Journal of Threatened Taxa | www.threatenedtaxa.org | 26 October 2014 | 6(11): 6480–6484

ISSN 0974-7907 (Online)
ISSN 0974-7893 (Print)

OPEN ACCESS

Taxonomic notes on stingless bee *Trigona* (*Tetragonula*) *iridipennis* Smith (Hymenoptera: Apidae) from India

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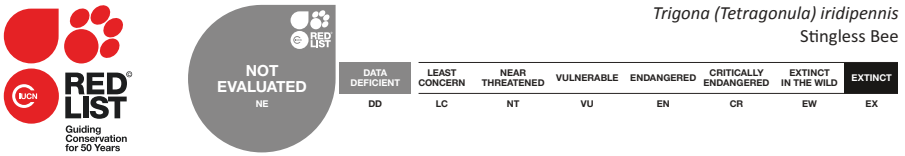
Stingless bees are a monophyletic group principally found in the tropical and subtropical areas of America, Africa, Australia and parts of Asia (Roubik 1989). The stingless bee species are taxonomically organized into two major genera viz., *Trigona*, the largest group and *Melipona*, a genera consisting exclusively of the genus *Melipona*. Most of the Asian and African stingless bee species belong to the genera *Trigona* (Michener 2013). Taxonomic identification of stingless bees remains unclear and requires experienced taxonomists. The total number of species is estimated to be about 500 described species worldwide (Michener 2013) and 43 species occur in the Asian region (Michener 2000).

The scientific genus-group names for the different stingless bees from India have long been *Trigona* and *Lisotrigona*. *Tetragonula* is the single largest and most widespread genus in the Indo-Malayan regions, reported from India and extending to the Solomon and Caroline Islands. *Trigona iridipennis* is the type species of the subgenus *Tetragonula* (Sakagami 1978; Michener 2013; Rasmussen 2013) and this species was originally described from Ceylon by Smith in the year 1854.

Studies of species diversity of *Trigona* in different parts of India are lacking. Scarce literature is available on stingless bee species diversity in India. The distribution of *T. iridipennis* was reported in Bengaluru, Karnataka (Biesmeijer 1993) and in Kerala (Mohan & Devanesan 1999).

The diversity of stingless bees in the Indian subcontinent has been summarized by Rasmussen (2013). The "*iridipennis*" species group is extremely similar in external morphology of the workers and the morphological characteristics of the male genitalia and molecular data of the species are needed to separate the species from the "*iridipennis*" group. Vijayakumar & Jayaraj (2013) discriminate the three species (*T. iridipennis, T. laeviceps* and *Lepidotrigona arcifera*) of stingless bees by using relative warp analysis of the forewings from India. The present study reports the morphological key characteristics of male and female bees of *Tetragonula iridipennis* in Nellithurai Village, Tamil Nadu, India.

Most of the researchers in India concentrated only



Trigona (Tetragonula) iridipennis
Stingless Bee

DOI: http://dx.doi.org/10.11609/JoTT.o3773.6480-4 | **ZooBank:** urn:lsid:zoobank.org:pub:0DADA717-8726-4D19-A5CA-9E858669C072

Editor: P.M. Sureshan, Zoological Survey of India, Calicut, India. **Date of publication:** 26 October 2014 (online & print)

Manuscript details: Ms # o3773 | Received 16 September 2013 | Final received 09 August 2014 | Finally accepted 29 September 2014

Citation: Vijayakumar, K. & R. Jeyaraaj (2014). Taxonomic notes on *Trigona* (*Tetragonula*) *iridipennis* Smith (Hymenoptera: Apidae) from India. *Journal of Threatened Taxa* 6(11): 6480–6484; http://dx.doi.org/10.11609/JoTT.o3773.6480-4

Funding: None.

Competing Interest: The authors declare no competing interests.

Acknowledgements: We are grateful to Dr. Deborah Smith from University of Kansas, USA for helping in identifying the stingless bee species and useful comments. I also express my sincere thanks to Dr. M. Muthuraman, for his encouragement and motivation to pursue the research work. I would also like to thank beekeepers Mr. K. Udayakumar, Mr. G.K. Thangavelu, Mr. Navaneethan from Nellithurai Village for their participation during sample collection and documentation.

on stingless bee biology, morphometry, natural enemies and its pollination biology (Muthuraman & Saravanan 2004; Danareddi & Viraktamath 2009; Vijayakumar et al. 2012). The studies on stingless bee species diversity in India are rare and our understanding of their identification is at an early stage.

