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Nest architecture and nesting site preference of *Tetragonula iridipennis* Smith in different Agro-climatic regions of Karnataka, India

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Abstract

The present study was conducted during 2024-25 to investigate the nest architecture and nesting site preferences of the stingless bee, *Tetragonula iridipennis* Smith across three agro-climatic regions of Karnataka-Northern Dry Zone (NDZ), Southern Dry Zone (SDZ) and Southern Transitional Zone (STZ). Survey was carried out during winter and summer season to record external and internal nest characteristics. Stingless bees preferred enclosed cavities such as wall crevices, wooden boxes, meter boxes and tree hollows, with nest heights ranging from 0.95 to 1.76 m. Entrance tubes were predominantly oval or elliptical, showing regional variation in length (63.22-86.89 mm in SDZ, 20.70-22.80 mm in STZ and 12.92 mm in NDZ) and orientation (south in SDZ, east/north in STZ, south/north in NDZ). Internally, pollen pots were located near the entrance, brood cells at the centre and honey pots on the periphery. Pollen and honey pots were largest in SDZ, whereas NDZ colonies had smaller pots but higher brood cell density, indicating adaptive strategies to local resource availability. Seasonal variation was minor. The study demonstrates that *T. iridipennis* maintains a stable nest architecture while exhibiting adaptive structural variations in response to regional climatic and ecological conditions, providing insights for conservation and management of stingless bees in Karnataka.

Keywords: Entrance tube, nesting sites, *Tetragonula iridipennis*, stingless bee

Introduction

Stingless bees (Hymenoptera: Apidae: Meliponini) represent the most diverse group of eusocial bees, comprising more than 630 described species in 55 genera distributed across tropical and subtropical regions of the world, including the Afrotropical, Indo-Malayan, Australasian and Neotropical zones (Michener, 2000; Rasmussen and Cameron, 2010; Engel *et al.*, 2023) [5, 8, 13]. They are close relatives of honey bees and bumble bees but are distinguished by their atrophied stings, rendering them harmless to humans. These bees range from 2 mm (*Leurotrigona pusilla*) to 15 mm (*Melipona fuliginosa*) in size (Roubik, 2006) [15] and are valued for their roles in honey production, pollination and maintenance of tropical biodiversity (Heard, 1999; Slaa *et al.*, 2006) [7, 19].

In India, 22 species of stingless bees have been reported under three genera-*Tetragonula*, *Lisotrigona* and *Lepidotrigona* of which *Tetragonula* is the most dominant (Viraktamath & Roy, 2022) [20]. *Tetragonula iridipennis* Smith is the most widely distributed species in southern India and occurs abundantly in both wild and human-modified habitats, contributing significantly to crop pollination and honey production.

Stingless bee pollination enhances fruit set, yield and quality in a wide range of crops including cucurbits, coffee and guava (Heard, 1999; Slaa *et al.*, 2006) [7, 19]. Nest site selection and architecture are vital components of stingless bee ecology, influencing thermoregulation, defence, reproduction and colony productivity. Nests are constructed using cerumen a mixture of wax and plant resin and consist of distinct structures such as entrance tubes, brood combs, food storage pots, involucre and batumen layers (Roubik, 2006) [15]. Stingless bees occupy diverse nesting sites including tree cavities, termite mounds, rock crevices and man-made structures (Charan *et al.*, 2023) [1]. Environmental factors such as temperature, humidity, vegetation type and availability of substrates strongly influence nest distribution and design (Minaxi and Sisodiya 2024) [9].

Understanding the nesting ecology of *T. iridipennis* is essential for its conservation and for enhancing its potential in pollination and meliponiculture. Nesting behavior reflects a colony's adaptation to environmental pressures, resource availability and habitat modifications (Roubik, 2006) [15]. With increasing deforestation, land-use changes and urbanization, natural nesting sites are declining, forcing colonies to adapt to artificial or altered habitats. Documenting how *T. iridipennis* selects and modifies its nesting environment under varying ecological conditions provides valuable insights into its resilience and supports the development of sustainable management and conservation strategies.

Karnataka, with its diverse agro-climatic conditions, provides a range of ecological environments that may influence the nesting patterns of *T. iridipennis*. However, comprehensive studies on how environmental variables and regional differences affect its nesting site selection, architecture and colony structure are still limited. Such knowledge is essential for understanding the adaptability of this species and for promoting sustainable meliponiculture and pollination management.

