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Judul Artikel : The effect of different beehives on the activity of foragers, honey pots number, and honey production from stingless bee *Tetragonula* sp.

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Penulis : Dr. Ir. Erwan, M.Si.

No.	Perihal	Tanggal
1	Bukti Submit Artikel ke Livestock Research for Rural Development (LRRD) dan Artikel yang di Submit	20 Juni 2020
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3	Komentar dari Reviewer terhadap Artikel dan File Komentar dari Reviewer	8 Juli 2020
4	Bukti Submit Perbaikan/Revisi Artikel dan Artikel Hasil Perbaikan Revisi Pertama	9 Juli 2020
5	Permintaan Pengiriman Kembali Hasil Perbaikan Artikel oleh Editor in Chief LRDD dan Artikel Hasil Perbaikan Revisi Pertama	17 Juli 2020
6	Komentar Kedua dari Reviewer dan Balasan Komentar Kedua dari Reviewer	23-24 Juli 2020
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Gmail erwan apis <apiserwan@gmail.com>

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erwan apis <apiserwan@gmail.com> 22 Juni 2020 pukul 09.51
Kepada: reg.preston@gmail.com

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Affiliation: 1 Faculty of Animal Science, University of Mataram, Indonesia
2 Faculty of Animal Science, Universitas Gadjah Mada, Indonesia

one of the author (Agussalim) have been published some paper in LRRD Journal and we hope this paper can be accepted and published in Livestock Research for Rural Development

Best Regards,

Dr. Erwan
Faculty of Animal Science, University of Mataram, Indonesia

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ARTIKEL YANG DI SUBMIT KE LIVESTOCK RESEARCH FOR RURAL DEVELOPMENT

The effect of different beehives on the activity of foragers, honey pots number, and honey production from stingless bee *Tetragonula* sp.

Erwan[1], Meiyana Astuti[1], Syamsuhaidi[1], Muhammad Muhsinin[1] and Agussalim[2]

Faculty of Animal Science, University of Mataram, Jl. Majapahit No. 62, Mataram – 83125, Indonesia

Faculty of Animal Science, Universitas Gadjah Mada, Jl. Fauna 3, Bulaksumur, Yogyakarta – 55281, Indonesia

Email: apiserwan@gmail.com

Abstract

Tetragonula sp. is one of stingless bee species nesting in bamboos hive and produced honey, bee pollen (bee bread), and propolis. The objective of this study was to evaluate the exit activity of foragers, honey pots number, honey volume each pot, and production of honey from stingless bee *Tetragonula* sp. Thirty colonies of stingless bee *Tetragonula* sp. from bamboos hive were divided into two groups were bamboos and boxes hives, each group consisted of 15 colonies. The colonies from bamboos hive were transferred to boxes hive consisted of a queen bee, foragers, drones, brood cells, and then meliponiculture one-month in Sukadana Bee Village, North Lombok, Indonesia. The results showed that exit activity in the morning and afternoon of foragers from stingless bee *Tetragonula* sp. in the boxes hives was higher than bamboos hive ($P<0.01$). The honey pots number, honey volume each pot, and honey production (big, medium, and small pots) in boxes hive were higher than in bamboos hive ($P<0.01$).

Keywords: meliponiculture, Sukadana bee village, bamboo hive, box hive, nectar

Introduction

The stingless bees include tropical bee groups, in the world, more than 500 species have been identified and possibly more than 100 species unidentified. The colonies consist of three castes (a queen, workers, and drones) and usually only one queen as the female reproductive for each colony. In addition, the morphologically different worker and queen, and reduced stings that impact them cannot sting (Michener 2013). In Indonesia, the stingless bees (*tribe Meliponini*) are at least 46 species (Kahono et al 2018). Stingless bees in Indonesia mostly found nesting in bamboos, sugar palm stalks, tree trunks or woods, and in the ground (Agussalim et al 2015).

Tetragonula sp. is one of the stingless bee species that nesting in a bamboo (Agus et al 2019a; Agussalim et al 2019). *Tetragonula* sp. can produce honey, bee pollen or bee bread, and propolis. Honey is used by the bees as the food reserve when lacking foods, especially in the rain season to maintain from collapse colonies. Honey is defined as the natural food made from the nectar that collects by foragers from plant flowers, extrafloral nectar, and honeydew or excretions of plants sucking insects (Codex Alimentarius 2001) that deposited in the pots for stingless bees and the comb for honeybees. Honey production from stingless bee *Trigona* sp. (*Tetragonula* sp.) after meliponiculture two months was ranged from 49.20 to 66.60 ml (Agussalim et al 2017). The objective of this study was to evaluate the exit activity of foragers, honey pots number, honey volume each pot, and production of honey from stingless bee *Tetragonula* sp.

Materials and Methods

Colony Transfer

The stingless bee *Tetragonula* sp. as much 30 colonies were adapted for one week in the Sukadana Bee Village, Bayan, North Lombok, Indonesia. The colonies were divided into two groups and each group consists of 15 colonies. The first group was box as the modern hive with size 40 x 20 x 15 cm. The second group was bamboo as the natural hive with the length 30 to 40 cm and diameter 7 to 8 cm. Fifteen colonies from bamboos were transferred to boxes consisted of a queen bee, workers (foragers), drones, brood cells or eggs, and all of the colonies were meliponiculture for one-month.

Temperature and Humidity Environment

The temperature and humidity environment were measured every day for one month using thermo-hygrometer in the morning (08:00 am) and in the afternoon (4:00 pm).

Honey Production

Honey production of stingless bee *Tetragonula* sp. was measured after meliponiculture one month. In brief, honey was harvested from boxes and bamboos with cutting the propolis as the construction in the boxes wall, then the honey was placed in the plastic bottles. Furthermore, honey was squeezed using hand to separated honey from propolis, then honey was measured by graduated cylinders. The plant types as the source of nectar to produce honey were identified.

Daily Activity of Foragers

The daily activity of the foragers was counted every day for one month i.e. the exit activity from hives was counted using hand counter check. The exit number of foragers from hives was counted by standing in front of the hive entrance at a distance 1 meter for 5 minutes each hive and was performed in the morning (08:00 am) and in the afternoon (4:00 pm). The number of entering foragers to the hives was not counted because the exit foragers will be entering back to the hives.

Honey Pots Number

The pots honey number was counted after meliponiculture one month were divided into three categories were big pots (diameter mean 1.1 cm), medium pots (diameter mean 0.7 cm), and small pots (diameter mean 0.4 cm). The boxes and bamboos hives were opened and then the number of honey pots was counted in the night was equipped with lighting. In addition, the production of honey from each honey pot was aspirated using syringe 1 ml and the honey volume each pot was measured.

Statistical analysis

The data of honey production, exit activity of foragers, pots honey number, and honey volume each pot from stingless bee *Tetragonula* sp. were analyzed by T-test, and the temperature and humidity environment were analyzed by descriptive analysis using SPSS statistics version 23.

Results and Discussion

Temperature and Humidity Environment

The results showed that the environment temperature in the Sukadana Bee Village, North Lombok was ranged from 25.0 to 26.1^{o}C in the morning, while in the afternoon was ranged from 28.6 to 30.4^{o}C. The environment humidity was ranged from 68.0 to 74.4% in the morning, while in the afternoon was ranged from 57.9 to 64.9% (Table 1). The temperature and humidity environment in the Sukadana Bee Village, North Lombok was including the normal temperature and humidity required by stingless bees to optimally productivity.

Table 1. The mean of temperature and humidity environment every week in the Sukadana Bee Village, North Lombok

Weeks	Temperature (^{o}C)		Humidity (%)	
	Morning	Afternoon	Morning	Afternoon
First	25.1	28.6	74.7	63.9
Second	25.7	30.4	68.0	61.3
Third	26.1	29.1	68.4	64.9
Fourth	25.0	30.1	69.9	57.9

The environment temperature required by the bees to collect food was ranged from 5 to 45^{o}C and if under or above it, decrease the activities of honeybees and even until its death (Abrol 2011). The elevated temperatures and the concomitant lack of water during dry periods can be induced absconding in stingless bees (Maia-Silva et al 2015). Heard and Hendrikz (1993) explained that the temperature was a significant effect on the flight activity of stingless bee *Trigona carbonaria*, but not consistent on humidity relative. The temperature threshold to activity was ranged from 18 to 19^{o}C. The peak activity *T. carbonaria* was ranged from 26.1 to 29.8^{o}C with humidity relative 35 to 90%. The temperature and humidity in the study was differ from those previously reported Agussalim et al (2015) for *Trigona* sp. (*Tetragonula* sp.) and Heard and Hendrikz (1993) for *T. carbonaria*.

Daily Activity of Foragers

The results showed that the exit activity from hives by foragers in boxes hive in the morning was higher than the exit activity hive in bamboos hive (50.1 versus 36.6 heads/5 minutes) and in the afternoon (29.3 versus 25.3 heads/5 minutes) ($P<0.01$). In addition, the exit activity from hives by foragers in the morning was higher than in the afternoon for bamboos hive (36.6 versus 25.3 heads/5 minutes) and boxes hive (50.1 versus 29.3 heads/5 minutes) ($P<0.01$) (Table 2). The exit activity from boxes hives was higher than bamboos hives might be the foragers in the boxes must gather more materials to build the nest and be creating comfort conditions than bamboos hives. In addition, it also might be affected by the foragers and egg number, and the productivity of the queen bee, but in our study not measured.

Table 2. The mean of exit activity of foragers stingless bee *Tetragonula* sp. from bamboos and boxes hives

Observation time	Bamboos hive (heads/5 minutes)	Boxes hive (heads/5 minutes)	SEM	*P*
Morning (08:00 am)	36.6^{bx}	50.1^{ax}	0.47	0.00
Afternoon (4:00 pm)	25.3^{by}	29.3^{ay}	0.22	0.00

^{a,b} Different superscripts within rows indicate differences at $p<0.05$

[x,y] Different superscripts within column indicate differences at p<0.05

The exit activity of foragers stingless bee *Tetragonula* sp. in the morning was higher than in the afternoon because in the morning very abundant blooming flowers as the food source like nectar (raw material to produce honey) and pollen (raw material to produce bee-pollen or bee bread), and resin (raw material to produce propolis). The exit activity hives from stingless bee *Tetragonula* sp. in this study was differ from those previously for stingless bees *Tetragonula laeviceps*, *Heterotrigona itama*, and *Lepidotrogona terminata* (Atmowidi et al 2018), for *T. laeviceps* (Agus et al 2019b; Gadhiya and Pastagia 2019), and for *Trigona* sp. (*Tetragonula* sp.) (Agussalim et al 2015). The different daily activity from each stingless bee was affected by the different stingless bee species, geographical origin (related to temperature, humidity, light intensity, wind velocity), foragers and egg number.

Honey Production

The results showed that the honey pots number after meliponiculture one-month from boxes hive was higher than from bamboos hive for all of the honey pots size were 18.1 versus 8.27 pots for big pots, 25.8 versus 16.3 pots for medium pots, and 26.8 versus 17.6 pots for small pots (P<0.01) (Table 3). The honey pots number was higher in the boxes hive was affected by the good development of colonies from boxes such as eggs or brood cells and foragers number much more that impact on the higher exit activity from the hive by foragers in boxes hive than in bamboos hive (Table 2).

Table 3. The mean of honey pots number from stingless bee *Tetragonula* sp. after one-month meliponiculture

Honey Pots Number	Bamboos hive (pots)	Boxes hive (pots)	SEM	*P*
Big	8.27[b]	18.1[a]	1.11	0.00
Medium	16.3[b]	25.8[a]	1.34	0.00
Small	17.6[b]	26.8[a]	1.53	0.00

[a,b] Different superscripts within rows indicate differences at p<0.05

The foragers in the boxes hive very actively to collect nectar from flowers and resin from plants than from bamboos hive was shown by the higher exit activity of foragers (Table 2). In addition, the volume from boxes hive was proportional for *Tetragonula* sp. than bamboos hive volume was smaller, thus allowing the colonies in boxes hives to develop properly. The volume each honey pot from boxes hive was higher than bamboo hive for all of the honey pots size were 0.37 versus 0.32 ml for the big pot, 0.28 versus 0.25 ml for the medium pot, and 0.18 versus 0.14 ml for the small pot (P<0.01) (Table 4). The higher of honey volume each pot from boxes hive might be related to the ability of workers to produce the big pot and the foragers very active to collect nectar and resin from plants was shown by the higher exit activity of foragers in boxes hive than in bamboos hive (Table 2).

Table 4. The mean of honey volume each pot from bamboos and boxes hives by stingless bee *Tetragonula* sp.

Honey volume (mL)	Bamboos hive	Boxes hive	SEM	*P*
Big pot	0.32[b]	0.37[a]	0.01	0.01
Medium pot	0.25[b]	0.28[a]	0.01	0.02
Small pot	0.14[b]	0.18[a]	0.01	0.01

[a,b] Different superscripts within rows indicate differences at p<0.05

The honey production of stingless bee *Tetragonula* sp. from Boxes hive was higher than bamboos hive for all of the honey pot were 6.68 versus 2.65 ml for the big honey pot, 7.22 versus 4.07 ml for the medium honey pot, and 4.82 versus 2.46 ml for the small honey pot ($P<0.01$) (Table 5). The honey production in Sukadana Bee Village was supported by plants as the source of nectar were longan, banana, mango, cashew, sunflowers, start fruit, bilimbi, coconut, calliandra, Jamaica cherry, papaya, and cassava. The plants have different times for flowering and blooming, but they support each other.

Table 5. Honey production of stingless bee *Tetragonula* sp. for one-month meliponiculture in Sukadana Bee Village, North Lombok

Honey production (mL)	Bamboos hive	Boxes hive	SEM	*P*
Big pot	2.65^{b}	6.68^{a}	0.43	0.00
Medium pot	4.07^{b}	7.22^{a}	0.39	0.00
Small pot	2.46^{b}	4.82^{a}	0.29	0.00

^{a,b} Different superscripts within rows indicate differences at $p<0.05$

The higher honey production in boxes hive than bamboos hive was affected the higher exit activity of foragers in the boxes hive than bamboos hive in the morning and afternoon (Table 2) that impact on much more nectar and resin has been collected by foragers to produce honey and propolis. Furthermore, the nectar and resin much more will impact the increase of honey pots number (Table 3).

Production of honey stingless bee *Tetragonula* sp. in this study (Table 5) was differ from reported by Agussalim et al (2017) for stingless bee *Trigona* sp. (*Tetragonula* sp.). The difference of honey production with this study was affected by the plant types as the food source, the bee species which involved in honey production, the daily activities of foragers especially when collecting nectar, and resin from plants and also foragers number. In addition, in Sukadana Bee Village was the center for research, development, empowerment, and community service to poverty alleviation and livelihood security of communities, especially beekeepers in North Lombok Regency, West Nusa Tenggara Province, Indonesia. Thus, in the future is required advanced study about the roles of stingless bees meliponiculture on the income of beekeepers and poverty alleviation in communities.

