Content list available at http://epubs.icar.org.in, www.kiran.nic.in; ISSN: 0970-6429

Indian Journal of Hill Farming

Special Issue 2021, Volume-34, Page 110-120

Spatial and Temporal Distribution of Stingless Bees in Mid Hills of Meghalaya

T. Narendra • N. Kennedy • T. Rojeet

School of crop protection, Central Agricultural University, Umiam, Meghalaya-793103

ARTICLE INFO

Article history:
Received: 24th November 2020
Revision Received: 24th July 2021
Accepted: 21th September 2021

Key words: *Stingless bees, Nesting sites, Lepidotrigona arcifera, Tetragonula sp.*

ABSTRACT

The present study entitled "Spatial and temporal distribution of stingless bees in mid-hills of Meghalaya" was conducted at college of agriculture, Kyrdemkulai and School of Crop Protection, College of Post Graduate Studies in Agricultural Sciences, Umiam, Barapani, Meghalaya, with the objectives to study the stingless bee diversity in Meghalaya and document their nesting site characteristics. A survey was conducted in six different locations in mid hills of Meghalaya *viz.,* Umiet, Barapani, Sumer, Kyrdemkulai, Ziro point, RRTC. During the course of investigation, a total of 13 different colonies of stingless bees belonging to the family, Apidae were observed. The samples were collected, preserved, identified and catalogued. Based on the identification and taxonomic classification, all these collected 13 colonies were grouped into three species named *viz., Tetragonula* sp*., Tetragonula nov*. 1 and *Lepidotrigona arcifera*. During the study, *Tetragonula nov.* 1 was reported as an entirely novel species. A new species, *Tetragonula nov.* 1 was reported only in Kyrdemkulai. Data analysis on species richness and abundance reported that January month showed maximum and March month showed minimum index value. A study of nesting site characteristics reported that, out of 4 colonies of *Lepidotrigona arcifera*, 3 colonies are hollow trunk tree type collected from Umiet and 1 colony is wooden box type collected from Ziro point. Nesting site entrance is brown, soft and round with protruding entrance. Whereas, out of 7 colonies of *Tetragonula* sp., 5 colonies are stone wall type collected from Ziro point, 2 colonies are wooden box type of which 1 collected from Barapani and 1 from RRTC. Nesting site entrance is dark, hard, and irregular. However 2 colonies of *Tetragonula nov.*1 are collected from soil (Kyrdemkulai). Nesting site entrance is hard, and round without protruding entrance. Therefore, there is a need to conserve the diversity of stingless bees in their natural habitat & also popularisation of meliponiculture in the region. There is a need to study other aspects *viz.,* honey production, honey quality and potential of stingless bees in the pollination of crops, which can be exploited for better crop production and improve livelihood of farmers community.

1. Introduction

Stingless bees are small to medium-sized eusocial bees belonging to family Apidae, subfamily Apinae. They are considered as the key pollinators of the tropical and subtropical flora. They possess vestigial or underdeveloped sting and they use their mandibles as a defensive tool against intruders. They are commonly known as "Dammer bees" and are named "Syor or Rkai" in the local language of Meghalaya. Stingless bees produce honey of high medicinal value (Rs. 2500- 4000/kg). Generally honey bees contain one queen per colony but stingless bees contains more than one queen per colony. Stingless bees are known from years back, they even existed before the continental drift (Willie, 1983) and they are distributed all over the tropical regions of the world. In India, two genera (*Tetragonula* & *Lepidotrigona*) comprising 6 species were recognized and among these, *Tetragonula iridipennis* and *Tetragonula laeviceps* are observed in all parts of India as compared to other species (Rahman *et al.,* 2015).

*Corresponding author: narendrakumarthota143@gmail.com

As stingless bees are largest and most diverse group among social bees, they are well known as the key pollinator in the tropical and subtropical flora (Roubik, 1989), that has gained an increasing attention recently. They also resemble in most of the characters of honey bees (Polylecty, shows floral constancy, lives in perennial colonies, keeping food reserves etc.) (Heard, 1999). They are advised to be hopeful candidates for future commercial pollinators in conservative or protected cultivation.

