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 of Nagaland state of India. A total of 1,568 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 study, six species from different districts were reported. These species were categorised district-wise and altitude-wise ranging from 100 to 3,230 m amsl based on GPS coordinates and distribution pattern was also observed. Species distribution map was created using the species diversity data according to the number of species recorded from each district. Among all the districts, maximum five species were recorded from district Peren followed by 4 from Mokokchung district and Mon and Kiphire districts with 3 species each. Kohima, Zunheboto, Tuensang, Noklak and Wokha districts were least diversified for stingless bee fauna with only 2 species recorded from each district. This was the first attempt in the country to map the stingless bee diversity. The study will provide a base for further studies on stingless bee diversity and rearing experiments in the country.

Keywords: Stingless bee; distribution; mapping; diversity

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 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, *L mohandasi* Jobiraj and Narendran, *Tetragonula* aff *laeviceps* Smith, *T bengalensis* Cameron and *T ruficornis* Smith) belonging to three genera have been reported in India by several researchers (Sakagami 1978, Rasmussen 2008, Rasmussen and Cameron 2007, 2010). However the northeastern region of the country which forms part of the Indo-Burma biodiversity hotspots has not been explored due to different topographical and social constraints (Vijayakumar 2014). Among all northeastern states, Nagaland is one of the biodiversity hotspots spread in 12 different districts in 16,579 square kilometres with 80 per cent of the land covered with forests (Anon 2019) and the climate ranged from sub-temperate to tropical hence harbouring huge floral and faunal biodiversity. Stingless bees are present in Nagaland but are not explored (Singh 2016).

In northeast 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 was 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.

MATERIAL and METHODS

The study was carried out in Nagaland in northeastern India having an elevation between 90 to 3,826 m amsl with geographical location of 25°45'43" N latitude and 93°33'04" E longitude.

Survey was conducted during 2019-2020 from March to December in different districts of Nagaland in accordance with the survey lines used by various researchers with slight modifications (Rahman et al 2015). The districts were divided into four agro-climatic zones ranging between 100 to >2000 m (Table 1). These zones were further divided into different locations for multi-directional survey (Table 2). The samples were collected between 0700 to 1600 hours from variety of flora and nesting sites. The collected samples were put in 70 per cent alcohol and 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, Nagaland. The specimens of stingless bees were preserved as dry and wet in 70 per cent alcohol for the systematic study. The preserved specimens were treated with relaxing fluid (75% alcohol 106 ml, distilled water 98 ml , benzene 14 ml and ethyl acetate 38 ml) for 2-4 h. Various body parts like wings, legs, sterna, mouth parts (mandibles) and metasoma were dissected after water bath boiling in 10 per cent KOH (potassium hydroxide) solution for 2-3 minutes. The parts were rinsed with water and placed in glacial acetic acid to neutralize the KOH and preserved in glycerine. The measurement of the species along with body parts like head length and width, mesosoma length and width, metasoma length and width and the total length was taken as per Rahman et al (2015). Total 1,568 samples were collected during the study. The individual mounted specimens were also matched with the previously identified samples, 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

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, *T laeviceps* Smith, *Lepidotrigona ventralis* Smith, *L 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 of 110-1,464 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 458-2,018 m amsl with lower altitude coordinates of 25º39.894 N; 93º51.268 E and higher altitude coordinates 25º34'15" N; 94º17'43" E. Similarly *L canifrons* was found at an altitudinal range between 177- 910 m amsl having coordinates of lower altitude 25º38.799 N; 93º51.263 E and higher altitude coordinates of 25º42'28.752 N; 93º33'37.16" E. The samples of *T laeviceps* were found between an altitude of 662-830 m amsl and the coordinates were between 25º38.827 N; 93º51.268 E (lower altitude) and 25º34'15"N; 94º17'43" E (higher altitude). The newly recorded species *T gressitti* was found at an altitude of 956-1,154 m amsl with coordinates at 25º37'49" N and 93º32'40" E. Earlier this species was reported from southern Veitnam in 1978 followed by Arunachal Pradesh in 2013 in India and southwest China in 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.

Table 1. Agro-climatic zones of Nagaland

Agro-climatic zone	Approximate elevation range (m) amsl	Areas
Foothills and plains	100-200	Sovima, Ingtanki, Choumukedima, Merapani, Naginimora, Namsa, Tuli
Low hills	200-1,000	Aonokpu, Punglawa, Baghty, Bhandari, Zubza, Changtongya, Chare, Doyang area, Kiphire, Jalukie, Mangkolemba, Medziphema, Meluri, Mon, Pangsa, Tobu, Tsurangkong,Tizit
Medium hills	1,000-1,450	Akuloto, Changki Range, Chen, Chessore, Mima, Khonoma, Chozuba, Longleng, Tamlu, Bhumnyu, Longwa, Mokokchung, Peren, Sanis, Sangsang, Tuensang, Tseminyu, Wakehing, Wahezo, Wokha
High hills	1,450->2,000	Aghunato, Chentang, Khonoma, Chenmoho, Kidima, Helipong, Japhu range, Kikruma, Kohima, Longkhim, Noklak, Pfutsero, Phek, Saramati, Surohoto, Shammatore, Tokiye, Zunheboto

