Table 1). The wild stingless bee honey production varies from season to season according to respondents' answers and cross-checking the available market information; more honey is collected in spring compared to autumn, winter or summer. Overall, stingless bee honey production across four seasons was significantly different ($F=100.22$; $df=3,11$; $p<0.0001$; Fig. 3). The colour of honey varies among seasons and localities. Thus, yellow honey was collected in autumn at Libo Kemkem; honey was colourless in winter at Wegera; and a high amount of golden honey was collected in spring at Alepha.

The brood cells are arranged vertically in the centre of the nest cavity and form horizontal combs (Fig. 2D). The mean brood comb diameter and the mean number of brood combs in a nest cavity are 10.3±1.8 cm and 10.0±1.8, respectively. The mean brood cell height and diameter are 0.9±0.2 and 0.7±0.1 cm, respectively. The mean the number of brood cells per a nest is 5767.3±1626.7.

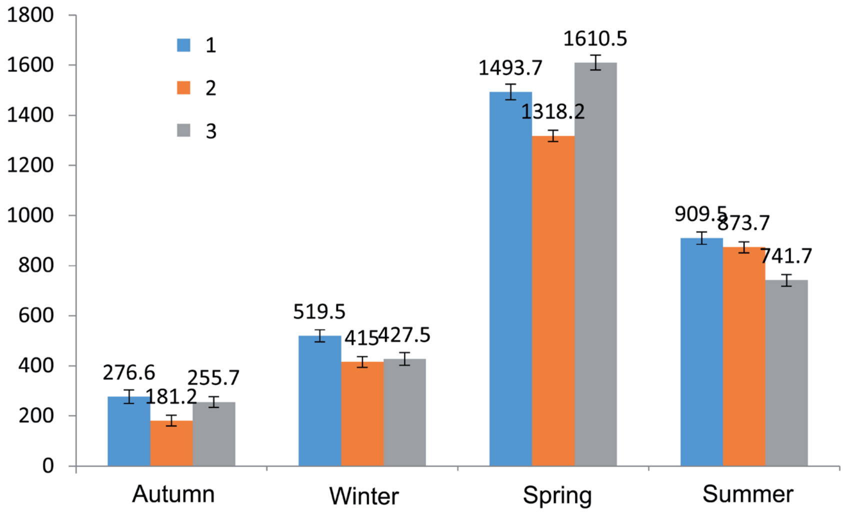

Fig. 3: Honey production (ml) per one nest at Wegera (1), Alepha (2) and Libo Kemkem (3) in four different seasons.

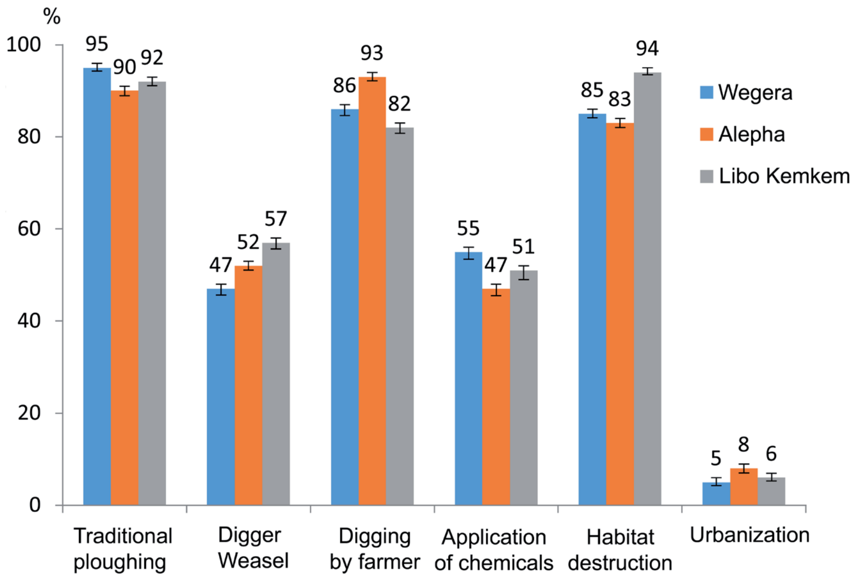

Fig. 4: Agricultural and other factors influencing stingless bee populations, according to interviewees' responses.

Table 2. The use of stingless bee honey in traditional medicine for various ailments (N=60).

Medical conditions	Responded	%	Rank
Respiratory infection (coughing)	56	93.3	1
Asthma	51	85.0	2
Bladder pain	42	70.0	3
Stomach disorder	35	58.3	4
Tuberculosis	29	48.3	5
Dental caries	27	45.0	6
Baby teething	25	41.6	7
Diarrhoea	16	26.0	8
Cardiovascular diseases	15	25.0	9
Sore throat	14	23.3	10
Wound healing	12	20.0	11
Anaemia	10	16.6	12
Eye infection	8	13.3	13
Anti-ageing	5	8.3	14
Antidiabetic	3	5.0	15

Effect of agricultural activities on the honey production

The study focussed on the major agricultural activities that lead to environmental change and affected stingless bee populations and honey production at Libo Kemkem, Wegera and Alepha. These activities included traditional ploughing, application of fertilizers and pesticides, destruction of natural habitats; the traditional method of honey collection; mechanical damage of ground nests; and expanding urbanization. All activities, save for expanding urbanization, have been found statistically significant in their contribution to declining stingless bee populations and honey production ($F=172.299$; $df=5,12$; $p<0.0001$; Fig. 4).

