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Morphometrical Variations of *Tetragonula laeviceps* in Different Habitats in Central Sulawesi Province

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Abstract

Background: Habitat is a place for living things to grow and develop. Differences in habitat in an area can affect the size of an organism. This study aims to determine the morphometric variations of *Tetragonula laeviceps* found in urban and forest habitats in Central Sulawesi Province. Methods: This research was conducted with roaming technique. Morphometric characters observed were 35 characters of stingless bee and analyzed using Microsoft Excel software. Results: The results of this study indicated that the morphometric size variation of *T. laeviceps* found in forest habitats (3.58 mm) is greater than that of wild bee in urban habitats (3.05 mm). Conclusions: Different habitat characteristics can affect the morphometry variations of the bee, especially in *T. laeviceps* species. The bee's morphometry body size is greater than in the forest habitat, because in that habitat there are environmental temperatures and types of plant sources of nectar which are more supportive for bee life compared to urban habitats.

Keywords: Forest; Morphometrics; Tetragonula laeviceps; Urban

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Introduction

Stingless bees or in English called stingless bees (*Hymenoptera: Meliponini*) are one of the groups of eusocial insects that live together in the hive (Michener, 2007). These bees play an important role in helping the process of pollination of plants (Free, 1982; Inoue et al., 1985; Roubik, 1989; Trianto & Marisa, 2020), honey and propolis producers (Lourino et al., 2006; Francoy, 2009; Kumar et al., 2012; Suprianto et al., 2020).

Indonesia has many species of stingless bees that are widespread almost throughout the island (Rassmusen, 2008), one of which is Sulawesi Island. On Sulawesi Island there are at least eight stingless bees reported by Kahono (2008) and Sayusti et al. (2021), one of them is *Tetragonula laeviceps.*

T. laeviceps is a species of stingless bee characterized by shiny black body parts, black thoraxes covered with brownish to black hair on the mesonotum, the hair band pattern is not very pronounced, the squatelum part extends to the propodeum, the blackish tegula, the tibia on the limbs is black, the back tibia is slightly hairy, the back basitarsus is slightly oval with the near shiny base covered with fine hairs, hairless, slippery, shiny, hairless, and shiny brown propodeum, totaling 5 hamuli (Smith, 2012).

Judging by its characteristics, *T. laeviceps* is a type of stingless bee that is almost found in all places, namely in forest habitats, in urban areas, and rural regions (Boontop et al., 2008; Salim et al., 2012; Kelly et al., 2014; Shafrizal et al., 2014; Rahman et al., 2015). Hamid et al. (2016) research on the distribution and morphometry variation of stingless bees in urban and forest areas on Penang island Malaysia mentioned that habitat

differences can affect bees' distribution and morphometric characteristics without stinging.

This research focused on exploring stingless bee species found in Central Sulawesi Province based on morphometric character variation data from one of the stingless bee species, namely Tetragonula laeviceps, found in two different habitat types, namely in urban and forest habitats. So that in the future the results of this study can be considered before carrying out the bee cultivation process without a sting. In addition, publications on *T. laeviceps* attributed to different habitat types in Central Sulawesi Province are still lacking. This study aims to determine morphometric variations of *T. laeviceps* found in urban habitats and forests in Central Sulawesi Province.

Methods

Time and Place of Research

This research was conducted in May-June 2022 in Urban areas and Forests in Central Sulawesi Province. This research was conducted by surveying directly using the roam method. The data collected in this study are morphometric data from the Stingless bee species *T. laeviceps* obtained at the study site. The identification process is carried out at the Biological Laboratory, Tadulako University.

Tools and materials

The tools used in this study were the Oven, OptiLab professional, XSZ-107 BN binocular microscope, rod thermometer, and cannon EOS 1100D camera. The materials used in this study were T. laeviceps, 95% alcohol, tweezers, 0.1 mm insect needles, petri dishes, clear plastic, sterofoam, brushes, label paper, and razor blades.

Procedure

The procedure in this study consists of the stages of specimen collection and mounting, identification of bees without a sting, and measurement of morphometric characters:

Specimen collection and mounting

Bees were collected from the study site using insect jarring. The stingless bees obtained were then put into bottles containing 95% alcohol for morphometric analysis purposes. Before the morphometric character measurement process is carried out, the stingless bee specimen is mounted so that the important characters on the bee's body are easily observed and not damaged. The mounting process is carried out by sticking an insect needle in the thorax and tidying up all body parts. Furthermore, the stingless bee specimen was dioven at 35^{o}C for three days.

