

# MAPPING OF STINGLESS BEE FAUNA IN NAGALAND

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## ABSTRACT

A comprehensive survey was conducted to know the diversity of stingless bee fauna in Nagaland. The stingless bee specimens were collected from different districts under Nagaland state of India. Total 1568 samples were collected from forests and nesting hives. A new species of stingless bee, *Tetragonula gressitti* Sakagami was recorded for the first time. During the studies a total of six different species from different districts were reported. These species were categorised district wise and altitude wise ranged from 100 m to 3230 m AMSL based on GPS coordinates and distribution pattern was also observed. According to the numbers of species recorded from each district a species distribution map was created using the species diversity data. Among all different districts, highest five different species were recorded from district Peren followed by 4 species from Mokokchung district and Mon and Kiphire district with 3 species. Kohima, Zunheboto, Tuensang, Noklak and Wokha districts were least diversified for stingless bee fauna with only 2 species recorded. This was the first attempt in the country to map the stingless bee diversity. These studies will provide a base for further stingless bee diversity explorations and rearing experiments in the country.

## INTRODUCTION

Stingless bees are a large group of bees having about 500 described species (Michener, 2013). They belong to the family Apidae, and are closely related to common honeybees. Stingless bees have many genera that can be found in most tropical or subtropical regions of the world (Silveira *et al.*, 2002). The honeybees and bumble bees are well studied for their diversity and other characters like pollination (Chauhan *et al.*, 2016) while, the present state of knowledge on stingless bees of India, their diversity and foraging plants are not clearly known. Rasmussen (2013) in his pioneer research on stingless bees, studied the distribution and concluded that stingless bees are available in most parts of the Indian subcontinent. Six different species of stingless bees (*Lepidotrigona arcifera* Cockerell, *Lisotrigona cacciae* Nurse, *Lisotrigona mohandasi* Jobiraj and Narendran, *Tetragonula* aff. *laeviceps* Smith, *Tetragonula bengalensis* Cameron and *Tetragonula ruficornis* Smith) belonging to three genera have been reported in India by several researchers time to time (Sakagami 1978; Rasmussen 2008; Rasmussen and Cameron, 2007; 2010). However, the North-Eastern Region of the country which forms part of the Indo-Burma biodiversity hotspots was not explored due to different topographical and social constraints (Kumar, 2014). Among all North Eastern states, Nagaland is one of the biodiversity hotspot spread in 12 different districts in 16579 square kilometres with 80 % of the land covered with forests (Anonymous, 2019) and the climate ranged from sub-temperate to tropical hence harbouring huge floral and faunal biodiversity. Stingless bees are present in Nagaland but not explored (Singh, 2016).

In North East India, only in second decade of present century

the stingless bee exploration started and five species were reported by Rahman *et al.* (2015) viz. *Tetragonula bengalensis*, *T. iridipennis*, *T. ruficornis*, *T. laeviceps* and *Lepidotrigona arcifera* and later Rathor *et al.* (2013) reported *T. gressitti* from Arunachal Pradesh. In Nagaland, Singh (2016) has observed three species viz. *T. iridipennis*, *T. laeviceps* and *Lophotrigona canifrons*. However, later on these were updated to five stingless bee species viz. *T. iridipennis*, *T. laeviceps*, *L. ventralis*, *L. arcifera* and *L. canifrons* (Chauhan *et al.*, 2019) but still a proper geographical stingless bee distribution record was not available and more studies were required to explore the stingless bee fauna of this region with scientific approach. Keeping in view the importance of exploration of stingless bee diversity in this region of the country, present study has been conducted to generate a scientific database on stingless bee fauna available in different districts of Nagaland for their conservation and to generate the rearing protocols for their use in pollination of crops and honey production.

## MATERIALS AND METHODS

The study was carried out at Nagaland in North Eastern India having an elevation ranged between 90 m – 3826 m above mean sea level (amsl) with geographical location of 25°45'43" N latitude and 93°33'04" E longitude.

A survey was conducted during 2019-2020 during different seasons from March to December in different districts of Nagaland in accordance with the survey lines used by different researchers with slight modifications (Rahman *et al.*, 2015). The different districts were divided in four agro-climatic zones ranged between 100 m - > 2000 m (Table 1). These zones were further divided into different locations for multidirectional

