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A New Subterranean Species of *Tetragonula* Moure, 1961 (Hymenoptera: Apidae: Meliponini) from Wokha (Nagaland, India) with Comparative Notes on the Species from India

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Abstract

This paper describes a new subterranean species of stingless bee, *Tetragonula yikhumensis* **sp. nov.**, with associated females (workers) and males from Wokha district of Nagaland, India. It is the largest species of stingless bees found in India. It is distinctive in shape, size, coloration, pubescence, and especially its genital capsule and its associated sterna. The sternum 5 apicomedial region has a parabolic concavity, the apicomedial process of sternum 6 is urn-shaped, the gonostylus has a lateral origin, and the penis valve has a distinctive shape. This paper supports many prior studies that have emphasized the importance of males in distinguishing close species and in erecting new ones, as the samples studied exhibited variation. A brief account of the nest structure as well as an updated checklist of stingless bees found in India is also provided.

Introduction

Stingless bees are highly eusocial insects and are called so because of the atrophied sting, which cannot be used for defense (Wille, 1983). They are primarily distributed in the tropical and subtropical regions of the world (Quezada-Euán, 2018; Grüter, 2020), and have inhabited these regions for over 65 million years (Camargo & Pedro, 1992; Michener, 2013). They are valued worldwide for the medicinal honey they produce and for their other hive products, which are also highly regarded for their therapeutic properties (Martínez-Puc et al., 2022). Additionally, they are recognized and acclaimed for their role as pollinators (Heard, 1999; Slaa et al., 2006). Stingless bees are perennial in nature and exhibit multifaceted nesting biology. Their colonies are mostly nested in dark places previously occupied by termites and ants, including tree branches, inside tree trunks, cracks and crevices in walls, and underground (Roubik, 2006; Michener, 2013). The entrance tube and the nest architecture of stingless bees vary within and among species and are sometimes used as diagnostic traits for species identification (Sakagami, 1982; Rasmussen & Camargo, 2008; Michener, 2013).

With over 605 described species, stingless bees are the most diverse group of bees within the corbiculate bees (Engel et al., 2023). The genus *Tetragonula* Moure, with 45 species worldwide, is among the oldest, richest, and most diverse of the Old World stingless bees (Engel et al., 2023). In India, a total of 25 stingless bee species belonging to three genera have been reported: *Tetragonula* Moure, 1961; *Lisotrigona* Moure, 1961; and *Lepidotrigona* Schwarz, 1939 (Rasmussen, 2013; Viraktamath & Roy, 2022). Seventeen species of these belong to the genus *Tetragonula*. The workers of the *Tetragonula* genus are characterized by a well-projected scutellum, dark mesoscutum, and a distinct basal sericeous patch of short and dense hairs in the inner hind basitarsus, as *Trigona* Jurine, 1807, and workers of *Tetragonisca* Moure, 1946 (Moure, 1961; Rasmussen, 2013). This genus is notorious for its complexity, as many species exhibit very close resemblance,

while workers from the same nest of some species show variation (Sakagami, 1978; Rasmussen, 2013). The significance of male genitalia in the morpho-taxonomic identification of stingless bees has long been recognized and emphasized by several since 1939 (Schwarz, 1939). However, taxonomic studies based on male samples have garnered attention only very recently. We add to this growing research and describe a new subterranean species of stingless bee, *Tetragonula yikhumensis* Odyuo sp. nov., along with associated females (workers) and males from the Wokha district of Nagaland, India. This paper supports many prior studies that have emphasized the importance of males in distinguishing close species and in erecting new ones, as the samples studied exhibited variation. A brief account of the nest structure as well as an updated checklist of stingless bees found in India is also provided.

Materials and Methods

Extensive fieldwork was conducted from November 2022 to June 2025 in various areas under the Wokha district, Nagaland. Both male and worker samples of this species were collected from 12 different locations (Fig 1).

Samples were collected directly from the entrance tube using a transparent, empty bottle from each colony and then transferred to specimen vials containing absolute ethyl alcohol. The vials were labeled with the necessary details, including the name of the collector, date, and place of collection, and were brought to the Entomology and Animal Physiology Laboratory, Department of Zoology, Nagaland University, Lumami. Samples were removed from the ethanol and appropriately stretched. After that, the processed specimens were mounted on a triangular card for morphometric and taxonomic studies.

Identification of the samples at the generic level was done using the keys of Rasmussen (2013) and Engel (2023). The morphological characters were selected to study the morphometry of the samples using a Leica Ivesta 3 Binocular Stereomicroscope and the software Enersight 1.0.2.97. Images of the samples were taken at the Hymenoptera Section, Zoological Survey of India, New Alipore, Kolkata, using a Nikon SMZ25 stereo Microscope, and the captured images were processed further using Adobe Photoshop CC 20.0.4.

Type specimens were deposited at the Zoological Museum, Nagaland University, Lumami, and National Zoological Collection (NZC), Zoological Survey of India, Kolkata.

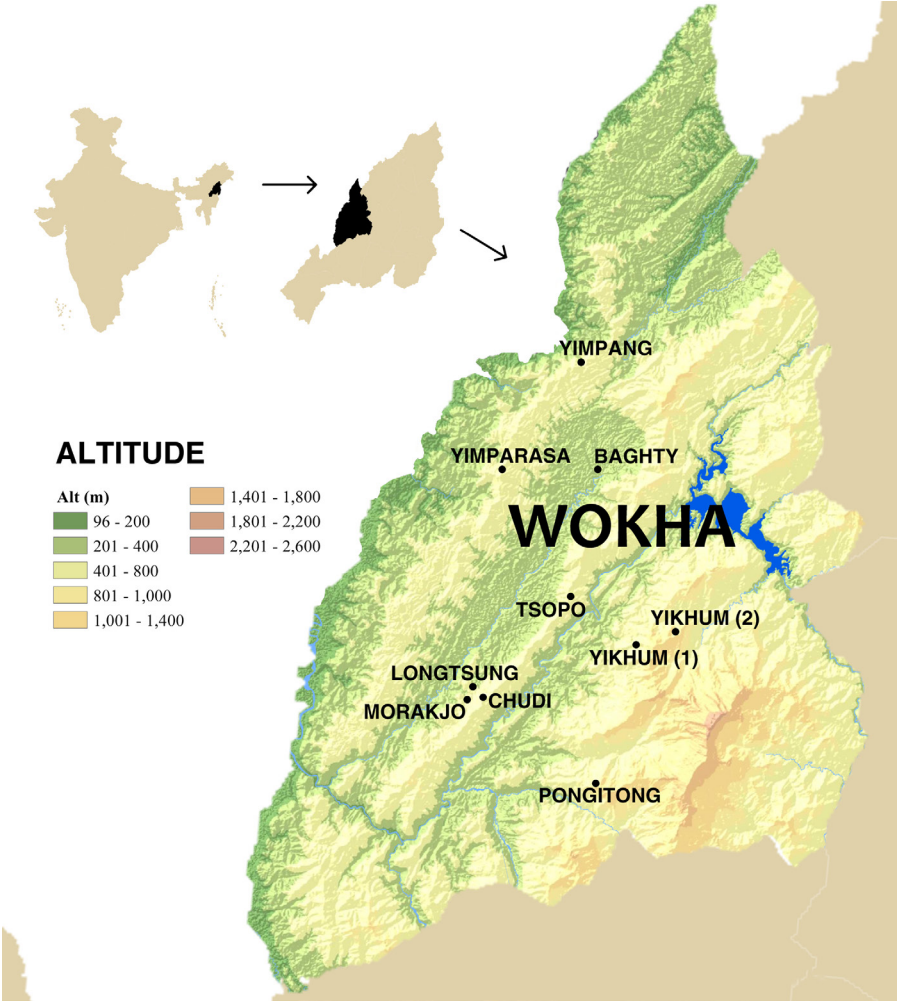

Fig 1. Locations in Wokha from where *Tetragonula yikhumensis* Odyuo **sp. nov.** samples for this study were collected. This map is based on the Physical map of Nagaland Prepared by Nagaland GIS & Remote Sensing Centre Planning & Co-ordination Department, Government of Nagaland, India.

Three nests were excavated for this study, one each from Yikhum, Longtsung, and Yimparasa. However, the description of the nest architecture and details of its attributes, such as the size and length of the nest entrance, honey and pollen pots, and brood chambers, presented in this paper, are based on the first nest from which the holotype was collected. A Canon EOS 700D was used to take field photographs.

Forty-four morphological characters were examined. These are based on Viraktamath & Thangjam (2021), with the addition of the following characters: lower interocular distance; interocular distance through antenna; distance between antennal sockets; antennocellar distance; antennocular distance; length of labrum; width of labrum; antennal socket maximum diameter; length of hind wing; width of hind wing. Ratios of ten morphological parameters (Sakagami, 1978) are also included. The morphological terminology used for the description of this species follows Sakagami (1978), Michener (2007), and Rasmussen (2013). We include, for the first time, a description of pretarsus. Sternum 5 and sternum 6 are abbreviated as S5 and S6, respectively, and tergum 1 and tergum 2 as T1 and T2, respectively.