Conclusions

- The exit activity of hives from stingless bee *Tetragonula* sp. foragers in the boxes hive was ranged from 29.3 to 50.1 heads/5 minutes and was ranged from 25.3 to 36.6 heads/5 minutes for bamboos hive
- The honey pots number from stingless bee *Tetragonula* sp. in boxes hive after meliponiculture one-month were 18.1 pots (big pot), 25.8 pots (medium pot), 26.8 pots (small pot), and 8.27 pots (big pot), 16.3 (medium pot), and 17.6 pots (small pot) for bamboos hive
- The honey volume of stingless bee *Tetragonula* sp. from boxes hive in each pot were 0.37 ml (big pot), 0.28 ml (medium pot), 0.18 ml (small pot), and 0.32 ml (big pot), 0.25 ml (medium pot), and 0.14 ml (small pot) for bamboos hive
- The honey production of stingless bee *Tetragonula* sp. after meliponiculture one-month in boxes hive were 6.68 ml (big pot), 7.22 ml (medium pot), 4.82 ml (small pot) and 2.65 ml (big pot), 4.07 ml (medium pot), and 2.46 ml (small pot) for bamboos hive.

Acknowledgments

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Best Regards,

Dr. Erwan
Faculty of Animal Science, University of Mataram, Indonesia

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FILE KOMENTAR DARI REVIEWER
(8 JULI 2020)

In general:

I suggest change meliponiculture expression by the stingless beekeeping
I think they should make improvements to the writing and submit again.

In Specific:

In the Introduction, I think that the authors has experience in publication in LRRD and they should to do a better introduction that strengthening of our journal, specialy Agus and Agussalim.

Colony Transfer
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Honey Production
The authors should explain what´s the period of hive transfer (Modern and traditional hive). They don¨t explain which is the bees calendar it´s very important for Understand how is the bees dinamics. I seems like me it is short time for adaptation, they insure prodution in one month after transfer.

Daily Activity of Foragers:
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The effect of different beehives on the activity of foragers, honey pots number, and honey production from stingless bee *Tetragonula* sp.

Erwan[1], Meiyana Astuti[1], Syamsuhaidi[1], Muhammad Muhsinin[1] and Agussalim[2]

Commented [FME1]: Please review authors guide. Remember to use the last name, the first letter of the name and after the institutional affiliation number

Faculty of Animal Science, University of Mataram, Jl. Majapahit No. 62, Mataram – 83125, Indonesia

Faculty of Animal Science, Universitas Gadjah Mada, Jl. Fauna 3, Bulaksumur, Yogyakarta – 55281, Indonesia

Email: apiserwan@gmail.com

Abstract
Tetragonula sp. is one of stingless bee species nesting in bamboos hive and produced honey, bee pollen (bee bread), and propolis. The objective of this study was to evaluate the exit activity of foragers, honey pots number, honey volume each pot, and production of honey from stingless bee *Tetragonula* sp. Thirty colonies of stingless bee *Tetragonula* sp. from bamboos hive were divided into two groups were bamboos and boxes hives, each group consisted of 15 colonies. The colonies from bamboos hive were transferred to boxes hive consisted of a queen bee, foragers, drones, brood cells, and then meliponiculture one-month in Sukadana Bee Village, North Lombok, Indonesia. The results showed that exit activity in the morning and afternoon of foragers from stingless bee *Tetragonula* sp. in the boxes hives was higher than

bamboos hive (P<0.01). The honey pots number, honey volume each pot, and honey production (big, medium, and small pots) in boxes hive were higher than in bamboos hive (P<0.01).

Keywords: meliponiculture, Sukadana bee village, bamboo hive, box hive, nectar

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Introduction

The stingless bees include tropical bee groups, in the world, more than 500 species have been identified and possibly more than 100 species unidentified. The colonies consist of three castes (a queen, workers, and drones) and usually only one queen as the female reproductive for each colony. In addition, the morphologically different worker and queen, and reduced stings that impact them cannot sting (Michener 2013). In Indonesia, the stingless bees (*tribe Meliponini*) are at least 46 species (Kahono et al 2018). Stingless bees in Indonesia mostly found nesting in bamboos, sugar palm stalks, tree trunks or woods, and in the ground (Agussalim et al 2015).

Tetragonula sp. is one of the stingless bee species that nesting in a bamboo (Agus et al 2019a; Agussalim et al 2019). *Tetragonula* sp. can produce honey, bee pollen or bee bread, and propolis. Honey is used by the bees as the food reserve when lacking foods, especially in the rain season to maintain from collapse colonies. Honey is defined as the natural food made from the nectar that collects by foragers from plant flowers, extrafloral nectar, and honeydew or excretions of plants sucking insects (Codex Alimentarius 2001) that deposited in the pots for stingless bees and the comb for honeybees. Honey production from stingless bee *Trigona* sp. (*Tetragonula* sp.) after meliponiculture two months was ranged from 49.20 to 66.60 ml (Agussalim et al 2017). The objective of this study was to evaluate the exit activity of foragers, honey pots number, honey volume each pot, and production of honey from stingless bee *Tetragonula* sp.

Materials and Methods

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Colony Transfer

The stingless bee *Tetragonula* sp. as much 30 colonies were adapted for one week in the Sukadana Bee Village, Bayan, North Lombok, Indonesia. The colonies were divided into two groups and each group consists of 15 colonies. The first group was box as the modern hive with size 40 x 20 x 15 cm. The second group was bamboo as the natural hive with the length 30 to 40 cm and diameter 7 to 8 cm. Fifteen colonies from bamboos were transferred to boxes consisted of a queen bee, workers (foragers), drones, brood cells or eggs, and all of the colonies were meliponiculture for one-month.

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Temperature and Humidity Environment

The temperature and humidity environment were measured every day for one month using thermo-hygrometer in the morning (08:00 am) and in the afternoon (4:00 pm).

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Honey Production

Honey production of stingless bee *Tetragonula* sp. was measured after meliponiculture one month. In brief, honey was harvested from boxes and bamboos with cutting the propolis as the construction in the boxes wall, then the honey was placed in the plastic bottles. Furthermore, honey was squeezed using hand to separated honey from propolis, then honey was measured by graduated cylinders. The plant types as the source of nectar to produce honey were identified.

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Daily Activity of Foragers

The daily activity of the foragers was counted every day for one month i.e. the exit activity from hives was counted using hand counter check. The exit number of foragers from hives was counted by standing in front of the hive entrance at a distance 1 meter for 5 minutes each hive and was performed in the morning (08:00 am) and in the afternoon (4:00 pm). The number of entering foragers to the hives was not counted because the exit foragers will be entering back to the hives.

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Honey Pots Number

The pots honey number was counted after meliponiculture one month were divided into three categories were big pots (diameter mean 1.1 cm), medium pots (diameter mean 0.7 cm), and small pots (diameter mean 0.4 cm). The boxes and bamboos hives were opened and then the number of honey pots was counted in the night was equipped with lighting. In addition, the production of honey from each honey pot was aspirated using syringe 1 ml and the honey volume each pot was measured.

Statistical analysis

The data of honey production, exit activity of foragers, pots honey number, and honey volume each pot from stingless bee *Tetragonula* sp. were analyzed by T-test, and the temperature and humidity environment were analyzed by descriptive analysis using SPSS statistics version 23.

Results and Discussion

Temperature and Humidity Environment

The results showed that the environment temperature in the Sukadana Bee Village, North Lombok was ranged from 25.0 to 26.1^{o}C in the morning, while in the afternoon was ranged from 28.6 to 30.4^{o}C. The environment humidity was ranged from 68.0 to 74.4% in the morning,

while in the afternoon was ranged from 57.9 to 64.9% (Table 1). The temperature and humidity environment in the Sukadana Bee Village, North Lombok was including the normal temperature and humidity required by stingless bees to optimally productivity.

Table 1. The mean of temperature and humidity environment every week in the Sukadana Bee Village, North Lombok

Weeks	Temperature (°C)		Humidity (%)	
	Morning	Afternoon	Morning	Afternoon
First	25.1	28.6	74.7	63.9
Second	25.7	30.4	68.0	61.3
Third	26.1	29.1	68.4	64.9
Fourth	25.0	30.1	69.9	57.9

The environment temperature required by the bees to collect food was ranged from 5 to 45°C and if under or above it, decrease the activities of honeybees and even until its death (Abrol 2011). The elevated temperatures and the concomitant lack of water during dry periods can be induced absconding in stingless bees (Maia-Silva et al 2015). Heard and Hendrikz (1993) explained that the temperature was a significant effect on the flight activity of stingless bee *Trigona carbonaria*, but not consistent on humidity relative. The temperature threshold to activity was ranged from 18 to 19°C. The peak activity *T. carbonaria* was ranged from 26.1 to 29.8°C with humidity relative 35 to 90%. The temperature and humidity in the study was differ from those previously reported Agussalim et al (2015) for *Trigona* sp. (*Tetragonula* sp.) and Heard and Hendrikz (1993) for *T. carbonaria*.

Daily Activity of Foragers

The results showed that the exit activity from hives by foragers in boxes hive in the morning was higher than the exit activity hive in bamboos hive (50.1 versus 36.6 heads/5 minutes) and in the afternoon (29.3 versus 25.3 heads/5 minutes) ($P<0.01$). In addition, the exit activity from hives by foragers in the morning was higher than in the afternoon for bamboos hive (36.6 versus 25.3 heads/5 minutes) and boxes hive (50.1 versus 29.3 heads/5 minutes) ($P<0.01$) (Table 2). The exit activity from boxes hives was higher than bamboos hives might be the foragers in the boxes must gather more materials to build the nest and be creating comfort conditions than bamboos hives. In addition, it also might be affected by the foragers and egg number, and the productivity of the queen bee, but in our study not measured.

Table 2. The mean of exit activity of foragers stingless bee *Tetragonula* sp. from bamboos and boxes hives

Observation time	Bamboos hive (heads/5 minutes)	Boxes hive (heads/5 minutes)	SEM	*P*
Morning (08:00 am)	36.6^{bx}	50.1^{ax}	0.47	0.00
Afternoon (4:00 pm)	25.3^{by}	29.3^{ay}	0.22	0.00

^{a,b} Different superscripts within rows indicate differences at $p<0.05$
^{x,y} Different superscripts within column indicate differences at $p<0.05$

The exit activity of foragers stingless bee *Tetragonula* sp. in the morning was higher than in the afternoon because in the morning very abundant blooming flowers as the food source like nectar (raw material to produce honey) and pollen (raw material to produce bee-pollen or bee bread), and resin (raw material to produce propolis). The exit activity hives from stingless bee *Tetragonula* sp. in this study was differ from those previously for stingless bees *Tetragonula*

laeviceps, *Heterotrigona itama*, and *Lepidotrogona terminata* (Atmowidi et al 2018), for *T. laeviceps* (Agus et al 2019b; Gadhiya and Pastagia 2019), and for *Trigona* sp. (*Tetragonula* sp.) (Agussalim et al 2015). The different daily activity from each stingless bee was affected by the different stingless bee species, geographical origin (related to temperature, humidity, light intensity, wind velocity), foragers and egg number.

Honey Production

The results showed that the honey pots number after meliponiculture one-month from boxes hive was higher than from bamboos hive for all of the honey pots size were 18.1 versus 8.27 pots for big pots, 25.8 versus 16.3 pots for medium pots, and 26.8 versus 17.6 pots for small pots ($P<0.01$) (Table 3). The honey pots number was higher in the boxes hive was affected by the good development of colonies from boxes such as eggs or brood cells and foragers number much more that impact on the higher exit activity from the hive by foragers in boxes hive than in bamboos hive (Table 2).

Table 3. The mean of honey pots number from stingless bee *Tetragonula* sp. after one-month meliponiculture

Honey Pots Number	Bamboos hive (pots)	Boxes hive (pots)	SEM	*P*
Big	8.27^{b}	18.1^{a}	1.11	0.00
Medium	16.3^{b}	25.8^{a}	1.34	0.00
Small	17.6^{b}	26.8^{a}	1.53	0.00

^{a,b} Different superscripts within rows indicate differences at $p<0.05$

The foragers in the boxes hive very actively to collect nectar from flowers and resin from plants than from bamboos hive was shown by the higher exit activity of foragers (Table 2). In addition, the volume from boxes hive was proportional for *Tetragonula* sp. than bamboos hive volume was smaller, thus allowing the colonies in boxes hives to develop properly. The volume each honey pot from boxes hive was higher than bamboo hive for all of the honey pots size were 0.37 versus 0.32 ml for the big pot, 0.28 versus 0.25 ml for the medium pot, and 0.18 versus 0.14 ml for the small pot ($P<0.01$) (Table 4). The higher of honey volume each pot from boxes hive might be related to the ability of workers to produce the big pot and the foragers very active to collect nectar and resin from plants was shown by the higher exit activity of foragers in boxes hive than in bamboos hive (Table 2).

Table 4. The mean of honey volume each pot from bamboos and boxes hives by stingless bee *Tetragonula* sp.

Honey volume (mL)	Bamboos hive	Boxes hive	SEM	*P*
Big pot	0.32^{b}	0.37^{a}	0.01	0.01
Medium pot	0.25^{b}	0.28^{a}	0.01	0.02
Small pot	0.14^{b}	0.18^{a}	0.01	0.01

^{a,b} Different superscripts within rows indicate differences at $p<0.05$

The honey production of stingless bee *Tetragonula* sp. from Boxes hive was higher than bamboos hive for all of the honey pot were 6.68 versus 2.65 ml for the big honey pot, 7.22 versus 4.07 ml for the medium honey pot, and 4.82 versus 2.46 ml for the small honey pot ($P<0.01$) (Table 5). The honey production in Sukadana Bee Village was supported by plants as the source of nectar were longan, banana, mango, cashew, sunflowers, start fruit, bilimbi, coconut, calliandra, Jamaica cherry, papaya, and cassava. The plants have different times for flowering and blooming, but they support each other.

Table 5. Honey production of stingless bee *Tetragonula* sp. for one-month meliponiculture in Sukadana Bee Village, North Lombok

Honey production (mL)	Bamboos hive	Boxes hive	SEM	*P*
Big pot	2.65[b]	6.68[a]	0.43	0.00
Medium pot	4.07[b]	7.22[a]	0.39	0.00
Small pot	2.46[b]	4.82[a]	0.29	0.00

[a,b] Different superscripts within rows indicate differences at $p<0.05$

The higher honey production in boxes hive than bamboos hive was affected the higher exit activity of foragers in the boxes hive than bamboos hive in the morning and afternoon (Table 2) that impact on much more nectar and resin has been collected by foragers to produce honey and propolis. Furthermore, the nectar and resin much more will impact the increase of honey pots number (Table 3).

Production of honey stingless bee *Tetragonula* sp. in this study (Table 5) was differ from reported by Agussalim et al (2017) for stingless bee *Trigona* sp. (*Tetragonula* sp.). The difference of honey production with this study was affected by the plant types as the food source, the bee species which involved in honey production, the daily activities of foragers especially when collecting nectar, and resin from plants and also foragers number. In addition, in Sukadana Bee Village was the center for research, development, empowerment, and community service to poverty alleviation and livelihood security of communities, especially beekeepers in North Lombok Regency, West Nusa Tenggara Province, Indonesia. Thus, in the future is required advanced study about the roles of stingless bees meliponiculture on the income of beekeepers and poverty alleviation in communities.