Ethnomedicinal effect of stingless bee honey

The present study indicates that the stingless bee honey is used to treat a good range of ailments such as respiratory infection, asthma, bladder pain, stomach problems, etc. (Table 2). One interviewee indicated that 3–5 tablespoons of fresh honey or honey mixed with other ingredients like milk, garlic (*Alium sativum*) and ginger (*Zingiber officinale*) in the morning alleviate symptoms of coughing, bladder pain and asthma.

DISCUSSION

The size and structure of stingless bee nests vary greatly (e.g. Alves *et al.* 2003; Eltz *et al.* 2003; Barbosa *et al.* 2013), but there is no consensus whether these parameters are species-specific or not (Franck *et al.* 2014; Ndungu *et al*. 2019). Moreover, nests of some *Meliponula* species—e.g. *M. bocandei* and *M. ferruginea*—are built in tree trunks or bamboo stems (Njoya *et al*. 2018, 2019) and markedly differ from underground nests of other species. Therefore, it would be more appropriate to compare our data with those published on hypogeic nests of *Meliponula beccarii* (Gribodo, 1879) (Portugal Araujo 1963; Njoya *et al*. 2017).

Entrances to stingless bee nests are protected by guards. The number of guarding bees varies from 1–14 among different species and genera, possibly depending on the size of the colony (Couvillon *et al.* 2008). It may also fluctuate diurnally; thus, Kärcher and Ratnieks (2009) mention 13.8±6.1 standing guards for *Tetragonisca angustula* across the day. We observed 3–7 guards at each entrance in all three study sites, which is similar to the number of guards in *M. beccarii* in Cameroon (3–5; Njoya *et al*. 2017) and falls within the range of other previously published data.

All studied ground nests of the *Meliponula* bees in the Amhara Region were situated at the edges of cultivated areas, where the nests were exposed to morning light and somehow protected from flooding. In Angola, Portugal Araujo (1963) reported the *M. beccarii* nests from grasslands mentioning that they were never discovered in forests. In Cameroon, 25 studied nests were almost equally distributed among *Eucalyptus* plantations, farmlands and secondary forests with scanty undergrowth and enough light reaching the forest floor (Njoya *et al*. 2017). The detritus adorning the entrance guides foraging bees to the nest. It is speculated that debris around the entrance to the nest helps to protect the colony and to prevent germination and development of weeds that may block the entrance.

The excess of water entering the nest cavity during rain or flooding is removed through a drainage tube below the nest cavity. In our study the length of the tube varied from 165–205 cm, which was significantly greater compared to 60–90-cm long drainage tubes measured by Portugal Araujo (1963) for both *Meliponula beccarii* and *Plebeiella lendliana* in the Moxico and Huíla provinces of Angola, and even more so to only 16.5-cm long tubes of *M. beccarii* in the North West Region of Cameroon (Njoya *et al*. 2017). The length of the drainage tube possibly depends on the soil properties and the ability of water to penetrate into soil, in particular. Thus, Portugal Araujo (1963) reports arenaceous soils in his study sites in Angola, and the North West Region of Cameroon is characterized by predominantly (well-drained) ferrasols and nitrisols (Jones *et al*. 2013), whereas soils in the Amhara Region are heavier (Jones *et al*. 2013) and longer drainage tube are apparently necessary to accommodate an excess of liquid.

Otherwise the studied *M. beccarii* nests in the Amhara Region are generally similar to those reported from Angola and/or Cameroon, although not without di in their details and in dimensions of different elements. The entrance tubes of the nests in Ethiopia are basically as long as their counterparts in Cameroon (23.4–35.4 vs 27.5–34.5 cm), but are significantly wider (1.8–2.3 vs 1.0–1.4 cm) (Njoya *et al*. 2017). The entrance burrows of *M. beccarii* nests in Angola are much longer (66–90 cm), but narrower (0.8–1 cm) (Portugal Araujo 1963). Curiously, the nest size of the Ethiopian and Angolan bees is similar (25–32×23–29 and 25–35×30 cm, respectively), whereas the nests in Cameroon are only half of that size (12–13×14–16 cm). Thus, the length of the entrance may depend also on the soil type or some other unknown variable(s), so further research into this matter is required.

