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MORPHOMETRIC ANALYSIS OF STINGLESS BEE *(Trigona* sp.) IN THE AREA OF KAWASAN RUMAH PANGAN LESTARI (KRPL) CENTRAL LOMBOK

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Abstract: This study aims to determine the morphometric characteristics of the bee *Trigona*sp. in the Kawasan Rumah Pangan Lestari (KRPL) Central Lombok. The research sample consisted of 28 worker bees *Trigona* sp. taken from 14 colonies in KRPL. The study was conducted in October-November 2020. The morphological characters of each worker bee were observed and 33 morphometric characters were measured. The results of species identification based on morphological and morphometric characters showed that there were two species of *Trigona*sp. Those in KRPL are *Trigona fusco balteata* and *Trigona clypearis.* The morphological differences that are quite clear between the two species are the structure of the *hairbands* on the *meso shield, the* color of the abdomen, and the color of the wing venation. The color of the abdomen of *Trigona fusco balteata* is brownish yellow, while the color of the abdomen of *Trigona clypealis* is blackish brown. Wing venation color, the structure of the *hairbands,* is more pronounced in *Trigona fusco balteata*. Variations in the measured morphometric characteristics can be seen from the standard deviation values. The highest standard deviation values inspecies *Trigona fusco balteata were hindwing* found in length (SD±0.26), body length (SD±0.23), forewing length of tegula (SD±0.19), and forewing length (SD). ±0.18). Meanwhile, in the species, *Trigona clypealis* the highest standard deviation values were found in body length (SD±0.20), forewing length of tegula (SD±0.15), and forewing length (SD±0.27).

Keywords: *Morphology, Morphometry, Trigona fusco balteata, Trigona clypearis, and size variations*

INTRODUCTION

Climate change is any significant change in climate measures (temperature, precipitation, or wind) that occurs over a long period [1]. Global climate change (*Global Climate Change*) has recently caused sea levels to rise, rainfall patterns to change, and the earth's temperature to increase [2]. It certainly affects several sectors of life, such as agriculture, tourism, and other sectors. To minimize the impact of climate change, the Ministry of Agriculture, through the Agricultural Research and Development Agency, developed a concept called the Sustainable Food Home Area Model (MKRPL) and replicated it into a Sustainable Food Home Area (KRPL) [3]. Sustainable Food House supervision (KRPL) is limited land use to produce food products [4]. The KRPL development approach is carried out through sustainable agricultural development (*sustainable agriculture*), utilization of local resources (*local wisdom*) and community empowerment so that natural preservation is maintained [5].

Insects in an ecosystem have a very important role [6]. Bee*Trigona* is a stingless bee species that is an important insect pollinator [7]. *Trigona* sp. produce honey that has a higher selling price than other types of honey. Besides that, these bees can also produce propolis which is beneficial for health [8]. Another advantage of bees*Trigona*that is adaptive, has indications *of lower constancy*, is easily domesticated, and has high colony resistance [8]. Therefore, *Trigona* sp. is one of the potential local resources to be cultivated in KRPL.

Indonesia is a country that has high rainfall, which allows many types of plants to grow and develop properly [9]. These conditions support the cultivation of honey bees Plants is an ideal feed for honey bee cultivation [10]. Indonesia has approximately 37 species of bees*Trigona*, two of which are found in Lombok, namely *Trigona the wise*and*Trigona clypearis* [11]. Various advantages of bees*Trigona*sp. Little is known due to a need for more information [12].

Bee*Trigona*in Lombok Island is important local biodiversity to be introduced. One way that can be done to raise this species is to describe the species of bees*Trigona*from a morphometric point of view. Morphometrics is a method for identifying species by representing them through measurements, calculations, or giving values or scores [13]. Aspects of bee morphometry determine the growth of bee species concerning pollen and nectar collection [14]. In addition, body size can describe environmental conditions because it is related to the provision of resources and the abundance and composition of resources [15]. Research on morphometric *Trigona* sp. important to do considering the characteristics of the bee species*Trigona*cultivated in Lombok has never been published.