Taxonomy

Family Apidae Latreille, 1802
Subfamily Apinae Latreille, 1802
Tribe Meliponini Lepeletier, 1836
Genus *Tetragonula* Moure, 1961

Remarks

This species is placed in the genus *Tetragonula* Moure, 1961, based on the keys of Rasmussen (2013). It is marked by the presence of a distinctive basal sericeous area composed of short, dense hair on the inner surface of the hind basitarsus in the workers.

Tetragonula yikhumensis **Odyuo sp. nov.** Figs 2, 3, 4, 5, 6
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Diagnosis

Tetragonula yikhumensis **sp. nov.** belongs to the *iridipennis* species group, despite being bigger in size with its gonostylus arising laterally, because of the presence of a dark mesoscutum with distinct hair bands that are separated by a glabrous interspace. Male bees measure a mean of 5.58 mm in body length and 1.9 mm in head width; body black and shiny; head covered with plumose hairs, short thick hairs at the base and long thin hairs at the frons and vertex; clypeus brown with whitish plumose hairs; compound eyes reddish brown. Flagellum chestnut brown; mandibles with inner tooth smaller than the outer tooth (Fig 2a). Mesoscutellum bordered with yellow hairs, long yellow hairs at the scutellum (Fig 2b). Gonostylus arises laterally from the gonocoxa, weakly clavate; penis valve stout basally swollen, exhibits subtle inward basal curvature laterally, with no mid-length curvature and terminates into long deep curvature like a sickle apex (Fig 3c).

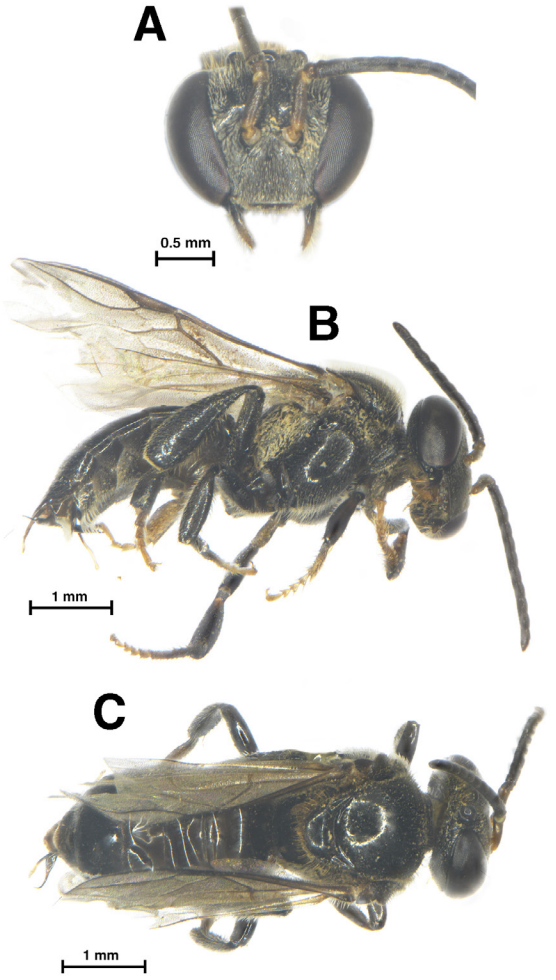

Fig 2. *Tetragonula yikhumensis* **sp. nov.** Holotype Male: (a) Head frontal view (b) Lateral habitus (c) Dorsal habitus.

Tetragonula yikhumensis **sp. nov.** shares resemblance with *T. kyrdemkulaiensis* and *T. gressitti* in having a clavate gonostylus, but is distinctive because of the following characters: face covered with crowded/dense hairs; thin erect hairs at the frons and vertex, and crowded hairs at the gena; clypeus with uniform and closely arranged short hairs, campanulate in shape. In *T. kyrdemkulaiensis*, the frons and vertex have lesser erect hairs; hairs on the gena are less crowded, and the shape of the clypeus is trapezoidal. *T. gressitti*, on the other hand, has more erect hairs on the vertex than on the frons. This species can also be differentiated by differences in its S5, S6, and penis valve. S5 gradulus does not touch the antecosta apicomedially; the subgradular area is pigmented with a brown patch and with no visible medial division; perfect inverted U-shaped emargination basomedially. In contrast, the gradulus of S5 of *T. kyrdemkulaiensis* touches the antecosta apicomedially, the dark patch of the subgradular area appears divided medially with a transparent V-shaped structure, and two processes extend apicobasally. In *T. gressitti*, S5 has a median area free of dark coarse spots and a small, narrow medioapical emargination. The S6 of *T. yikhumensis* and *T. kyrdemkulaiensis* have shorter and wider apicomedial processes, but the wing-like lateral process is more closely associated with the medially sinuate apicomedial process in *T. yikhumensis,*

while *T. gressitti* has a long and narrow apicomedial process. The penis valves in *T. yikhumensis* and *T. gressitti* show very subtle inward curvature near the base, but the apex curvates more in *T. yikhumensis*. In *T. kyrdemkulaiensis*, the penis valve shows distinctive curvature inward and appears like an inverted seahorse (Fig 4).

Workers measure a mean of 5.15 mm in body length and 1.94 mm in head width. It can be differentiated from that of *T. kyrdemkulaiensis*, *T. gressitti* and other species under the genus *Tetragonula* because of the following characters: head covered with short crowded hairs except at the vertex; clypeus densely covered by hairs; distinctively visible median line superior to the antennal sockets runs along the upper part of the face and bifurcates below the median ocelli making it appear like the top of cordate; upper part of the face has less crowded hairs as compared to the lower part; compound eyes jester red with black patches; labrum yellow fringed with both long and short golden hairs, usually with two thick long hairs descending from the basal sides. Mesoscutum with four prominent longitudinal hair bands separated by glabrous interspace; the margin of the mesoscutum fringed with long yellow hairs, crowded in the propodeum.

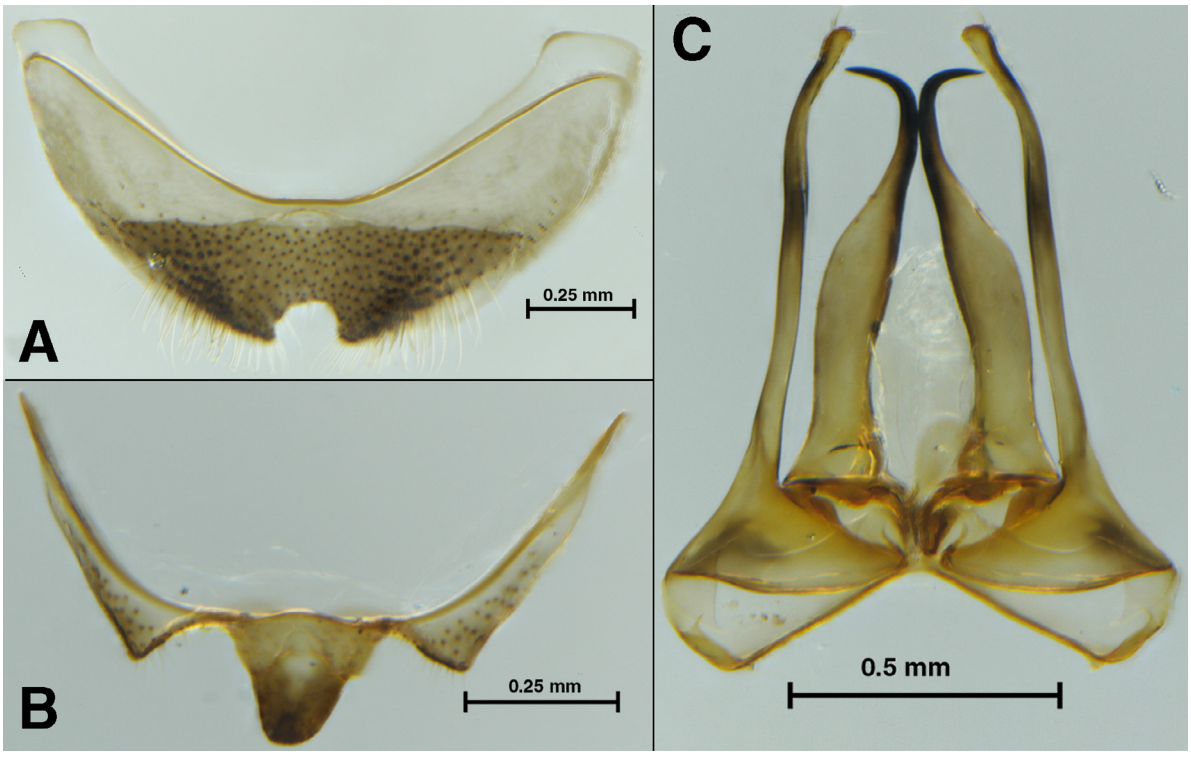

Fig 3. *Tetragonula yikhumensis* **sp. nov.** Male genitalia: (a) Sternum 5 (b) Sternum 6 (c) Genitalia.