Identification of bees without a sting

Stingless bees were observed using an XSZ-107 BN binocular microscope connected to a professional OptiLab camera. Observations of morphological and morphometric characters to identify types of bees without a sting based on Smith (2012), Trianto & Purwanto (2021), and Purwanto et al. (2022).

The stingless bee individuals used in morphometric character measurements are 20 individuals in each habitat. The morphometric characters observed follow Smith (2012), Trianto & Purwanto (2021), and Purwanto et al. (2022). The mophometric characters measured were body length (BL), head width (LK), eye length and width (PM and LM), maximum and minimum interorbital distance (JMI and LOD), upper interocellar distance (JIA), lower interocellar distance (IOD), ocellocular distance (JO), gena width (LG), malar length (PML), length and width of flagellomere IV (PF and LF), length of the forewings of the tegula (WL1), the length of the distance between the venation M-Cu (WL2), the length of the hind tibia (PTB), the width of the hind tibia (LTB), the width and length of the basitarsus (LBB and PBB), (Sakagami, 1978). In addition, measurements were made for

head length (PK), clypeus length (PC), longest and closest interocular distance (JIB and JIA), interantennal distance (JI), antennocellar (JA), antennocullar (JO) (Michener 2007), length and width of the mandible (PM and LM), length and width of the mesoscutum (PMS and LMS) (Rasmussen, 2013), length and width of the front wings (PSD and LSD), length and width of the rear wings (PSB and LSB), number of hamuli (JH), femur length (PJB), width and length of basitarsus (LBB and PBB).

Measurement of ambient temperature

The ambient temperature in this study was measured using a rod thermometer. Each habitat is measured four times.

Data analysis

The morphometry data of stingless bees obtained from each habitat were then analyzed using Microsoft Excell to obtain the average values of the 20 individual stingless bees analyzed in each habitat.

Result

Ambient temperature

The ambient temperature obtained in urban habitats is 31°C, 30°C, 30°C, and 32°C or ranges from 30°C-32°C. Meanwhile, the forest habitat is 26°C, 27°C, 25°C, and 28°C (Figure 1).

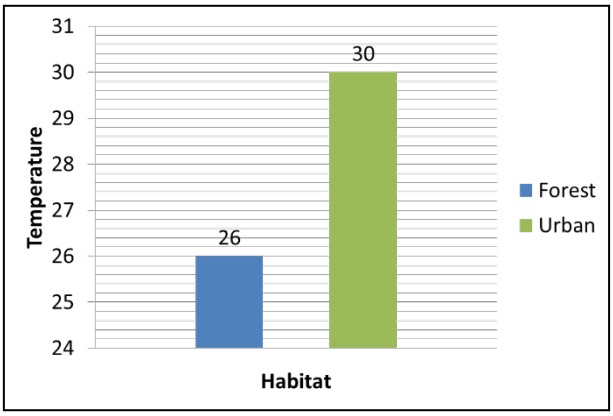

Figure 1. Environmental temperatures in Forest and Urban habitats in Central Sulawesi Province

Morphometric character of T. laeviceps

Based on the results of the studies obtained, the morphometric character in stingless bees *Tetragonula laeviceps* from forest areas (3.58 mm) has a larger body size than stingless bees originating from urban areas (3.05 mm). The same is true of the other 33 characters. Meanwhile, in the character of the number of hamuli, *T. laeviceps* species originating from urban areas and forests have the same number of 5 (Table 1). This can happen because the number of hamuli 5 in bees without a sting is a characteristic of the species *T. laeviceps* which distinguishes it from other species.

Table 1. Morphometric character of *T. laeviceps* in forest and urban habitats (unit: mm)

