

Species Diversity of Stingless Bees (Hymenoptera: Meliponini) in Chili PEPPER (*Capsicum annum* L.) Plantation in West Sumatera

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Abstract: *Stingless bees are social insects like honey bees which can function as pollinator. Some of them can be pollinator in chili pepper plants which is very important role in increasing chili pepper production in West Sumatera. The objective of this research was to study the species diversity of stingless bees in chili pepper plantations in West Sumatera. Stingless bees were collected using insect net from nine districts/towns and in every district /town 2 sampled locations were determined. Results showed that there were three species of stingless bees found to visit chili pepper plantations, Trigona (Tetragonula) leviceps Smith (58.85%), T. minangkabau Sakagami et Inoue (40.18%), and T.(Heterotrigona) itama cockerel (3.97%). The species diversity was low with Shannon-Wiener index 0.82 , similarity indeks 0.75 and dominance indeks 0.475. There were two dominant species, T. leviceps and T. minangkabau.*

Keywords: species diversity, stingless bees, pollinator, chili pepper

1. Introduction

There are 41 species, one subspecies, and two forms of stingless bees (Meliponini) found in Indo-Malaya, and 18 species found in Sumatera (Sakagami *et al.* 1990). Sakagami and Inoue in 1987 reported that there were 23 species and one form of stingless bees found in central Sumatera. Species of stingless bees are distributed in primery and secondary forests, and in people settlements from low to high lands up to 1.500 m asl. (Salmah *et al.*1990).

Like honey bees (*Apis* spp), stingless bees (*Trigona* spp.) also function as pollinating insects. Due to their small body size, 2-14 mm (Sakagami *et al.* 1985, Osawa and Tsubaki 2003), stingless bees could obtain nectar from relatively small size flowers. Thus, stingless bees have more various foods compared to honey bees.

Chili pepper (*Capsicum annum* L.) can be planted in low and high lands (Sumarni and Muharam 2005). In West Sumatera chili pepper is a vegetable crop having important

advantages, and even socially in Minangkabau society it is considered as primery crop. For this reason, chili pepper plantations or production centres can be found in many areas in West Sumatera. Due to widely distribution of chili pepper production centres and diverse species of stingless bees, it is very important to study the species diversity of stingless bees visiting chili pepper plantations in West Sumatera

2. Materials and Methods

Study Areas

Stingless bees were collected from chili pepper production centres located in nine districts/towns in West Sumatera: Lima Puluh Kota (1-2), Payakumbuh (3-4), Padang Panjang (5-6), Tanah Datar (7-8), Agam (9-10), Padang (11-12), Solok (13- 14), Pesisir Selatan (15-16), and Padang Pariaman (17-18)(Fig. 1). Two sampling locations were determined in each district/town. The samples were collected from November 2013 until April 2014.

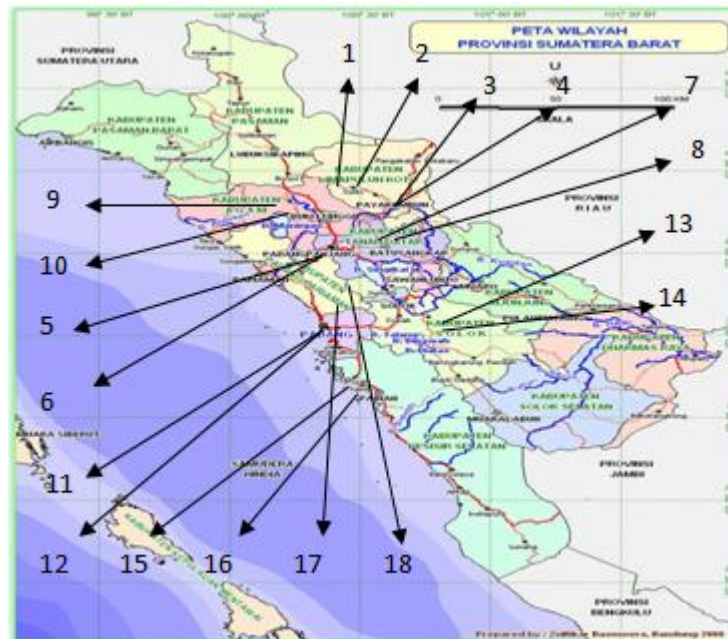


Figure 1: Locations from which stingless bees were collected in West Sumatra: 1. Koto Panjang Suluki, 2. Japang Manganti, 3. By Pass Payakumbuh, 4. Baringin, 5. Ganting, 6. Gunung, 7. Sabu, 8. Sikaladi, 9. Kubang Putihah, 10. Batutaba, 11. Kampung Dalam, 12. Lubuk Minturun, 13. Panyangkalan, 14. Batu Banyak, 15. Kubang Bayang, 16. Barangin Salido, 17. Kataping, 18. Lubuk Alung

3. Methods

Stingless bees were collected using scan sampling method (Martin and Bateson 1993) by counting the number of species and individuals visiting the flowers of chili pepper. Insects were collected in 10 m² areas of plantations within 3 time periods: (7.00, 8.00, 9.00 a.m.), (10.00, 11.00, 12.00 a.m.), and (1.00, 2.00, 3.00 p.m.). In each time period the insects capture was done for 15 minutes. The capture was done in good and bright days.