Description

Holotype: Male

Coloration: Body black and shiny; head black; ocelli transparent and shiny; compound eyes reddish brown; scape brown with hues of yellow at the apical end and whitish colour at the basal area; pedicel light brown; flagellomeres chestnut brown on both sides; clypeus black; labrum yellow with coarse spots; mandibles black at the base 1/3, golden yellow apically 2/3 (Fig 2a); thorax black, scutellum brown (Fig 2b); all legs black; coxae light yellow; trochanters yellowish brown; tibia and basitarsus black; tarsomeres yellow; pretarsus brown. Tegula brown; wings hyaline with light brownish hues; pterostigma and veins brown; hind wings translucent with tinge of yellow and pale venation; metasomal terga reddish black and shiny; sterna basally yellowish-brown (Fig 2c).

Pubescence: Head covered with whitish-yellow appressed crowded hairs; lower part of the face covered with short whitish hairs, while the upper part of the face with erect yellow hairs; vertex with thin long golden yellow erect hairs; frons with intermixed short and long thin whitish and yellow hairs; gena with short whitish crowded hairs; clypeus with whitish short appressed hairs; scape with short thin yellow hairs; flagellum with very short whitish hairs. Mandibles fringed with long golden hairs (Fig 2a); mesoscutum with thin yellow hairs bands; mesoscutellum bordered with long, erect golden hairs, metapostnotum with long golden hairs; mesepisternum with plumose white hairs becoming denser towards the lateral area of propodeum (Fig 2b). Coxae and trochanters with long pale whitish hairs; femur with short whitish hairs; hind tibia retromarginally margined with black spinose setae and whitish plumose hairs; basitarsus with brownish black spinose setae; tarsomeres with few brownish spinose setae. Metasomal terga with fine, pale, and sparse hairs; sterna with whitish hairs, the density and length of which increase towards the terminal segments (Fig 2c).

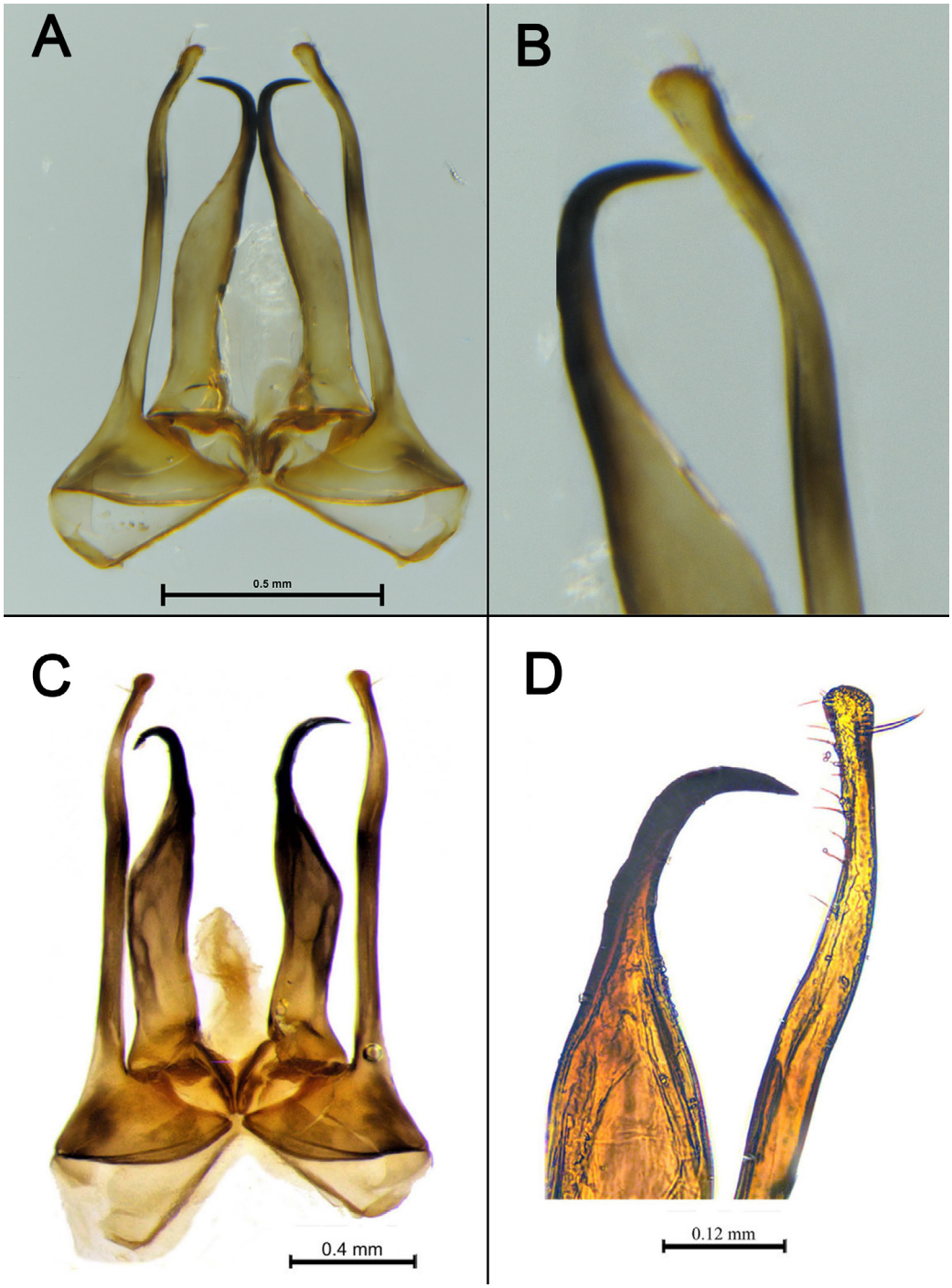

Fig 4. Comparison of male genitalia: (a) and (b) *Tetragonula yikhumensis* **sp. nov.**; (c) and (d) *T. kyrdemkulaiensis* (Viraktamath & Thangjam, 2021).

Surface sculpture: Head, thorax, legs and metasoma shiny; labrum with piligerous punctures, clypeus, gena and frons densely punctate; antennae densely punctate with brown pits; legs densely punctate, more pronounced towards the tibial ends; mesoscutum finely punctate on the metasomal terga, varies in density; thin and faint on T1 to T3 but the density progresses posteriorly; depression on S1 to S5 (more pronounced in S3).

Metasomal sterna and genitalia: Apicomedial region of S5 exhibits a parabolic concavity resembling the inner surface of a shallow bowl, and the gradulus does not touch the antecosta apicomedially; subgradular region pigmented with a distinctive brown patch and dark punctures within the pigmented areas from which thick, long golden setae arise; a perfectly inverted U-shaped mediobasal emargination; basal margins fringed with long brownish golden hairs (Fig 3a). S6 medially sinuate, bearing an urn-shaped medioapical process that is longer (0.24 mm) than wide (0.21 mm), gradually attenuating and terminating in an obtuse, blunt apex. (Fig 3b).

Genitalia light brown in colour with some black hues; gonocoxa wider than long; gonostyli arises from the lateral side of the gonocoxa, length 0.88 mm; basal width 0.07 mm, narrowing shortly to 0.05 mm and then to 0.04 mm along most of its length; distally incurved over a length of 0.06 mm (preceded by a black patch), further tapering to 0.03 mm and terminating into a clavate apex 0.05 mm wide; apical clavate bearing long yellow setae. Body of the penis valve light brown and black in colour with the shape of a bell, wide at the base and tapering towards the apex with outwardly curved apex, 0.77 mm in length, 0.18 mm wide at the base, sclerotized and robust slightly shorter than the gonosytli; immediately following the base, it curves inward to 0.09 mm, then assumes a convex shape along the length and widens medially to 0.12 mm, then curves strongly inwards and narrows to 0.04 mm and finally curves outward terminating to a hook like apex 0.12 mm left and 0.1 mm right; does not overlap with each other (Fig 3c).

Morphometry: Ratios of head length and width 0.81; eye length and upper interocular distance 1.2; interocellar and ocello-ocular distance 2.2; scape length and eye length 0.48; forewing length and width 3.19; wing diagonal and head width 0.67; hind tibia length and head width 0.86; hind tibia length and wing diagonal 1.28; hind tibia width and length 0.29; hind basitarsus width and length 0.49. Detailed morphometry is given in Table 1.

Variations in the male paratypes: Morphologically corresponds in huge degree to the holotype in coloration, pubescence, and body sculpture, with the exception of the density of hairs on the margins of the mesoscutum. Paratypes also differ from the holotype in the morphometric data provided in Table 1. Ratio of head length and width 0.81 mm; eye length and upper interocular distance 1.19 mm; scape length and eye length 0.48 mm; forewing length and width 3.7 mm; wing diagonal and head width 0.67 mm; hind tibial length and head width 0.86 mm; hind basitarsus width and length 0.45 mm.