RESEARCH METHODS

This type of research is descriptive and exploratory. Descriptive research exploratory is research that describes conditions or phenomena by studying matters relating to the object of research [16]. Trigona sp. sampling *wa*s conducted in early October at KRPL Lombok Tengah. Meanwhile, the samples' morphological, morphometric, and identification observations were carried out at the Biology Laboratory of FKIP University of Mataram from mid-October to early November 2020.

The population in this study were all *Trigona* sp. cultivated in the KRPL Area. The research samples were 28 workers bees*Trigona*sp. of the 14 staff in KRPL. Bees are caught by opening the lid and then seeing the bees. After that, worker bees from each step were put into different bottles. Bee samples were preserved in 4% formalin and observed using a stereo microscope connected to the optilab camera.

Each worker bee measured 33 morphometric characteristics using the application *Image Raster*. The morphometric characteristics measured can be seen in table 1. In addition, the morphological characteristics of worker bees are also described. The morphological characteristics of worker bees observed were the color of the head, thorax, abdomen, wings, and hind limbs. In addition, the pattern and color of the hair on the head, thorax, and hind limbs were also observed. Identify the bee species*Trigona*sp. Based on morphological and morphometric characteristics referring to Dollin [17], Sakagami [18], and Smith [19].

RESULTS AND DISCUSSION

Kawasan Rumah Pangan Lestari (KRPL) Central Lombok located in Mertak Tombok Village, Praya District, Central Lombok Regency. The environmental conditions at KRPL can potentially become a place for bee-keeping *Trigona* sp. because it is a lowland area with a reasonably extensive rice field composition. The altitude at KRPL ranges from 185-230 meters above sea level. Meanwhile, the temperature in KRPL ranged from 27-38℃, and the humidity ranged between 50-88%. The temperature that bees like ranges between 27-29℃, while humidity ranges from 60.5-70% [20]. Abiotic factors in the environment affect the rate of development of insects, survival, health, individual activity, and population distribution and size [6].

The bee colonies in KRPL come from Sigar Penjalin Village and Bayan Village, North Lombok Regency. The Bayan Colony is larger than the Sigar Penjalin Colony in terms of the number of eggs, individuals, and food reserves. The Sigar Penjalin colony is located at stup 1-8, while the Bayan colony is located at stup 9-14. Based on the identification results, the species cultivated in KRPL are classified as species*Trigona fuscobalteata*and*Trigonashield*. Characteristics of worker bee morphometry *Trigona fusco balteata*and *Trigona clypearis* can be seen in table 2.

Morphological characteristic

Worker bee morphology*Trigona fusco balteata* described in this study are consistent with the descriptions of Dolin [17] and Sakagami [18]. Worker bee body*Trigona fusco balteata* black. The black head is covered by white hair. The hair is very sparse on the top of the face and on the bottom is very tight. Hair on part*supraklipear* and *supraantennal*grayish white, while on the part*vertex* black hair. Compound eyes are dark brown to black in color*eyes* black. The antenna consists of*scape*, *pedicel*, and 10*flagellomere*. *Mesoscutum* and*mesoscutelum* black. The hair on the mesoscutum is white to form a hair band pattern (*hair bands*), while on*mesostellum* is scattered and yellowish-white in color. *The tile* is black. The abdomen is brownish-yellow. On the rear wing, there are *five don't talk*. The hair on the outer tibia is black and long, and the arrangement of the hair is very sparse on the middle part of the tibia. On the inner side of the tibia *is keirotrichia* white in color*Basitarsus* covered with fine pale yellow hair.

Worker bee body*Trigona clypearis* black. The head is covered with grayish-white hair. Facial hair arrangement is like the species *Trigona fusco balteata*. The antenna consists of*scape*, *pedicel*, and 10 *flagellomer*. The abdomen is blackish brown and longer than the species *Trigona fusco balteata*. On the hind wings, there are five hamuli. Sterna is dark brown to black. The antenna consists of a scape, pedicel, and ten flagellomer. *Mesoscutum* and *Mesoscutelum* black. The hair on the mesoscutum is white to form a hair band pattern (*hair bands*), while in the mesosctellum the hair is scattered and yellowish white. The sterna are yellow to brownish yellow and the terga are light brown. On the hind wings, there are five hamuli. Tegula is black. The tibia is longer than the femur. The hair on the outer tibia is black and long, the hair arrangement is very sparse on the middle part of the tibia. On the inside of the tibia there is *keirotrichia* colored white. The basilarsus is covered with pale yellow fine hairs.