2. Materials and Methods

2.1 Study area

Collection of the specimens were done from different parts of Meghalaya. The mid hills of Meghalaya were covered during the study by collecting samples from Ri-Bhoi district. Sampling was done in such a way that maximum geographic area of the state was covered. Most of the samples were collected from natural colonies of plains, coastal area and hill regions.

Map of Ri Bhoi District

2.2 Identification of Feral Colonies.

Natural colonies were located by observing the movement of bees in bright sunlight, presence of bees in the nearby flora, recognizing the stingless bee's swarms and a random visit to various gardens, forest areas etc. Samples were also collected from various farmers across Meghalaya state who reared stingless bees by collecting feral colonies of their own location.

2.3 Nest architecture

Nest entrance characters of the all the visited places are properly recorded. Characters such as a location of nesting sites, shape & colour of entrance, rigidity of entrance, number of guard bees, length of entrance tube, horizontal length and the vertical length of the opening of entrance, height from ground level, length & width of brood cell, length & width of pollen pot, length & width of honey pot of natural colonies were recorded. (Kelly *et al.*, 2014).

2.4 Data analysis: Biodiversity analysis was carried out using appropriate softwares like Biodiversity Pro, XLSTAT and SPSS.

3. Results

The present study entitled "Spatial and temporal distribution of stingless bees in mid-hills of Meghalaya" was carried out covering different regions of the mid hills of Meghalaya during the period 2019-2020. The results obtained from the study are described below.

3.1. Stingless bee diversity/collection of specimens

3.1.1 Stingless bee diversity

Based on the identification and taxonomic classification, the collected 13 colonies were grouped into three species named *viz., Lepidotrigona arcifera, Tetragonula* sp., and *Tetragonula nov.* 1 (Fig 3.1, 3.2 and 3.3). During the study, *Tetragonula nov.* 1 was reported as an entirely novel species which are new to science.

A new species, *Tetragonula nov.* 1 was reported only in Kyrdemkulai and found to be absent in all the 5 remaining regions. Whereas, *Tetragonula* sp. was recorded from three locations *viz.,* Barapani, Ziro point and RRTC, and was not reported from the remaining three locations *viz.,* Umiat, Sumer and Kyrdemkulai. However, *Lepidotrigona arcifera* was found from only two locations *viz.,* Umiat and Ziro point.

Fig. 3.1. *Lepidotrigona arcifera*

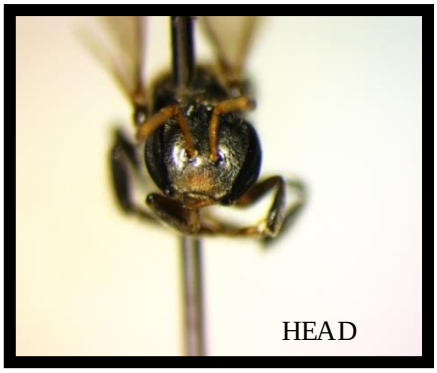


Fig. 3.2. *Tetragonula* sp.

Fig. 3.3. *Tetragonula nov.*1

3.1.2 Biodiversity indices study of stingless bees

3.1.2.1 Species richness indices

3.1.2.1.1 Species number

During the study period, species number of *Tetragonula* sp. recorded was in the range of 15 to 55 and highest species number of 55 was observed in the month of September. Whereas, species number of *Tetragonula nov.* 1 was observed maximum of 9 in the month of October with a range of 0 to 9. Meanwhile, maximum number (21) of *Lepidotrigona arcifera* was observed in the month of August in the range of 11 to 21 during the survey period (Table 3.3 and Fig. 3.4).