Paratype: Worker

Coloration: Body black and shiny; head black; ocelli transparent and shiny; compound eyes jester red; scape yellowish-brown with hues of yellow, both at the apical and basal ends; pedicel light brown; flagellum chestnut brown on the outside and yellow in the inside; clypeus black; labrum light yellow with coarse black spots; mandibles black spots prominent in the medial base, bright yellow mid length and light brown apically 2/3 (Fig 5a); thorax black; scutellum brown (Fig 5b); all legs brownish black; coxae light yellow; trochanters light brown; hind basitarsus brown; tarsomeres yellow; pretarsus brown. Tegula dark brown; wings hyaline with tinge of brown hues; pterostigma and veins brown; hind wings translucent with tinge of yellow and pale venation; metasomal terga reddish brown and shiny, pale yellowish interspace making it appear segmented; sterna brown with pale interspace (Fig 5d).

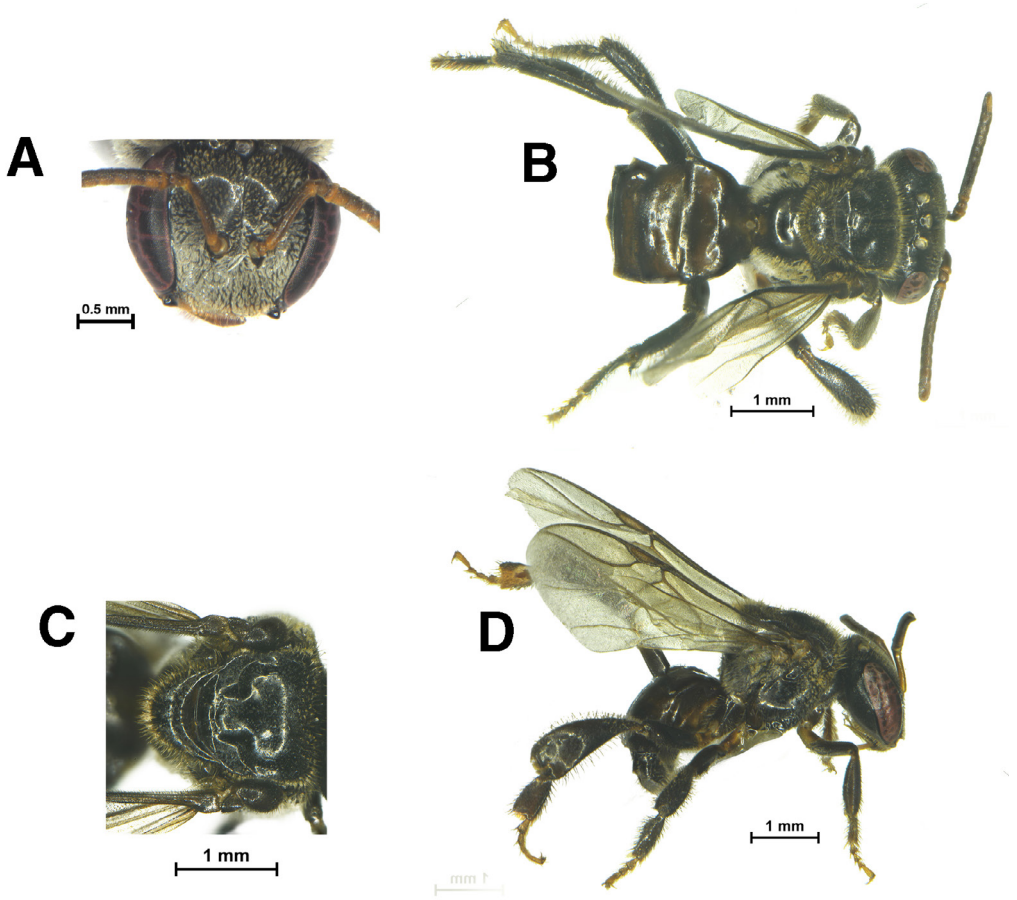

Fig 5. *Tetragonula yikhumensis* **sp. nov.** Female (worker) paratype (a) Head frontal view (b) Dorsal habitus (c) Mesoscutum with four hair bands (d) Lateral habitus.

Table 1. Morphometry of *T. yikhumensis* sp. nov. (in mm).

Parameters	Holotype	Paratype Male (n = 12)	Paratype Female (n = 44)
Length of body	5.59	5.58 ± 0.02	5.15 ± 0.05
Width of the head with eyes	1.92	1.90 ± 0.02	1.94 ± 0.01
Length of head	1.56	1.54 ± 0.02	1.57 ± 0.06
Length of clypeus	0.42	0.42 ± 0.01	0.34 ± 0.04
Width of clypeus	0.64	0.64 ± 0.01	0.73 ± 0.1
Malar space length	0.02	0.02 ± 0.01	0.05 ± 0.0
Lower interocular distance	0.72	0.71 ± 0.0	0.98 ± 0.01
Upper interocular distance	1.07	1.07 ± 0.0	1.08 ± 0.00
Interocular distance through antennal sockets	0.98	0.97 ± 0.01	1.20 ± 0.03
Length of compound eye	1.29	1.27 ± 0.01	1.3 ± 0.02
Width of compound eye	0.42	0.42 ± 0.0	0.36 ± 0.01
Distance between antennal sockets	0.22	0.22 ± 0.0	0.22 ± 0.02
Interocellar distance	0.4	0.36 ± 0.04	0.41 ± 0.01
Ocello-ocular distance	0.18	0.17 ± 0.01	0.28 ± 0.0
Diameter of median ocellus	0.2	0.2 ± 0.0	0.19 ± 0.01
Antennocellar distance	0.74	0.73 ± 0.00	0.85 ± 0.03
Antennocular distance	0.22	0.22 ± 0.01	0.33 ± 0.0
Length of labrum	0.14	0.14 ± 0.03	0.2 ± 0.16
Width of labrum	0.44	0.43 ± 0.01	0.46 ± 0.02
Antennal sockets max diameter	0.18	0.18 ± 0.01	0.15 ± 0.02
Length of scape	0.62	0.61 ± 0.01	0.76 ± 0.01
Width of scape	0.14	0.14 ± 0.01	0.13 ± 0.01
Length of pedicel + flagellum	1.21	1.22 ± 0.4	1.17 ± 0.5
Length of flagellomere 1	0.14	0.14 ± 0.01	0.12 ± 0.02
Length of flagellomere 2	0.22	0.22 ± 0.01	0.13 ± 0.01
Length of flagellomere 3	0.23	0.22 ± 0.16	0.13 ± 0.12
3rd flagellomere diameter	0.16	0.16 ± 0.00	0.17 ± 0.0
Length of mandible	0.53	0.54 ± 0.01	0.8 ± 0.02
Width of mandible	0.12	0.13 ± 0.02	0.2 ± 0.05
Length of forewing (+ tegula)	4.76	4.76 ±0.01	4.83 ± 0.1
Width of forewing	1.19	1.26 ± 0.04	1.72 ± 0.12
Length of pterostigma	0.68	0.68 ± 0.00	0.7 ± 0.06
Length of marginal cell	1.56	1.56 ± 0.01	1.58 ± 0.04
Width of marginal cell	0.35	0.36 ± 0.01	0.39 ± 0.02
Wing diagonal length	1.3	1.28 ± 0.01	1.3 ± 0.03
Length of hind wing	3.38	3.37 ± 0.02	3.19 ± 0.2
Width of hind wing	0.83	0.83 ± 0.01	0.7 ± 0.1
Hamuli number	6	6	6
Length of mesoscutum	1.74	1.74 ± 0.00	1.57 ± 0.05
Max width of mesoscutum	1.37	1.36 ± 0.01	1.35 ± 0.02
Length of hind tibia	1.67	1.65 ± 0.01	1.82 ± 0.06
Width of hind tibia	0.49	0.49 ± 0.00	0.61 ± 0.02
Length of hind basitarsus	0.57	0.57 ± 0.01	0.64 ± 0.03
Width of hind basitarsus	0.28	0.26 ± 0.02	0.32 ± 0.05

Pubescence: Head covered with white crowded hairs; lower part of the face covered in appressed short whitish hairs, while the upper part of the face with thin short and less crowded erect white hairs; vertex with thick long brownish sparse erect hairs; frons with thin short and white hairs; gena with short whitish crowded hairs; clypeus with whitish short appressed hairs; scape with short thin yellow hairs; flagellum with very short whitish hairs; mandibles fringed with long golden hairs (Fig 5a); mesoscutum with thin yellow hairs forming four distinct longitudinal hair bands separated by glabrous interspace; mesoscutum margin bordered with long, erect golden hairs; metapostnotum with long golden hairs; scutellum clothed with long erect black and yellow intermixed hairs (Fig 5c); mesepisternum with plumose white hairs becoming denser towards the lateral area of propodeum. Coxae and trochanters with pale short and long hairs (denser on the margin); femurs with short spinose setae; hind tibia retromarginally fringed with yellowish plumose hairs and dark brown spinose setae; hind basitarsus with golden brown spinose setae and a distinct patch of basal sericeous short and dense hairs in the inner surface; tarsomeres with few brownish spinose setae and short brown hairs. Metasomal terga with sparse fine and pale hairs; sterna with whitish hairs, the density and length of which increase towards the terminal segments (Fig 5d).