Morphometric characteristics

Bee sample body length*Trigona fuscobalteata* from Sri Lanka reported by Sakagami [18], namely 2.8 - 3.2 mm, not much different from the sample in this study, namely 2.62 - 3.76 mm. Meanwhile, *Trigona fuscobalteata*, those found in the Kapuas Hulu forest, are larger, measuring 3.60-3.64 mm [21]. Suriawanto [13] also described the morphological and morphometric characters of worker bees*Trigona fuscobalteata.* Comparison of several body sizes of worker bees*Trigona fuscobalteata* in this study and Suryawanto's research [13] are listed in Table 1.

Bee sample body length*Trigona clypearis* in this study, namely 3.16-3.57 mm, which is not much different from samples from northern Australia and South Australia (3.2 – 3.7 mm) described by Dolin

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[17] Species*Trigona clypearis* is a species of bee*Trigona*which have been identified in Lombok. Bee size range*Trigona clypearis* in Lombok, namely 3.2-3.8 mm. Species*Trigona clypearis* Not much has been reported on its morphological and morphometric characteristics.

The size variation of each characteristic in bee samples can be seen based on the standard deviation [16]. The standard deviation is a measure used to measure the amount of variation or distribution of several data values. The highest standard deviation value for the species *Trigona fusco balteata* found in hind wing length (SD±0.26), body length (SD±0.23), forewing length from tegula (SD±0.19), and forewing length (SD±0.18). Meanwhile, on species*Trigona clypearis* the highest standard deviation value is found in body length (SD ± 0.20), forewing length from *the tile* (SD±0.15), and forewing length (SD±0.27).

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Figure 1. The morphology of worker bees *T. fuscobalteata*: (A) Whole body viewed laterally; (B) Head; (C) Mesoscutum; (D) Forewings; (E) Hind wing; (F) Hind legs.

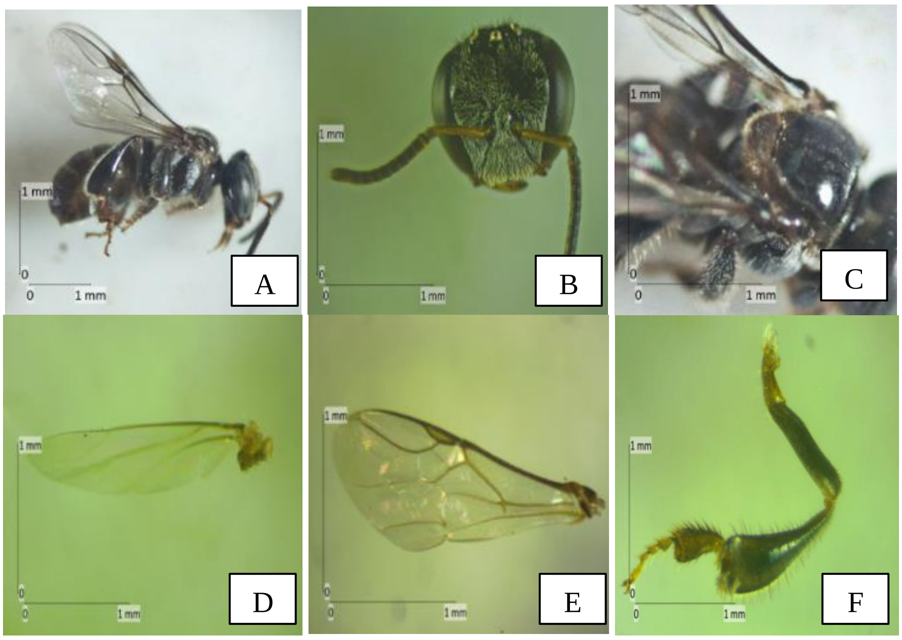

Figure 2**.** Worker bee morphology*Trigona clypearis*: (A) Whole body viewed laterally; (B) Head; (C)Mesoscutum; (D) Forewings; (E) Hind wing; (F) Hind legs.