Hence, the present study was undertaken to investigate the nest architecture and nesting site preference of *T. iridipennis* across different agro-climatic regions of Karnataka. The specific objectives:

1. To analyze variations in nest architecture of *T. iridipennis* across different agro-climatic zones of Karnataka

Material and methods

Study area

Karnataka is situated in the Deccan Plateau with three principal physical zones *viz.*, coastal strip called Karavali, Western Ghats called Malenad and Deccan Plateau called Bayalu Seeme/ Maidan. Further, it is divided into 10 agro climatic zones. However, Present investigation was undertaken in three different agro-climatic zones of Karnataka to study the nest construction behaviour of stingless bees during winter and summer season of 2024-25, which includes the northern dry zone, southern dry zone and southern transitional zone. In each zone, particular place was fixed for survey. The identified places were Koppal (15. 6219° N, 76. 1784° E: 540 m above MSL) in northern dry zone, Ponnampet (12.1515° N, 75. 9430° E: 851 m above MSL) in southern dry zone and Sagara (4.1670° N, 75. 0403° E: 640 m MSL) in southern transitional zone. In each selected location, seven stingless bee colonies were identified and marked for further observation.

Methodology

1. Winter survey: The external characters of all seven marked colonies were observed. The external nest characters like, nest habitat preference and nest height from the ground was recorded by using measuring tape. Nest entrance tube dimensions (length, width and height) were recorded with measuring scale and orientation of nest entrance tube was recorded with the help of a compass. Compass was mounted on a stable base and direction of the entrance was recorded. Shape and colour of nest entrance tube were recorded visually (Plate 1).

Out of the seven stingless bee colonies selected in each agro-climatic zone, two colonies were randomly selected and dissected to observe their internal nest architecture and colony structure. Measurements like nest cavity diameter

and internal tunnel length were taken using a measuring scale and expressed in centimetre. Detailed observations were made on the shape, colour, arrangement and placement of brood cells and storage pots (honey and pollen pots). Further, five brood cells, pollen pots and honey pots were randomly selected from each opened colony for measuring their diameter, height and weight. The diameter and height of each cell were measured using a vernier caliper and expressed in millimetre. The weight of each cell was recorded using a weighing balance and expressed in gram. The density of brood cells, pollen pots and honey pots were measured by counting number of cells per cubic inch.

2. Summer survey

The same procedure was followed as mentioned in winter survey during summer for observing external nest characters. All the five nests were opened to study the internal characters.

All data on nesting habitat type, nest architecture and internal parameters including both qualitative and quantitative nest characteristics were recorded. Frequency analysis was done for qualitative characters while descriptive analysis was done for quantitative characters.

Results

External nest characteristics of stingless bee

Based on the survey conducted in different agro-climatic zones of southern Karnataka, most of the stingless bee colonies were observed in wall cavities, which included both mud and stone wall cavities. Colonies were also observed inside the hollow cavities of the trees, meter box, wooden beam junctions of doors and window, cracks of roof. The colonies of *T. iridipennis* were found at a mean height of 1.04 m above the ground in northern dry zone, 0.95 m in southern dry zone and 1.76 m in southern transitional zone. The nest architecture starts with nest entrance, which is tubular in shape and serve as passage for the movement of bee from internal nest chamber to outside environment. It is coated with fresh resin that prevents the entry of ants and other predatory insects into the nest. During winter, the entrance tubes in the NDZ were oval in shape with an average size of 7.58 mm in width and 11.42 mm in height, brown in colour and constructed using resin and mud particles their orientation was mainly towards the south and north. In the SDZ, the entrance tubes were elliptical to oval, larger in size with a mean width of 22.67 mm and height of 12.22 mm and varied in colour from brown to grey, they were made of resin, mud, sand and wood particles were consistently oriented towards the south. In the STZ, the entrance tubes were predominantly oval or elliptical, measuring 10.20 mm in width and 17.80 mm in height, blackish brown in colour and constructed using resin, mud, sand and wood particles their orientation was mainly towards the east or north. Across all zones, the entrance tube shape, size, colour, construction material and orientation remained unchanged during the summer season, except for an increase in tube length in the SDZ and STZ. The entrance tube length of stingless bee colonies showed clear regional variation (Plate 2 and 3). The colonies in the SDZ had the longest entrance tubes, with a mean length of 63.22 mm in winter and 86.89 mm in summer, followed by those in the STZ (20.70 mm in winter and 22.80 mm in summer) and in NDZ entrance tube length remains same in both seasons, measuring 12.92 mm (Table 1 and 2).