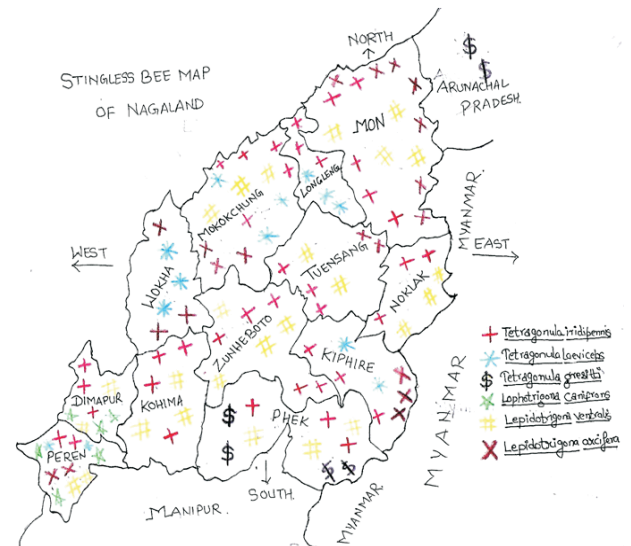
survey (Table 2). The samples were collected between 0700 h to 1600 h from different flora and nesting sites. The collected samples were put in 70 % alcohol and then brought to the laboratory at All India Coordinated Research Project on Honey Bees and Pollinators, School of Agricultural Sciences and Rural Development, Nagaland University, Medziphema. The specimens of stingless bees were preserved as dry and wet in 70% alcohol for the systematics study. The preserved specimens were treated with relaxing fluid (75 per cent alcohol 106 ml, distilled water 98 ml, benzene 14 ml and ethyl acetate 38 ml.) for 2 -4 hours. Various body parts like wings, legs, sterna, mouth parts (mandibles) and metasoma were dissected after water bath boiling in 10 % KOH (Pottasium hydroxide) solution for 2 - 3 minutes. Then the parts were rinsed in water and placed in glacial acetic acid to neutralize the KOH and preserved in glycerin. The measurements of different species along with body parts like head length and width, mesosoma length and width, metasoma length and width and the total length were taken as per Rahman et al. (2015). Total 1568 samples were collected during the studies. The individual mounted specimens were also matched with the previously identified samples and then observed under microscope and identified morphologically based on established taxonomic keys (Rasmussen, 2013; Rathor et al., 2013). The identified species were then labeled along with their locations, name of collector and date of collection and submitted to the department of Entomology insect museum. The samples were also sent to Division of Entomology, IARI, New Delhi for confirmation of identification.

**RESULTS AND DISCUSSION**

After analysing all the collected specimens of stingless bees, a total of six species of stingless bees were recorded and identified (Table 3). These were *Tetragonula iridipennis* Smith, *Tetragonula laeviceps* Smith, *Lepidotrigona ventralis* Smith, *Lepidotrigona arcifera* Cockrell and *Lophotrigona canifrons* Smith. One new species of stingless bee, *Tetragonula gressitti* Sakagami was recorded for the first time from Phek district in Nagaland and from second state after Arunachal Pradesh in India. The altitudinal distribution of different species revealed the presence of *T. iridipennis* at an altitude between 110 - 1464 m amsl with lower altitude coordinates at 25°39'10.398"N; 94°1'22.812"E and higher altitude at 25°42'53.927"N; 94°2'25.525"E, irrespective of districts. *L. ventralis* and *L. arcifera* were recorded at altitude range of 458 - 2018 m amsl with lower altitude coordinates of 25°39.894N; 93°51.268E and higher altitude coordinates 25°34'15"N;

**Table 2 : District wise distribution of areas for stingless bees survey**

District	Areas
Dimapur	Sovima, Medziphema, Choumukedima,
Peren	Ingtanki, Jalukie, Pungawla, Gaili
Wokha	Merapani, Baghty, Bhandari, Doyang area, wokha, Sanis
Kohima	Tseminyu, Zubza, Khonoma, Mima, Japhu range, kohima
Phek	Tuzatsu, Chare, meluri, Wazeho, Chessore, Pfutsero, ,phek, chozuba, Wahezo, Kikruma, Kizari
Kiphire	Kiphire, Pungro, Longmatra, Saramati
Tuensang	Shamatore, Tuensang, Pangsa, Chentang
Zunheboto	Lumami, Suruhoto, Aghunato, Akuloto, Zunheboto
Mon	Tobu, Tizit, Wakehing, Naginimora, Mon, Chen, Longwa, Apao, Namsa
Mokokchung	Tuli, Aonokpu, Mangkolemba, Tsurangkong, Changki range, Longkhim,
Longleng	Longleng, Tamlu, Bhumnyu
Noklak	Noklak village, Panso, Nokhu



**Figure 1: Distribution map of stingless bee species in different districts of Nagaland, India**

94°17'43" E. Similarly, *L. canifrons* were found at an altitudinal range between 177- 910 m having coordinates of lower altitude 25°38.799 N; 93°51.263E and higher altitude coordinates of 25°42'28.752N; 93° 33'37.16"E. The samples of *T. laeviceps* were found between an altitude of 662-830 m amsl and the coordinates were between 25°38.827N; 93°51.268E (lower altitude) 25°34'15"N; 94°17'43" E (higher altitude). The newly