Surface sculptures: Body and face shinny; clypeus, gena, frons distinctively punctate; scape and flagellomere finely punctate; legs finely punctate; metasoma terga punctate with density increasing towards terminal terga; metasoma sterna densely punctate (Fig 5b).

Morphometry: Detailed morphometry for the worker paratype is given in Table 1. Ratios of head length and width 0.8; eye length and upper interocular distance 1.2; interocellar and ocello-ocular distance 1.46; scape length and eye length 0.58; forewing length and width 2.8; wing diagonal and head width 0.67; hind tibial length and head width 0.93; hind tibial length and wing diagonal 1.4; hind tibial width and length 0.33; hind basitarsus width and length 0.2.

Variations in workers

Upon detailed comparison of workers from all 12 colonies, striking variations in morphometry and morphology were observed. The variations were more pronounced in the facial features, with some samples having jester-red compound eyes, others having brown compound eyes (Fig 6a), and yet others having green and yellow compound eyes (Fig 6b and 6c). Worker bees also exhibited differences in the ocelli color, with some having transparent and shiny ocelli, while others had brownish ocelli. The metasoma was brown in some samples and black in some. The density of the hairs bordering the mesoscutum also varied.

Etymology

The species is named after the first place where it was collected, i.e., Yikhum village in Wokha district, Nagaland, India.

Materials examined

Holotype: 1 male, deposited at the Zoological Museum, Nagaland University, Lumami, labeled as "NU/ZOO/MUS. COLL.STINGLESSBEE/*TETRAGONULA YIKHUMNENSIS*/ India: Nagaland, Yikhum, 26.1435° N, 94.2269° E, Altitude 725 m. 19.i.2023, leg. Noyingbeni M Odyuo, HOLOTYPE".

Paratypes: *Measured Paratypes*: *All labeled as* "PARATYPES" with the same details as the holotype. 3 males and 9 females deposited at National Zoological Collection (NZC), Zoological Survey of India, Kolkata; 2 males and 3 females deposited

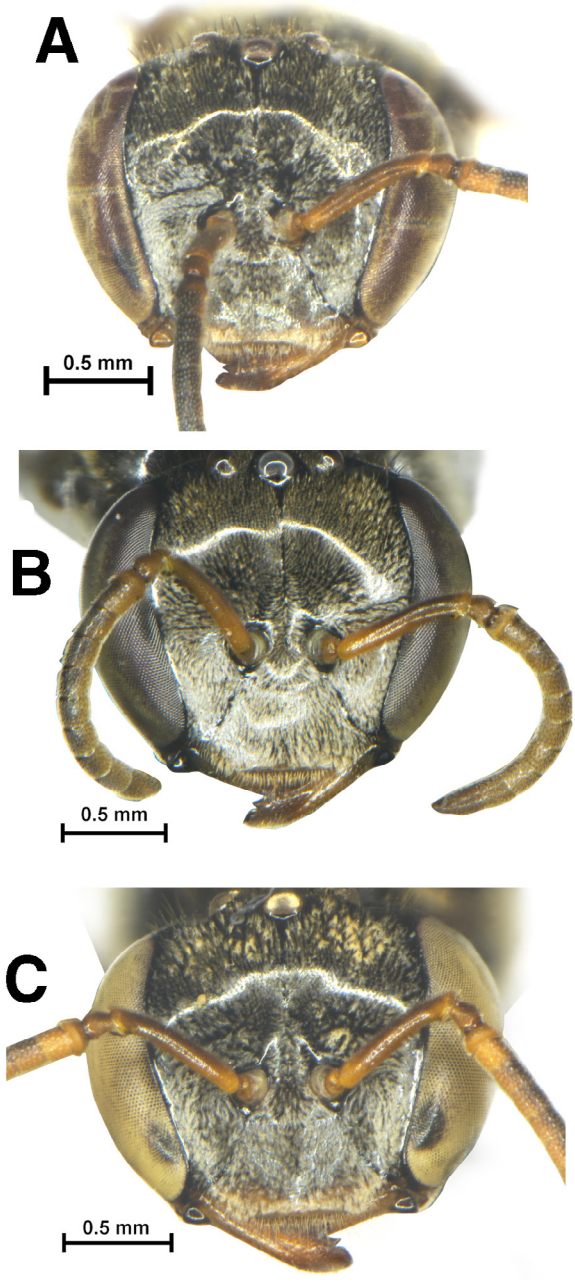

Fig 6. *Tetragonula yikhumensis* **sp. nov.** Variation of eye color in workers (a) Nagaland, Yimparasa, 26.2539° N, 94.1322° E, 729 m, 25.x.2023 (b) Nagaland, Baghty, 26.2531° N, 94.1994° E, 320 m, 7.vi. 2025 (c) Nagaland, Pongitong, 26.0559° N, 94.1993° E, 721 m, 18.vi.2025.

at National Zoological Collections of the Western Ghat Regional Center, Zoological Survey of India, Kozhikode (ZSIK), Kerala, India; 7 males and 12 females deposited at the Zoological Museum, Nagaland University, Lumami.

Non- measured paratypes: 2 males and 5 workers deposited at National Zoological Collection (NZC), Zoological Survey of India, Kolkata, and 9 males and 6 workers deposited at the Zoological Museum, Nagaland University, Lumami, labeled as "NU/ZOO/MUS.COLL.STINGLESSBEE/*TETRAGONULA YIKHUMNENSIS*/India: Nagaland, Yimparasa, 26.2539° N, 94.1322° E, Altitude 729 m, 25.x.2023. leg. Noyingbeni M. Odyuo, PARATYPES"; 1 male and 3 workers deposited at National Zoological Collection (NZC), Zoological Survey of India, Kolkata; 2 males and 10 workers deposited at the Zoological Museum, Nagaland University, Lumami, labeled as "NU/ZOO/MUS.COLL.STINGLESSBEE/*TETRAGONULA YIKHUMNENSIS*/India: Nagaland, Baghty, 26.2531° N, 94.1994° E, Altitude 320 m, 7.vi. 2025, leg. Noyingbeni M. Odyuo, PARATYPE"; 5 males and 13 workers deposited at the Zoological Museum, Nagaland University, Lumami, labeled as "NU/ZOO/MUS.COLL.STINGLESSBEE/*TETRAGONULA YIKHUMNENSIS*/ India: Nagaland, Pongitong, 26.0559° N, 94.1993° E, Altitude 721 m, 18.vi.2025, leg. Noyingbeni M. Odyuo, PARATYPES" 5 males and 11 workers, the Zoological Museum, Nagaland University, Lumami, labeled as "NU/ZOO/MUS.COLL.STINGLESSBEE/*TETRAGONULA YIKHUMNENSIS*/ India: Nagaland, Yimpang, 26.3219° N, 94.1872° E, Altitude 718 m, 19.i.2024, leg. Noyingbeni M. Odyuo, PARATYPES"; 4 males 11 workers, the Zoological Museum, Nagaland University, Lumami, labeled as "NU/ZOO/MUS.COLL.STINGLESSBEE/*TETRAGONULA YIKHUMNENSIS*/India: Nagaland, Chudi, 26.1114° N, 94.1194° E, Altitude 687 m, 27.i. 2024, leg. Noyingbeni M. Odyuo, PARATYPES"; 7 males and 10 workers, the Zoological Museum, Nagaland University, Lumami, labeled as "NU/ZOO/MUS.COLL.STINGLESSBEE/*TETRAGONULA YIKHUMNENSIS*/India: Nagaland, Longtsung, 26.1199° N, 94.1138° E, Altitude 417 m, 5.ii.2025, leg. Noyingbeni M. Odyuo, PARATYPES"; 4 males and 17 workers, the Zoological Museum, Nagaland University, Lumami, labeled as "NU/ZOO/MUS.COLL.STINGLESSBEE/*TETRAGONULA YIKHUMNENSIS*/India: Nagaland, Morakjo, 26.1100° N, 94.1092° E, Altitude 433 m, 6.v.2025, leg. Noyingbeni M, PARATYPES". Odyuo; 3 males 13 workers, the Zoological Museum, Nagaland University, Lumami, labeled as "NU/ZOO/MUS.COLL.STINGLESSBEE/*TETRAGONULA YIKHUMNENSIS*/India: Nagaland, Tsopo, 26.1749° N, 94.1811° E, Altitude 729 m, 25.vi.2025, leg. Noyingbeni M. Odyuo, PARATYPES".

Nest structure

The nest was found at a depth of 209 cm, with its external entrance 1.4 cm above the ground and a diameter of 1 cm. The external entrance was circular in shape, hard, and black in color, and was made of propolis mixed with some soil (Fig 7a). Connected to the external entrance structure was a tunnel that led to the nest cavity.

The nest measured 22.9 cm in length, 17.7 cm in width, and 16.2 cm in height. It was spherical in shape and was covered by layers of hard and brittle black batumen plates with no pillar-like attachment to the soil (Fig 7b). The nest was divided into five distinct parts: honey pots, pollen pots, brood chamber, brittle batumen plates, and folded layers of involucrum.