Internal nest characteristics of stingless bee

Northern Dry Zone (NDZ)

Across both winter and summer season, the nesting structure in NDZ followed a similar pattern, pollen pots positioned near the entrance tube, honey pots arranged along the periphery and brood cells located at the centre. Pollen pots in both seasons were brown and oval, measuring 6.70 mm width, 9.20 mm length and 0.70 g weight in winter and 7.00 mm width, 9.20 mm length and 0.72 g weight in summer. Honey pots were dark brown, with 7.00 mm width, 9.60 mm length and 0.72 g in winter and 7.20 mm width, 9.50 mm length and 0.62 g in summer. Brood cells were light to dark brown, with dimensions of 2.90 mm width, 3.40 mm length and 0.03 g in winter and 3.16 mm width, 3.96 mm length and 0.03 g in summer. Brood cell density was the highest among all zones, increasing from 22.30 cells/in³ in winter to 24.80 cells/in³ in summer, indicating a highly compact brood arrangement adapted to dry climatic conditions (Table 3 and 4).

Southern Dry Zone (SDZ)

In both winter and summer season, brood cells were located at the centre and surrounded by honey pots, while pollen pots were positioned near the entrance tube. Pollen pots measured 8.50 mm width, 9.50 mm length and 0.75 g in winter and 8.00 mm width, 9.60 mm length and 0.76 g in summer. Honey pots were larger than those in NDZ, measuring 8.60 mm width, 10.80 mm length and 0.65 g in winter and 8.40 mm width, 10.20 mm length and 0.70 g in summer. Brood cells were similar across seasons, with dimensions of 3.10 mm width, 3.90 mm length and 0.03 g in winter, and 3.40 mm width, 4.20 mm length and 0.03 g in summer. Brood cell density remained constant across seasons (20.14 cells/in³) and was lower than NDZ. The larger pollen and honey pots indicate greater floral resource availability in this zone (Table 3 and 4).

Southern Transitional Zone (STZ)

Across both seasons, the internal nest structure remained consistent, with pollen pots near the entrance tube, brood cells at the centre and honey pots placed along the periphery. A distinguishing feature of this zone was the yellowish colour of pollen pots in both seasons. Pollen pots measured 7.50 mm width, 9.80 mm length and 0.69 g in winter and 7.60 mm width, 9.50 mm length and 0.74 g in summer. Honey pots were dark brown and oval to irregular, with 8.20 mm width, 10.20 mm length and 0.64 g in winter and 7.80 mm width, 9.80 mm length and 0.65 g in summer. Brood cells showed slight seasonal variation, measuring 3.00 mm width, 3.30 mm length and 0.02 g in winter, and 3.20 mm width, 4.00 mm length and 0.04 g in summer. Brood cell density was the lowest among all zones, ranging from 19.70 cells/in³ in winter to 20.50 cells/in³ in summer, indicating a moderately compact brood arrangement influenced by transitional climatic conditions (Table 3 and 4).

Discussion

External nest characteristics of stingless bee

From the present investigations it is evidenced that the stingless bees prefer enclosed structures for nesting and never builds open nests. Wall cavities made up of stone, cement and mud wall, hollow tree cavity, wooden logs, empty wooden boxes, meter box and wooden beam

junctions of windows, were found to be most preferred nesting site of stingless bees in different regions. Stingless bees use close cavities for nesting to regulate nest temperature, avoid exposure to sunlight and protect itself from predators. Present observations are in conformity with the findings of Ramya *et al.* (2015) who reported that, mud wall, meter box and tree cavities are preferred nesting site of stingless bees in different agroclimatic zones of Karnataka. Sheetal and Basavarajappa (2009) ^[18] reported that, nesting sites of stingless bee are stone wall, mud wall, pillars, metallic sheath, iron water pipe, plastic water pipe, electric box, lamppost, telephone wires, wooden door rim and windows rim.