**Table 1: Agroclimatic zones of Nagaland**

Agro climatic zones	Approximate elevation range (amsl)	Areas
Foot hills and plains	100- 200 m	Sovima, Ingtanki, Choumukedima, Merapani, Naginimora, Namsa, Tuli
Low hills	200-1000 m	Aonokpu, Punglawla, Baghty, Bhandari, Zubza, Changtongya, Chare, Doyang area, Kiphire, Jalukie, Mangkolemba, Medziphema, Meluri, Mon, Pangsa, Tobu, Tsurangkong, Tizit
Medium hills	1000 - 1450 m	Akuloto, Changki Range, Chen, Chessore, Mima, Khonoma, Chozuba, Longleng, Tamlu, Bhumnyu, Longwa, Mokokchung, Peren, Sanis, Sangsang, Tuensang, Tseminyu, Wakehing, Wahezo, Wokha
High hills	1450-> 2000 m	Aghunato, Chentang, Khonoma, Chenmoho, Kidima, Helipong, Japhu range, Kikruma, Kohima, Longkhim, Noklak, Pfutsero, Phek, Saramati, Suruhoto, Shamatore, Tokiye, Zunheboto

**Table 3: Distribution of stingless bees in different areas of Nagaland, India**

Name of species	Approximate elevation range (amsl)	GPS Coordinates	Areas
<i>Tetragonula iridipennis</i> Smith	110-1464 m	25°39'10.398" N 25°42'53.927" N  94°1'22.812"E 94° 2'25.525"E	Sovima, Ingtanki, Choumukedima, Gaili, Merapani, Naginimora, Namsa, Tuli, Aonokpu, Punglaw, Baghty, Bhandari, Zubza, Changtongya, Chare, Doyang area, Kiphire, Jalukie, Mangkolemba, Medziphema, Meluri, Mon, Pangsa, Tobu, Tsurangkong, Panso, Tizit, Akuloto, Changki Range, Chen, Chessore, Mima, Khonoma, Chozuba, Longleng, Tamlu, Bhumnyu, Longwa, Mokokchung, Peren, Sanis, Sangsang, Tuensang, Tseminyu, Wakehing, Wahezo, Wokha
<i>Lepidotrigona ventralis</i> Smith and <i>L. arcifera</i> Cockrell	458-2018 m	25° 39.894 N 25° 34'15" N  93° 51 .268 E 94° 17'43" E	Tuzatsu, Aonokpu, Punglaw, Baghty, Bhandari, Zubza, Changtongya, Chare, Doyang area, Kiphire, Jalukie, Mangkolemba, Medziphema, Meluri, Mon, Pangsa, Tobu, Tsurangkong, Tizit, Akuloto, Changki Range, Chen, Chessore, Mima, Khonoma, Chozuba, Longleng, Tamlu, Bhumnyu, Longwa, Mokokchung, Peren, Sanis, Sangsang, Tuensang, Tseminyu, Wakehing, Wahezo, Wokha, Aghunato, Chentang, Khonoma, Chenmoho, Kidima, Helipong, Japhu range, Kikruma, Kohima, Longkhim, Noklak, Pftusero, Phek, Saramati, Surohoto, Shammatore, Tokiye, Zunheboto
<i>Lophotrigona canifrons</i> Smith	177- 910 m	25° 38.799 N 25° 42'28.752 93° 51 .263 E 93° 33'37 .16" E	Aonokpu, Punglaw, Baghty, Bhandari, Zubza, Changtongya, Chare, Doyang area, Kiphire, Jalukie, Mangkolemba, Medziphema, Meluri, Apio, Mon, Pangsa, Tobu, Tsurangkong, Tizit
<i>Tetragonula laeviceps</i> Smith	662- 830 m	25° 38.827 N 25° 34'15" N 93° 51 .268 E 94° 17'43" E	Punglaw, Apao, Medziphema village, Jalukie, Pherema
<i>Tetragonula gressitti</i> Sakagami	956- 1154 m	25° 37'49" N 93° 32'40" E	Kizari, Tuzatsu, Phek

