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Biology of the stingless bees, *Tetragonula laeviceps* Smith

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Abstract
Studies on biology of *T. laeviceps* revealed that the queen laid single egg into brood cells filled up with honey and pollen and a worker bee quickly sealed the brood cell though resin mixed with wax. The egg was smooth, cylindrical and light creamish in colour. The egg, larval and pupal period of *T. laeviceps* was recorded as 5.37±0.81, 11.20±0.81 and 31.83±1.35 days. The total period of development from egg to adult was 48.77±1.74 days. The colour of newly emerged adult was light yellowing brown. The body of the developed worker bee was shiny black. The abdomen was blackish brown.

Keywords: biology, stingless bees, *Tetragonula laeviceps* Smith

Introduction
Stingless bees are smallest of the honey producing bees. The nests of stingless bees are more elaborate and complex than those of Apis honey bees. They are highly social insect like honey bees living in permanent colonies, nesting in old walls, logs, crevices and such other concealed places. But the sting is greatly reduced without an effective tip. Hence, the defence behaviour is by chasing the intruders by biting, becoming entangled in the intruder's hairs and getting into the nose, ears and eyes. Beekeeping with stingless bees is called Meliponiculture. Worker brood cells of *Trigona iridipennis* were in the range of 3.0 to 3.3 mm diameter and 3.50 to 4.50 mm in height. Newly constructed cells were polished and filled with thick liquid food and mass provisioning was seen. Usually, 5-6 attendant workers were involved in filling up with larval food. After mass provisioning, the queen laid an egg on it, 4-5 seconds after egg laying, one of the attendant worker bees attended closing the cells with wax. The time taken for sealing a cell ranged between 2 minutes 40 seconds to 3 minutes (Kishirasagar and Chauhan, 1977) [1]. The studies with two mature colonies of *Trigona moorei* Schwarz maintained in glass topped hives showed that the total development time from oviposition to emergence of adult worker was 46.50 days comprising 5.5, 10 and 31 days for egg, larval and pupal stages, respectively (Salmah *et al.*, 1987) [5]. The studies on colonies of *Trigona itama* maintained in glass topped hives showed that the total development time from oviposition to emergence of adult worker was 46.50 days comprising 4.20, 10.40 and 31.90 days for egg, larval and pupal stages, respectively. The length of this period was twice that of *A. Mellifera* (Wittman *et al.*, 1991) [10]. Similar studies have indicated that the total development time from oviposition to emergence of adult worker was 46.50 days comprising 4.20, 10.40 and 31.90 days for egg, larval and pupal stages respectively for *T. itama* (Salmah *et al.*, 1996) [4].

Materials and Methods
Biology of *Tetragonula laeviceps*
The study on biology of *T. laeviceps* was carried out at Sahyadri Honey Hut, Soldhara, Taluka – Chikhli District – Navsari 396 521 Gujarat during the period of October-2017 to March-2018. The dry period of study was selected for study of biology of *T. laeviceps* as colony mortality of *T. angustula*, species of stingless bees peaked at the end of the wet season, while colony reproduction was most frequent during the dry season in the Tropics of Guanacaste, Costa Rica (Slaa, 2006) [7].

Formation of new colony for biological studies
The old, healthy, strong established stingless bee colony was utilised to split off the colony into new hive and the same was examined to study the biology of *T. laeviceps*. A healthy, strong colony from one box was split to form two separate halves, thus forming two new

colonies from one initial colony. During an ideal split, the nest is divided equally with regard to honey and pollen stores as well as brood. Once a colony was split into two separate halves, an empty half box was then added to each of these halves to form two new complete boxes (Shanks, 2015) [6]. The bee hives were arranged with the distance of five meters. Five brood cells were marked by white paint with gentle hand (Photo 3). The observations were made from oviposition to emergence of adult in case of workers and the duration of egg, larval and pupal period was recorded.