The outer half of the nest consisted of three layers of batumen plates, and between them, two layers each containing honey and pollen pots made of soft cerumen and dark brown in color. Individual honey pots measured a mean of 1.35 cm in length and 1.32 cm in width, while the pollen pots measured a mean of 1.17 cm in length and 1.17 cm in width (Fig 7c).

Beneath these layers was an interior cavity with an intricate pattern of a hard, bristle-like web enclosing the brood chamber. Individual brood cells were composed of thin, yellowish cerumen and were vertically oval, measuring a mean of 0.67 cm in length and 0.3 cm in width. Two distinct types of brood cell clusters were observed: one with dark brownish**,** closely clustered cells (advanced fronts or new brood cells) and the other with yellowish cells (matured brood cells) arranged one above the other. These were connected to the substratum by a thin pillar-like attachment**.** Tiny visible gaps were observed within the brood chamber (Fig 7d). Some young worker bees were seen nipping off the top of some brood cells from where the younger ones emerged.

Immediately after the layers of honey, pollen pots and batumen, at the extreme end of the nest (towards the end with the brood chamber) were folds of brownish soft brittle involucrum that measured 17.8 cm in length and 25.8 cm in width, which seemed like a layer of protection for the brood chamber (Fig 7e).

Variations were observed among the 12 colonies in their external nest entrances. Seven colonies had an above-ground external entrance structure, while five lacked one (Fig 8).

Discussion

Studies have revealed a remarkable diversity of stingless bees in the Northeast region of India. Of the 25 different species reported from India, i.e., 17 *Tetragonula* (Hadimani & Dey, 2025), 3 *Lisotrigona* (after *L. mohandasi*, *L. chandrai,* and *L. revanai* were synonymized with *L. cacciae* by Rasmussen et al. (2017) (but see Viraktamath et al., 2023), and 5 *Lepidotrigona* (Viraktamath & Thangjam, 2022) (Table 2), as many as 14 are found in the Northeast region. In the state of Nagaland, a recent survey reported six species, namely, *Tetragonula iridipennis*, *T. laeviceps*, *T. gressitti*, *Lepidotrigona arcifera*, *L. ventralis*, and *Lophotrigona canifrons* (Chauhan & Singh, 2022). Of these, *Lepidotrigona ventralis* and *Lophotrigona canifrons* are reported only in Nagaland. Furthermore, though *L. canifrons* and *L. ventralis* have been reported from Wokha,

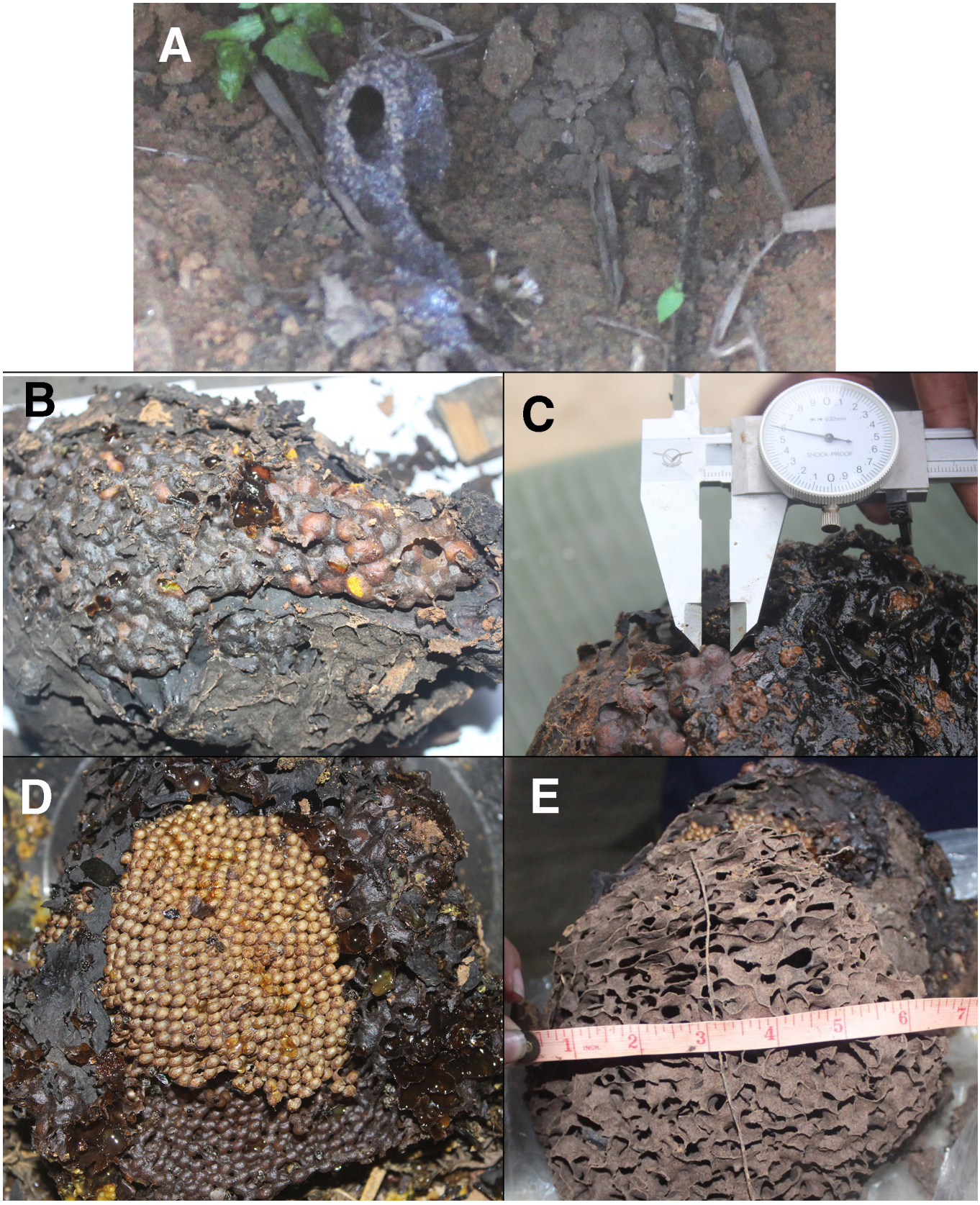

Fig 7. *Tetragonula yikhumensis* **sp. nov.** holoype nest (a) External entrance structure (b) Exposed honey and pollen pots (c) Broodcells (d) & (e) Edge of nest with hard protective involucrum.