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The characteristics of worker bee morphometry *Trigona* sp. that had the highest variation in this study were in body length and wings. Larger worker bees can have a wider range of food searches [22]. According to Araújo [23], Body size in worker bees, especially wing dimensions, is proportional to the maximum distance for searching for food. The length of the forewings from the tegula is closely related to flight distance because, in the intertegular area, there are muscles for flight [24]. Body size can be a limiting factor in the maximum flight capacity of worker bees. However, according to Araújo [23] the small flight distance of worker bees is not only caused by body size. Still, it can be caused by several factors, such as foraging behavior related to specialization in searching for certain flowers, the orientation of food search, food abundance, and nest location.

The average body length (BL) and head length (PK) in worker bee samples were greater in parrot colonies. Meanwhile, the average length of the forewing from the tegula (WL1) and the length of the hind tibia (PTB) in worker bee samples was greater in the Sigar Penjalin colony. Various factors influence body size in worker bees. According to Veiga [25] reduced food reserves cause individual worker bees to become smaller, especially in parts*intertegular*, but has*corbicula*the greater ones. In addition, the adaptation of food given to the larvae also affects the size of the bees [22]. Meanwhile, according to Chole [15], determining the size of a bee's body involves various factors that work in a complex system.

Table 1. Comparison of Average Size of Several Body Parts of Worker Bees *Trigona fuscobalteata*

Character	Body Size(mm)	
	This research (n=24)	Suriawanto (n=3)
Body Length (BL)	2.62-3.76	3.47-3.54
Forewing Length of Tegula (WL1)	2.81-3.66	3.36-3.54
Head Length (PK)	1.00-1.23	1.11-1.14
Rear Tibia Length (PTB)	0.81-1.29	1.33-1.58