Table 3.3. Species number of *Tetragonula* sp., *Tetragonula nov.* 1 and *Lepidotrigona arciferal* in Ri-Bhoi district

Species	JULY	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR
***Tetragonula* sp.**	25	41	55	35	29	33	15	32	39
***Tetragonula nov.* 1**	7	5	7	9	7	5	8	0	0
Lepidotrigona arcifera	19	21	17	19	15	17	21	11	13

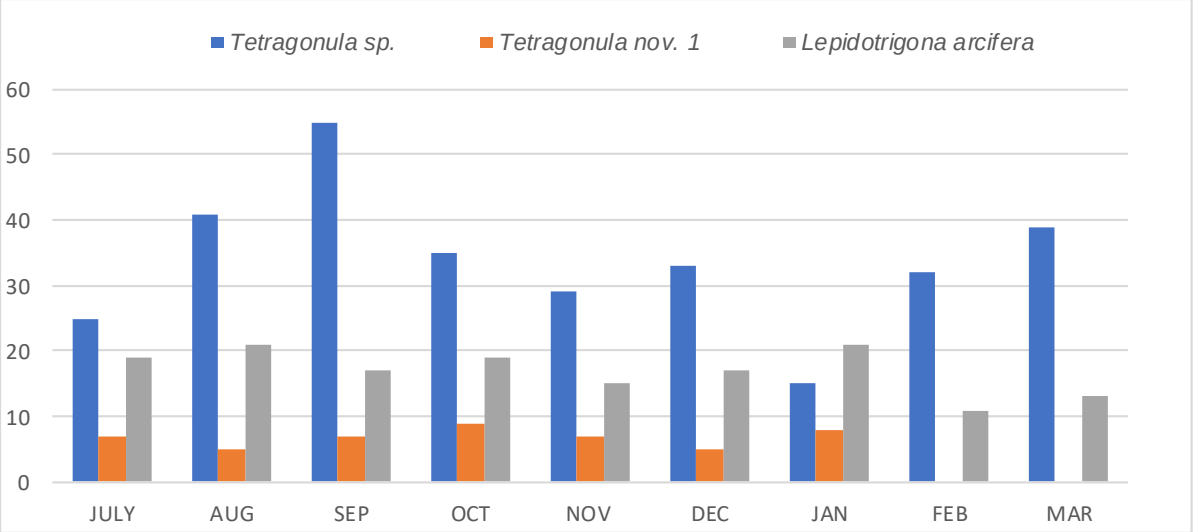


Fig. 3.4. Species number of *Tetragonula* sp., *Tetragonula nov.* 1 and *Lepidotrigona arcifera* in Ri- Bhoi district

3.1.2.1.2 Shannon-Weiner index

The highest value of Shannon-Weiner index based on species level recorded was 1.0298 in the month of January and lowest was 0.5623 in March (Table 3.4 and Fig 3.5).

3.1.2.1 Simpson Diversity index

The highest value of Simpsons Diversity (D) of species level recorded was 0.618 in the month of March and lowest was 0.363 .in January. While, Simpsons Reciprocal Diversity (1/D) was highest and lowest during the months of January (2.758) and March (1.619), respectively as shown in Table 3.5 and Fig 3.6.

3.1.2.2 Dominance indices

3.1.2.2.1 Simpson Diversity index

The highest value of Simpsons Diversity (D) of species level recorded was 0.618 in the month of March and lowest was 0.363 .in January. While, Simpsons Reciprocal Diversity (1/D) was highest and lowest during the months of January (2.758) and March (1.619), respectively as shown in Table 3.5 and Fig 3.6.

Table 3.4. Shannon weiner index *of Tetragonula* sp., *Tetragonula nov.* 1 and *Lepidotrigona arcifera* in Ri- Bhoi district

Index	JULY	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR
Shannon H	0.9899	0.8578	0.7974	0.9660	0.9535	0.8874	1.0298	0.5686	0.5623