Egg period
Egg period was determined by gently dissecting the marked brood with the help of needle every day and again cover the brooder cell and observed till the egg hatched.

Larval period
Larval period was calculated as the days between hatching of egg to pupation. It was determined by dissecting the marked brood cells eight days after hatching of eggs and also by observing the exhaustion of brood food and the changes in the colour of brood cells. The colour of larval brood cell was creamish to light brown in colour.

Pupal period
The pupal period was calculated between initiation of pupa to adult emergence. The pupation of larva was decided by changing colour of brood cell from light brown to dark brown in colour.

Developmental period
The period from egg laying to emergence of adult for five individuals of six different dates of each month from October – 2017 to March – 2018. The observations of individual brood cell were recorded separately.

Appearance of adult
The specimens of worker stingless bees were brought to laboratory of Entomology department, N. M. College of Agriculture, Navsari Agricultural University, Navsari, Gujarat for morphological identification based on morphological characters described by Sakagami (1978), Sakagami and Inoue (1987) [2], Dollin *et al.* (1997) and Smith (2012) [3].

Statistical analysis
The descriptive statistical analysis was performed for all parameters of biology of *T. laeviceps*.

Result and Discussion
Biology of *Tetragonula laeviceps*
The present investigation on the study of biology of stingless bee (*T. laeviceps*) was carried out during October 2017 to March 2018 at Sahyadri Honey Hut, Soldhara village, District– Navsari. Wherein different stages of life cycle *viz*.; egg, larva, and pupa were described for their appearance and duration. The study on biology of stingless bee (*T. laeviceps*) indicated that *T. laeviceps* passed through four stages like; egg, larva, pupa and adult. In this study the observations on duration of egg, larva and pupa were recoded, however adult life duration was not recorded as individual cannot be marked separately due to its foraging habits. The morphological appearance of adult was observed and described. The data thus obtained are presented in Table 1 and discussed hereunder.

Egg period
The stingless bee (*T. laeviceps*) stores pollen and nectar in pot-like structures in the nest. The queen laid single egg into brood cells filled up with honey and pollen and a worker bee quickly sealed the brood cell though resin mixed with wax. Workers collect nectar and pollen as food from a number of different flowers and stored it into nest. The eggs of the *T. laeviceps* were smooth, cylindrical and transparent in appearance. The egg was light creamish in colour. The results presented in Table 1 revealed that the egg period of *T. laeviceps* was recorded in the range of 4.80 – 6.40 days with an average of 5.37±0.81days. The eggs were hatched in 4.80±0.45, 5.00±0.71, 5.40±0.89, 5.40±0.55, 6.40±0.55 and 5.20±0.84 days during October - 2017 to March – 2018, respectively. The egg development period was recorded in the range of 4.80 – 6.40 days with an average of 5.37±0.81 days (Table 1).

Table 1: Biology of stingless bee (*Tetragonula laeviceps*)

Date of egg laying	Egg Period (day)	Larval Period (day)	Pupal Period (day)	Total developmental period(day)
20-10-2017	4.80±0.45	11.40±0.55	30.60±1.14	46.80±1.10
18-11-2017	5.00±0.71	11.20±0.84	32.40±1.14	48.60±2.07
17-12-2017	5.40±0.89	11.20±0.45	33.40±1.14	50.00±1.58
20-01-2018	5.40±0.55	11.00±1.00	32.20±1.48	48.60±1.52
18-02-2018	6.40±0.55	10.40±0.55	32.60±0.89	49.40±1.52
17-03-2018	5.20±0.84	12.00±0.71	32.00±1.00	49.20±1.30
Range	4.80-6.40	10.40-12.00	31.00-33.40	46.80-50.00
Mean	5.37±0.81	11.20±0.81	31.83±1.35	48.77±1.74

Larval period
The newly hatched larva looked whitish cream in colour, whereas full grown larva became light brownish. In order to view the study of larval period of *T. laeviceps* the larvae were creamy white, apodous and 'C' shaped. The larval duration varies in different month *i.e.*, 11.40±0.55, 11.20±0.84, 11.20±0.45, 11.00±1.00, 10.40±0.55, 12.00±0.71 days during October - 2017 to March – 2018, respectively. The larval period was noticed in the range of 10.40 – 12.00 with an average of 11.20±0.81 days (Table 1).