Stingless bee nest were found at different height from the ground, ranged from 0.95 to 1.76 m in different regions of Karnataka. Present observations are in conformity with Chavan *et al.* (2025) ^[2] who reported that stingless bee nests were found at heights ranging from 1.5 to 21.0 ft above the ground, with an average height of 5.59 ft and 66 per cent of colonies occurred at lower elevations of 0 to 5 ft. Choudhary *et al.* (2021) ^[3] reported that, the average nest height from ground ranged between 0.75 to 6.32 m. Longer and narrow entrance tubes in SDZ are likely an adaptation to higher rainfall and greater humidity, where this extended entrance tube provide protection against rain splash and help to buffer microclimatic fluctuations within the nest. The richer vegetation and resin availability in this zone may also facilitate the construction of longer tubes, which additionally serve as barriers against ants and other natural enemies which were found in large number in that region. In contrast, the colonies found in NDZ which is characterized by hot and dry conditions with limited rainfall and resin resources were found to have shorter entrances tube. This shorter entrance tube improves ventilation and airflow thus preventing overheating of the brood chamber. Present findings are in line with the results of Ramya *et al.* (2015) who reported that, the length of nest entrance tube ranges from 5 to 90 mm in different agro-climatic zones of Karnataka. Roubik (2006) ^[15] reported that, variation of nest entrances tube length of stingless bees related to many factors, such as age of nest, microclimate, predators, parasites and symbionts.

Considerable variation was observed in shape, colour and orientation of nest entrances among colonies across the three regions. In total three colouration viz., brown, black, grey were recorded. Nests in cement wall had grey entrance and was made up of sand particles, dry leaf bits and wood particles. Nest in tree trunk and stone wall had black and brown colour, made up of resin and mud particles, the colour of the nest entrance merged with the substratum which help to overcome the predators or natural enemies problem. This finding is in agreement with Shaguftha and Basavarajappa (2024) ^[17] reported that, variation in colour may be due to availability of resin and material used for construction and the colour of the tube which mimic the surrounding nest site environment. The shape of the nest entrance tube did not show much variations across the regions. In all the three regions, entrance tubes were predominantly oval and elliptical in shape. Present observations are in line with Shaguftha and Basavarajappa (2024) ^[17] reported that, oval shaped entrance tube is predominant in southern Karnataka. Likewise, Choudhary *et al.* (2021) ^[3] reported that, the majority of *T. iridipennis* nest has elliptical shape entrance tube followed by circular

shape. The nest orientation of nest entrance shows some regional differences. South is most preferred direction in SDZ, east and north in STZ and south and north in NDZ. Present observations are in similar with Shaguftha and Basavarajappa (2024) ^[17] reported that, southeast is most preferred orientation of stingless bees in Delhi, India. Chavan *et al.* (2025) ^[2] reported that, east is the most preferred nest orientation direction followed by north and west in Konkan of Maharashtra. Nest orientation also has a clear and causal relationship to nest microclimate (Nayak *et al.*, 2013) ^[10].

Internal nest characteristics of stingless bee

Irrespective of the seasons and regions some of the internal nest characters *viz.*, Arrangement, shape, colour, location of brood cells, honey and pollen pots were almost similar, but few characters such as dimensions, density and weight of brood cells, honey and pollen pots were differed between the regions. In all zones, pollen pots were always located near the entrance tube, honey pots were located at periphery and brood cells at the centre of the colony. Pollen and honey pots were compactly arranged, in some of the colonies, pollen and honey pots are intermixed due to restricted space availability. Pollen pots were completely filled with pollen and closed only unfilled pollen pots were opened. Whereas brood cells were arranged in clusters with space for easy movement of bees with in the cluster. The colour of pollen pots are brown colour in the most of the colonies but in contrary, yellowish colour pollen pots were observed in STZ which may be probably due to different pollen source, honey pots were predominantly dark brown and brood cells ranged from light brown to dark brown. Brood cells containing eggs and larvae are brown in colour, while the cell containing pupae are creamy white in colour. The general shape of pots were oval, although honey pots occasionally appeared irregular. Present findings are similar with Rasmussen and Cameron (2007) ^[12] who reported that, stingless bees typically exhibit stable internal nest architecture, regardless of geography. Roopa *et al.* (2015) ^[14] reported that, newly constructed brood cells were brownish, which become straw coloured with the advancement of age in stingless bees.