Conclusions

- The exit activity of hives from stingless bee *Tetragonula* sp. foragers in the boxes hive was ranged from 29.3 to 50.1 heads/5 minutes and was ranged from 25.3 to 36.6 heads/5 minutes for bamboos hive
- The honey pots number from stingless bee *Tetragonula* sp. in boxes hive after meliponiculture one-month were 18.1 pots (big pot), 25.8 pots (medium pot), 26.8 pots (small pot), and 8.27 pots (big pot), 16.3 (medium pot), and 17.6 pots (small pot) for bamboos hive
- The honey volume of stingless bee *Tetragonula* sp. from boxes hive in each pot were 0.37 ml (big pot), 0.28 ml (medium pot), 0.18 ml (small pot), and 0.32 ml (big pot), 0.25 ml (medium pot), and 0.14 ml (small pot) for bamboos hive
- The honey production of stingless bee *Tetragonula* sp. after meliponiculture one-month in boxes hive were 6.68 ml (big pot), 7.22 ml (medium pot), 4.82 ml (small pot) and 2.65 ml (big pot), 4.07 ml (medium pot), and 2.46 ml (small pot) for bamboos hive.

Acknowledgments

The authors to thank Directorate General of Innovation Strengthen, Ministry of Research, Technology, and Higher Education of the Republic of Indonesia for financial support of this project through *Klaster Inovasi Lebah Madu* with contract number 002/F1/PPK.1/Kp/V/2019.

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Gmail erwan apis <apiserwan@gmail.com>

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erwan apis <apiserwan@gmail.com> 8 Juli 2020 pukul 09.14
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In Colombia

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Kepada: erwan apis <apiserwan@gmail.com>

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REgards

TRP

Professor T R Preston, PhD, DSc

Investigador Emérito
Centro para la Investigación en Sistemas Sostenibles
de Producción Agropecuaria (CIPAV),
Carrera 25 No 6-62 Cali, Colombia

Senior Editor, Livestock Research for Rural Development
http://www.lrrd.org (The international on-line journal on sustainable livestock-based agriculture)

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Gmail erwan apis <apiserwan@gmail.com>

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erwan apis <apiserwan@gmail.com> 9 Juli 2020 pukul 10.15
Kepada: Reg Preston <reg.preston@gmail.com>

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as the Senior Editor in Livestock Research for Rural Development
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Thanks very much for comments and suggestions to improve our paper and we have been revising the paper according to comments and suggestions from the reviewer especially in introduction and materials and methods. In the materials and methods we use beekeeping for one-month because to determine the honey production in one month as the preliminary study for future study and also as the information for beekeepers in the North Lombok especially to predict income from honey sale. For meliponiculture has been replaced with beekeeping and we attached file revision
Thanks very much.

Best Regards,

Dr. Erwan
Faculty of Animal Science, University of Mataram, Indonesia

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Pengiriman ulang revisi/perbaikan artikel ke LRRD

Gmail **erwan apis <apiserwan@gmail.com>**

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erwan apis <apiserwan@gmail.com> 9 Juli 2020 pukul 00.48
Kepada: Reg Preston <reg.preston@gmail.com>

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Thanks very much for comments and suggestions to improve our paper and we have been revising the paper according to comments and suggestions from the reviewer especially in introduction and materials and methods. in the materials and methods we use beekeeping for one-month because to determine the honey production in one month as the preliminary study about the honey production. For meliponiculture has been replaced with beekeeping and we attached file after revision

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Dr. Erwan
Faculty of Animal Science, University of Mataram, Indonesia

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Reg Preston <reg.preston@gmail.com> 9 Juli 2020 pukul 19.16
Kepada: erwan apis <apiserwan@gmail.com>

Well received and sent to the reviewer

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TRP
Professor T R Preston, PhD, DSc

Investigador Emérito
Centro para la Investigación en Sistemas Sostenibles
de Producción Agropecuaria (CIPAV),
Carrera 25 No 6-62 Cali, Colombia

Senior Editor, Livestock Research for Rural Development
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Dear Professor T R Preston, Ph.D., DSc.
as the Senior Editor in Livestock Research for Rural Development
in Colombia

Message well received and Thanks very much for your information

Best Regards,

Dr. Erwan
Faculty of Animal Science, University of Mataram, Indonesia

[Kutipan teks disembunyikan]

---

erwan apis <apiserwan@gmail.com> 16 Juli 2020 pukul 23.45
Kepada: Reg Preston <reg.preston@gmail.com>

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as the Senior Editor in Livestock Research for Rural Development
in Colombia

We ask about the second revision for our journal and have it been finished reviewed ?
Thanks very much

Best Regards,

Dr. Erwan
Faculty of Animal Science, University of Mataram

On Thu, Jul 9, 2020 at 7:16 PM Reg Preston <reg.preston@gmail.com> wrote:
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ARTIKEL HASIL PERBAIKAN REVISI PERTAMA

The effect of different beehives on the activity of foragers, honey pots number, and honey production from stingless bee *Tetragonula* sp.

Erwan[1], Meiyana Astuti[1], Syamsuhaidi[1], Muhammad Muhsinin[1] and Agussalim[2]

[1]Faculty of Animal Science, University of Mataram, Jl. Majapahit No. 62, Mataram – 83125, Indonesia

[2]Faculty of Animal Science, Universitas Gadjah Mada, Jl. Fauna 3, Bulaksumur, Yogyakarta – 55281, Indonesia

Email: apiserwan@gmail.com

Abstract

Tetragonula sp. is one of stingless bee species nesting in bamboos hive and produced honey, bee bread, and propolis. The objective of this study was to evaluate the exit activity of foragers, honey pots number, honey volume each pot, and production of honey from stingless bee *Tetragonula* sp. Thirty colonies of stingless bee *Tetragonula* sp. from bamboos hive were divided into two groups were bamboos and boxes hives, each group consisted of 15 colonies. The colonies were transferred in the night to avoid stress in the bees consisted of a queen bee, foragers, drones, brood cells, and then beekeeping one-month in Sukadana Bee Village, North Lombok, Indonesia. The results showed that exit activity in the morning and afternoon of foragers from stingless bee *Tetragonula* sp. in the boxes hives was higher than bamboos hive ($P<0.01$). The honey pots number, honey volume each pot, and honey production (big, medium, and small pots) in boxes hive were higher than in bamboos hive ($P<0.01$).

Keywords: Beekeeping, Sukadana bee village, bamboo hive, box hive, nectar

Introduction

The stingless bees include tropical bee groups, in the world, more than 500 species have been identified and possibly more than 100 species unidentified (Michener 2013). In Indonesia, the stingless bees (*tribe Meliponini*) are at least 46 species (Kahono et al 2018) and mostly found nesting in bamboos, sugar palm stalks, tree trunks or woods, and in the ground (Agussalim et al 2015). One of the stingless bee species that can be found in Indonesia is *Tetragonula* sp. that nesting in a bamboo (Agus et al 2019a; Agussalim et al 2019). Stingless bee *Tetragonula* sp. can be producing honey, bee bread, and propolis like *Apis mellifera*, but the honey production is generally lower than honey production from all of honeybees *Apis genus*. In addition, the stingless bees much more in propolis production. Honey is a natural food made from the nectar that collected by worker bees or foragers from plant flowers (floral nectar), extrafloral nectar, and honeydew with adding enzymes (Codex Alimentarius 2001; Sihombing 2005).

In North Lombok, West Nusa Tenggara, Indonesia mostly beekeepers using box and bamboo as the hive for stingless beekeeping, but the information about the honey production from each beehive not available. Agussalim et al (2017) reported that honey production from stingless bee *Trigona* sp. (*Tetragonula* sp.) that domesticated from sugar palm stalks to various sizes of beehives using box was ranged from 49.20 to 66.60 ml after beekeeping two months. Although it has been performed study about honey production from stingless bee *Trigona* sp., the different sources of habitat from the stingless bee, different locations for beekeeping, and the type of hive will be influencing the activity of bees and honey production. The objective of this

study was to evaluate the exit activity of foragers, honey pots number, honey volume each pot, and production of honey from stingless bee *Tetragonula* sp.

Materials and Methods

Colony Transfer

The stingless bee *Tetragonula* sp. as much 30 colonies were adapted for one week in the Sukadana Bee Village, Bayan, North Lombok, Indonesia. The colonies were divided into two groups and each group consists of 15 colonies. The first group was box hive with size 40 x 20 x 15 cm and the second group was bamboo hive with the length 30 to 40 cm and diameter 7 to 8 cm. Thirty colonies of stingless bee *Tetragonula* sp. from bamboos were transferred to boxes and bamboos each hive was 15 colonies and performed in the night to avoid stress in the bees. The colonies were transferred consisted of a queen bee, workers (foragers), drones, brood cells or eggs, and all the colonies were beekeeping for one-month in Sukadana Bee Village.

Temperature and Humidity Environment

The temperature and humidity environment were measured every day for one-month using thermo-hygrometer in the morning (08:00 am) and in the afternoon (4:00 pm).

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Honey production of stingless bee *Tetragonula* sp. was measured after beekeeping one month. In brief, honey was harvested from boxes and bamboos with cutting the propolis as the construction in the boxes wall, then the honey was placed in the plastic bottles. Furthermore, honey was squeezed using hand to separated honey from propolis, then honey was measured by graduated cylinders. The plant types as the source of nectar to produce honey were identified.

Daily Activity of Foragers

The daily activity of the foragers was counted every day for one month i.e. the exit activity from hives was counted using hand counter check. The exit number of foragers from hives was counted by standing in front of the hive entrance at a distance 1 meter for 5 minutes each hive and was performed in the morning (08:00 am) and in the afternoon (4:00 pm).

Honey Pots Number

The pots honey number was counted after beekeeping one month were divided into three categories were big pots (diameter mean 1.1 cm), medium pots (diameter mean 0.7 cm), and small pots (diameter mean 0.4 cm). The boxes and bamboos hives were opened and then the number of honey pots was counted in the night was equipped with lighting. In addition, the production of honey from each honey pot was aspirated using syringe 1 ml and the honey volume each pot was measured.

Statistical analysis

The data of honey production, exit activity of foragers, pots honey number, and honey volume each pot from stingless bee *Tetragonula* sp. were analyzed by T-test, and the temperature and humidity environment were analyzed by descriptive analysis using SPSS statistics version 23.

Results and Discussion

Temperature and Humidity Environment

The results showed that the environment temperature in the Sukadana Bee Village, North Lombok was ranged from 25.0 to 26.1^{o}C in the morning, while in the afternoon was ranged from 28.6 to 30.4^{o}C. The environment humidity was ranged from 68.0 to 74.4% in the morning, while in the afternoon was ranged from 57.9 to 64.9% (Table 1). The temperature and humidity environment in the Sukadana Bee Village, North Lombok was including the normal temperature and humidity required by stingless bees to optimally productivity.

Table 1. The mean of temperature and humidity environment every week in the Sukadana Bee Village, North Lombok

Weeks	Temperature (^{o}C)		Humidity (%)	
	Morning	Afternoon	Morning	Afternoon
First	25.1	28.6	74.7	63.9
Second	25.7	30.4	68.0	61.3
Third	26.1	29.1	68.4	64.9
Fourth	25.0	30.1	69.9	57.9

The environment temperature required by the bees to collect food was ranged from 5 to 45^{o}C and if under or above it, decrease the activities of honeybees and even until its death (Abrol 2011). The elevated temperatures and the concomitant lack of water during dry periods can be induced absconding in stingless bees (Maia-Silva et al 2015). Heard and Hendrikz (1993) explained that the temperature was a significant effect on the flight activity of stingless bee *Trigona carbonaria*, but not consistent on humidity relative. The temperature threshold to activity was ranged from 18 to 19^{o}C. The peak activity *T. carbonaria* was ranged from 26.1 to 29.8^{o}C with humidity relative 35 to 90%. The temperature and humidity in the study was differ from those previously reported Agussalim et al (2015) for *Trigona* sp. (*Tetragonula* sp.) and Heard and Hendrikz (1993) for *T. carbonaria*.

Daily Activity of Foragers

The results showed that the exit activity from hives by foragers in boxes hive in the morning was higher than the exit activity hive in bamboos hive (50.1 versus 36.6 heads/5 minutes) and in the afternoon (29.3 versus 25.3 heads/5 minutes) ($P<0.01$). In addition, the exit activity from hives by foragers in the morning was higher than in the afternoon for bamboos hive (36.6 versus 25.3 heads/5 minutes) and boxes hive (50.1 versus 29.3 heads/5 minutes) ($P<0.01$) (Table 2). The exit activity from boxes hives was higher than bamboos hives might be the foragers in the boxes must gather more materials to build the nest and be creating comfort conditions than bamboos hives. In addition, it also might be affected by the foragers and egg number, and the productivity of the queen bee, but in our study not measured.

Table 2. The mean of exit activity of foragers stingless bee *Tetragonula* sp. from bamboos and boxes hives

Observation time	Bamboos hive (heads/5 minutes)	Boxes hive (heads/5 minutes)	SEM	*P*
Morning (08:00 am)	36.6^{bx}	50.1^{ax}	0.47	0.00
Afternoon (4:00 pm)	25.3^{by}	29.3^{ay}	0.22	0.00

[a,b] Different superscripts within rows indicate differences at $p<0.05$
[x,y] Different superscripts within column indicate differences at $p<0.05$

The exit activity of foragers stingless bee *Tetragonula* sp. in the morning was higher than in the afternoon because in the morning very abundant blooming flowers as the food source like nectar (raw material to produce honey) and pollen (raw material to produce bee-pollen or bee bread), and resin (raw material to produce propolis). The exit activity hives from stingless bee *Tetragonula* sp. in this study was differ from those previously for stingless bees *Tetragonula laeviceps*, *Heterotrigona itama*, and *Lepidotrogona terminata* (Atmowidi et al 2018), for *T. laeviceps* (Agus et al 2019b; Gadhiya and Pastagia 2019), and for *Trigona* sp. (*Tetragonula* sp.) (Agussalim et al 2015). The different daily activity from each stingless bee was affected by the different stingless bee species, geographical origin (related to temperature, humidity, light intensity, wind velocity), foragers and egg number.

Honey Production

The results showed that the honey pots number after beekeeping one-month from boxes hive was higher than from bamboos hive for all of the honey pots size were 18.1 versus 8.27 pots for big pots, 25.8 versus 16.3 pots for medium pots, and 26.8 versus 17.6 pots for small pots ($P<0.01$) (Table 3). The honey pots number was higher in the boxes hive was affected by the good development of colonies from boxes such as eggs or brood cells and foragers number much more that impact on the higher exit activity from the hive by foragers in boxes hive than in bamboos hive (Table 2).