Species Identification

Stingless bees collected were preserved in alcohol 70%. They were then separated based on morphological characters using binokuler microscope. Identification to species level was conducted by using binokuler microscope completed with optilab viewer. Reference books used for identification were Sakagami *et al.* 1990 and Michener 2007.

Data Analysis

Data analysis were done descriptively to the species of stingless bees and individual captured per time period. Diversity index based on Shannon-Wiener (Margurran 1988):

$$H' = - \sum p_i \ln p_i$$

(H' = Diversity index of Shannon-Wiener, p_i = proportion of number individuals of a species i to total individuals (n_i/N)).

Criteria used to interpret diversity:

$H' < 1$ = low

$H' 1-3$ = middle

$H' > 3$ = high

Dominance index was used to obtain information about dominant species in one community on each habitat. Dominance index used based on Simpson (Ludwig and Reynold 1988):

$$D = \sum (p_i)^2 = \sum (n_i/N)^2$$

(D = Dominance index, p_i = proportion of number individuals of a species i to total individuals)

4. Results

There were 3 species of stingless bees identified from sampled chili pepper plantations in West Sumatra. They were *Trigona (Tetragonula) leviceps* Smith, *Trigona (Tetragonula) minangkabau* Sakagami et Inoue and *Trigona (Heterotrigona) itama* Cockerell (Sakagami *et al.*, 1990). It showed specific species in certain locations with different altitudes (Tabel 1).

Table 1: Species of stingless bees and total individuals found in different locations in chili pepper production centres in West Sumatera

No	Location	Altitude (m asl)	Species of stingless bees			Total individuals
			<i>Trigona Leviceps</i>	<i>Trigona Minangkabau</i>	<i>Trigona itama</i>	
1.	Koto Panjang Suliki	650	49	-	-	49
2.	Japang Manganti	520	50	-	-	50
3.	By Pass Payakumbuh	600	62	-	-	62
4.	Baringin	600	37	-	-	37
5.	Ganting	740	51	-	-	51
6.	Gunung	760	54	-	-	54
7.	Sabu	910	53	-	-	53
8.	Sikaladi	880	-	60	-	60
9.	Kubang Putih	900	-	40	-	40
10.	Batu Taba.	900	-	49	-	49
11.	Kampung Dalam	50	57	-	-	57
12.	Lubuk Minturun	30	-	61	-	61
13.	Panyangkalan	830	-	49	-	49
14.	Batu Banyak	800	43	-	-	43
15.	Kubang Bayang	100	36	-	-	36
16.	Barangan Salido	25	-	-	35	36
17.	Kataping	30	-	44	-	44
18.	Lubuk Alung	40	-	51	-	51
Total			492	354	35	881
Percentage			55.85	40.18	3.97	100

T. leviceps were captured in locations with altitudes range 50 – 910 m asl., temperature range 22–35 °C and humidity 32–78 %. Locations for capturing *T. minangkabau* were 30–900 m asl., temperature range 21-35 °C, and humidity 35–78%. The hive of stingless bees were found in stem and branch cavities, bamboo poles, house wall and stone cracks.

T. itama was found only in one location, in Barangan IV Jurai Subdistrict Pesisir Selatan, located at 25 m asl., temperature range 26 -36 °C and humidity 38 - 64 %. Chili pepper plantations in which the stingless bees were captured were located in secondary forest and other horticultural habitats. *Trigona leviceps* and *T. minangkabau* preferred to make hives in people settlements while *T. itama* preferred to do it in living trees. Field observation indicated that stingless bees visiting chili pepper plantations came from the hives near the plantations. It was found there were two plots of chili pepper about 100 m distance and both were located in the same line with stingless bee hives on which one plot was

nearer to hive than another one. With this condition, intensity of stingless bees visits was higher in chili pepper plot closer to stingless bee hive compared to further one. Other observation indicated that when position of bee hive was opposite direction of two location of chili pepper plots, stingless bees only visited the closer plot but no visit to plot further to hive. Field observation also proved, if hives found in chili pepper plantation belonged to *Trigona leviceps*, thus only the species found to visit the pepper plants. The same thing happened to species of *T. Minangkabau*.