Materials and Methods

Sample collection: The adult worker samples from nest entrance and male bees during the swarming period were collected at Nellithurai (11^{0}16'59.74"N & 76^{0}53'6.24"E), Tamil Nadu, India (Image 1) and preserved in 90% ethyl alcohol for further identification. Taxonomic identification was based on the nest architecture and morphology according to Sakagami et al. (1983) and Schwarz (1939). The preserved male and female stingless bees were dissected and the morphological characteristics of the worker and drone stingless bees were photographed by using a Leica M165C stereo microscope with image analyzer. The male genitalia were cleared in a 0.5% KOH solution and examined in both wet and dry conditions. In addition, male sternum V and sternum VI were used as a key characteristic for distinguishing the *Tetragonula* stingless bees used by Schwarz (1939). Species identity was confirmed by Dr. Deborah Smith, Department of Ecology and Evolutionary, Biology/Entomology, the University of Kansas, USA.

Results

The identity of the *Trigona (Tetragonula) iridipennis* Smith, depends strongly on the works of Schwarz (1939), Sakagami (1978) and Sakagami & Inoue (1987) for the subgeneric characterization and for species recognition. These authors indicated that the size differences as well as male genitalia and sternal characters are important key morphological characteristics for identifying the species. The species descriptions are given below.

Description: *T. iridipennis* is the type species of the subgenus *Tetragonula*. This species has formerly been regarded as very widespread from India to Solomon Island. The "*iridipennis"* species group is the largest and most widespread group in the Indo-pacific areas.

Diagnostic characters of worker (Images 2 a–h): The malar space is vestigial and the scutellum is extended backward. The mandible with two well developed teeth on the inner half of its apex. The basal sericeous area positioned more than half of the length of basitarsus.

Metric values: The total body length ranges from 3.5–4.0 mm, and head width ranges from 1.50–1.68

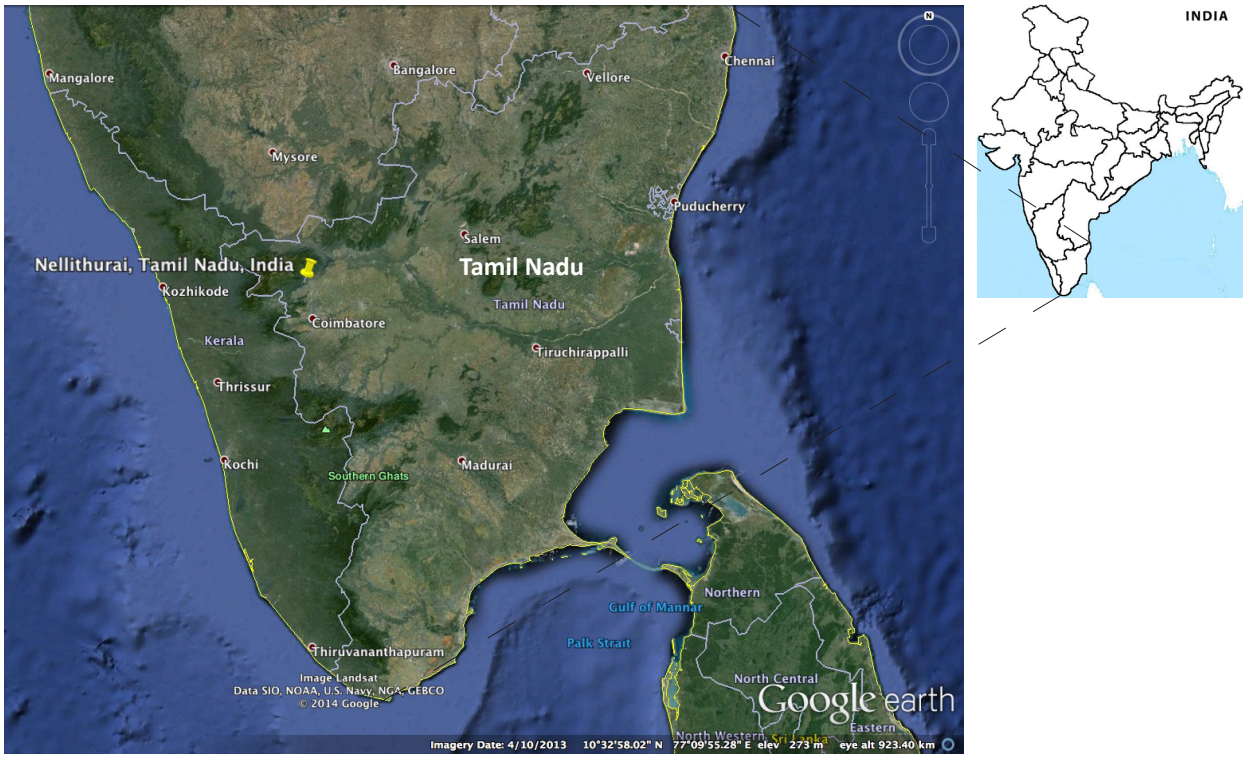


Image 1. Nellithurai, Tamil Nadu, India (Source: Google Earth)

mm; forewing length includes tegula ranging from 3.2–3.9 mm, bifurcation between vein *m* and *cu* ranges from 0.90–1.12 mm and hind tibial length ranges from 1.29–1.57 mm.