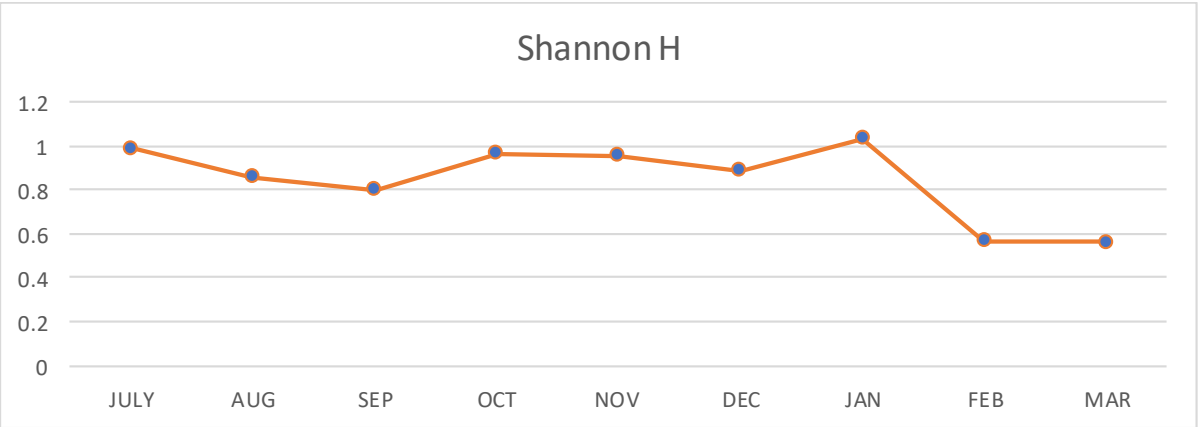


Fig. 3.5. Shannon weiner index of *Tetragonula* sp., *Tetragonula nov.*1 and *Lepidotrigona arcifera* in Ri- Bhoi district

Table. 3.5. Simpson diversity index of *Tetragonula* sp., *Tetragonula nov.* 1 and *Lepidotrigona arcifera* in Ri- Bhoi district

Index	JULY	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR
Simpsons Diversity (D)	0.386	0.47	0.533	0.411	0.417	0.454	0.363	0.61	0.618
Simpsons Reciprocal Diversity (1/D)	2.591	2.126	1.876	2.435	2.397	2.203	2.758	1.639	1.619

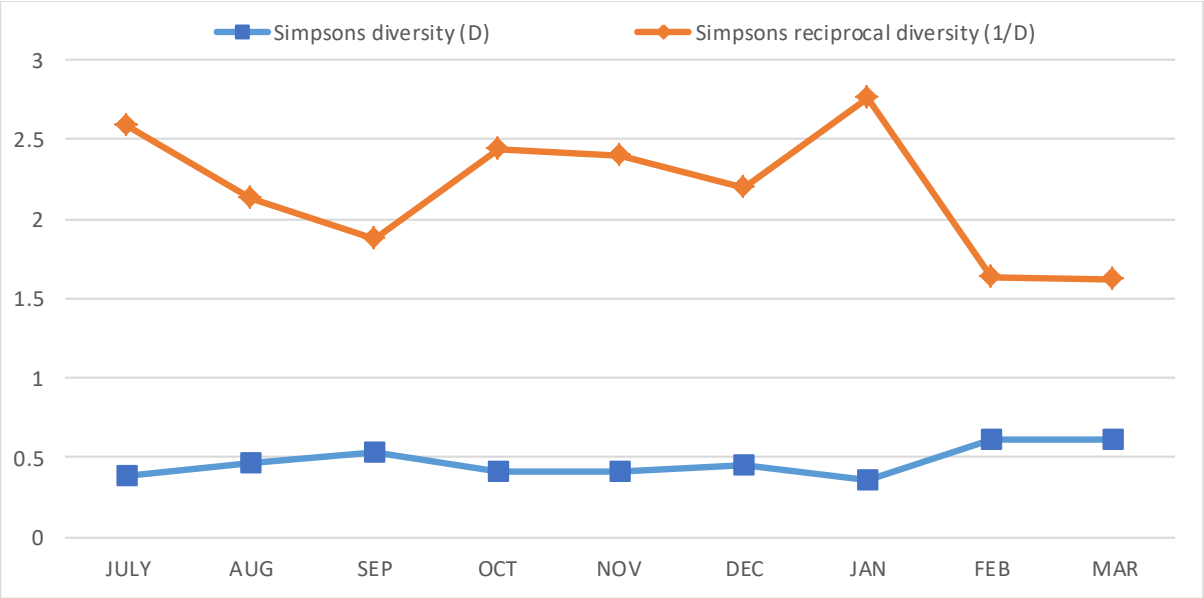


Fig. 3.6. Simpson diversity index of *Tetragonula* sp., *Tetragonula nov.* 1 and *Lepidotrigona arcifera* in Ri- Bhoi district

4.2.3 Nesting site characteristics of individual stingless bees

Out of the 13 colonies observed, 4 belonged to *Lepidotrigona arcifera*, 7 belonged to *Tetragonula* sp. and 2 belonged to *Tetragonula nov.*1. The details of above species are clearly discussed below.