Table 3. The mean of honey pots number from stingless bee *Tetragonula* sp. after beekeeping one-month

Honey Pots Number	Bamboos hive (pots)	Boxes hive (pots)	SEM	*P*
Big	8.27^{b}	18.1^{a}	1.11	0.00
Medium	16.3^{b}	25.8^{a}	1.34	0.00
Small	17.6^{b}	26.8^{a}	1.53	0.00

[a,b] Different superscripts within rows indicate differences at $p<0.05$

The foragers in the boxes hive very actively to collect nectar from flowers and resin from plants than from bamboos hive was shown by the higher exit activity of foragers (Table 2). In addition, the volume from boxes hive was proportional for *Tetragonula* sp. than bamboos hive volume was smaller, thus allowing the colonies in boxes hives to develop properly. The volume each honey pot from boxes hive was higher than bamboo hive for all of the honey pots size were 0.37 versus 0.32 ml for the big pot, 0.28 versus 0.25 ml for the medium pot, and 0.18 versus 0.14 ml for the small pot ($P<0.01$) (Table 4). The higher of honey volume each pot from boxes hive might be related to the ability of workers to produce the big pot and the foragers very active to collect nectar and resin from plants was shown by the higher exit activity of foragers in boxes hive than in bamboos hive (Table 2).

Table 4. The mean of honey volume each pot from bamboos and boxes hives by stingless bee *Tetragonula* sp.

Honey volume (mL)	Bamboos hive	Boxes hive	SEM	*P*
Big pot	0.32^{b}	0.37^{a}	0.01	0.01
Medium pot	0.25^{b}	0.28^{a}	0.01	0.02
Small pot	0.14^{b}	0.18^{a}	0.01	0.01

^{a,b} Different superscripts within rows indicate differences at $p<0.05$

The honey production of stingless bee *Tetragonula* sp. from Boxes hive was higher than bamboos hive for all of the honey pot were 6.68 versus 2.65 ml for the big honey pot, 7.22 versus 4.07 ml for the medium honey pot, and 4.82 versus 2.46 ml for the small honey pot ($P<0.01$) (Table 5). The honey production in Sukadana Bee Village was supported by plants as the source of nectar were longan, banana, mango, cashew, sunflowers, start fruit, bilimbi, coconut, calliandra, Jamaica cherry, papaya, and cassava. The plants have different times for flowering and blooming, but they support each other.

Table 5. Honey production of stingless bee *Tetragonula* sp. for one-month beekeeping in Sukadana Bee Village, North Lombok

Honey production (mL)	Bamboos hive	Boxes hive	SEM	*P*
Big pot	2.65^{b}	6.68^{a}	0.43	0.00
Medium pot	4.07^{b}	7.22^{a}	0.39	0.00
Small pot	2.46^{b}	4.82^{a}	0.29	0.00

^{a,b} Different superscripts within rows indicate differences at $p<0.05$

The higher honey production in boxes hive than bamboos hive was affected the higher exit activity of foragers in the boxes hive than bamboos hive in the morning and afternoon (Table 2) that impact on much more nectar and resin has been collected by foragers to produce honey and propolis. Furthermore, the nectar and resin much more will impact the increase of honey pots number (Table 3).

Production of honey stingless bee *Tetragonula* sp. in this study (Table 5) was differ from reported by Agussalim et al (2017) for stingless bee *Trigona* sp. (*Tetragonula* sp.). The difference of honey production with this study was affected by the plant types as the food source, the bee species which involved in honey production, the daily activities of foragers especially when collecting nectar, and resin from plants and also foragers number. In addition, in Sukadana Bee Village was the center for research, development, empowerment, and community service to poverty alleviation and livelihood security of communities, especially beekeepers in North Lombok Regency, West Nusa Tenggara Province, Indonesia. Thus, in the future is required advanced study about the roles of stingless bees beekeeping on the income of beekeepers and poverty alleviation in communities.

Conclusions

- The exit activity of hives from stingless bee *Tetragonula* sp. foragers in the boxes hive was ranged from 29.3 to 50.1 heads/5 minutes and was ranged from 25.3 to 36.6 heads/5 minutes for bamboos hive
- The honey pots number from stingless bee *Tetragonula* sp. in boxes hive after beekeeping one-month were 18.1 pots (big pot), 25.8 pots (medium pot), 26.8 pots (small pot), and 8.27 pots (big pot), 16.3 (medium pot), and 17.6 pots (small pot) for bamboos hive

- The honey volume of stingless bee *Tetragonula* sp. from boxes hive in each pot were 0.37 ml (big pot), 0.28 ml (medium pot), 0.18 ml (small pot), and 0.32 ml (big pot), 0.25 ml (medium pot), and 0.14 ml (small pot) for bamboos hive
- The honey production of stingless bee *Tetragonula* sp. after beekeeping one-month in boxes hive were 6.68 ml (big pot), 7.22 ml (medium pot), 4.82 ml (small pot) and 2.65 ml (big pot), 4.07 ml (medium pot), and 2.46 ml (small pot) for bamboos hive.

Acknowledgments

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PERMINTAAN PENGIRIMAN KEMBALI HASIL PERBAIKAN ARTIKEL OLEH EDITOR IN CHIEF LRDD (17 JULI 2020)

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Reg Preston <reg.preston@gmail.com> 17 Juli 2020 pukul 03.39
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DEar Authors
My apologies if you received already these comments

If you have responded please send your revised paper as I cannot locae it in my computer
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from the reviewer
****
In general:

I think they should make improvements to the writing and submit again.
I suggest change meliponiculture expression by the stingless beekeeping

In Specific:

In the Introduction, I think that the authors has experience in publication in LRRD and they should to do a better introduction that strengthening of our journal, specialy Agus and Agussalim.

Colony Transfer
There are problems with redaction. Please, finish the sentence idea and start other idea. First, moder hive gruop and after bamboo hive.

Honey Production
The authors should explain what´s the period of hive transfer (Modern and traditional hive). They don¨t explain which is the bees calendar it´s very important for Understand how is the bees dinamics. I seems like me it is short time for adaptation, they insure prodution in one month after transfer.

Daily Activity of Foragers:
It´s important describe aleatory form of sampñling.

Included paper reviewed.

Professor T R Preston, PhD, DSc

Investigador Emérito
Centro para la Investigación en Sistemas Sostenibles
de Producción Agropecuaria (CIPAV),
Carrera 25 No 6-62 Cali, Colombia

Senior Editor, Livestock Research for Rural Development
http://www.lrrd.org (The international on-line journal on sustainable livestock-based agriculture)

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erwan apis <apiserwan@gmail.com> 17 Juli 2020 pukul 16.18
Kepada: Reg Preston <reg.preston@gmail.com>

Dear Professor T R Preston, Ph.D., DSc.
as the Senior Editor in Livestock Research for Rural Development
in Colombia

Thanks very much for comments and suggestions to improve our paper and we have been revising the paper according to comments and suggestions from the reviewer especially in introduction and materials and methods. in the materials and methods we use beekeeping for one-month because to determine the honey production in one month as the preliminary study about the honey production and in addition it very important information for beekeepers in Notrh Lombok Indonesia. For meliponiculture word has been replaced with beekeeping. We send again and attached file after revision

Best Regards,

Dr. Erwan
Faculty of Animal Science, University of Mataram, Indonesia

[Kutipan teks disembunyikan]

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Reg Preston <reg.preston@gmail.com> 17 Juli 2020 pukul 20.07
Kepada: erwan apis <apiserwan@gmail.com>

Well received
I will send to the reviewer

Regards

TRP
Professor T R Preston, PhD, DSc

Investigador Emérito
Centro para la Investigación en Sistemas Sostenibles
de Producción Agropecuaria (CIPAV),
Carrera 25 No 6-62 Cali, Colombia

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[Kutipan teks disembunyikan]

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erwan apis <apiserwan@gmail.com> 17 Juli 2020 pukul 21.24
Kepada: Reg Preston <reg.preston@gmail.com>

Thanks very much Professor T R Preston, Ph.D., DSc. and we wait revision our paper

Best Regards,

Dr. Erwan
Faculty of Animal Science, University of Mataram
[Kutipan teks disembunyikan]

ARTIKEL HASIL PERBAIKAN REVISI PERTAMA

The effect of different beehives on the activity of foragers, honey pots number, and honey production from stingless bee *Tetragonula* sp.

Erwan[1], Meiyana Astuti[1], Syamsuhaidi[1], Muhammad Muhsinin[1] and Agussalim[2]

[1]Faculty of Animal Science, University of Mataram, Jl. Majapahit No. 62, Mataram – 83125, Indonesia

[2]Faculty of Animal Science, Universitas Gadjah Mada, Jl. Fauna 3, Bulaksumur, Yogyakarta – 55281, Indonesia

Email: apiserwan@gmail.com

Abstract

Tetragonula sp. is one of stingless bee species nesting in bamboos hive and produced honey, bee bread, and propolis. The objective of this study was to evaluate the exit activity of foragers, honey pots number, honey volume each pot, and production of honey from stingless bee *Tetragonula* sp. Thirty colonies of stingless bee *Tetragonula* sp. from bamboos hive were divided into two groups were bamboos and boxes hives, each group consisted of 15 colonies. The colonies were transferred in the night to avoid stress in the bees consisted of a queen bee, foragers, drones, brood cells, and then beekeeping one-month in Sukadana Bee Village, North Lombok, Indonesia. The results showed that exit activity in the morning and afternoon of foragers from stingless bee *Tetragonula* sp. in the boxes hives was higher than bamboos hive ($P<0.01$). The honey pots number, honey volume each pot, and honey production (big, medium, and small pots) in boxes hive were higher than in bamboos hive ($P<0.01$).

Keywords: Beekeeping, Sukadana bee village, bamboo hive, box hive, nectar

Introduction

The stingless bees include tropical bee groups, in the world, more than 500 species have been identified and possibly more than 100 species unidentified (Michener 2013). In Indonesia, the stingless bees (*tribe Meliponini*) are at least 46 species (Kahono et al 2018) and mostly found nesting in bamboos, sugar palm stalks, tree trunks or woods, and in the ground (Agussalim et al 2015). One of the stingless bee species that can be found in Indonesia is *Tetragonula* sp. that nesting in a bamboo (Agus et al 2019a; Agussalim et al 2019). Stingless bee *Tetragonula* sp. can be producing honey, bee bread, and propolis like *Apis mellifera*, but the honey production is generally lower than honey production from all of honeybees *Apis genus*. In addition, the stingless bees much more in propolis production. Honey is a natural food made from the nectar that collected by worker bees or foragers from plant flowers (floral nectar), extrafloral nectar, and honeydew with adding enzymes (Codex Alimentarius 2001; Sihombing 2005).

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The data of honey production, exit activity of foragers, pots honey number, and honey volume each pot from stingless bee *Tetragonula* sp. were analyzed by T-test, and the temperature and humidity environment were analyzed by descriptive analysis using SPSS statistics version 23.

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The results showed that the environment temperature in the Sukadana Bee Village, North Lombok was ranged from 25.0 to 26.1^{o}C in the morning, while in the afternoon was ranged from 28.6 to 30.4^{o}C. The environment humidity was ranged from 68.0 to 74.4% in the morning, while in the afternoon was ranged from 57.9 to 64.9% (Table 1). The temperature and humidity environment in the Sukadana Bee Village, North Lombok was including the normal temperature and humidity required by stingless bees to optimally productivity.

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Third	26.1	29.1	68.4	64.9
Fourth	25.0	30.1	69.9	57.9

The environment temperature required by the bees to collect food was ranged from 5 to 45^{o}C and if under or above it, decrease the activities of honeybees and even until its death (Abrol 2011). The elevated temperatures and the concomitant lack of water during dry periods can be induced absconding in stingless bees (Maia-Silva et al 2015). Heard and Hendrikz (1993) explained that the temperature was a significant effect on the flight activity of stingless bee *Trigona carbonaria*, but not consistent on humidity relative. The temperature threshold to activity was ranged from 18 to 19^{o}C. The peak activity *T. carbonaria* was ranged from 26.1 to 29.8^{o}C with humidity relative 35 to 90%. The temperature and humidity in the study was differ from those previously reported Agussalim et al (2015) for *Trigona* sp. (*Tetragonula* sp.) and Heard and Hendrikz (1993) for *T. carbonaria*.

Daily Activity of Foragers

The results showed that the exit activity from hives by foragers in boxes hive in the morning was higher than the exit activity hive in bamboos hive (50.1 versus 36.6 heads/5 minutes) and in the afternoon (29.3 versus 25.3 heads/5 minutes) ($P<0.01$). In addition, the exit activity from hives by foragers in the morning was higher than in the afternoon for bamboos hive (36.6 versus 25.3 heads/5 minutes) and boxes hive (50.1 versus 29.3 heads/5 minutes) ($P<0.01$) (Table 2). The exit activity from boxes hives was higher than bamboos hives might be the foragers in the boxes must gather more materials to build the nest and be creating comfort conditions than bamboos hives. In addition, it also might be affected by the foragers and egg number, and the productivity of the queen bee, but in our study not measured.

Table 2. The mean of exit activity of foragers stingless bee *Tetragonula* sp. from bamboos and boxes hives

Observation time	Bamboos hive (heads/5 minutes)	Boxes hive (heads/5 minutes)	SEM	*P*
Morning (08:00 am)	36.6^{bx}	50.1^{ax}	0.47	0.00
Afternoon (4:00 pm)	25.3^{by}	29.3^{ay}	0.22	0.00

[a,b] Different superscripts within rows indicate differences at $p<0.05$
[x,y] Different superscripts within column indicate differences at $p<0.05$

The exit activity of foragers stingless bee *Tetragonula* sp. in the morning was higher than in the afternoon because in the morning very abundant blooming flowers as the food source like nectar (raw material to produce honey) and pollen (raw material to produce bee-pollen or bee bread), and resin (raw material to produce propolis). The exit activity hives from stingless bee *Tetragonula* sp. in this study was differ from those previously for stingless bees *Tetragonula laeviceps*, *Heterotrigona itama*, and *Lepidotrogona terminata* (Atmowidi et al 2018), for *T. laeviceps* (Agus et al 2019b; Gadhiya and Pastagia 2019), and for *Trigona* sp. (*Tetragonula* sp.) (Agussalim et al 2015). The different daily activity from each stingless bee was affected by the different stingless bee species, geographical origin (related to temperature, humidity, light intensity, wind velocity), foragers and egg number.

Honey Production

The results showed that the honey pots number after beekeeping one-month from boxes hive was higher than from bamboos hive for all of the honey pots size were 18.1 versus 8.27 pots for big pots, 25.8 versus 16.3 pots for medium pots, and 26.8 versus 17.6 pots for small pots ($P<0.01$) (Table 3). The honey pots number was higher in the boxes hive was affected by the good development of colonies from boxes such as eggs or brood cells and foragers number much more that impact on the higher exit activity from the hive by foragers in boxes hive than in bamboos hive (Table 2).