Colour and pilosity: The entire body is black to blackish-brown. The clypeus, tegula, legs and metasoma are dark in colour (Image 2a). The frontal hairs are fulvous to whitish and plumose (Image 2b). The mesoscutal hairs well banded and fulvous to testaceous in colour (Image 2c). The mesoscutellar fringes are fulvous to testaceous. The erect hairs of the mesopleura are silvery to white in colour. The frontal hairs are mostly fulvous to whitish (Image 2d). The anterior veins and stigma of forewings are dark brown.

The hairs fringing on the hind tibiae posterior are plumose and the outer surface of hind tibia with dark brown stout setae (Image 2e). The hairs on upper surface of thorax is mostly light in colour and the hairs fringing the anterior contour of the hind tibiae are black (Image 2f). The basal and apical half of the wings are uniform in colour and the anterior veins and stigma dark brown (Image 2g). The number of hamuli on hind wing is constantly five per wing (Image 2h).

Diagnostic characters of male (Image 3 a–h): The structural characteristics are more similar to female bees (Images 3a–c). The posterior margin of basitarsus is imperceptibly angulate. The outer surface of the hind tibiae medially gently convex and apically slightly

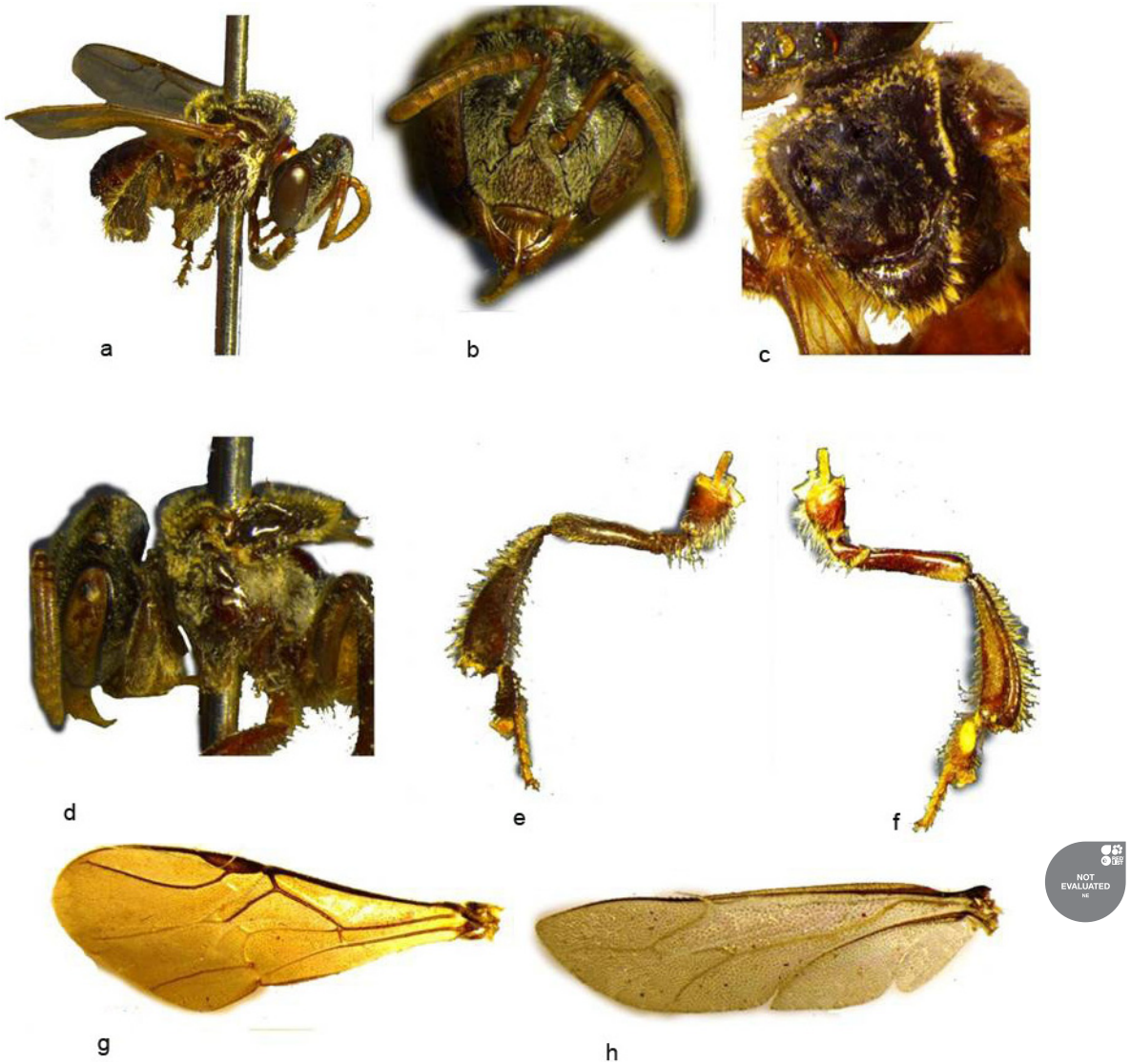


Image 2. Diagnostic characters of *Trigona* (*Tetragonula*) *iridipennis* - female. © K. Vijayakumar
a - Body dorsal view; b - Head front view; c - Mesoscutum; d - Propodeum and mesosomal side; e - Outer view of right hind tibia; f - Inner view of right hind tibia; g - Forewing; h - Hindwing

Image 3. Diagnostic characters of *Trigona* (*Tetragonula*) *iridipennis* - male. © K. Vijayakumar
a - Body dorsal view; b - Head front view; c - Propodeum and mesosomal side; d - Outer view of right hind tibia; e - Inner view of right hind tibia; f - Forewing; g - Sternum VI (S6); h - male genitalia

depressed (Image 3d).

Metric values: The total body length ranges from 2.5–3.5 mm, head width ranges from 1.38–1.43 mm, forewing length including tegula ranges from 3.1–3.8 mm, bifurcation between m and cu ranges from 0.88–0.95 mm; hind tibial length ranges from 0.96–1.23 mm.

Colour and pilosity: The male stingless bees are similar to female bees in colour characteristics. The dense plumose hairs cover the posterior fringe of the mid tibia. The hairs on the outer surface of the hind tibiae are plumose and sparser (Image 3e,f). The sternum V (S5) is small and the sternite VI (S6) is antegladular area medially long and postgladular area short (Image 3g). The median depression of sternite VI with sparse hairs and the apex is narrowly and shallowly incised.