4.2.3.1 *Lepidotrigona arcifera*

Out of 4 colonies, 3 colonies were hollow trunk tree type collected from Umiet farmer field and 1 colony was wooden box type collected from Ziro point of Geographical location 25.6143^0 N latitude and 91.6512^0 E longitude.

Table 3.6. Nesting characteristics of *Lepidotrigona arcifera* in mid hills of Meghalaya

S.No.	Characters	Range	Mean
1	Location of nesting site	Hollow trunk tree	
2	Shape of entrance	Round with protruding entrance	
3	Colour of entrance	Light brown	
4	Rigidity of entrance	Soft	
5	Height from ground surface (mm)	650 - 770	710±26.72
6	Length of entrance tube (mm)	250 - 100	175±22.11
7	Height of entrance	30 - 26	28±0.75
7	Width of entrance tube (mm)	10 - 14	22±1.19

8	Length of brood cell (mm)	2.0 – 2.2	2.1±0.02
9	Width of brood cell (mm)	1.5 - 1.7	1.6±0.02
10	Length of pollen pot (mm)	6.5- 7.3	6.9±0.11
11	Width of pollen pot (mm)	4.1- 5.7	4.9±0.23
12	Length of honey pot (mm)	7.1 – 7.9	7.5±0.11
13	Width of honey pot (mm)	4.7-5.5	5.1±0.11

**The data of Brood cell, Pollen and Honey pots were taken from 9 numbers and are given in average number along with standard error

Fig. 3.7. Colony of *Lepidotrigona arcifera*

a. Hollow trunk tree

b. Wooden box

c. Brood cell

d. Pollen pot

e. Honey pot

3.2.3.2 *Tetragonula* sp.

Out of 7 colonies, 5 colonies were stone wall type collected from Ziro point, 2 colonies were wooden box type of which 1 collected from Barapani and 1 from RRTC of Geographical location 25.6532^0 N latitude and 91.8843^0 E longitude.

Table 3.7 Nesting characteristics of *Tetragonula* sp. in mid hills of Meghalaya

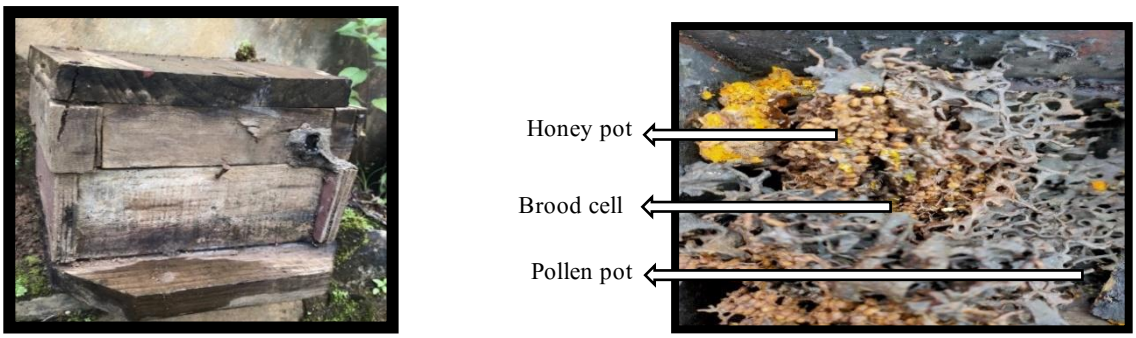
S.No.	Characters	Range	Mean
1	Location of nesting site	Stone wall	
2	Shape of entrance	irregular	
3	Colour of entrance	Dark brown	
4	Rigidity of entrance	Hard	
5	Height from ground surface (mm)	500 - 540	520±6.17
6	Length of entrance tube (mm)	20 - 18	19±7.18
7	Height of entrance	5 - 10	7.5±0.60
7	Width of entrance tube (mm)	10 - 8	9±0.30
8	Length of brood cell (mm)	2.3 - 2.8	2.5±0.07
9	Width of brood cell (mm)	1.9 - 2.1	2.0±0.02
10	Length of pollen pot (mm)	7.5 - 8.1	7.8±0.08
11	Width of pollen pot (mm)	4.7- 6.1	5.4±0.20
12	Length of honey pot (mm)	7.5- 8.5	8.0±0.14
13	Width of honey pot (mm)	5.3-6.1	5.7±0.11