Table 3. The mean of honey pots number from stingless bee *Tetragonula* sp. after beekeeping one-month

Honey Pots Number	Bamboos hive (pots)	Boxes hive (pots)	SEM	*P*
Big	8.27^{b}	18.1^{a}	1.11	0.00
Medium	16.3^{b}	25.8^{a}	1.34	0.00
Small	17.6^{b}	26.8^{a}	1.53	0.00

[a,b] Different superscripts within rows indicate differences at $p<0.05$

The foragers in the boxes hive very actively to collect nectar from flowers and resin from plants than from bamboos hive was shown by the higher exit activity of foragers (Table 2). In addition, the volume from boxes hive was proportional for *Tetragonula* sp. than bamboos hive volume was smaller, thus allowing the colonies in boxes hives to develop properly. The volume each honey pot from boxes hive was higher than bamboo hive for all of the honey pots size were 0.37 versus 0.32 ml for the big pot, 0.28 versus 0.25 ml for the medium pot, and 0.18 versus 0.14 ml for the small pot ($P<0.01$) (Table 4). The higher of honey volume each pot from boxes hive might be related to the ability of workers to produce the big pot and the foragers very active to collect nectar and resin from plants was shown by the higher exit activity of foragers in boxes hive than in bamboos hive (Table 2).

Table 4. The mean of honey volume each pot from bamboos and boxes hives by stingless bee *Tetragonula* sp.

Honey volume (mL)	Bamboos hive	Boxes hive	SEM	*P*
Big pot	0.32^{b}	0.37^{a}	0.01	0.01
Medium pot	0.25^{b}	0.28^{a}	0.01	0.02
Small pot	0.14^{b}	0.18^{a}	0.01	0.01

^{a,b} Different superscripts within rows indicate differences at $p<0.05$

The honey production of stingless bee *Tetragonula* sp. from Boxes hive was higher than bamboos hive for all of the honey pot were 6.68 versus 2.65 ml for the big honey pot, 7.22 versus 4.07 ml for the medium honey pot, and 4.82 versus 2.46 ml for the small honey pot ($P<0.01$) (Table 5). The honey production in Sukadana Bee Village was supported by plants as the source of nectar were longan, banana, mango, cashew, sunflowers, start fruit, bilimbi, coconut, calliandra, Jamaica cherry, papaya, and cassava. The plants have different times for flowering and blooming, but they support each other.

Table 5. Honey production of stingless bee *Tetragonula* sp. for one-month beekeeping in Sukadana Bee Village, North Lombok

Honey production (mL)	Bamboos hive	Boxes hive	SEM	*P*
Big pot	2.65^{b}	6.68^{a}	0.43	0.00
Medium pot	4.07^{b}	7.22^{a}	0.39	0.00
Small pot	2.46^{b}	4.82^{a}	0.29	0.00

^{a,b} Different superscripts within rows indicate differences at $p<0.05$

The higher honey production in boxes hive than bamboos hive was affected the higher exit activity of foragers in the boxes hive than bamboos hive in the morning and afternoon (Table 2) that impact on much more nectar and resin has been collected by foragers to produce honey and propolis. Furthermore, the nectar and resin much more will impact the increase of honey pots number (Table 3).

Production of honey stingless bee *Tetragonula* sp. in this study (Table 5) was differ from reported by Agussalim et al (2017) for stingless bee *Trigona* sp. (*Tetragonula* sp.). The difference of honey production with this study was affected by the plant types as the food source, the bee species which involved in honey production, the daily activities of foragers especially when collecting nectar, and resin from plants and also foragers number. In addition, in Sukadana Bee Village was the center for research, development, empowerment, and community service to poverty alleviation and livelihood security of communities, especially beekeepers in North Lombok Regency, West Nusa Tenggara Province, Indonesia. Thus, in the future is required advanced study about the roles of stingless bees beekeeping on the income of beekeepers and poverty alleviation in communities.

Conclusions

- The exit activity of hives from stingless bee *Tetragonula* sp. foragers in the boxes hive was ranged from 29.3 to 50.1 heads/5 minutes and was ranged from 25.3 to 36.6 heads/5 minutes for bamboos hive
- The honey pots number from stingless bee *Tetragonula* sp. in boxes hive after beekeeping one-month were 18.1 pots (big pot), 25.8 pots (medium pot), 26.8 pots (small pot), and 8.27 pots (big pot), 16.3 (medium pot), and 17.6 pots (small pot) for bamboos hive

- The honey volume of stingless bee *Tetragonula* sp. from boxes hive in each pot were 0.37 ml (big pot), 0.28 ml (medium pot), 0.18 ml (small pot), and 0.32 ml (big pot), 0.25 ml (medium pot), and 0.14 ml (small pot) for bamboos hive
- The honey production of stingless bee *Tetragonula* sp. after beekeeping one-month in boxes hive were 6.68 ml (big pot), 7.22 ml (medium pot), 4.82 ml (small pot) and 2.65 ml (big pot), 4.07 ml (medium pot), and 2.46 ml (small pot) for bamboos hive.

Acknowledgments

The authors to thank Directorate General of Innovation Strengthen, Ministry of Research, Technology, and Higher Education of the Republic of Indonesia for financial support of this project through *Klaster Inovasi Lebah Madu* with contract number 002/F1/PPK.1/Kp/V/2019.

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KOMENTAR KEDUA DARI REVIEWER
(23 JULI 2020)

200622apise

Reg Preston <reg.preston@gmail.com> 23 Juli 2020 pukul 22.36
Kepada: erwan apis <apiserwan@gmail.com>

Dear Authors
The reviewer is pleased with the corrections. Only asks about wax and propolis in the honey pots

The paper is accepted but ensure you have followed all the norms of LRRD (attached) and send me final version which we can format in HTML

Regards

TRP

From the reviewer
****

Existe sensibles mejoras en el documento, es muy interesante.
Solo sugerirles a los autores el uso adecuado de términos. En materiales y metodos, sección Honey production.
Honey pots is a good word. But There are confused of concept about the composition of the honey pots. It´is possible there is propolis in build of them but it's mainly wax. Please review biology of hive.

Lo demas siento que esta bien. (the rest is OK)

Professor T R Preston, PhD, DSc

Investigador Emérito
Centro para la Investigación en Sistemas Sostenibles
de Producción Agropecuaria (CIPAV),
Carrera 25 No 6-62 Cali, Colombia

Senior Editor, Livestock Research for Rural Development
http://www.lrrd.org (The international on-line journal on sustainable livestock-based agriculture)

Tropical Animal Production
http://www.cipav.org.co/TAP/tapindex.htm

Matching Ruminant Production Systems with Available Resources in the Tropics and Sub-Tropics
http://www.cipav.org.co/PandL/Preston_Leng.htm

El sitio Web sobre Producción Tropical Sostenible (Universidad de los Llanos, Colombia)
www.produccionTropicalsostenible.info

Web site (old) of MEKARN I

http://hostcambodia.com/mekarn/indexold.htm

BALASAN KOMENTAR KEDUA DARI REVIEWER
(24 JULI 2020)

200622apise

erwan apis <apiserwan@gmail.com> 24 Juli 2020 pukul 23.23
Kepada: Reg Preston <reg.preston@gmail.com>

Dear Professor T R Preston
as the Senior Editor in Livestock Research for Rural Development
in Colombia

Thanks very much for your information and we must clarify some mistakes about wax and propolis in the nest. The nests of Apis mellifera honeybees are made from their beeswax, and their hives are coated with propolis as a sealant. On the other hand, the nests of stingless bees are constructed of propolis, because stingless bees do not produce hexagonal beeswax combs. The entire nests of stingless bees in tropical regions are referred to as “propolis” (Miyata et al 2020) from the journal: J. Nat. Prod. 2019, 82, 205−210 with title of paper: Propolis Components from Stingless Bees Collected on South Sulawesi, Indonesia, and Their Xanthine Oxidase Inhibitory Activity.
So the pot honey we can called as the cerumen or propolis not wax and we attached paper after the second revision

Best regards

Dr. Erwan
Faculty of Animal Science, University of Mataram

On Thu, Jul 23, 2020 at 10:36 PM erwan apis <apiserwan@gmail.com> wrote:

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ARTIKEL HASIL PERBAIKAN REVISI KEDUA

The effect of different beehives on the activity of foragers, honey pots number, and honey production from stingless bee *Tetragonula* sp.

Erwan[1], Meiyana Astuti[1], Syamsuhaidi[1], Muhammad Muhsinin[1] and Agussalim[2]

[1]Faculty of Animal Science, University of Mataram, Jl. Majapahit No. 62, Mataram – 83125, Indonesia

[2]Faculty of Animal Science, Universitas Gadjah Mada, Jl. Fauna 3, Bulaksumur, Yogyakarta – 55281, Indonesia

Email: apiserwan@gmail.com

Abstract

Tetragonula sp. is one of stingless bee species nesting in bamboos hive and produced honey, bee bread, and propolis. The objective of this study was to evaluate the exit activity of foragers, honey pots number, honey volume each pot, and production of honey from stingless bee *Tetragonula* sp. Thirty colonies of stingless bee *Tetragonula* sp. from bamboos hive were divided into two groups were bamboos and boxes hives, each group consisted of 15 colonies. The colonies were transferred in the night to avoid stress in the bees consisted of a queen bee, foragers, drones, brood cells, and then beekeeping one-month in Sukadana Bee Village, North Lombok, Indonesia. The results showed that exit activity in the morning and afternoon of foragers from stingless bee *Tetragonula* sp. in the boxes hives was higher than bamboos hive ($P<0.01$). The honey pots number, honey volume each pot, and honey production (big, medium, and small pots) in boxes hive were higher than in bamboos hive ($P<0.01$).

Keywords: Beekeeping, Sukadana bee village, bamboo hive, box hive, nectar

Introduction

The stingless bees include tropical bee groups, in the world, more than 500 species have been identified and possibly more than 100 species unidentified (Michener 2013). In Indonesia, the stingless bees (*tribe Meliponini*) are at least 46 species (Kahono et al 2018) and mostly found nesting in bamboos, sugar palm stalks, tree trunks or woods, and in the ground (Agussalim et al 2015). One of the stingless bee species that can be found in Indonesia is *Tetragonula* sp. that nesting in a bamboo (Agus et al 2019a; Agussalim et al 2019). Stingless bee *Tetragonula* sp. can be producing honey, bee bread, and propolis like *Apis mellifera*, but the honey production is generally lower than honey production from all of honeybees from *Apis genus*. In addition, the stingless bees much more in propolis production. Honey is a natural food made from the nectar that collected by worker bees or foragers from plant flowers (floral nectar), extrafloral nectar, and honeydew with adding enzymes (Codex Alimentarius 2001; Sihombing 2005).

In North Lombok, West Nusa Tenggara, Indonesia mostly beekeepers using box and bamboo as the hive for stingless beekeeping, but the information about the honey production from each beehive not available. Agussalim et al (2017) reported that honey production from stingless bee from genus of *Tetragonula* that origin from Genggelang North Lombok that domesticated from sugar palm stalks to various sizes of beehives using box was ranged from 49.20 to 66.60 ml after beekeeping two months. Although it has been performed study about honey production from stingless bee *Trigona* sp., the different sources of habitat from the stingless bee, different locations for beekeeping, and the type of hive will be influencing the activity of bees and honey

production. The objective of this study was to evaluate the exit activity of foragers, honey pots number, honey volume each pot, and production of honey from stingless bee *Tetragonula* sp.

Materials and Methods

Colony Transfer

The stingless bee *Tetragonula* sp. as much 30 colonies were adapted for one week in the Sukadana Bee Village, Bayan, North Lombok, Indonesia. The colonies were divided into two groups and each group consists of 15 colonies. The first group was box hive with size 40 x 20 x 15 cm and the second group was bamboo hive with the length 30 to 40 cm and diameter 7 to 8 cm. Thirty colonies of stingless bee *Tetragonula* sp. from bamboos were transferred to boxes and bamboos were performed in the night to avoid stress in the bees. The colonies were transferred consisted of a queen bee, workers (foragers), drones, brood cells, and then all the colonies were beekeeping for one-month in Sukadana Bee Village.

Temperature and Humidity Environment

The temperature and humidity environment were measured every day for one-month using thermo-hygrometer in the morning (08:00 am) and in the afternoon (4:00 pm).

Honey Production

Honey production of stingless bee *Tetragonula* sp. was measured after beekeeping one month. In brief, honey was harvested from boxes and bamboos with cutting the propolis as the construction in the boxes wall, then the honey was placed in the plastic bottles. Furthermore, honey was squeezed using hand to separated honey from cerumen or propolis, then honey was measured by graduated cylinders. The predominant plant types as the source of nectar to produce honey also were identified at a maximum distance was 200 meters.

Daily Activity of Foragers

The daily activity of the foragers was counted every day for one month i.e. the exit activity from hives was counted using hand counter check. The exit number of foragers from hives was counted by standing in front of the hive entrance at a distance 1 meter for 5 minutes each hive and was performed in the morning (08:00 am) and in the afternoon (4:00 pm).

Honey Pots Number

The pots honey number was counted after beekeeping one month were divided into three categories were big pots (diameter mean 1.1 cm), medium pots (diameter mean 0.7 cm), and small pots (diameter mean 0.4 cm). The boxes and bamboos hives were opened and then the number of honey pots was counted in the night was equipped with lighting. In addition, the production of honey from each honey pot was aspirated using syringe 1 ml and the honey volume each pot was measured.

Statistical analysis

The data of honey production, exit activity of foragers, pots honey number, and honey volume each pot from stingless bee *Tetragonula* sp. were analyzed by T-test, and the temperature and humidity environment were analyzed by descriptive analysis using SPSS statistics version 23.

Results and Discussion

Temperature and Humidity Environment

The results showed that the environment temperature in the Sukadana Bee Village, North Lombok was ranged from 25.0 to 26.1^{o}C in the morning, while in the afternoon was ranged from 28.6 to 30.4^{o}C. The environment humidity was ranged from 68.0 to 74.4% in the morning, while in the afternoon was ranged from 57.9 to 64.9% (Table 1). The temperature and humidity environment in the Sukadana Bee Village, North Lombok was including the normal temperature and humidity required by stingless bees to optimally productivity.

Table 1. The mean of temperature and humidity environment every week in the Sukadana Bee Village, North Lombok

Weeks	Temperature (^{o}C)		Humidity (%)	
	Morning	Afternoon	Morning	Afternoon
First	25.1	28.6	74.7	63.9
Second	25.7	30.4	68.0	61.3
Third	26.1	29.1	68.4	64.9
Fourth	25.0	30.1	69.9	57.9

The environment temperature required by the bees to collect food was ranged from 5 to 45^{o}C and if under or above it, decrease the activities of honeybees and even until its death (Abrol 2011). The elevated temperatures and the concomitant lack of water during dry periods can be induced absconding in stingless bees (Maia-Silva et al 2015). Heard and Hendrikz (1993) explained that the temperature was a significant effect on the flight activity of stingless bee *Trigona carbonaria*, but not consistent on humidity relative. The temperature threshold to activity was ranged from 18 to 19^{o}C. The peak activity *T. carbonaria* was ranged from 26.1 to 29.8^{o}C with humidity relative 35 to 90%. The temperature and humidity in the study was differ from those previously reported Agussalim et al (2015) for *Trigona* sp. (*Tetragonula* sp.) and Heard and Hendrikz (1993) for *T. carbonaria*.