The number of brood combs in both Ethiopian and Angolan nests is 8–12, which is greater than in the nests in Cameroon (6–8 combs), probably because of the smaller size of the latter. However, the diameters of the brood combs are overall similar in all three countries (8–12, 10–13 and 5.5–12 cm). Likewise, the dimensions of brood cells (diameter and height) in Ethiopian and Angolan nests are about twice as great as those in Cameroon (5–8/7–12 and 4/7 mm vs 2–3/3–4 mm). Contrary to this, honey storage pots in our study are noticeably smaller (diameter, 1.6–2.4; height, 1.3–2.9 cm) compared to honey pots of *M. beccarii* in both Angola and Cameroon (diameter, 2.5–3.2; height, 3–4 cm). Correspondingly, the total volume of honey from one nest in our study was considerably lower—on average less than 1 litre—than the amount of honey (2 l) reported from one *M. beccarii* nest in Angola (Portugal Araujo 1963) or from one meliponine nest in the Southern Nations, Nationalities and Peoples' Region, south-western Ethiopia (Awraris Getachew Shenkute *et al.* 2012); older nests can even yield up to five litres of honey (Amenay Assefa Kidane *et al.* 2021). It should be re-emphasized that production of honey varies greatly in the study region depending on the season, from 190 to 1750 ml per nest.

The colour of fresh honey is defined by several factors like floral origin, acidity and mineral content (Ramalhosa *et al.* 2011). Thus, Awraris Getachew Shenkute *et al.* (2012) report white honey produced from *Schefflera abyssinica* and its red variety from *Croton macrostachyus* and *Aningeria adolfi-friederici* in the Southern Nations, Nationalities and Peoples' Region. Our observations of yellow honey collected in autumn, colourless honey in winter and golden honey in spring also prompt that the honey colour depends on its floral source, but a dedicated palynological study is required to establish the source plants of honey in the Amhara Region.

Bees, including stingless bees, play a key role in pollinating both native flora and crops, and their diversity and abundance are affected by land-use and agricultural practices (Samejima *et al.* 2004; Kremen *et al.* 2007; Winfree *et al.* 2009). Other factors that contribute to the decline of the stingless bee populations in Ethiopia include destructive harvesting, deforestation, soil degradation, use of pesticides, and a range of honeybee enemies like ants, honey badgers, birds and hive beetles (Awraris Getachew Shenkute *et al.* 2012; Amenay Assefa Kidane *et al.* 2021). Njoya *et al.* (2017) also briefly noted that agricultural activities and poor harvesting techniques often lead to the loss of *M. beccarii* colonies in Cameroon. According to our respondents, the major threats to stingless bee populations and honey production in the Amhara Region are agricultural practices, including the use of fertilizers and pesticides, destruction of natural habitats and damage to ground nests.

Being highly nutritious, stingless bee honey is traditionally valued above ordinary honey in Ethiopia and is commonly used as a food supplement and for treatment of a broad range of ailments like respiratory conditions, infections, diarrhoea etc. (Berhanu Andualem 2013; Amenay Assefa Kidane *et al.* 2021). Most people in Ethiopia have a board acceptance of the medicinal value of stingless bee honey and advocate its cultural importance. Our respondents have mentioned 15 medical conditions, for which the honey is used (Table 2). These range from respiratory ailments to infections and even diabetes, but they are treated unequally with honey in the local communities. A surprisingly low—11 out of 15—ranking was given to wound-healing properties of honey among the respondents, although it has been used for wound treatment since ancient times (see Abd Jali *et al*. 2017 for review) and clinical studies support this (e.g. Vandamme *et al*. 2013; Nordin *et al*. 2020). According to one traditional medical practitioner in the Amhara Region, 3–5 tablespoons of fresh honey or honey mixed with other ingredients like milk, garlic (*Alium sativum*) and ginger (*Zingiber officinale*) given to patients in the morning alleviate symptoms of coughing, bladder pain and asthma. A higher efficacy of honey when used in combination with garlic was noted in another study in Ethiopia (Berhanu Andualem 2013).

Eardley (2004) and Eardley and Kwapong (2013) noted that meliponiculture is generally uncommon in Africa compared to, say, South America. Indeed, only a single respondent out of 60 interviewees in a study in the south-western Ethiopia practiced keeping of stingless bees; otherwise harvesting honey is mainly destructive (Amenay Assefa Kidane *et al*. 2021). Results of the present study, as well as those published elsewhere, must be utilized for developing a management programme that will promote conservation of stingless bees through optimized landscape management and responsible agricultural practices. Given the nutritional, medicinal and monetary value of stingless bee honey, meliponiculture in Ethiopia should be promoted, like it has been done in East and West Africa (Eardley & Kwapong 2013).

ACKNOWLEDGEMENTS

The authors gratefully acknowledge the financial support received from the University of Gondar (Project Reference Number VP/RCS/05/191/2016 and Fund Number 6223). The agriculture extension officers, farmers, school teachers, and local experts from Libo Kemkem, Wegera and Alepha woredas are thanked for their technical support during data collection. Two anonymous reviewers provided most valuable comments on an earlier draft of the manuscript.

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