**The data of Brood cell, Pollen and Honey pots were taken from 9 numbers and are given in average number along with standard error

Fig. 3.8. Colony of *Tetragonula* sp.

a. Stone wall

b. Wooden box



c. External view of colony **d. Internal view of colony**

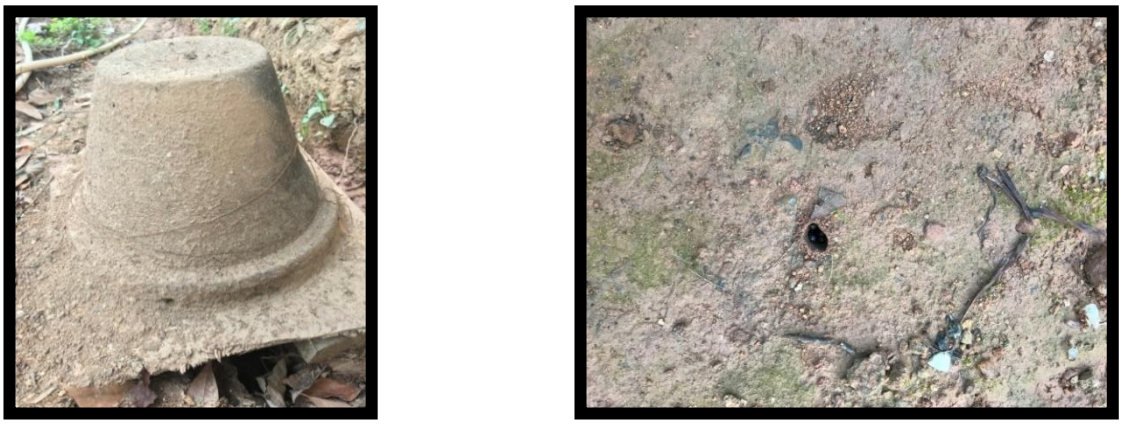
A total of 2 colonies were collected from soil (Kyrdemkulai) of geographical location 25.7848^0 N latitude and 91.7895^0 E longitude.

Table 3.8. Nesting characteristics of *Tetragonula nov.* 1 in mid hills of Meghalaya

S.No.	Characters	Range	Mean
1	Location of nesting site	Soil	
2	Shape of entrance	Round without protruding entrance	
3	Colour of entrance	Light brown	
4	Rigidity of entrance	Hard	
5	Height from ground surface (mm)	-	
6	Length of entrance tube (mm)	-	
7	Height of entrance	-	
7	Width of entrance tube (mm)	-	
8	Length of brood cell (mm)	4.0- 6.0	5.0
9	Width of brood cell (mm)	2.0-4.0	3.0
10	Length of pollen pot (mm)	11.0 -14.0	12.5
11	Width of pollen pot (mm)	10.0 -12.0	11.0
12	Length of honey pot (mm)	11.0-12.0	11.5
13	Width of honey pot (mm)	6.0-8.0	7.0

**The data of Brood cell, Pollen and Honey pots were taken from 10 numbers and are given in average number along with standard error

Fig.3.9. Colony of *Tetragonula nov.* 1



a. Colonies from soil

b. Internal view of colony

4. Discussion

4.1. Stingless bee diversity/collection of specimens

During the course of the present investigation, survey was conducted in six different locations in mid hills of Meghalaya *viz.*, Umiet, Barapani, Sumer, Kyrdemkulai, Ziro point, RRTC. A total of 13 different colonies of stingless bees belonging to the family, Apidae were observed, sampled, collected, identified, preserved and catalogued.