Daily Activity of Foragers

The results showed that the exit activity from hives by foragers in boxes hive in the morning was higher than the exit activity hive in bamboos hive (50.1 versus 36.6 heads/5 minutes) and in the afternoon (29.3 versus 25.3 heads/5 minutes) ($P<0.01$). In addition, the exit activity from hives by foragers in the morning was higher than in the afternoon for bamboos hive (36.6 versus 25.3 heads/5 minutes) and boxes hive (50.1 versus 29.3 heads/5 minutes) ($P<0.01$) (Table 2). The exit activity from boxes hives was higher than bamboos hives might be the foragers in the boxes must gather more materials to build the nest and be creating comfort conditions than bamboos hives. In addition, it also might be affected by the foragers and egg number, and the productivity of the queen bee, but in our study not measured.

Table 2. The mean of exit activity of foragers stingless bee *Tetragonula* sp. from bamboos and boxes hives

Observation time	Bamboos hive (heads/5 minutes)	Boxes hive (heads/5 minutes)	SEM	*P*
Morning (08:00 am)	36.6^{bx}	50.1^{ax}	0.47	0.00
Afternoon (4:00 pm)	25.3^{by}	29.3^{ay}	0.22	0.00

[a,b] Different superscripts within rows indicate differences at $p<0.05$
[x,y] Different superscripts within column indicate differences at $p<0.05$

The exit activity of foragers stingless bee *Tetragonula* sp. in the morning was higher than in the afternoon because in the morning very abundant blooming flowers as the food source like nectar (raw material to produce honey) and pollen (raw material to produce bee-pollen or bee bread), and resin (raw material to produce propolis or cerumen or geopropolis). The exit activity hives from stingless bee *Tetragonula* sp. in this study was differ from those previously for stingless bees *Tetragonula laeviceps*, *Heterotrigona itama*, and *Lepidotrogona terminata* (Atmowidi et al 2018), for *T. laeviceps* (Agus et al 2019b; Gadhiya and Pastagia 2019), and for *Trigona* sp. (*Tetragonula* sp.) (Agussalim et al 2015). The different daily activity from each stingless bee was affected by the different stingless bee species, geographical origin (related to temperature, humidity, light intensity, wind velocity), foragers and egg number.

Honey Production

The results showed that the honey pots number after beekeeping one-month from boxes hive was higher than from bamboos hive for all of the honey pots size were 18.1 versus 8.27 pots for big pots, 25.8 versus 16.3 pots for medium pots, and 26.8 versus 17.6 pots for small pots ($P<0.01$) (Table 3). The honey pots number was higher in the boxes hive was affected by the good development of colonies from boxes such as eggs or brood cells and foragers number much more that impact on the higher exit activity from the hive by foragers in boxes hive than in bamboos hive (Table 2).

Table 3. The mean of honey pots number from stingless bee *Tetragonula* sp. after beekeeping one-month

Honey Pots Number	Bamboos hive (pots)	Boxes hive (pots)	SEM	*P*
Big	8.27^{b}	18.1^{a}	1.11	0.00
Medium	16.3^{b}	25.8^{a}	1.34	0.00
Small	17.6^{b}	26.8^{a}	1.53	0.00

[a,b] Different superscripts within rows indicate differences at $p<0.05$

The foragers in the boxes hive very actively to collect nectar from flowers and resin from plants than from bamboos hive was shown by the higher exit activity of foragers (Table 2). In addition, the volume from boxes hive was proportional for *Tetragonula* sp. than bamboos hive volume was smaller, thus allowing the colonies in boxes hives to develop properly. The volume each honey pot from boxes hive was higher than bamboo hive for all of the honey pots size were 0.37 versus 0.32 ml for the big pot, 0.28 versus 0.25 ml for the medium pot, and 0.18 versus 0.14 ml for the small pot ($P<0.01$) (Table 4). The higher of honey volume each pot from boxes hive might be related to the ability of workers to produce the big pot and the foragers very active to collect nectar and resin from plants was shown by the higher exit activity of foragers in boxes hive than in bamboos hive (Table 2).

Table 4. The mean of honey volume each pot from bamboos and boxes hives by stingless bee *Tetragonula* sp.

Honey volume (mL)	Bamboos hive	Boxes hive	SEM	*P*
Big pot	0.32^{b}	0.37^{a}	0.01	0.01
Medium pot	0.25^{b}	0.28^{a}	0.01	0.02
Small pot	0.14^{b}	0.18^{a}	0.01	0.01

^{a,b} Different superscripts within rows indicate differences at $p<0.05$

The honey production of stingless bee *Tetragonula* sp. from Boxes hive was higher than bamboos hive for all of the honey pot were 6.68 versus 2.65 ml for the big honey pot, 7.22 versus 4.07 ml for the medium honey pot, and 4.82 versus 2.46 ml for the small honey pot ($P<0.01$) (Table 5). The honey production in Sukadana Bee Village was supported by plants as the source of nectar were longan, banana, mango, cashew, sunflowers, start fruit, bilimbi, coconut, calliandra, Jamaica cherry, papaya, and cassava. The plants have different times for flowering and blooming, but they support each other.

Table 5. Honey production of stingless bee *Tetragonula* sp. for one-month beekeeping in Sukadana Bee Village, North Lombok

Honey production (mL)	Bamboos hive	Boxes hive	SEM	*P*
Big pot	2.65^{b}	6.68^{a}	0.43	0.00
Medium pot	4.07^{b}	7.22^{a}	0.39	0.00
Small pot	2.46^{b}	4.82^{a}	0.29	0.00

^{a,b} Different superscripts within rows indicate differences at $p<0.05$

The higher honey production in boxes hive than bamboos hive was affected the higher exit activity of foragers in the boxes hive than bamboos hive in the morning and afternoon (Table 2) that impact on much more nectar and resin has been collected by foragers to produce honey and propolis. Furthermore, the nectar and resin much more will impact the increase of honey pots number (Table 3).

Production of honey stingless bee *Tetragonula* sp. in this study (Table 5) was differ from reported by Agussalim et al (2017) for stingless bee *Trigona* sp. (*Tetragonula* sp.). The difference of honey production with this study was affected by the plant types as the food source, the bee species which involved in honey production, the daily activities of foragers especially when collecting nectar, and resin from plants and also foragers number. In addition, in Sukadana Bee Village was the center for research, development, empowerment, and community service to poverty alleviation and livelihood security of communities, especially beekeepers in North Lombok Regency, West Nusa Tenggara Province, Indonesia. Thus, in the future is required advanced study about the roles of stingless bees beekeeping on the income of beekeepers and poverty alleviation in communities.

Conclusions

- The exit activity of hives from stingless bee *Tetragonula* sp. foragers in the boxes hive was ranged from 29.3 to 50.1 heads/5 minutes and was ranged from 25.3 to 36.6 heads/5 minutes for bamboos hive
- The honey pots number from stingless bee *Tetragonula* sp. in boxes hive after beekeeping one-month were 18.1 pots (big pot), 25.8 pots (medium pot), 26.8 pots (small pot), and 8.27 pots (big pot), 16.3 (medium pot), and 17.6 pots (small pot) for bamboos hive

- The honey volume of stingless bee *Tetragonula* sp. from boxes hive in each pot were 0.37 ml (big pot), 0.28 ml (medium pot), 0.18 ml (small pot), and 0.32 ml (big pot), 0.25 ml (medium pot), and 0.14 ml (small pot) for bamboos hive
- The honey production of stingless bee *Tetragonula* sp. after beekeeping one-month in boxes hive were 6.68 ml (big pot), 7.22 ml (medium pot), 4.82 ml (small pot) and 2.65 ml (big pot), 4.07 ml (medium pot), and 2.46 ml (small pot) for bamboos hive.

Acknowledgments

The authors to thank Directorate General of Innovation Strengthen, Ministry of Research, Technology, and Higher Education of the Republic of Indonesia for financial support of this project through *Klaster Inovasi Lebah Madu* with contract number 002/F1/PPK.1/Kp/V/2019.

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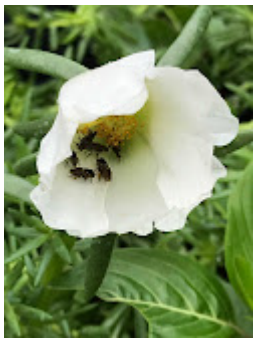

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The effect of different beehives on the activity of foragers, honey pots number, and honey production from stingless bee *Tetragonula* sp.

Erwan, Meiyana Astuti, Syamsuhaidi, Muhammad Muhsinin and Agussalim[1]

Faculty of Animal Science, University of Mataram, Jl. Majapahit No. 62, Mataram – 83125, Indonesia
apiserwan@gmail.com
Faculty of Animal Science, Universitas Gadjah Mada, Jl. Fauna 3, Bulaksumur, Yogyakarta – 55281, Indonesia

Abstract

Tetragonula sp. Is one of stingless bee species nesting in bamboos hive and produced honey, bee bread, and propolis. The objective of this study was to evaluate the exit activity of foragers, honey pots number, honey volume in each pot, and production of honey from stingless bee *Tetragonula* sp. Thirty colonies of stingless bee *Tetragonula* sp. from bamboo hives were divided into two groups: bamboo and box hives, each group consisted of 15 colonies. The colonies were transferred in the night to avoid stress in the bees consisting of a queen bee, foragers, drones, brood cells. The study of beekeeping one-month in Sukadana Bee Village, North Lombok, Indonesia.

Exit activity in the morning and afternoon of foragers from stingless bee *Tetragonula* sp. in the box hives was higher than in bamboos hive. The honey pots number, honey volume in each pot, and honey production (big, medium, and small pots) in box hive were higher than in bamboo hives.

Keywords: *bamboo hive, box hive, nectar*

Introduction

The stingless bees include tropical bee groups. In the world, more than 500 species have been identified and possibly more than 100 species unidentified (Michener 2013). In Indonesia, the stingless bees (*tribe Meliponini*) are at least 46 species (Kahono et al 2018) and mostly found nesting in bamboos, sugar palm stalks, tree trunks or woods, and in the ground (Agussalim et al 2015). One of the stingless bee species that can be found in Indonesia is *Tetragonula* sp. that is nesting in a bamboo (Agus et al 2019a; Agussalim et al 2019). Stingless bee *Tetragonula* sp. can be producing honey, bee bread, and propolis like *Apis mellifera*, but the honey production is generally lower than honey production from all of honeybees from *Apis genus*. In addition, the stingless beesar much more in propolis production. Honey is a natural food made from the nectar collected by worker bees or foragers from plant flowers (floral nectar), extrafloral nectar, and honeydew with adding enzymes (Codex Alimentarius 2001; Sihombing 2005).

In North Lombok, West Nusa Tenggara, Indonesia mostly beekeepers are using box and bamboo as the hive for stingless beekeeping, but the information about the honey production from each beehive isnot available. Agussalim et al (2017) reported that honey production from stingless bee from genus of *Tetragonula* that origin from Genggelang North Lombok that domesticated from sugar palm stalks to various sizes of beehives using box hives ranged from 49.2 to 66.6 ml after beekeeping for two months. Although it has been performed a study about honey production from stingless bee *Trigona* sp., the different sources of habitat from the stingless bee, different locations for beekeeping, and the type of hive will be influencing the activity of bees and honey production. The objective of this study was to evaluate the exit activity of foragers, honey pots number, honey volume in each pot, and production of honey from stingless bee *Tetragonula* sp.

Materials and methods

Colony transfer

The stingless bee *Tetragonula* sp. in 30 colonies were adapted for one week in the Sukadana Bee Village, Bayan, North Lombok, Indonesia. The colonies were divided into two groups and each group consisted of 15 colonies. The first group was box hive with size 40 x 20 x 15 cm and the second group was bamboo hive with the length 30 to 40 cm and diameter 7 to 8 cm. Thirty colonies of stingless bee *Tetragonula* sp. from bamboos were transferred to box hives and bamboos performed in the night to avoid stress in the bees. The colonies were transferred consisted of a queen bee, workers (foragers), drones, brood cells, and then all the colonies were studied for one-month in Sukadana Bee Village.

Temperature and humidity environment

The temperature and humidity environment were measured every day for one-month using thermo-hygrometer in the morning (08:00 am) and in the afternoon (4:00 pm).

Honey production

Honey production of stingless bee *Tetragonula* sp. was measured after beekeeping one month. In brief, honey was harvested from boxes and bamboos with cutting the propolis as the construction in the box walls, then the honey was placed in the plastic bottles. Furthermore, honey was squeezed using hand to separate honey from cerumen or propolis, then honey was measured by graduated cylinders. The predominant plant types as the source of nectar to produce honey also were identified at a maximum distance of 200 meters.

Daily activity of foragers

The daily activity of the foragers was counted every day for one month i.e. the exit activity from hives was counted using hand counter check. The exit number of foragers from hives was counted by standing in front of the hive entrance at a distance 1 meter for 5 minutes each hive and was performed in the morning (08:00 am) and in the afternoon (4:00 pm).

Honey pots number

The pots number was counted after beekeeping one month and were divided into three categories: big pots (diameter mean 1.1 cm), medium pots (diameter mean 0.7 cm), and small pots (diameter mean 0.4 cm). The boxes and bamboos hives were opened and then the number of honey pots was counted in the night equipped with lighting. In addition, the production of honey from each honey pot was aspirated using a syringe 1 ml and the honey volume in each pot was measured.

Statistical analysis

The data of honey production, exit activity of foragers, pots honey number, and honey volume each pot from stingless bee *Tetragonula* sp. were analyzed by T-test, and the temperature and humidity environment were analyzed by descriptive analysis using SPSS statistics version 23.

Results and discussion

Temperature and humidity environment

The results showed that the environment temperature in the Sukadana Bee Village, North Lombok ranged from 25.0 to 26.1^{o}C in the morning, while in the afternoon was ranged from 28.6 to 30.4^{o}C. The environment humidity ranged from 68.0 to 74.4% in the morning, while in the afternoon was ranged from 57.9 to 64.9% (Table 1). The temperature and humidity environment in the Sukadana Bee Village, North Lombok was including the normal temperature and humidity required by stingless bees for optimally productivity.

Table 1. The mean of temperature and humidity environment every week in the Sukadana Bee Village, North Lombok

Weeks	Temperature (^{o}C)		Humidity (%)	
	Morning	Afternoon	Morning	Afternoon
First	25.1	28.6	74.7	63.9
Second	25.7	30.4	68.0	61.3
Third	26.1	29.1	68.4	64.9
Fourth	25.0	30.1	69.9	57.9

The environment temperature required by the bees to collect food was ranged from 5 to 45^{o}C and if under or above it, decrease the activities of honeybees and even until death (Abrol 2011). The elevated temperatures and the concomitant lack of water during dry periods can be induced absconding in stingless bees (Maia-Silva et al 2015). Heard and Hendrikz (1993) explained that the temperature was a significant effect on the flight activity of stingless bee *Trigona carbonaria*, but not consistent on relative humidity. The temperature threshold to activity was ranged from 18 to 19^{o}C. The peak activity *T. carbonaria* was ranged from 26.1 to 29.8^{o}C with humidity relative 35 to 90%. The temperature and humidity in the study was differ from those previously reported (Agussalim et al 2015) for *Trigona* sp. (*Tetragonula* sp.) and Heard and Hendrikz (1993) for *T. carbonaria*.