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

Table 3. Distribution of stingless bees in different areas of Nagaland

Species	Approximate elevation range (m) amsl	GPS coordinates	Areas
Tetragonula iridipennis Smith	110-1464	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, Punglawa, 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
Lepidotrigona ventralis Smith and *L arcifera* Cockrell	458-2018 m	25º 39.894 N 25º 34’15" N 93º 51 .268 E 94º 17’43" E	Tuzatsu, Aonokpu, Punglawa, 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, Pfutsero, Phek, Saramati, Surohoto, Shammatore, Tokiye, Zunheboto
Lophotrigona canifrons Smith	177- 910	25º 38.799 N 25º 42’28.752 93º 51 .263 E 93º 33’37 .16" E	Aonokpu, Punglawa, Baghty, Bhandari, Zubza, Changtongya, Chare, Doyang area, Kiphire, Jalukie, Mangkolemba Medziphema, Meluri, Apio, Mon, Pangsa, Tobu, Tsurangkong, Tizit
Tetragonula laeviceps Smith	662- 830 m	25º 38.827 N 25º 34’15" N 93º 51 .268 E 94º 17’43" E	Pungalwa, Apao, Medziphema village, Jalukie, Pherema
Tetragonula gressitti Sakagami	956- 2073 m	25º 37’49" N 93º 32’40" E	Kizari, Tuzatsu, Phek

Table 4. Distribution of stingless bee species in different districts of Nagaland

District	Species
Dimapur	*Tetragonula iridipennis, Lepidotrigona ventralis, Lophotrigona canifrons*
Peren	*Tetragonula iridipennis, T laeviceps*, *Lepidotrigona ventralis, L arcifera, Lophotrigona canifrons*
Wokha	*Tetragonula iridipennis, T laeviceps*
Kohima	*Tetragonula iridipennis, Lepidotrigona ventralis*
Phek	*Tetragonula iridipennis, T gressitti, Lepidotrigona ventralis*
Kiphire	*Tetragonula iridipennis, T laeviceps, Lepidotrigona arcifera*
Tuensang	*Tetragonula iridipennis, Lepidotrigona ventralis, L arcifera*
Zunheboto	*Tetragonula iridipennis, Lepidotrigona ventralis*
Mon	*Tetragonula iridipennis, Lepidotrigona ventralis, L arcifera*
Mokokchung	*Lepidotrigona ventralis, L arcifera, Tetragonula iridipennis, T laeviceps*
Longleng	*Tetragonula iridipennis, Lepidotrigona ventralis*
Noklak	*Tetragonula iridipennis, Lepidotrigona ventralis*

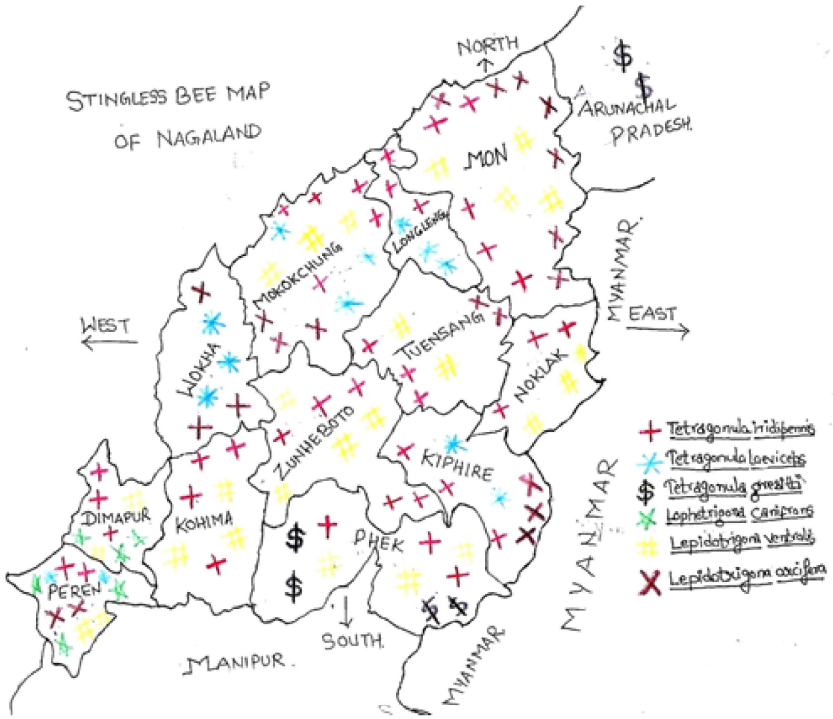

Fig 1. Distribution map of stingless bee species in different districts of Nagaland

The distribution map was drawn for showing the diversity of stingless bee fauna in different districts of Nagaland (Fig 1, Table 4). A new species, *Tetragonula gressitti* Sakagami was reported for the first time from Phek district along with other two species viz *T iridipennis* and *L ventralis*.

Peren district is having plains, low hills and mid-hills and was found 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.* In 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 and Noklak only two species were observed. They were *T iridipennis* and *L ventralis*. Similarly Wokha district was 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*. 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 was most dominant stingless bee species.

DISCUSSION

Stingless bees are important pollinator bees found in northeast India, south India and several states of central and north India. In the present study, total six species of stingless bees were reported from Nagaland. Likewise earlier, different workers explained different species from different parts of the northeastern India. Sakagami (1978) and Rasmussen (2008, 2013) described stingless bees of Indian subcontinent. Contrary to Rasmussen (2013), stingless bees were also recorded from higher altitudes. Rahman et al (2015) also reported *T iridipennis*, *T laeviceps*, *T ruficornis*, *T bengalensis* and *L arcifera* from northeastern 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 was required in biology and nesting of this species. Das et al (2019) reported *T iridipennis* and *L canifrons* being reared in houses in Nagaland. 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). Bui et al (2020) reported *L arcifera* from Arunachal Pradesh and *Tetragonula* sp1 and sp2 from Nagaland. Contrary to Rasmussen (2013), *L ventralis* was recorded from higher altitudes of the state. 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 are still unknown to rest of the world.

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