The highest species diversity of stingless bees of Indian subcontinent had been reported on the genus *Tetragonula* with more than 30 described species (Rasmussen, 2008). The present findings are in close conformity with the work of (Rasmussen, 2008) as in the present findings 13 colonies were collected which were grouped into three species named *viz.*, *Tetragonula* sp., *Tetragonula nov.* 1 and *Lepidotrigona arcifera* which shows the abundance of *Tetragonula* sp. During the study, *Tetragonula nov.* 1 was reported as entirely novel species. It was found that most of the stingless bees constructs their hive on hollow trunk, stone wall, wooden box, bamboo tree, soil and wall crevices.

Amongst *Tetragonula* species groups members of the "*iridipennis*" group are characterized by having a dark mesoscutum with four distinct hair bands separated by broad glabrous interspaces and by their smaller body size. Mesoscutum with distinct bands of pubescence separated by broad glabrous interspaces (Rasmussen, 2013). The present findings are in close conformity with the work of (Rasmussen, 2013) as in present findings also *Tetragonula* sp. and *Tetragonula nov.* 1 shows dark head and thorax, Mesoscutum with glabrous interspace.

Lateral surface of propodeum is with fine short pale yellowish white hairs (sometimes yellowish brown) in *Lepidotrigona satun* as reported by Attasopa *et al.* (2018). Yellow colouration at propodeum was also observed in *Lepidotrigona arcifera* in our findings.

4.1.2 Biodiversity indices study of stingless bees

The Shahnon-weiner species diversity index (H') indicated that Perak has the highest diversity with a H' of 2.64, while the lowest H' was recorded at 1.24 for Wilayah Persekutuan (Jaapar *et al.*, 2016). The Shahnon-weiner species diversity index (H') of the three primary forest sites (Bekok, Belumut and Bukit Timah) is 1.543,0.881 and 0.765 respectively (Liow *et al.*, 2001). During the survey period, the Shannon-Weiner index based on species level was found that January month had recorded highest with a value of 1.0298 and lowest of 0.5623 in March.

4.2. Nesting site characteristics of individual stingless bees

The brood cells height and width of studied colonies ranges from 2.1-2.7mm and 1.7-2.0mm with an average of 2.5 and 2.0mm respectively (Roopa *et al.*, 2015). The present findings are in close conformity with the work of (Roopa *et al.*, 2015) as in present findings also *Tetragonula* sp. and *Lepidotrigona arcifera* the brood cells height is with an average of 2.5 and 2.1 mm respectively and the brood cells height is with an average of 2.0 and 1.6mm respectively. But in *Tetragonula nov.* 1 the brood cells height and width ranges from 4.0-6.0 and 2.0-4.0 respectively.

Pollen pot width ranges from 4.2-5.5mm with an average of 4.9mm, honey pot width ranges from 5.2-6.1 mm

with an average of 5.8mm respectively (Roopa *et al.*, 2015).The present findings are in close conformity with the work of (Roopa *et al.*, 2015) as in present findings also *Tetragonula* sp. and *Lepidotrigona arcifera* pollen pot width is with an average of 5.4 and 4.9mm respectively and honey pot width of *Tetragonula* sp. and *Lepidotrigona arcifera* is with an average of 5.7 and 5.1 respectively. But in *Tetragonula nov.* 1 the pollen pot width and honey pot width ranges from 10.0-12.0 and 6.0-8.0 respectively.

The brood cells height and width of studied colonies ranges from 1.36-2.8 mm and 1.06-2.21 mm with an average of 2.14 and 1.70 mm respectively (Danaraddi *et al.*, 2009). The present findings are in close conformity with the work of (Danaraddi *et al.*, 2009) as in present findings also *Tetragonula* sp. and *Lepidotrigona arcifera* the brood cells height is with an average of 2.5 and 2.1 mm respectively and the brood cells width is with an average of 2.0 and 1.6mm respectively.