Daily activity of foragers

The results showed that the exit activity from hives by foragers in box hive in the morning was higher than the exit activity in bamboohive (50.1 versus 36.6 heads/5 minutes) and in the afternoon (29.3 versus 25.3 heads/5 minutes) (Table2). In addition, the exit activity from hives by foragers in the morning was higher than in the afternoon for bamboos hive (36.6 versus 25.3 heads/5 minutes) and boxes hives (50.1 versus 29.3 heads/5 minutes) (Table 2). That the exit activity from boxes hives was higher than bamboos hives might be the foragers in the boxes must gather more materials to build the nest and be creating comfort conditions than bamboos hives. In addition, it also might be affected by the foragers and egg number, and the productivity of the queen bee, but in our study this w as not measured.

Table 2. The mean of exit activity of foragers stingless bee*Tetragonula* sp. from bamboos and boxes hives

Observation time	Bamboos hive (heads/5 minutes)	Boxes hive (heads/5 minutes)	SEM	*p*
Morning (08:00 am)	36.6^{bx}	50.1^{ax}	0.47	<0.001

Afternoon (4:00 pm)	25.3^{by}	29.3^{ay}	0.22	<0.001

[a,b] Different superscripts within rows indicate differences at p<0.05

[x,y] Different superscripts within column indicate differences at p<0.05

The exit activity of foragers stingless bee *Tetragonula* sp. in the morning was higher than in the afternoon because in the morning very abundant blooming flowers as the food source like nectar (raw material to produce honey) and pollen (raw material to produce bee-pollen or bee bread), and resin (raw material to produce propolis or cerumen or geopropolis). The exit activit from stingless bee *Tetragonula* sp. in this study was differemt from those previously for stingless bees*Tetragonula laeviceps*, *Heterotrigona itama*, and*Lepidotrogona terminata* (Atmowidi et al 2018), for *T.laeviceps* (Agus et al 2019b; Gadhiya and Pastagia 2019), and for *Trigona* sp. (*Tetragonula* sp.) (Agussalim et al 2015). The different daily activity from each stingless bee was affected by the different stingless bee species, geographical origin (related to temperature, humidity, light intensity, wind velocity), foragers and egg number.

Honey production

The results showed that the honey pots number after beekeeping one-month from box hive was higher than from bamboo hive for all of the honey pots size 18.1 versus 8.27 pots for big pots, 25.8 versus 16.3 pots for medium pots, and 26.8 versus 17.6 pots for small pots (Table 3). The honey pots number was higher in the box hive andwas affected by the good development of colonies from boxes such as eggs or brood cells and foragers numberthat impacted on the higher exit activity from the hive by foragers in box hive than in bamboos hive (Table 3).

Table 3. The mean of honey pots number from stingless bee*Tetragonula* sp. after beekeeping one-month

Honey Pots Number	Bamboos hive (pots)	Boxes hive (pots)	SEM	*P*
Big	8.27^{b}	18.1^{a}	1.11	0.00
Medium	16.3^{b}	25.8^{a}	1.34	0.00
Small	17.6^{b}	26.8^{a}	1.53	0.00

[a,b] Different superscripts within rows indicate differences at p<0.05

The foragers in the box hive very were active to collect nectar from flowers and resin from plants than from bamboo hive was shown by the higher exit activity of foragers (Table 2). In addition, the volume from boxes hive was higher for *Tetragonula* sp. than bamboos hive volume foor which was smaller, thus allowing the colonie in box hives to develop properly. The volume each honey pot from box hive was higher than bamboo hive for all of the honey pots sizes: 0.37 versus 0.32 ml for the big pot, 0.28 versus 0.25 ml for the medium pot, and 0.18 versus 0.14 ml for the small pot (Table 4). The higher honey volume each pot from boxe hive might be related to the ability of workers to produce the big pot and the foragers very active to collect nectar and resin from plants was shown by the higher exit activity of foragers in box hive than in bamboos hive (Table 2).

Table 4. The mean of honey volume each pot from bamboos and boxes hives by stingless bee *Tetragonula sp*

Honey volume (mL)	Bamboo hive	Box hive	SEM	*p*
Big pot	0.32^{b}	0.37^{a}	0.01	0.01
Medium pot	0.25^{b}	0.28^{a}	0.01	0.02
Small pot	0.14^{b}	0.18^{a}	0.01	0.01

[a,b] Different superscripts within rows indicate differences at p<0.05

The honey production of stingless bee *Tetragonula* sp. from Boxes hive was higher than frombamboo hive for all of the honey pots were 6.68 versus 2.65 ml for the big honey pot, 7.22 versus 4.07 ml for the medium honey pot, and 4.82 versus 2.46 ml for the small honey pot (P<0.01) (Table 5). The honey production in Sukadana Bee Village was supported by plants as

the source of nectar were longan, banana, mango, cashew, sunflowers, start fruit, bilimbi, coconut, calliandra, Jamaica cherry, papaya, and cassava. The plants have different times for flowering and blooming, but they support each other.

Table 5. Honey production of stingless bee *Tetragonula* sp. for one-month beekeeping in Sukadana Bee Village, North Lombok

Honey production (mL)	Bamboos hive	Boxes hive	SEM	*p*
Big pot	2.65^{b}	6.68^{a}	0.43	0.00
Medium pot	4.07^{b}	7.22^{a}	0.39	0.00
Small pot	2.46^{b}	4.82^{a}	0.29	0.00

^{a,b} *Different superscripts within rows indicate differences at $p<0.05$*

The higher honey production in boxhive than bamboo hive was affected by the higher exit activity of foragers in the box hive than bamboo hive in the morning and afternoon (Table 2) that impacted on much more nectar and resin has been collected by foragers to produce honey and propolis. Furthermore, the nectar and resin much more will impact the increase of honey pots number (Table 3).

Production of honey from stingless bee *Tetragonula* sp. in this study (Table 5) was differ from reported by Agussalim et al (2017) for stingless bee *Trigona* sp. (*Tetragonula* sp.). The difference of honey production with this study was affected by the plant types as the food source, the bee species which involved in honey production, the daily activities of foragers especially when collecting nectar, and resin from plants and also foragers number. In addition, in Sukadana Bee Village was the center for research, development, empowerment, and community service to poverty alleviation and livelihood security of communities, especially beekeepers in North Lombok Regency, West Nusa Tenggara Province, Indonesia. Thus, in the future is required advanced study about the roles of stingless bee keeping on the income of beekeepers and poverty alleviation in communities.

Conclusions

- The exit activity of hives from stingless bee *Tetragonula* sp. foragers in the box hives was ranged from 29.3 to 50.1 heads/5 minutes and ranged from 25.3 to 36.6 heads/5 minutes for bamboo hive
- The honey pots number from stingless bee *Tetragonula* sp. in box hive after beekeeping one-month were 18.1 pots (big pot), 25.8 pots (medium pot), 26.8 pots (small pot), and 8.27 pots (big pot), 16.3 (medium pot), and 17.6 pots (small pot) for bamboos hive
- The honey volume of stingless bee *Tetragonula* sp. from box hive in each pot were 0.37 ml (big pot), 0.28 ml (medium pot), 0.18 ml (small pot), and 0.32 ml (big pot), 0.25 ml (medium pot), and 0.14 ml (small pot) for bamboos hive
- The honey production of stingless bee *Tetragonula* sp. after beekeeping one-month in box hive were 6.68 ml (big pot), 7.22 ml (medium pot), 4.82 ml (small pot) and 2.65 ml (big pot), 4.07 ml (medium pot), and 2.46 ml (small pot) for bamboos hive.

Acknowledgments

The authors thank Directorate General of Innovation Strengthen, Ministry of Research, Technology, and Higher Education of the Republic of Indonesia for financial support of this project through *Klaster Inovasi Lebah Madu* with contract number 002/F1/PPK.1/Kp/V/2019.

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erwan apis <apiserwan@gmail.com> 30 Agustus 2020 pukul 17.02
Kepada: Reg Preston <reg.preston@gmail.com>

Dear Professor T R Preston, Ph.D., DSc.
as the Senoir Editor in Livestock Research for Rural Development

We Apologize for the late revise for proofread our journal
We attached photos of bamboo and box hives in word version and attach photo (it location in materials and methods)

some revise for our journal after proofread consist of

Affiliation

Faculty of Animal Science, Universitas Gadjah Mada should be [1]Faculty of Animal Science, Universitas Gadjah Mada

In Abstract

Tetragonula sp. Is one should be *Tetragonula* sp. is one

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Exit activity should be The exit activity

small pots) in box hive should be small pots) in box hives

Keywords: bamboo hive, box hive, nectar should be bamboo hive, box hive, nectar, bee village (please added)

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In Materials and methods

Colony Transfer

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Statistical analysis

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Results and discussion

Temperature and humidity environment

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Daily activity of foragers

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Best Regards,

Dr. Erwan

Faculty of Animal Science, University of Mataram, Indonesia

[Kutipan teks disembunyikan]

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Bamboo hives.jpeg
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Box hives.jpeg
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Figures for LRRD in Materials and Methods (Send).docx
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The figures location in materials and methods

Figure 1. The colonies of stingless bee *Tetragonula* sp. from bamboo hives

Figure 2. The colonies of stingless bee *Tetragonula* sp. from box hives

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Stay well

TRP
Professor T R Preston, PhD, DSc

Investigador Emérito
Centro para la Investigación en Sistemas Sostenibles
de Producción Agropecuaria (CIPAV),
Carrera 25 No 6-62 Cali, Colombia

Senior Editor, Livestock Research for Rural Development
http://www.lrrd.org (The international on-line journal on sustainable livestock-based agriculture)

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HASIL PROOFREAD PERTAMA
(7 SEPTEMBER 2020)

The effect of different beehives on the activity of foragers, honey pots number, and honey production from stingless bee *Tetragonula* sp.

Erwan, Meiyana Astuti, Syamsuhaidi, Muhammad Muhsinin and Agussalim[1]

Faculty of Animal Science, University of Mataram, Jl. Majapahit No. 62, Mataram – 83125, Indonesia
apiserwan@gmail.com
[1]*Faculty of Animal Science, Universitas Gadjah Mada, Jl. Fauna 3, Bulaksumur, Yogyakarta – 55281, Indonesia*

Abstract

Tetragonula sp. is one of stingless bee species nesting in bamboos hive and produced honey, bee bread, and propolis. The objective of this study was to evaluate the exit activity of foragers, honey pots number, honey volume in each pot, and production of honey from stingless bee *Tetragonula* sp. Thirty colonies of stingless bee *Tetragonula* sp. from bamboo hives were divided into two groups: bamboo and box hives, each group consisted of 15 colonies. The colonies were transferred in the night to avoid stress in the bees consisting of a queen bee, foragers, drones, and brood cells. The colonias were beekeeping one-month in Sukadana Bee Village, North Lombok, Indonesia.

The exit activity in the morning and afternoon of foragers from stingless bee *Tetragonula* sp. in the box hives was higher than in bamboos hive. The honey pots number, honey volume in each pot, and honey production (big, medium, and small pots) in box hives were higher than in bamboo hives.

Keywords: *bamboo hive, box hive, nectar should be bamboo hive, box hive, nectar, bee village*

Introduction

The stingless bees include tropical bee groups. In the world, more than 500 species have been identified and possibly more than 100 species unidentified (Michener 2013). In Indonesia, the stingless bees (*tribe Meliponini*) are at least 46 species (Kahono et al 2018) and mostly found nesting in bamboos, sugar palm stalks, tree trunks or woods, and in the ground (Agussalim et al 2015). One of the stingless bee species that can be found in Indonesia is *Tetragonula* sp. that is nesting in a bamboo (Agus et al 2019a; Agussalim et al 2019). Stingless bee *Tetragonula* sp. can be producing honey, bee bread, and propolis like *Apis mellifera*, but the honey production is generally lower than honey production from all of honeybees from *Apis genus*. In addition, the stingless bees are much more in propolis production. Honey is a natural food made from the nectar collected by worker bees or foragers from plant flowers (floral nectar), extrafloral nectar, and honeydew with adding enzymes (Codex Alimentarius 2001; Sihombing 2005).

In North Lombok, West Nusa Tenggara, Indonesia mostly beekeepers are using box and bamboo as the hive for stingless beekeeping, but the information about the honey production from each beehive is not available. Agussalim et al (2017) reported that honey production from stingless bee from genus of *Tetragonula* that origin from Genggelang North Lombok that

domesticated from sugar palm stalks to various sizes of beehives using box hives ranged from 49.2 to 66.6 ml after beekeeping for two months. Although it has been performed a study about honey production of stingless bee *Tetragonula* sp., the different sources of habitat from the stingless bee, different locations for beekeeping, and the type of hive will be influencing the activity of bees and honey production. The objective of this study was to evaluate the exit activity of foragers, honey pots number, honey volume in each pot, and production of honey from stingless bee *Tetragonula* sp.

Materials and methods

Colony transfer

Thirty colonies of stingless bee Tetragonula sp. from bamboo hives colonies were adapted for one week in the Sukadana Bee Village, Bayan, North Lombok, Indonesia. The colonies were divided into two groups and each group consisted of 15 colonies. The first group was box hive with size 40 x 20 x 15 cm and the second group was bamboo hive with the length 30 to 40 cm and diameter 7 to 8 cm. Thirty colonies of stingless bee *Tetragonula* sp. from bamboos were transferred to box and bamboo hives were performed in the night to avoid stress in the bees. The colonies were transferred consisted of a queen bee, workers (foragers), drones, brood cells, and then all colonies were beekeeping for one-month in Sukadana Bee Village.

Figure 1. The colonies of stingless bee Tetragonula sp. from bamboo hives

Figure 2. The colonies of stingless bee Tetragonula sp.
from box hives

Temperature and humidity environment

The temperature and humidity environment were measured every day for one-month using thermo-hygrometer in the morning (08:00 am) and in the afternoon (4:00 pm).

Honey production

Honey production of stingless bee *Tetragonula* sp. was measured after beekeeping one month. In brief, honey was harvested from boxes and bamboos with cutting the propolis as the construction in the box walls, then the honey was placed in the plastic bottles. Furthermore, honey was squeezed using hand to separate honey from cerumen or propolis, then honey was

measured by graduated cylinders. The predominant plant types as the source of nectar to produce honey also were identified at a maximum distance of 200 meters.

Daily activity of foragers

The daily activity of the foragers was counted every day for one month i.e. the exit activity from hives was counted using hand counter check. The exit number of foragers from hives was counted by standing in front of the hive entrance at a distance 1 meter for 5 minutes each hive and was performed in the morning (08:00 am) and in the afternoon (4:00 pm).

Honey pots number

The pots number was counted after beekeeping one month and were divided into three categories: big pots (diameter mean was 1.1 cm), medium pots (diameter mean was 0.7 cm), and small pots (diameter mean was 0.4 cm). The boxes and bamboos hives were opened and then the number of honey pots was counted in the night equipped with lighting. In addition, the production of honey from each honey pot was aspirated using a syringe 1 ml and the honey volume in each pot was measured.