Genitalia: The male genitalia are one of the most important characteristics for taxonomic study. The gonostylus is long and slender, more or less sinuous with sparse hairs at apex, penis valve is very robust, tapering only at the apex, about as long as or slightly shorter than gonostylus. The gonostylus arises from the dorsum of gonocoxite (Image 3h).

Discussion

Stingless bees are a tropical group of over 500 species worldwide (Michener 2013). Recently, Rathor

et al. (2013) referred to seven stingless bee species in India. Rasmussen (2013) listed eight species from the Indian subcontinent and *T. iridipennis* is a wide spread species in India. He pointed out that the species of the *iridipennis* group are extremely similar in external morphology of the workers and a taxonomic revision of the species of India should include morphological characteristics of the male genitalia. The present study reports the key morphological characteristics of worker bees and male genitalia.

The *iridipennis* group is characterized by having a dark mesoscutum with four distinct hair bands separated by broad glabrous interspaces. The genital morphology and molecular data are needed for correctly describing the *iridipennis* species group. Because the *iridipennis* species group is extremely similar in external morphology to the workers, most of the authors pointed out that the mesoscutum with glabrous interspaces are the key characteristics for the *iridipennis* species group (Schwarz 1939; Sakagami 1978; Dollin et al. 1997; Rasmussen 2013). Based on the structure of male genitalia, Sakagami (1978) includes four species (*T. iridipennis*, *T. clypearis, T. fuscobalteata* and *T. pagdeni*) under the *iridipennis* group.

The present study reports the existence of *Tetragonula iridipennis* from the *iridipennis* group in Nellithurai village, Tamil Nadu, India. The female bees were morphologically similar and are marked with minor differences in hairs on head and thorax, sereceous space and marginal cell in forewing. The male genitalia are the best diagnostic characteristics for differentiating within *iridipennis* group, particularly, the shapes of the various parts of genitalia. The gonostylus of *T. iridipennis* is long and slender and sinuous with sparse hairs at apex. The penis valve is very robust and tapering only at the apex.

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