Despite these structural similarities, significant variations were observed in the dimensions, weight and density of the nest components across agro-climatic zones and seasons. Pollen and honey pots were consistently larger and heavier in SDZ followed by STZ and smaller in NDZ. This is due to greater resource availability in the SDZ, particularly in

terms of pollen and nectar sources, which are supported by better vegetation cover, higher floral diversity and more stable climatic conditions. In contrast, the NDZ has harsher and drier environment offers fewer floral resources, limiting the development of these storage structure. In contrast, brood cells show less regional variation in shape and arrangement, but their density was higher in NDZ, this could reflect an adaptive strategy in which bees in resource poor environments increase reproductive investment by producing more brood cells, even smaller in size. Higher brood cell density in harsher climates may be a compensatory mechanism to maintain colony strength.

Seasonal variations in nest component dimensions were present but less prominent than regional differences. Slightly larger and heavier nest structures brood cells and pollen and honey pots were observed during the summer, due to increased foraging activity and resource availability during this season.

These findings indicate that *T. iridipennis* maintained a stable nest architecture across different environments, adaptive variation in size, weight and density of internal structures of the colonies to optimize resource use and brood rearing under diverse climatic conditions. This shows nest structure of stingless bees were not only species-specific but also environmentally responsive. Similar observations recorded by Danaraddi (2007) ^[4] reported that, *T. iridipennis* colonies in dry areas had smaller but denser brood cells and storage pots, while in southern Karnataka, colonies showed larger pot sizes due to richer floral resources. Rukmi *et al.* (2022) reported that, stingless bee colonies adjusted pot size and density according to seasonal floral availability, with larger pots during high bloom periods and smaller pots during scarcity. Prato and Soares (2013) ^[11] reported that, climatic conditions and nest cavity size influence pot architecture, where larger cavities allow fewer but bigger pots. Ramya *et al.* (2015) reported that, brood cells measured 3.0 to 4.0 mm in length and 2.0 to 3.2 mm in width, the pollen pots measured 5.3 to 8.0 mm in length and 4.5 to 6.0 mm in width and the honey pots measured 6.5 to 8.0 mm in length and 5.2 to 6.6 mm in width across different agro-climatic zones of southern Karnataka. Gajanan *et al.* (2005) ^[6] reported that, the size of honey pots ranged from 6.2 to 7.8 mm in length and 5.0 to 6.4 mm in width, the pollen pots are 5.2 to 7.5 mm in length and 4.2 to 5.8 mm in width, brood cells are 3.8 to 4.5 mm in length and 3.3 to 4.0 mm in width in different agro-climatic zones of southern Karnataka.

Table 1: External nest characteristics of *T. iridipennis* in different regions of Karnataka during winter season

Sl. No.	Nest characteristics	Northern dry zone	Southern dry zone	Southern transitional zone
1	Nesting site	Stone wall, Cement wall,	Empty wooden boxes, cement wall, meter box	Meter box, tree cavity, wooden logs, stone wall, empty wooden boxes
2	Orientation of entrance tube	South, North	South	East, North
3	Shape of entrance tube	Oval	Elliptical, oval	Oval, elliptical
4	Colour of entrance tube	Brown,	Brown, grey	Black-brown
5	Materials used for construction of entrance tube	Resin, mud particles	Resin, mud, sand and wood particles	Resin, wood, mud and sand particles
6	Height from ground (m)	1.04±0.49	0.95±0.42	1.76±1.14
7	External length of entrance tube (mm)	12.92±9.32	63.22±15.26	20.70±11.20
8	Width of entrance tube (mm)	7.58±3.06	22.67±6.2	10.20±5.02
9	Height of entrance tube (mm)	11.42±4.72	12.22±4.97	17.80±5.60

* Values are mean of seven colonies

Table 2: External nest characteristics of *T. iridipennis* in different regions of Karnataka during summer season