Statistical analysis

The data of honey production, exit activity of foragers honey, pots number, and honey volume each pot from stingless bee *Tetragonula* sp. were analyzed by T-test, and the temperature and humidity environment were analyzed by descriptive analysis using SPSS statistics version 23.

Results and discussion

Temperature and humidity environment

The results showed that the environment temperature in the Sukadana Bee Village, North Lombok ranged from 25.0 to 26.1^{o}C in the morning, while in the afternoon was ranged from 28.6 to 30.4^{o}C. The environment humidity ranged from 68.0 to 74.4% in the morning, while in the afternoon was ranged from 57.9 to 64.9% (Table 1). The temperature and humidity environment in the Sukadana Bee Village, North Lombok was including the normal temperature and humidity required by stingless bees for optimally productivity.

Table 1. The mean of temperature and humidity environment every week in the Sukadana Bee Village, North Lombok

Weeks	Temperature (^{o}C)		Humidity (%)	
	Morning	Afternoon	Morning	Afternoon
First	25.1	28.6	74.7	63.9
Second	25.7	30.4	68.0	61.3
Third	26.1	29.1	68.4	64.9
Fourth	25.0	30.1	69.9	57.9

The environment temperature required by the bees to collect food was ranged from 5 to 45^{o}C and if under or above it, decrease the activities of honeybees and even until death (Abrol 2011). The elevated temperatures and the concomitant lack of water during dry periods can be induced absconding in stingless bees (Maia-Silva et al 2015). Heard and Hendrikz (1993) explained that the temperature was a significant effect on the flight activity of stingless bee *Trigona carbonaria*, but not consistent on relative humidity. The temperature threshold to activity was ranged from 18 to 19^{o}C. The peak activity of *T. carbonaria* was ranged from 26.1 to 29.8^{o}C

with humidity relative 35 to 90%. The temperature and humidity in the study was differ from those previously reported (Agussalim et al 2015) for *Trigona* sp. (*Tetragonula* sp.) and Heard and Hendrikz (1993) for *T. carbonaria*.

Daily activity of foragers

The results showed that the exit activity from hives by foragers in box hive in the morning was higher than the exit activity in bamboo hive (50.1 versus 36.6 heads/5 minutes) and in the afternoon (29.3 versus 25.3 heads/5 minutes) (Table2). In addition, the exit activity from hives by foragers in the morning was higher than in the afternoon for bamboos hive (36.6 versus 25.3 heads/5 minutes) and boxes hives (50.1 versus 29.3 heads/5 minutes) (Table 2). That the exit activity from boxes hives was higher than bamboos hives might be the foragers in the boxes must gather more materials to build the nest and be creating comfort conditions than bamboos hives. In addition, it also might be affected by the foragers and brood cells number, and the productivity of the queen bee, but in our study this was not measured.

Table 2. The mean of exit activity of foragers stingless bee *Tetragonula* sp. from bamboos and boxes hives

Observation time	Bamboos hive (heads/5 minutes)	Boxes hive (heads/5 minutes)	SEM	*p*
Morning (08:00 am)	36.6^{bx}	50.1^{ax}	0.47	<0.001
Afternoon (4:00 pm)	25.3^{by}	29.3^{ay}	0.22	<0.001

^{a,b} *Different superscripts within rows indicate differences at p<0.05*

^{x,y} *Different superscripts within column indicate differences at p<0.05*

The exit activity of foragers stingless bee *Tetragonula* sp. in the morning was higher than in the afternoon because in the morning very abundant blooming flowers as the food source like nectar (raw material to produce honey) and pollen (raw material to produce bee-pollen or bee bread), and resin (raw material to produce propolis or cerumen or geopropolis). The exit activity from stingless bee *Tetragonula* sp. in this study was differemt from those previously for stingless bee *Tetragonula laeviceps*, *Heterotrigona itama*, and *Lepidotrogona terminata* (Atmowidi et al 2018), for *T. laeviceps* (Agus et al 2019b; Gadhiya and Pastagia 2019), and for *Trigona* sp. (*Tetragonula* sp.) (Agussalim et al 2015). The different daily activity from each stingless bee was affected by the different stingless bee species, geographical origin (related to temperature, humidity, light intensity, wind velocity), foragers and brood cells number.

Honey production

The results showed that the honey pots number after beekeeping one-month from box hive was higher than from bamboo hive for all of the honey pots size 18.1 versus 8.27 pots for big pots, 25.8 versus 16.3 pots for medium pots, and 26.8 versus 17.6 pots for small pots (Table 3). The honey pots number was higher in the box hive and was affected by the good development of colonies from boxes such as boxes such as brood brood cells and foragers numberthat impacted on the higher exit activity from the hive by foragers in box hive than in bamboos hive (Table 3).

Table 3. The mean of honey pots number from stingless bee *Tetragonula* sp. after beekeeping one-month

Honey Pots Number	Bamboos hive (pots)	Boxes hive (pots)	SEM	*P*
Big	8.27^{b}	18.1^{a}	1.11	0.00
Medium	16.3^{b}	25.8^{a}	1.34	0.00
Small	17.6^{b}	26.8^{a}	1.53	0.00

^{a,b} *Different superscripts within rows indicate differences at p<0.05*

The foragers in the box hive very were active to collect nectar from plant flowers and resin from plants than from bamboo hive was shown by the higher exit activity of foragers (Table 2). In addition, the volume from boxes hive was higher for *Tetragonula* sp. than bamboos hive volume for which was smaller, thus allowing the colonies in box hives to develop properly. The volume each honey pot from box hive was higher than bamboo hive for all of the honey pots

sizes: 0.37 versus 0.32 ml for the big pot, 0.28 versus 0.25 ml for the medium pot, and 0.18 versus 0.14 ml for the small pot (Table 4). The higher honey volume each pot from boxe hive might be related to the ability of workers to produce the big pot and the foragers very active to collect nectar and resin from plants was shown by the higher exit activity of foragers in box hives than in bamboos hive (Table 2).

Table 4. The mean of honey volume each pot from bamboos and boxes hives by stingless bee *Tetragonula* sp

Honey volume (mL)	Bamboo hive	Box hive	SEM	*p*
Big pot	0.32^{b}	0.37^{a}	0.01	0.01
Medium pot	0.25^{b}	0.28^{a}	0.01	0.02
Small pot	0.14^{b}	0.18^{a}	0.01	0.01

^{a,b} *Different superscripts within rows indicate differences at p<0.05*

The honey production of stingless bee *Tetragonula* sp. from boxes hive was higher than from bamboo hive for all of the honey pots were 6.68 versus 2.65 ml for the big honey pot, 7.22 versus 4.07 ml for the medium honey pot, and 4.82 versus 2.46 ml for the small honey pot (Table 5). The honey production in Sukadana Bee Village was supported by plants as the source of nectar were longan, banana, mango, cashew, sunflowers, start fruit, bilimbi, coconut, calliandra, Jamaica cherry, papaya, and cassava. The plants have different times for flowering and blooming, but they support each other.

Table 5. Honey production of stingless bee *Tetragonula* sp. for one-month beekeeping in Sukadana Bee Village, North Lombok

Honey production (mL)	Bamboos hive	Boxes hive	SEM	*p*
Big pot	2.65^{b}	6.68^{a}	0.43	0.00
Medium pot	4.07^{b}	7.22^{a}	0.39	0.00
Small pot	2.46^{b}	4.82^{a}	0.29	0.00

^{a,b} *Different superscripts within rows indicate differences at p<0.05*

The higher honey production in box hive than bamboo hive was affected by the higher exit activity of foragers in the box hive than bamboo hive in the morning and afternoon (Table 2) that impacted on much more nectar and resin has been collected by foragers to produce honey and propolis. Furthermore, the nectar and resin much more will impact the increase of honey pots number (Table 3).

Production of honey from stingless bee *Tetragonula* sp. in this study (Table 5) was differ from reported by Agussalim et al (2017) for stingless bee *Trigona* sp. (*Tetragonula* sp.). The difference of honey production with this study was affected by the plant types as the food source, the bee species which involved in honey production, the daily activities of foragers especially when collecting nectar, and resin from plants and also foragers number. In addition, in Sukadana Bee Village was the center for research, development, empowerment, and community service to poverty alleviation and livelihood security of communities, especially beekeepers in North Lombok Regency, West Nusa Tenggara Province, Indonesia. Thus, in the future is required advanced study about the roles of stingless bee keeping on the income of beekeepers and poverty alleviation in communities.

Conclusions

- The exit activity of hives from stingless bee *Tetragonula* sp. foragers in the box hives was ranged from 29.3 to 50.1 heads/5 minutes and ranged from 25.3 to 36.6 heads/5 minutes for bamboo hive
- The honey pots number from stingless bee *Tetragonula* sp. in box hive after beekeeping one-month were 18.1 pots (big pot), 25.8 pots (medium pot), 26.8 pots (small pot), and 8.27 pots (big pot), 16.3 (medium pot), and 17.6 pots (small pot) for bamboos hive
- The honey volume of stingless bee *Tetragonula* sp. from box hive in each pot were 0.37 ml (big pot), 0.28 ml (medium pot), 0.18 ml (small pot), and 0.32 ml (big pot), 0.25 ml

(medium pot), and 0.14 ml (small pot) for bamboos hive

- The honey production of stingless bee *Tetragonula* sp. after beekeeping one-month in box hive were 6.68 ml (big pot), 7.22 ml (medium pot), 4.82 ml (small pot) and 2.65 ml (big pot), 4.07 ml (medium pot), and 2.46 ml (small pot) for bamboos hive.

Acknowledgments

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SUBMIT PROOFREAD KEDUA DAN KETIGA
(7-10 SEPTEMBER 2020)

apise32158.html

erwan apis <apiserwan@gmail.com> 7 September 2020 pukul 21.08
Kepada: Reg Preston <reg.preston@gmail.com>

Dear Professor T R Preston, Ph.D., D.Sc.
as the Senior Editor in Livestock Research for Rural Development
in Colombia

Thanks very much for correction some mistakes in our paper, but after read again we found some mistakes in our paper as follows:

In Abstract

The colonias The colonies

Keywords is double

bamboo hive, box hive, nectar should be bamboo hive, box hive, nectar, bee village
bamboo hive, box hive, nectar, bee village

Materials and Methods

Colony Trasnfer (In fist sentence)

Tetragonula *Tetragonula*

Figure 1. …… Tetragonula *Tetragonula*

Figure 2. ……

Tetragonula sp.

from box hives *Tetragonula* sp. from box hives

In Statistical analysis

foragers honey, pots number, foragers, honey pots number,

Results and Discussion

Daily activity of foragers

first paragraph

(Table2) (Table 2)

Second paragraph

Lepidotrogona Lepidotrigona

Honey Production

First Paragraph

boxes such as boxes such as brood brood boxes such as brood

numberthat number that

boxe box

References

Abrol D P2011 Abrol D P 2011

Agus A,…….. 2019 a 2019a

Gadhiya VC and Pastagia JJ Gadhiya V C and Pastagia J J

Thanks very much

Best Regards

Dr. Erwan

Faculty of Animal Science, University of Mataram, Indonesia

On Mon, Sep 7, 2020 at 9:09 AM erwan apis <apiserwan@gmail.com> wrote:

Gmail erwan apis <apiserwan@gmail.com>

apise32158.html

Reg Preston <reg.preston@gmail.com> 8 September 2020 pukul 07.14
Kepada: erwan apis <apiserwan@gmail.com>

More care needed. I think these are mostly your errors!!

My wife will do the corrections. She is more expert than I in HTML!

REgards

TRP
Professor T R Preston, PhD, DSc

Investigador Emérito
Centro para la Investigación en Sistemas Sostenibles
de Producción Agropecuaria (CIPAV),
Carrera 25 No 6-62 Cali, Colombia

Senior Editor, Livestock Research for Rural Development
http://www.lrrd.org (The international on-line journal on sustainable livestock-based agriculture)

Tropical Animal Production
http://www.cipav.org.co/TAP/tapindex.htm

Matching Ruminant Production Systems with Available Resources in the Tropics and Sub-Tropics
http://www.cipav.org.co/PandL/Preston_Leng.htm

El sitio Web sobre Producción Tropical Sostenible (Universidad de los Llanos, Colombia)
www.produccionтropicalsostenible.info

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http://hostcambodia.com/mekarn/indexold.htm

Gmail erwan apis <apiserwan@gmail.com>

apise32158.html

erwan apis <apiserwan@gmail.com> 8 September 2020 pukul 13.07
Kepada: Reg Preston <reg.preston@gmail.com>

Dear Professor T R Preston, Ph.D., D.Sc.
as the Senior Editor in Livestock Research for Rural Development
in Colombia

we apologize for the mistakes our journal and thanks very much for the correction and we wait the good news for the results of corrections

Best regards

Dr. Erwan
Faculty of Animal Science, University of Mataram, Indonesia
[Kutipan teks disembunyikan]

apise32158.html

Reg Preston <reg.preston@gmail.com> 9 September 2020 pukul 07.43
Kepada: erwan apis <apiserwan@gmail.com>

Dear Authors
The proof page has been refreshed with the corrections and photos.
Please check again.

REgard

TRP
Professor T R Preston, PhD, DSc

Investigador Emérito
Centro para la Investigación en Sistemas Sostenibles
de Producción Agropecuaria (CIPAV),
Carrera 25 No 6-62 Cali, Colombia

Senior Editor, Livestock Research for Rural Development
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Gmail erwan apis <apiserwan@gmail.com>

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erwan apis <apiserwan@gmail.com> 9 September 2020 pukul 12.38
Kepada: Reg Preston <reg.preston@gmail.com>

Dear Professor T R Preston, PhD, DSc
as the Senior Editor in Livestock Research for Rural Development

Thanks very much for the correction our paper mistakes in HTML but we apologize we found two mistakes as follows:

Figure 2. The colonies of stingless bee *Tetragonula* sp.
from box hives **Figure 2.** The colonies of stingless bee *Tetragonula* sp. from box hives

In Results and Discussion

Honey Production

First Paragraph

boxes such as boxes such as brood brood boxes such as brood

Thanks very much and we apologize for mistakes in our journal

Best Regards,

Gmail erwan apis <apiserwan@gmail.com>

apise32158.html

erwan apis <apiserwan@gmail.com> 10 September 2020 pukul 10.24
Kepada: Reg Preston <reg.preston@gmail.com>

Dear Professor T R Preston, Ph.D., D.Sc.
Senior Editor in Livestock Research for Rural Development
in Colombia

Thanks very much for correcting our paper and it has been correct and no mistakes. thanks very much

Gmail erwan apis <apiserwan@gmail.com>

apise32158.html

Reg Preston <reg.preston@gmail.com> 10 September 2020 pukul 20.36
Kepada: erwan apis <apiserwan@gmail.com>

Well received
Thankyou

TRP
Professor T R Preston, PhD, DSc

Investigador Emérito
Centro para la Investigación en Sistemas Sostenibles
de Producción Agropecuaria (CIPAV),
Carrera 25 No 6-62 Cali, Colombia

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