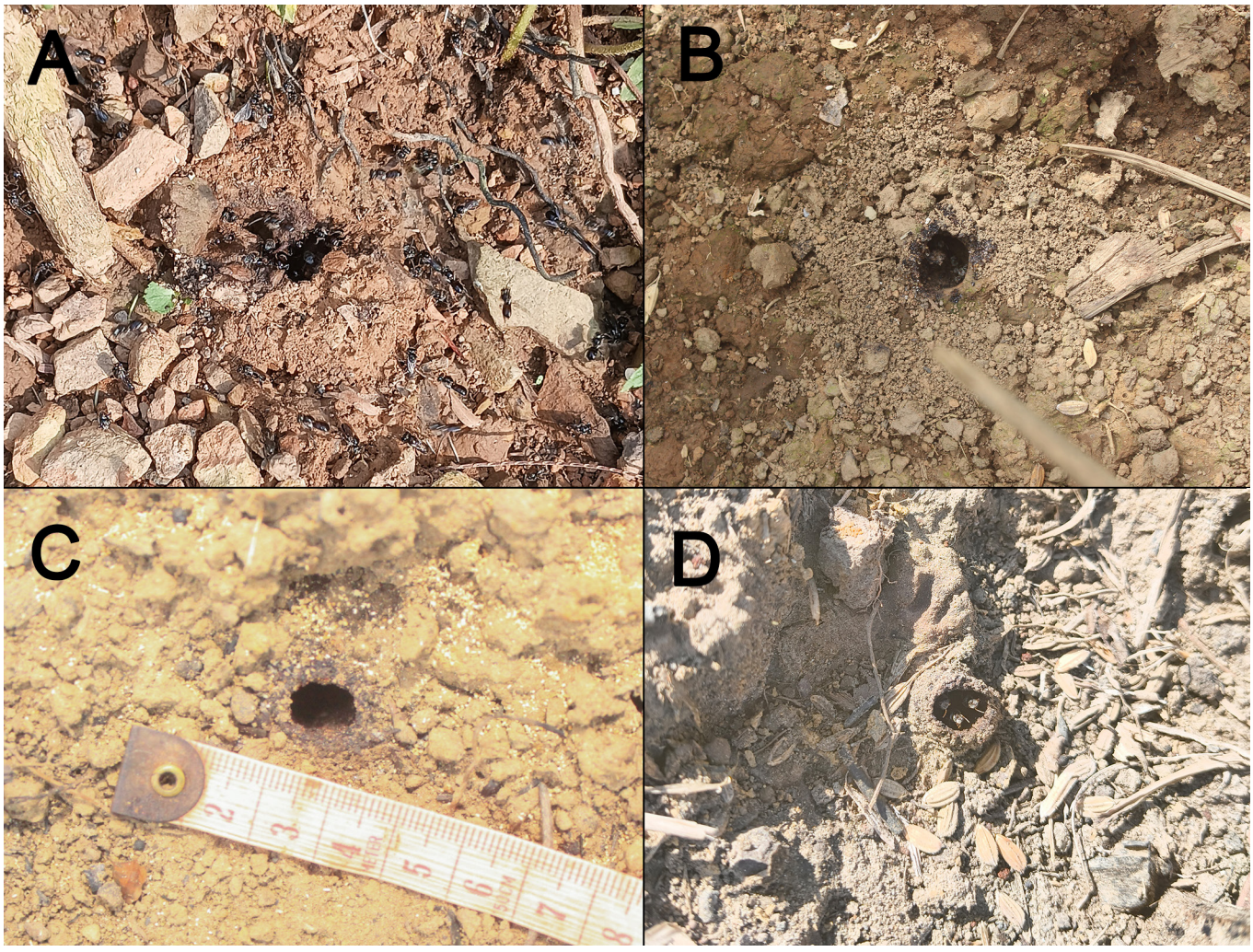

Fig 8. Variation in nest entrance (a) & (b) With external nest entrance structure (c) & (d) Without external nest entrance structure.

in our extensive fieldwork across the entire district for more than two and a half years, resulting in over a hundred different colonies, we have not come across either species. As a result, the status of *L. canifrons* and *L. ventralis* in Wokha remains to be positively confirmed.

We established the distinctiveness of *T. yikhumensis* **sp. nov.** after comparing it closely with the descriptions and images of other *Tetragonula* species reported from India (Rasmussen, 2013; Shanas & Faseeh, 2019; Viraktamath & Thangjam, 2021; Viraktamath & Roy, 2022; Hadimani & Dey, 2025). We also compared this species with the pictures and descriptions of *Tetragonula* species described elsewhere (Cockerell, 1929; Schwarz, 1939; Moure, 1961; Sakagami, 1975, 1978) and further substantiated its distinctiveness.

Morphological differences were evident across samples from all 12 colonies and are consistent with the species complexity for which the genus *Tetragonula* is notorious – distinct species within this genus are known to share very close morphological resemblance, while, in some species, morphological variances are observed even amongst workers from the same nest (Sakagami, 1978; Rasmussen, 2013). Despite the differences, one prominent morphological trait, i.e., the presence of mesoscutal hair bands, more pronounced in workers, was found to be unvarying in all the samples. Furthermore, upon dissection and examination of the male genitalia and associated sterna, all the structures were found consistent in the dissected male samples. This led us to conclude that all the samples from the 12 different locations belonged to the same species. Through this study, we reaffirm the significance of the male genitalia and the associated sterna in species identification, especially in the case of *Tetragonula*. The indispensable importance of males for segregating and erecting new species has been emphasized by many taxonomists (Sakagami, 1978; Rasmussen, 2013; Attasopa et al., 2018; Grüter, 2020; Viraktamath & Roy, 2022). Of the 17 *Tetragonula* species reported in India, only eight species, namely, *T. vikrami*, *T. sumae*, *T. ashishi*, *T. shishirae*, *T. subhami*, *T. kyrdemkulaiensis*, *T. kotagadensis* and *T. ruficornis* have been reported and described with male samples. In Nagaland, three species of *Tetragonula,* i.e., *T. iridipennis*, *T. laeviceps*, *T. gressitti* have been reported (Chauhan & Singh, 2022). But none of them have been

Table 2. Distribution of stingless bees in India.

Sl. no.	Species name	Distribution
1	*Tetragonula iridipennis* (Smith, 1854)	Tamil Nadu (Tej et al., 2017; Vijayakumar, 2014), Andhra Pradesh, Kerala, Karnataka, Arunachal Pradesh, Meghalaya (Rahman et al., 2015), Assam (Sen et al., 2023); Nagaland (Jamir, 2022; Sangma et al., 2022).
2	*Tetragonula gressitti* (Sakagami, 1978)	Arunachal Pradesh (Rathor, 2013), Nagaland (Chauhan & Singh, 2020).
3	*Tetragonula* aff. *laeviceps* (Smith, 1987)	Karnataka (Rasmussen, 2013), Andaman & Nicobar Island (Bentley & Osborn, 2025), Nagaland (Chauhan & Singh, 2022).
4	*Tetragonula fuscobalteata* (Cameron, 1908)	Uttar Pradesh (Ascher & Pickering, 2025).
5	*Tetragonula ruficornis* (Smith, 1870)	Uttar Pradesh (Rasmussen, 2013); Assam, Arunachal Pradesh, Meghalaya, Nagaland (Rahman et al., 2015); Uttarakhand, Haryana, Punjab and Delhi (Shanas & Faseeh, 2019).
6	*Tetragonula calophyllae* Shanas & Faseeh, 2019	Kerala (Shanas & Faseeh, 2019).
7	*Tetragonula perlucipinnae* Shanas & Faseeh, 2019	Kerala (Shanas & Faseeh, 2019).
8	*Tetragonula travancorica* Shanas & Faseeh, 2019	Kerala (Shanas & Faseeh, 2019).
9	*Tetragonula kyrdemkulaiensis* Viraktamath and Rojeet, 2021	Meghalaya (Viraktamath & Thangjam,,2021)
10	*Tetragonula srikantanathi* Viraktamath, 2021	Tripura (Viraktamath & Thangjam, 2021)
11	*Tetragonula sumae* Viraktamath, 2022	Tamil Nadu (Viraktamath & Roy, 2022)
12	*Tetragonula vikrami* Viraktamath, 2022	Karnataka (Viraktamath & Roy, 2022)
13	*Tetragonula shishirae* Viraktamath, 2022	Rajasthan (Viraktamath & Roy, 2022)
14	*Tetragonula shubhami* Viraktamath, 2022	Chhattisgarh (Viraktamath & Roy, 2022)
15	*Tetragonula ashishi* Viraktamath and Jagruti, 2022	Maharashtra (Viraktamath & Roy, 2022)
16	*Tetragonula bengalensis* (Cameron, 1897)	Assam, Arunachal Pradesh, Meghalaya, Nagaland (Rahman et al., 2015); Pondicherry, Uttar Pradesh, West Bengal (Ascher & Pickering, 2025).
17	*Tetragonula kotagadensis* Hadimani & Dey, 2025	Odisha (Hadimani & Dey, 2025)
18	*Listotrigona cacciae* (Nurse, 1907)	Madhya Pradesh (Nurse, 1907)
19	*Listotrigona. darbhaensis* Viraktamath, 2023	Chhattisgarh (Viraktamath et al., 2023)
20	*Listotrigona kosumtaraensis* Viraktamath, 2023	Maharashtra (Viraktamath et al., 2023)
21	*Lepidotrigona arcifera* (Cockerell, 1929)	West Bengal, Mizoram, Assam, Nagaland (Ascher & Pickering, 2025).
22	*Lepidotrigona thenzawlensis* Viraktamath and Thangjam, 2022	Mizoram (Viraktamath & Thangjam, 2022)
23	*Lepidotrigona rajithae* Viraktamath and Rojeet, 2022	Mizoram (Viraktamath & Thangjam, 2022)
24	*Lepidotrigona amruthae* Viraktamath and Thangjam, 2022	Mizoram (Viraktamath & Thangjam, 2022)
25	*Lepidotrigona sikkimensis* Viraktamath, 2022	Sikkim (Viraktamath & Thangjam, 2022)

described with male samples. *T. yikhumensis* **sp. nov.** is the first stingless bee species from Nagaland to be reported with morpho-taxonomical details of both male and worker samples and a detailed description of the male genitalia with its associated sterna. It is also the first subterranean stingless bee under the genus *Tetragonula* reported from Nagaland, and the second in India after *T. kyrdemkulaiensis*.

The Lothas who inhabit Wokha district call the subterranean stingless bees *litsuk*, which translates to 'ground bees'. The tribals highly value the honey and bee pollen of these bees for their medicinal properties.

With the holotype measuring 5.59 mm in body length and 1.9 mm in head width, *T. yikhumensis* **sp. nov.** is the largest stingless bee found in India. The discovery of *T. yikhumensis* **sp. nov.** elevates the number of stingless bee species in India from 25 to 26 and the number of species under the genus *Tetragonula* to 18.

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Authors' Contributions

NMO: Investigation, formal analysis, data curation, writing-original draft.
SD: Investigation, visualization, data curation.
BA: Writing-review and editing, investigation, supervision.
RK: supervision.
ARK: conceptualization, writing-review and editing, supervision.

References

Ascher, J. & Pickering, J. (2025). Discover life bee species guide and world checklist (Hymenoptera: Apoidea: Anthophila). https://discoverlife.org. (accessed date: 3 November 2025).