Sl. No.	Nest characteristic	Northern dry zone	Southern dry zone	Southern transitional zone
1	Nesting site	Stone wall, cement walls, mud wall	Wooden logs, empty boxes, cement wall, iron pipe, meter box	Meter box, tree, wooden logs. Stone wall, empty boxes
2	Orientation of entrance tube	South-North	South	East, North
3	Shape of entrance tube	Oval	Elliptical, oval	Oval, elliptical
4	Colour of entrance tube	Brown	Brown, Grey	Black-brown
5	Materials used for construction of entrance tube	Resin, mud particles	Resin, mud, sand and wood particles	Resin, wood, mud particles
6	Height from ground (m)	1.04±0.49	0.95±0.42	1.76±1.14
7	External length of entrance tube (mm)	12.92±5.46	86.89±12.56	22.80±8.92
8	Width of entrance tube (mm)	7.58±2.71	23.26±9.25	10.80±4.71
9	Height of entrance tube (mm)	11.42±4.72	12.89±4.52	18.30±3.82

* Values are mean of seven colonies

Table 3: Internal nest characteristics of *T. iridipennis* in different Agro-climatic zones of Karnataka during winter season

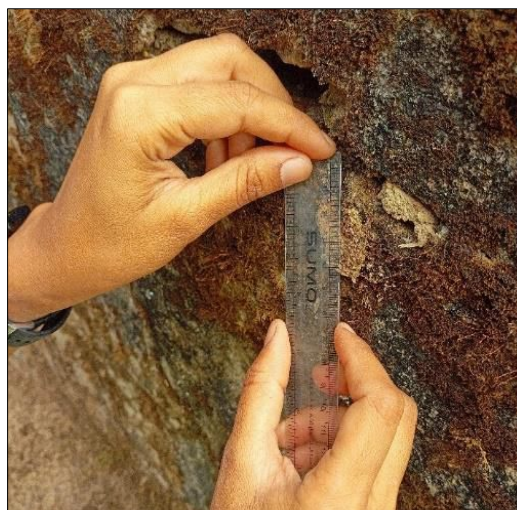
Sl. No.	Agro-climatic zones/Nest characteristics	Northern dry zone			Southern dry zone			Southern transitional zone		
		Pollen pots	Honey pots	Brood cells	Pollen pots	Honey pots	Brood cells	Pollen pots	Honey pots	Brood cells
1	Location	Near to entrance tube	Periphery	Centre	Near to entrance tube	Periphery	Centre	Near to entrance tube	Periphery	Centre
2	Arrangement	Compactly	compactly	Cluster	Compactly	compactly	Cluster	Compactly	Compactly	Cluster
3	Colour	Brown	Dark brown	Light brown	Brown	Dark brown	Light brown	Yellowish	Dark brown	Light brown
4	Shape	Oval	Oval	Oval	Oval	Oval	Oval	Oval	Oval	Oval
5	Width (mm)	6.70±1.42	7.00±2.40	2.90±0.63	8.50±2.62	8.60±1.32	3.10±0.42	7.50±0.94	8.20±0.47	3.00±0.56
6	Length (mm)	9.20±2.24	9.60±1.42	3.40±0.75	9.50±1.34	10.80±1.22	3.90±0.71	9.80±1.54	10.20±1.14	3.30±0.74
7	Weight (g)	0.70±0.04	0.72±0.15	0.03±0.01	0.75±0.22	0.65±0.22	0.03±0.05	0.69±0.17	0.64±0.12	0.02±0.01
8	Density (cells/cubic inch)	14.50±2.35	12.30±2.53	22.30±6.26	13.50±2.81	12.40±2.24	20.14±4.52	10.50±3.34	10.50±2.51	19.70±5.61

Table 4: Internal nest characteristics of *T. iridipennis* in different agro-climatic zones of Karnataka during summer season