**Table 4: Distribution of stingless bee species in different districts of Nagaland, India**

District	Stingless bee species
Dimapur	<i>Tetragonula iridipennis</i> , <i>Lepidotrigona ventralis</i> , <i>Lophotrigona canifrons</i>
Peren	<i>Tetragonula iridipennis</i> , <i>Tetragonula laeviceps</i> , <i>Lepidotrigona ventralis</i> , <i>Lepidotrigona arcifera</i> , <i>Lophotrigona canifrons</i>
Wokha	<i>Tetragonula iridipennis</i> , <i>Tetragonula laeviceps</i>
Kohima	<i>Tetragonula iridipennis</i> , <i>Lepidotrigona ventralis</i>
Phek	<i>Tetragonula iridipennis</i> , <i>Tetragonula gressitti</i> , <i>Lepidotrigona ventralis</i>
Kiphire	<i>Tetragonula iridipennis</i> , <i>Tetragonula laeviceps</i> , <i>Lepidotrigona arcifera</i>
Tuensang	<i>Tetragonula iridipennis</i> , <i>Lepidotrigona ventralis</i> , <i>Lepidotrigona arcifera</i>
Zunheboto	<i>Tetragonula iridipennis</i> , <i>Lepidotrigona ventralis</i>
Mon	<i>Tetragonula iridipennis</i> , <i>Lepidotrigona ventralis</i> , <i>Lepidotrigona arcifera</i>
Mokokchung	<i>Lepidotrigona ventralis</i> , <i>Lepidotrigona arcifera</i> , <i>Tetragonula iridipennis</i> , <i>Tetragonula laeviceps</i>
Longleng	<i>Tetragonula iridipennis</i> , <i>Lepidotrigona ventralis</i>
Noklak	<i>Tetragonula iridipennis</i> , <i>Lepidotrigona ventralis</i>

recorded species *T. gressitti* was found between an altitude of 956-1154 m amsl with coordinates at 25°37'49"N; 93°32'40" E. Earlier this species was reported from southern Vietnam (1978) followed by Arunachal Pradesh (2013) in India and Southwest China (2019). This is the first state in India to report *T. gressitti* from the nesting sites. With the discovery of new species, the Nagaland state reported six different species of stingless bees hence became the highest stingless bee diversity hotspot in India.

The distribution map was drawn for showing the diversity of stingless bee fauna in different districts of Nagaland (Fig. 1 and Table 4). A new species, *Tetragonula gressitti* Sakagami was reported first time from Phek district along with other two species i.e. *T. iridipennis* and *L. ventralis*. Peren district is having plains, low hills and mid hills and was recorded very rich in stingless bee species diversity. Total five species viz., *T. iridipennis*, *T. laeviceps*, *L. canifrons*, *L. ventralis* and *L. arcifera* were collected from flowering plants and nesting sites. The

diversity was followed by Mokokchung district, harbouring four different species. They were *T. iridipennis*, *T. laeviceps*, *L. ventralis* and *L. arcifera*. Dimapur district which is mostly a low land area, the different species of stingless bees recorded were *T. iridipennis*, *L. ventralis* and *L. canifrons*. However, in Kohima, Tuensang, Zunheboto, Noklak only two species were observed. They were *T. iridipennis* and *L. ventralis*. Similarly, Wokha district were having *L. arcifera* and *T. laeviceps*. Longleng district showed presence of *T. iridipennis* and *T. laeviceps*. Data from Mon district revealed three different species viz., *T. iridipennis*, *L. arcifera* and *L. ventralis*. While Kiphire district recorded three species, *T. iridipennis*, *T. laeviceps* and *L. arcifera*. Among all the species recorded in Nagaland, *T. iridipennis* was found in all districts and is most dominant stingless bee species.

Stingless bees are important pollinator bees found in North east India, South India and several states of Central and North India. In the present studies, total six species of stingless bees

were reported from Nagaland. Likewise earlier, different workers explained different species from different parts of the North eastern India. Sakagami (1978); Rasmussen (2008; 2013) described stingless bees of Indian subcontinent. Contrary to Rasmussen (2013), stingless bees were also recorded from higher altitudes. Afterwards, Rahman *et al.* (2015) also reported *T. iridipennis*, *T. laeviceps*, *T. ruficornis*, *T. bengalensis* and *L. arcifera* from North East India. In addition to this, *T. gressitti* was recorded from Arunachal Pradesh (Rathor *et al.*, 2013), but the sample size was very small and still more clarity is required in biology and nesting of this species. Das *et al.* (2019) reported *T. iridipennis* and *L. canifrons* being reared in houses in Nagaland. Likewise, Chauhan and Singh (2019) collected samples of stingless bees from Dimapur and reported them as *T. iridipennis* and *L. ventralis*. Four species of stingless bees were reported to visit ash gourd flowers in Nagaland (Chauhan *et al.*, 2019). Similarly, Bui *et al.* (2020) reported *L. arcifera* from Arunachal Pradesh and *Tetragonula* sp1 and *T. sp2* from Nagaland. Contrary to Rasmussen (2013), *L. ventralis* was recorded from higher altitudes of the state during the studies. Recently, Singh and Chauhan (2020) reported *T. iridipennis* as most dominant stingless bee species in Nagaland. These findings revealed the stingless bee diversity of Nagaland which will provide the opportunity to stingless bee researchers round the globe to explore the biology and nesting behaviour of some of these species which is still unknown to rest of the world.

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