Diversity index (H') of stingless bees in chili pepper plantations was 0.82 (low), Similarity Indeks was 0.75 ($E=0-1$) and Dominance Indeks was 0,475. There were two dominant species, *T. leviceps* (55.85 %) and *T. minangkabau* (40.18 %).

Density of the three species of stingless bees based on observation time is shown in Fig. 2.

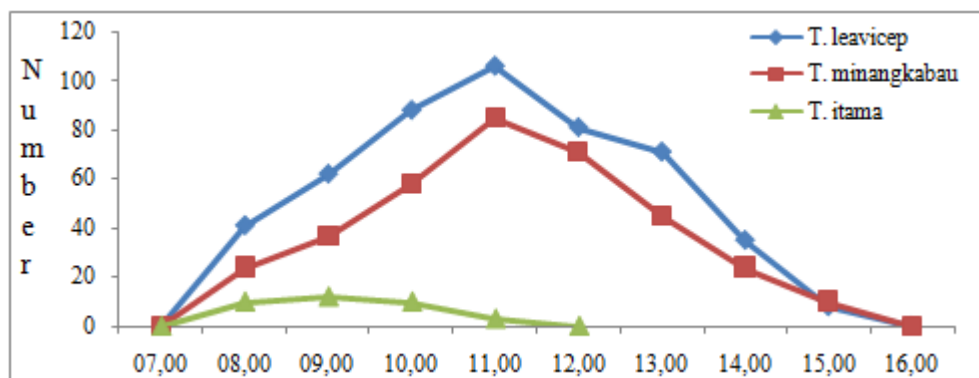


Figure 2: Stingless bees density in food searching activity

T. leviceps and *T. minangkabau* were captured in chili plantations from 8.00 a.m until 3.00 p.m., while *T. itama* were captured from 8.00 a.m. until 11.00 p.m.

The peak food searching time of *T. leviceps* and *T. minangkabau* was at 11.00 a.m. (106 individuals of *T. leviceps* and 85 individuals of *T. minangkabau*). The one for *T. itama* was at 09.00 a.m.

Stingless bees diversity visiting chili pepper besides being influenced by the presence of hives near location it was also affected by the presence of attractant. Chili pepper has nectar and pollen function as attractants. Although the sugar content of nectar was low in morning (37 %) but its volume was high enough (0,2 ul). However, in day time sugar content of nectar was high (52 %) but its volume was low (0,04 ul).

The peak of food searching activity of *T. leaviceps* and *T. minangkabau* occurred before day temperature reached maximum and relative humidity reached minimum, i.e. 12.00 a.m -13.00 p.m (Fig. 3).

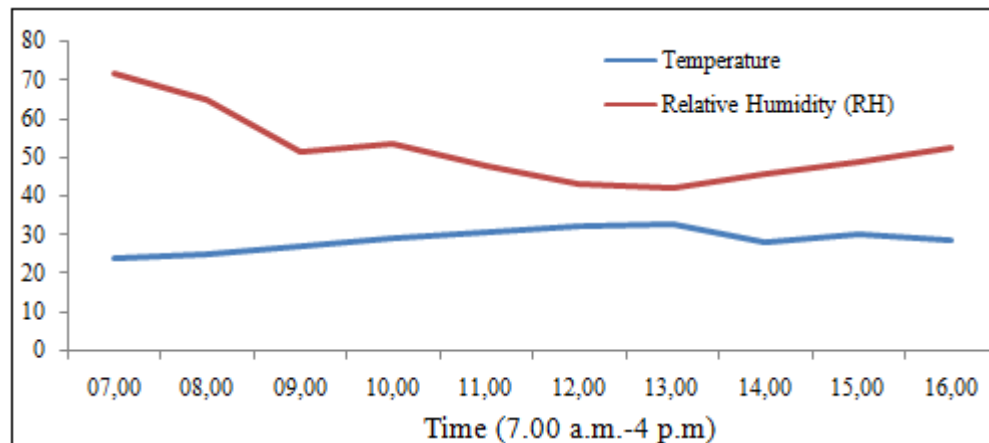


Figure 3: Temperature and humidity at the time of stingless bees captures

5. Discussion

There were 3 species of stingless bees captured in chili pepper plantations out of 23 species and one form found in West Sumatera (Salmah *et al.*, 1990). The low species diversity of stingless bees ($H' = 0,82 < 1$) visiting the chili pepper plants was assumed to be caused by their short flight distance. Compared to honey bees capable of flying up to 1.5 km (Roubik and Aluja 1983), stingless bees could only fly as far as 100 – 200 m (Dollin, 2010). Roubik (1989) estimated the flight distance of stingless bees to search for food less than 434 m, and maximum 500 m (Bartreau, 1996). For *T. carbonaria* the flight distance for food searching was usually 25-30 m from their hives. Due to their limited distance flight to search for food, stingless bees could fly to the nearest food sources from their hives. On the other side, if the chili plantations were far from their hives, the stingless bee were not found there.