Attasopa, K., Bänziger, H., Disayathanoowat, T. & 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: 63-82. https://doi.org/10.11646/zootaxa.4442.1.3

Bentley, A. & Osborn, R. (2025). Snow entomological museum collection. University of Kansas Biodiversity Institute. https://gbif.org/occurrence/1676102797 (accessed date: 3 November 2025).

Camargo, J.M.F. & Pedro, S.R.M. (1992). Systematics, phylogeny and biogeography of the Meliponinae (Hym., Apidae): a mini-review. Apidologie, 23: 509-522. https://doi.org/10.1051/apido:19920603

Chauhan, A. & Singh, H.K. (2020). A new record of stingless bee, *Tetragonula gressitti* Sakagami (Hymenoptera: Apidae: Meliponini) from Nagaland. India International Journal of Farm Sciences, 10: 83-87. https://doi.org/10.5958/2250-0499.2020.00057.9

Chauhan, A. & Singh, H.K. (2022). Mapping of stingless bee fauna in Nagaland. International Journal of Farm Sciences, 12: 117-122. https://doi.org/10.5958/2250-0499.2022.00061.1

Cockerell, T.D.A. (1929). LXX. – Descriptions and records of bees. – CXX. Annals and Magazine of Natural History, 4: 584–594. https://doi.org/10.1080/00222932908673101

Engel, M.S., Rasmussen, C., Ayala, R. & De Oliveira, F.F. (2023). Stingless bee classification and biology (Hymenoptera, Apidae): a review, with an updated key to genera and subgenera. ZooKeys, 1172: 239-312. https://doi.org/10.3897/zookeys.1172.104944

Grüter, C. (2020). Stingless bees: their behaviour, ecology and evolution. Cham: Springer, 385 p.

Hadimani, B.N. & Dey, D. (2025). A new species of *Tetragonula* (Apidae: Meliponini) from India with description of males of *Tetragonula ruficornis* (Smith, 1870). Oriental Insects, 59: 311-325. https://doi.org/10.1080/00305316.2024.2444352

Heard, T.A. (1999). The role of stingless bees in crop pollination. Annual Review of Entomology, 44: 183-206. https://doi.org/10.1146/annurev.ento.44.1.183

Jamir, T., Singh, H.K., Cauhan, A., Banik, S., & Kanaujia, S. (2022). Studies on impact of stingless bee (*Tetragonula iridipennis*) pollination in watermelon (*Citrullus lanatus*). The Pharma Innovation Journal, 11: 4801-4804.

Martínez-Puc, J.F., Cetzal-Ix, W., Basu, S.K., Enríquez-Nolasco, J.R. & Magaña-Magaña, M.A. (2022). Nutraceutical and medicinal properties of native stingless bees honey and their contribution to human health. In R.B. Singh, S. Watanabe, & A.A. Isaza (Eds.), Functional foods and nutraceuticals in metabolic and non-communicable diseases (pp. 481-489). London: Elsevier.

Michener, C.D. (2007). The bees of the world (2nd ed). Baltimore: Johns Hopkins University Press, 953 p.

Michener, C.D. (2013). The Meliponini. In P. Vit, S.R.M. Pedro & D.W. Roubik (Eds.), Pot-honey: A legacy of stingless bees (pp. 3-18). New York: Springer.

Moure, J.S. (1961). A preliminary supra-specific classification of the Old-World Meliponinae bees (Hymenoptera, Apoidea). Studia Entomologica, 5: 181-242.

Nurse, C.G. (1907). A new species of Indian wax-producing bee. The Journal of the Bombay Natural History Society, 17: 619.

Quezada-Euán, J.J.G. (2018). Stingless bees of Mexico: the biology, management and conservation of an ancient heritage. New York: Springer, 294 p.

Rahman, A., Das, K.P., Rajkumari, P., Saikia, J. & Sharmah, D. (2015). Stingless bees (Hymenoptera: Apidae: Meliponini):

diversity and distribution in India. International Journal of Science and Research (IJSR), 4: 77-81. https://doi.org/10.21275/v5i4.nov162857

Rasmussen, C. & Camargo, J.M.F. (2008). A molecular phylogeny and the evolution of nest architecture and behavior in *Trigona* s.s. (Hymenoptera: Apidae: Meliponini). Apidologie, 39: 102-118. https://doi.org/10.1051/apido:2007051

Rasmussen, C. (2013). Stingless bees (Hymenoptera: Apidae: Meliponini) of the Indian subcontinent: diversity, taxonomy and current status of knowledge. Zootaxa, 3647: 401-428. https://doi.org/10.11646/zootaxa.3647.3.1

Rasmussen, C., Thomas, J.C. & Engel, M.S. (2017). A new genus of eastern hemisphere stingless bees (Hymenoptera: Apidae), with a key to the supraspecific groups of Indomalayan and Australasian Meliponini. American Museum Novitates, 3888: 1-33. https://doi.org/10.1206/3888.1

Rathor, V.S., Rasmussen, C. & Saini, M.S. (2013). New record of the stingless bee *Tetragonula gressitti* from India (Hymenoptera: Apidae: Meliponini). Journal of Melittology: 1-5. https://doi.org/10.17161/jom.v0i7.4454

Roubik, D.W. (2006). Stingless bee nesting biology. Apidologie, 37: 124-143. https://doi.org/10.1051/apido:2006026

Sakagami, S.F. (1975). Stingless bees (excl. *Tetragonula*) from the continental Southeast Asia in the collection of Berince P. Bishop Museum, Honolulu (Hymenoptera, Apidae). Journal of the Faculty of Science, Hokkaido University, Series VI. Zoology, 20: 46-79.

Sakagami, S.F. (1978). *Tetragonula* stingless bees of the continental Asia and Sri Lanka (Hymenoptera, Apidae). Journal of the Faculty of Science, Hokkaido University. Series, VI, Zool. 21: 165-247.

Sakagami, S.F. (1982). Stingless bees. In H.R. Hermann (Ed.), Social insects: vol. 3 (pp. 361-423). New York: Academic Press.

Sangma, R.H.C., Singh, H.K. & Chauhan, A. (2022). Nesting structure of stingless bees, *Lophotrigona canifrons* Smith and *Tetragonula iridipennis* Smith (Hymenoptera: Apidae) in natural forests of Nagaland, India. Entomon, 47: 183-188. https://doi.org/10.33307/entomon.v47i2.721

Schwarz, F.H. (1939). The Indo-Malayan species of Trigona. Bulletin of American Museum of Natural History, 76: 83-141.

Sen, S., Borkataki, S., Sutradhar, P., Taye, R.R., Bhattacharyya, B., Saranya, P.S. & Reddy, M.D. (2023). Pollination efficiency of stingless bee, *Tetragonula iridipennis* (Smith) on greenhouse cucumber, *Cucumis sativus* (Linnaeus). Current Science, 125: 865-870. https://doi.org/10.18520/cs/v125/i8/865-870

Shanas, S. & Faseeh, P. (2019). A new subgenus and three new species of stingless bees (Hymenoptera: Apidae: Apinae: Meliponini) from India. Entomon, 44: 33-48. https://doi.org/10.33307/entomon.v44i1.424

Slaa, E.J., Sánchez Chaves, L.A., Malagodi-Braga, K.S. & Hofstede, F.E. (2006). Stingless bees in applied pollination: practice and perspectives. Apidologie, 37: 293-315. https://doi.org/10.1051/apido:2006022

Tej, M.K., Srinivasan, M.R., Rajashree, V. & Thakur, R.K. (2017). Stingless bee *Tetragonula iridipennis* Smith for pollination of greenhouse cucumber. Journal of Entomology and Zoology Studies, 5: 1729-1733.

Vijayakumar, K. & Jeyaraaj, R. (2014). Taxonomic notes on stingless bee *Trigona (Tetragonula) iridipennis* Smith (Hymenoptera: Apidae) from India. Journal of Threatened Taxa, 6: 6480-6484. https://doi.org/10.11609/jott.o3773.6480-4

Viraktamath, S. & Roy, J. (2022). Description of five new species of *Tetragonula* (Hymenoptera: Apidae: Meliponini) from India. Biologia, 77: 1769-1793. https://doi.org/10.1007/s11756-022-01040-8

Viraktamath, S., Roy, J., Jha, A.K. & Rao, S. (2023). Description of two new species of *Lisotrigona* (Hymenoptera, Apidae, Meliponini) from Central India and their nests. Entomon, 48: 149-166. https://doi.org/10.33307/entomon.v48i2.886

Viraktamath, S. & Thangjam, R. (2021). Two new species of *Tetragonula* (Hymenoptera: Apidae: Meliponini) from North-East India with notes on their nest structure. Biologia, 76: 1691-1704. https://doi.org/10.2478/s11756-020-00662-0

Viraktamath, S. & Thangjam, R. (2022). Description of four new species of *Lepidotrigona* (Hymenoptera: Apidae: Meliponini) from North-East India. Zootaxa, 5175: 1-30. https://doi.org/10.11646/zootaxa.5175.1.1

Wille, A. (1983). Biology of the stingless bee. Annual Review of Entomology, 28: 41-64.