Pupal period
The pupae of the *T. laeviceps* were exarate type, and development period varies in the different month *i.e.*, 30.60±1.14 days during October, 32.40±1.14 days during November and 33.40±1.14 days during December (2017), and 32.20±1.48, 32.60±0.89 and 32.00±1.00 days during January to March (2018) respectively, in the ranged between 31.00 – 33.40 days with an average of 31.83±1.35 days (Table 1).

Total developmental period
The period of development of stingless bee (*T. laeviceps*)

from egg to adult emergence were considered as total developmental period under present study.
The total period of development from egg to adult observed in the range of 46.80 to 50.00 days with an average of 48.77±1.74 days (Table 1).

Appearance of Adult
Upon emergence, the young adult was not found to much active, initially they worked within the brood chamber. The colour of newly emerged adult was light yellowing brown. The abdomen was blackish brown. Head was black, and sporadically covered with white fine hairs. Compound eyes were reddish. Tegula was brown and forewings uniformly coloured. Hind wings were semi-transparent and venation was dark brown. Hind tibiae were short, corbicula was pear shaped, sporadically covered with long setae at apical but short at basal portion. The stingless bee queen was easily distinguished though a smaller head and thorax and a larger abdomen. The queen was cared by workers.
The results of present work are similar with the work carried out by Shank (2015) [6] in Australia on *T. carbonatia* species of stingless bee who distinguished queen from worker easily though a smaller head and thorax and a larger abdomen. The appearance of worker bee is similar with the observation of Trianto and Purwanto (2020) [9]. Based on referred literature the work on biology of *T. laeviceps* is very less in the world. Hence, results of present study on biology of *T. laeviceps* are discussed with biological work carried out on another species of stingless bees. The results of present study are more or less similar with the work of Salmah *et al.* (1987) [5] who reported 5.5, 10 and 31 days for egg, larval and pupal stages of *T. moorei* respectively, in glass topped hives. Whereas, *Trigona itama* maintained in glass topped hives by Wittman *et al.* (1991) [10] showed that the total development time from oviposition to emergence of adult worker was 46.50 days comprising 4.20, 10.40 and 31.90 days for egg, larval and pupal stages respectively. Likely, the total development time from oviposition to emergence of adult worker was 46.50 days comprising 4.20, 10.40 and 31.90 days for egg, larval and pupal stages respectively, for *T. itama* (Salmah *et al.*, 1996) [4]. Similar study of Roopa (2002) [3] indicated the total developmental period from oviposition to emergence of adult worker was 53.30 days comprising 5.75, 12.70 and 35.30 days for egg, larval and pupal stages, respectively. The work on biology of stingless bee (*T. laeviceps*) was carried out for the first time in South Gujarat.

Conclusion
The egg period of *T. laeviceps* was recorded in the range of 4.80 – 6.40 days with an average of 5.37±0.81days. The newly hatched larva looked whitish cream in colour, whereas full grown larva became light brownish. The larval period of *T. laeviceps* was noticed in the range of 10.40 – 12.00 with an average of 11.20±0.81 days during October - 2017 to March – 2018. The pupae of the *T. laeviceps* were exarate type. The pupal period ranged between 31.00 – 33.40 days with an average of 31.83±1.35 days. The total development period from egg to adult observed in the range of 46.80 to 50.00 days with an average of 48.77±1.74 days. The colour of newly emerged adult was light yellowing brown. The body of the developed worker bee was shiny black. The abdomen was blackish brown. Head was black, and sporadically covered with white fine hairs.

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