Stingless bees hives were found mostly in stem and branch cavities, poles made of bamboos, house cracks and also found in bridge structure cracks. Danaraddi *et al.* (2009) reported that the places where stingless bees made hives depend on their species, usually in tree and branch cavities, stone cracks, wall cracks, old dump, drums for storage.

Stingless bees diversity visiting chili pepper plantations besides being influenced by the presence or absence of hives near the plantations, it was also influenced by the presence of attractants. Chili pepper plants have attractants like nectar and pollen. Although the sugar content of nectar is low in the morning (37 %) but its volume is high enough (0,2 ul). In the day time nectar sugar content is high (52 %) but its volume is low (0,04 ul). Faegri and Van der Pijl (1979); Graham *et al.* (2006) elaborated that nectar is produced in nectaries gland which consist of 25-75 % sugar with various amount of amino acid and fat.

The flower of chili pepper blossom (anthesis) three hours after the sun rises (Dag and Kammer, 2001; Cruz, 2005). At that time the volume of nectar is abundant (0,2 μ l) even though the content of sugar is low (37 %), therefore the visiting insects could obtain nectar easily. For this reason, in the morning there are more pollinating insects visit flowers and reach the peak at 11.00 a.m. On the other hand, at the day time the volume of nectar reduces (0,04 μ l) even though the sugar content increases (52 %), thus it will cause the pollinators difficult to obtain nectar and as a consequence the number of pollinators visiting flowers decreases.

The high volume of nectar in the morning is caused by low atmosphere temperature and high humidity. Under this condition the nectar has not evaporated yet. As the temperature increases and humidity decreases the nectar evaporates and cause the volume of nectar decreases in the day time and the number of insects visiting the flowers also decreases. Kwapong *et al.* (2010) indicated that the visit of insects to flowers in their activity of searching for food was influenced by weather condition such as temperature, humidity, and wind speed.

6. Conclusion

Diversity of stingless bees visiting chili pepper plantations consisted of three species, *Trigona (Tetragonula) leaviceps* Smith, *Trigona (Tetragonula) minangkabau* Sakagami *et Inoue* and *Trigona (Heterotrigona) itama* Cockerell). Stingless bees visiting the plants were the ones having hives near plantations. The presence of stingless bees in chili pepper plantations besides having hives near locations, it was also determined by the presence of attractants like nectar and pollen. Activity of searching food for *T.leaviceps* and *T. minangkabau* occurred from 08.00 a.m- 3.00 p.m with the peak at 11.00 a.m., and for *T. itama* occurred from 08.00-11.00 a.m local time.

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Appendix

Characteristic feature of *Trigona (Tetragonula) leviceps* Smith

Posterior fringe of hind tibia mosly consisting of flumose hairs,wing venation less reduced, pterostigma narrower. Body 4-4,5 mm average $4,4 \pm 0,2$ mm and wing 4,5–5,0 mm average $4,6 \pm 0,2$ mm with hamuli 5. Body color blackish brown



Figure 4: Worker *T. leviceps*, Hind tibia and wing venasi

Characteristic feature of *Trigona (Tetragonula) minangkabau* Sakagami et Inoue

Posterior fringe of hind tibia mosly consisting of flumose hairs,wing venation less reduced, pterostigma narrower. Body 3,2 – 3,5 mm average $3,3 \pm 0,2$ mm and wing 3,5 – 4,0 mm average $3,8 \pm 0,3$ mm with hamuli 5. Metasoma predominantly chestnut brown.



Figure 5: Worker *T. minangkabau*, Hind tibia and wing venasi

Characteristic feature of *Trigona (Heterotrigona) itama* Cockerell Body 5,5 – 6,0 mm average $5,9 \pm 0,2$ mm and wing 6,0 – 6,5 mm average $6,4 \pm 0,2$ mm with hamuli 7. Posterior fringe of hind tibia mosly consisting of flumose hairs, hind basitarsus about 2/3 hind tibia and black body color. Left mandible with one weak tooth.



Figure 5: Worker *T. itama*, Hind tibia and wing venasi