Sl. No.	Agro-climatic zones/Nest characteristics	Northern dry zone			Southern dry zone			Southern transitional zone		
		Pollen pots	Honey pots	Brood cells	Pollen pots	Honey pots	Brood cells	Pollen pots	Honey pots	Brood cells
1	Location	Near to the entrance tube	Periphery	Centre	Near to entrance tube	Periphery	Centre	Near to entrance tube	Periphery	Centre
2	Arrangement	Compactly	Compactly	Cluster	Compactly	Compactly	Cluster	Compactly	Compactly	Cluster
3	Colour	Brown	Dark brown	Light brown-dark brown	Brown	Dark brown	Light brown-dark brown	Brown	Dark brown	Light brown-dark brown
4	Shape	Oval	Oval, irregular	Oval	Oval	Oval, irregular	Oval	Oval	Oval, irregular	Oval
5	Width (mm)	7.00±0.89	7.20±1.00	3.16±0.43	8.00±2.44	8.40±1.27	3.40±0.49	7.60±0.93	7.80±0.33	3.20±0.44
6	Length (mm)	9.20±0.55	9.50±1.52	3.96±0.55	9.60±1.15	10.20±0.58	4.20±0.73	9.50±1.50	9.80±1.24	4.00±0.71
7	Weight (g)	0.72±0.78	0.62±0.63	0.03±0.03	0.76±0.22	0.70±0.23	0.03±0.05	0.74±0.15	0.65±0.10	0.04±0.01
8	Density (cells/cubic inch)	14.40±2.41	14.30±3.12	24.80±5.96	14.50±2.45	13.50±2.04	20.14±5.20	11.50±3.02	11.40±2.52	20.50±5.14



a) Height from ground



b) Length of entrance tube



c) Height of entrance tube



d) Width of entrance tube

Plate 1: Measuring external characteristics of nest entrance tube of *T. iridipennis*



a) Larger entrance tube in Southern dry zone, b) Medium size entrance tube in Southern transitional zone



c) Smaller entrance tube in Northern dry zone

Plate 2: Regional variation in nest entrance tube length of *T. iridipennis*

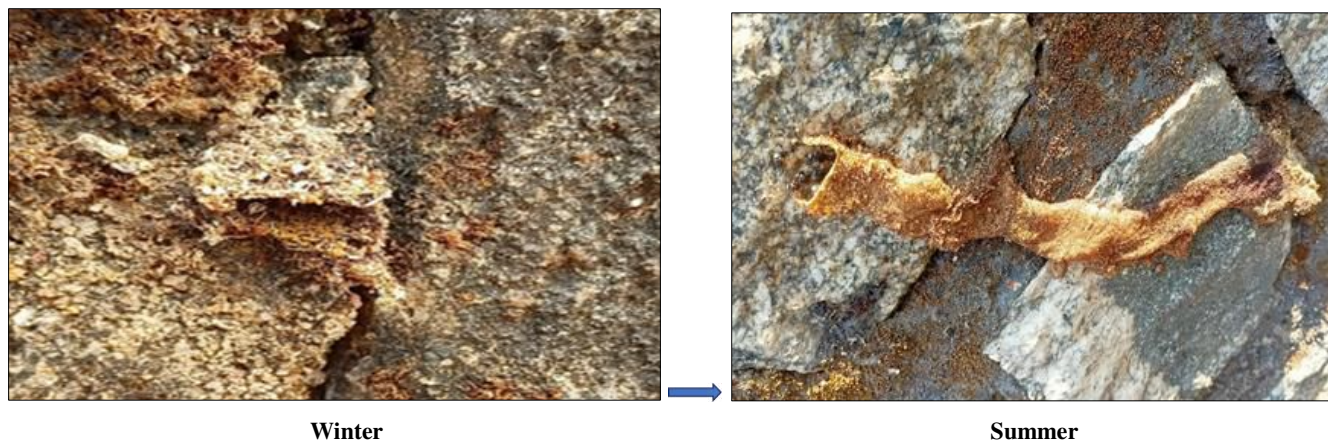


Plate 3: Seasonal variation in nest entrance tube length of *T. iridipennis*

Conclusion

The present study demonstrated that *T. iridipennis* maintains a generally stable nest architecture across Karnataka, while exhibiting distinct regional adaptations in response to local climatic and ecological conditions. Although the arrangement of internal structures-pollen pots near the entrance, brood cells at the centre and honey pots along the periphery-remained consistent, significant variation was observed in the size, weight and density of pots and brood cells across zones. Colonies in the Southern Dry Zone possessed the largest pollen and honey pots, reflecting richer floral resources, whereas the Northern Dry Zone showed smaller pot dimensions but the highest brood cell density, indicating an adaptive strategy to resource-poor, dry environments. Entrance tube characteristics such as length, colour and orientation also varied geographically, with longer tubes in humid regions and shorter tubes in drier areas. Seasonal influence on nest traits was minimal compared to regional differences. Overall, these findings highlight that while nest structure is species-specific, *T. iridipennis* exhibits environmentally responsive modifications that support colony survival under diverse climatic conditions, offering valuable insights for conservation and meliponiculture management.