No.	Characteristic	Habitat	
		Forest	Urban
1	Body Length (BL)	3,58	3,05
2	Head Length (PK)	1,30	1,25
3	Head Width (LK)	1,63	1,45
4	Mandible Length (PM)	0,87	0,63
5	Mandibular Width (LM)	0,23	0,22
6	Length of Clypeus (PC)	0,44	0,34
7	Lower Interocular Distance (JIB)	0,88	0,65
8	Upper Interocular Distance (JIA)	1,00	0,89
9	Eye Width (LM)	0,40	0,34
10	Eye Length (PM)	1,01	0,99
11	Maximum Interopbital Distance (JMI)	1,08	0,88
12	Minimum Interopbital Distance (LOD)	0,88	0,63
13	Interantennal Distance (JI)	0,19	0,14
14	Interocellar Distance (IOD)	0,20	0,16
15	Ocellocular Distance (JO)	0,22	0,20
16	Antennocellar Distance (JA)	0,64	0,34
17	Antenocular Distance (JAO)	0,29	0,20
18	Gena Width (LG)	0,23	0,16
19	Flagellomere Length IV (PF)	0,12	0,09
20	Flagellomere IV Width (LF)	0,14	0,10
21	Malar Length (PML)	0,07	0,05
22	Length of Mesoscutum (PMS)	0,86	0,67
23	Mesoscutum Width (LMS)	1,06	0,98
24	WL 1	3,63	3.24
25	WL 2	1,13	1,09
26	Front Wing Length (PSD)	3,58	3,23
27	Front Wingspan (LSD)	1,22	1,12
28	Rear Wing Length (PSB)	2,43	2,23
29	Rear Wingspan (LSB)	0,59	0,38
30	Number of Hamuli (JH)	5	5
31	Back Femoral Length (PJB)	0,98	0,76
32	Tibia Rear Width (LTB)	0,46	0,23
33	Tibia Rear Length (PTB)	1,39	1,10
34	Wide Rear Basitarsus (LBB)	0,28	0,19
35	Long Back Basitarsus (PBB)	0,59	0,32

Discussion

Based on the research results, the temperature obtained is the normal temperature needed by bees to develop properly. Tautz (2008) explained that bees can carry out normal activities at temperatures around 18 - 35oC and ideal temperatures of 26oC, while conditions above and below these temperatures their activities begin to be disrupted. Furthermore, Abrol (1991) reported that apis dorsata bees more actively collect nectar at temperatures around 24.5 - 34.5oC.

Meanwhile, based on the morphometric character obtained (Table 1), the stingless bees *Tetragonula laeviceps* from forest areas (3.58 mm) have a larger body size than those from urban areas (3.05 mm). The results of this study are also to the results reported by Hamid et al. (2016) that *T. laeviceps* stingless bees obtained in forest areas have a greater body morphometric character than those from urban areas. Furthermore, Hamid et al. (2016) explained that this can happen because forest areas have a more significant number and type of nectar source plants than urban areas, so that it will have an impact on the process of stingless bee activity in foraging and affect the morphometric character of bees without the sting itself.

Morphometric characters in stingless bees from forest habitats are larger, longer, and wider than urban habitat origins. However, when viewed from the number of bee hamuli

without stings, the species of *T. laeviceps* from urban areas and forests are the same, which is 5 (Table 1). This can happen because the number of hamuli 5 in bees without a sting is a characteristic of the species *T. laeviceps* which distinguishes it from other species. This is under what was reported by Smith (2012) that the number of hamuli in bees without a sting is one of the distinguishing features among each species, namely in the genus Tetragonula characterized by hamuli numbering 5. This is also supported by Trianto & Purwanto (2020), who obtained three genera of bees without a sting in their research, with the characteristics of the number of hamuli, namely the genus Heterotrigona totaling 7, Lepidotrigona totaling eight hamuli, and the genus Tetragonula totaling 5.

Based on the results of the research obtained, this can happen allegedly because it is influenced by several factors, such as temperature and the character of the habitat where the stingless bee is located. As already explained above, the environment's temperature is one of the important factors that can affect the morphometric character of bees without a sting. The ambient temperature obtained in this study is normal for bees without a *T. laeviceps* sting to move. However, when compared between the ambient temperature obtained in urban areas and forests, the ambient temperature in forest areas is more ideal and can support bees without stinging for activities.

- In addition, judging from the characteristics of the habitat, the forest area is an area densely overgrown with trees and plants. There is a unified ecosystem in the form of a stretch of land containing biological natural resources (FAO, 1999) that can support the life of bees because these plants can be used as nectar source plants. At the same time, the urban area is the border between the city and the village which has an urban-like nature. Urban areas have little vacant land, and little vegetation and almost the entire area is filled with buildings which are also habitats for insects. The type of housing in urban areas generally does not have yard land and the average house area is 96m2. Many waterways are closed so they cannot support the life of insects.

Conclusions

Different habitats can affect the morphometric variation of the stingless bee Tetragonula laeviceps. The larger morphometric size of the body of a bee without a sting is that it is in a forest habitat.

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Declaration statement

The authors reported no potential conflict of interest

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