5. Conclusion

A total of 13 different colonies of stingless bees belonging to the family, Apidae were recorded. All these collected 13 colonies were grouped into three species named *viz., Tetragonula* sp., *Tetragonula nov. 1* and *Lepidotrigona arcifera. Tetragonula nov. 1* was reported as entirely novel species. *Tetragonula* sp. was the most abundant species among all the stingless bee species. Species richness was maximum in the month of January and minimum in March. The state of Meghalaya has a diverse flora and fauna & is one of the important hotspot for biodiversity and therefore has a vast wasp range of floral diversity which support the existing of stingless bees in the region. There is need for conserve the environment of stingless bees & also popularisation of meliponiculture in the region. The study aims to see if stingless bees can be used for better pollination of the crops, which can be exploited by farmers.

6. Acknowledgement

The authors are highly thankful to the Dean, College of Post Graduate Studies in Agricultural Sciences and Chairman of School of Crop Protection, Umiam, Meghalaya for carrying out the research work. The authors are also thankful to the Assistant professor of Entomology (CPGSAS), Barapani, Meghalaya, for helping on research work. The authors also thankful to the Assistant professor of Entomology, College of Horticulture, CAU, Thenzawl, Mizoram for providing the necessary tools and resources required for the completion of this study.

7. References

Attasopa K, Bänziger H, Disayathanoowat T, and Packer L (2018). A new species of *Lepidotrigona* (Hymenoptera: Apidae) from Thailand with the description of males of *L. flavibasis* and *L. doipaensis* and comments on asymmetrical genitalia in bees. *Zootaxa*, 4442(1), pp. 63-82.

Danaraddi CS, Viraktamath S, Basavanagoud K, and Bhat ARS (2009). Nesting habits and nest structure of stingless bee, *Trigona iridipennis* Smith at Dharwad, Karnataka. Karnataka Journal of Agricultural Sciences, 22, 310–313.

Heard TA (1999). The role of stingless bees in crop pollination. *Annual review of entomology*, *44*(1), pp.183-206.

Jaapar MF, Halim M, Mispan MR, Jajuli R, Saranum MM, Zainuddin MY, Ghazi R, and Abd Ghani I (2016). The diversity and abundance of stingless bee (Hymenoptera: Meliponini) in Peninsular Malaysia. *Advances in Environmental Biology*, 10(9), pp. 1-8.

Kelly N, Farisya MSN, Kumara TK, and Marcela P (2014). Species diversity and external nest characteristics of stingless bees in Meliponiculture. *J. Trop. Agric. Sci.*, 37(3): 293-298.

Liow LH, Sodhi NS, and Elmqvist T (2001). Bee diversity along a disturbance gradient in tropical lowland forests of south-east Asia. *Journal of Applied Ecology*, pp. 180-192.

Rahman A, Das, PK, Rajkumari P, Saikia J, and Sharmah D (2015). Stingless Bees (Hymenoptera: Apidae: Meliponini): Diversity and distribution in India. *Int. J. Sci. Res.* 4(1): 77-81.

Rasmussen C (2008). Catalog of the Indo-Malayan/Australasian stingless bees (Hymenoptera: Apidae: Meliponini). *Zootaxa*, *1935*(1), pp.1-80.

Rasmussen C (2013). Stingless bees (Hymenoptera: Apidae: Meliponini) of the Indian subcontinent: Diversity, taxonomy and current status of knowledge. *Zootaxa.* 3647(3): 401-428.

Roopa AN, Eswarappa G, Sajjanar SM, and Gowda G (2015). Study on nesting characteristics and biology of stingless bee (*Trigona iridipennis* Smith). *J. Agric. Vet. Sci.,* 8(10): 34-36.

Roubik DW (1989). Ecology and Natural History of Tropical Bees. Cambridge University Press, New York. 514 p.

Willie A (1983). Biology of the Stingless Bees. *Ann. Rev. Entomol.* 28: 41-64.