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References

- Charan SK, Meena VK, Sharma P, Gunsaria S. Importance of studying nesting biology of stingless bee, *Tetragonula iridipennis* Smith (Hymenoptera: Apidae: Meliponini) in India. *Int J Entomol Res*. 2023;8(4):40-45.
- Chavan KG, Wankhede SM, Shinde BD, Sanap PB, Jalgaonkar VN, Naik KV, Patil SP. Study of nesting pattern of stingless bee in Konkan region of Maharashtra. *Int J Adv Biochem Res*. 2025;9(1):212-216.
- Choudhary A, Singh J, Chhuneja PK. Nest architecture and nesting site preference of *Tetragonula iridipennis* Smith in north-western plains of India. *J Apic Sci*. 2021;65(1):49-59.
- Danaraddi CS. Studies on stingless bee, *Trigona iridipennis* Smith with special reference to foraging behaviour and melissopalynology at Dharwad, Karnataka [MSc thesis]. Dharwad: University of Agricultural Sciences; 2007.
- Engel MS, Rasmussen C, Ayala R, de Oliveira FF. Stingless bee classification and biology (Hymenoptera, Apidae): A review, with an updated key to genera and subgenera. *ZooKeys*. 2023;1172(2):239-312.
- Gajanan S, Mohite, Kuberappa GC, Kencharaddi RN. The nest architecture of stingless bee, *Trigona iridipennis* Smith. *Indian Bee J*. 2005;67(2):36-40.
- Heard TA. The role of stingless bees in crop pollination. *Annu Rev Entomol*. 1999;44(3):183-206.
- Michener CD. *The bees of the world*. Baltimore (MD): Johns Hopkins University Press; 2000.
- Minaxi L, Sisodiya DB. Nesting behaviour of stingless bees, *Tetragonula* spp. in middle Gujarat. *J Pharm Innov*. 2024;13(8):89-92.
- Nayak P, Reddy SM, Jayaprakash J. Nesting pattern preferences of stingless bee, *Trigona iridipennis* Smith (Hymenoptera: Apidae) in Jnanabharathi Campus, Karnataka, India. *Int J Entomol Res*. 2013;9(1):79-86.
- Prato M, Soares AEE. Production of sexuals and mating frequency in the stingless bee, *Tetragonisca angustula* (Hymenoptera: Apidae). *Neotrop Entomol*. 2013;42(5):474-482.
- Rasmussen C, Cameron SA. A molecular phylogeny of the Old World stingless bees (Hymenoptera: Apidae: Meliponini) and the non-monophyly of the large genus *Trigona*. *Syst Entomol*. 2007;32(1):26-39.
- Rasmussen C, Cameron SA. Global stingless bee phylogeny supports ancient divergence, vicariance and long-distance dispersal. *Biol J Linn Soc*. 2010;99(3):206-232.
- Roopa AN, Eswarappa G, Sajjanar S, Gowda G. Study on nesting characteristics and biology of stingless bee, *Trigona iridipennis* Smith. *J Agri Vet Sci*. 2015;8(10):34-36.
- Roubik DW. Stingless bee nesting biology. *Apidologie*. 2006;37(2):124-143.
- Rumki HCS, Arensungla P, Bendangsenla, Singh HK. Stingless bee flora in foothills of Nagaland. *J Pharm Innov*. 2022;11(9):2935-2941.
- Shaguftha H, Basavarajappa S. Survey of stingless bee (Hymenoptera: Apidae: Meliponini) population at few constructing habitats of southern Karnataka, India. *Int J Entomol Res*. 2024;9(1):79-86.

18. Sheetal VK, Basavarajappa S. Spatial distribution of stingless bee, *Trigona iridipennis* Smith in Manasagangotri, Mysore, Karnataka. Hexapoda. 2009;16(3):136-140.
19. Slaa EJ, Chaves LAS, Malagodi-Braga KS, Hofstede FE. Stingless bees in applied pollination: practice and perspectives. Apidologie. 2006;37(2):293-315.
20. Viraktamath S, Roy J. Description of five new species of *Tetragonula* (Hymenoptera: Apidae: Meliponini) from India. Biologia. 2022;77(7):1769-1793.