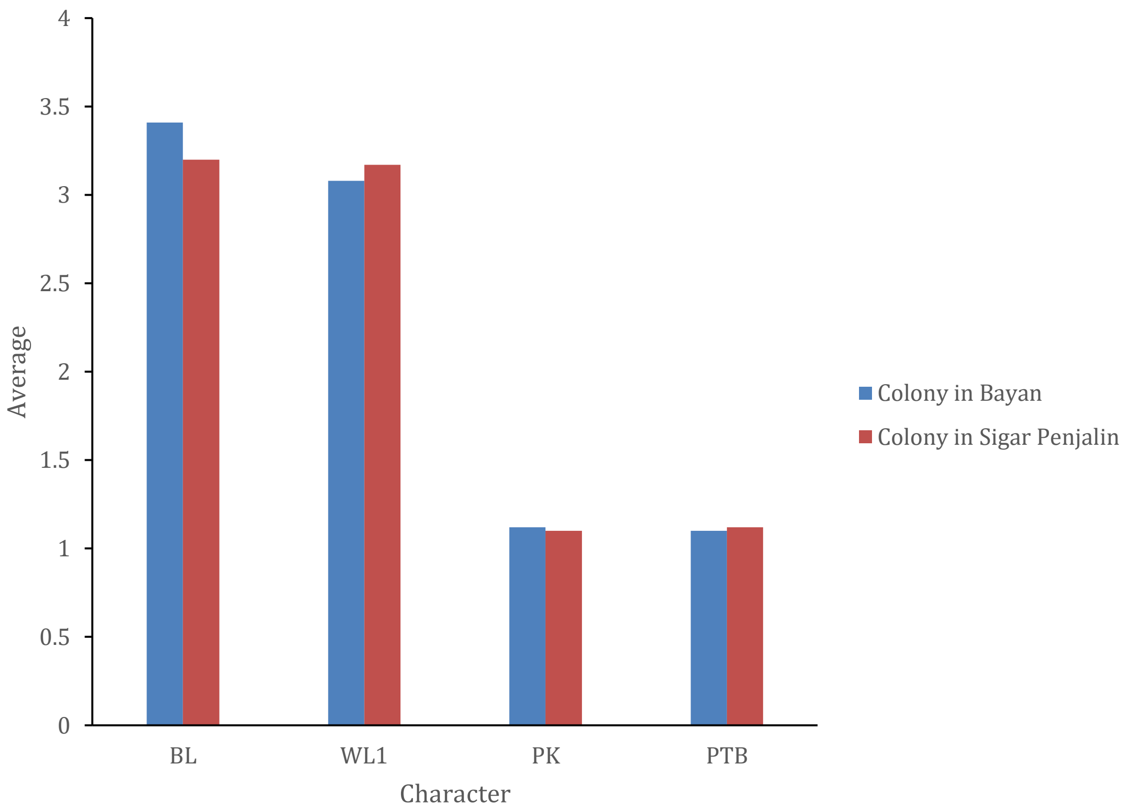

Figure 2. Character of Colony

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Table 2. Characteristics Worker Bee Morphometrics*Trigona fuscobalteata*and*Trigona clypearis*

No.	Body Character	Morphometric (mm)					
		Trigona fuscobalteata			*Trigona clypearis*		
		range	Rate-rate	SD	range	Rate-rate	SD
1	Body Length (BL)	2.62-3.76	3.28	0.23	3.16-3.57	3.35	0.20
2	Head Length (PK)	1.00-1.23	1.12	0.06	1.00-1.11	1.06	0.05
3	Head Width (LK)	1.18-1.49	1.37	0.07	1.15-1.41	1.32	0.12
4	Long*Clypeus* (PC)	0.19-0.33	0.29	0.03	0.26-0.30	0.28	0.02
5	Distance*Interocular* Bottom (JIB)	0.60-0.83	0.71	0.05	0.61-0.73	0.68	0.05
6	Distance *Interocular* Upper (JIA)	0.72-1.03	0.88	0.07	0.68-0.87	0.81	0.09
7	Eye Width (LM)	0.24-0.39	0.31	0.04	0.30-0.37	0.35	0.03
8	Eye Length (PM)	0.73-1.04	0.89	0.06	0.86-1.02	0.95	0.08
9	Maximum Distance *Interorbital* (JMI)	0.86-1.09	0.96	0.06	0.82-0.97	0.92	0.07
10	Min Distance *Interorbital* (LOD)	0.64-0.86	0.76	0.05	0.65-0.75	0.72	0.05
11	Distance *Interantennal* (SHOW UP)	0.11-0.18	0.14	0.02	0.12-0.14	0.13	0.01
12	Distance *Interocellar* (IOD)	0.25-0.38	0.31	0.04	0.21-0.38	0.27	0.08
13	Distance *Ocellocular* (JO)	0.17-0.27	0.22	0.04	0.19-0.21	0.20	0.01
14	Distance *Antennocellar* (AND)	0.51-0.68	0.60	0.03	0.48-0.60	0.53	0.06
15	Distance *Antennocular* (JAO)	0.17-0.26	0.23	0.02	0.20-0.23	0.22	0.01
16	Wide *Gena* (LG)	0.14-0.27	0.21	0.04	0.15-0.25	0.19	0.05
17	Long *Flagellomere* IV (PF)	0.07-0.10	0.09	0.01	0.07-0.10	0.09	0.01
18	Wide *Flagellomere* IV (LF)	0.08-0.11	0.10	0.01	0.09-0.10	0.10	0.01
19	Long *Malar* (PML)	0.06-0.10	0.08	0.01	0.05-0.10	0.08	0.02
20	Long *Mesoscutum* (PMS)	0.61-1.04	0.77	0.09	0.63-0.74	0.69	0.05
21	Wide *Mesoscutum* (LMS)	0.80-1.33	0.94	0.11	0.76-0.91	0.82	0.07
22	Fore wing length from tegula (WL1)	2.81-3.66	3.16	0.19	2.75-3.1	2.94	0.15
23	wl2	0.76-0.91	0.85	0.03	0.81-0.94	0.89	0.06
24	Front Wing Length (PSD)	2.17-2.79	2.55	0.18	2.38-2.97	2.62	0.27
25	Front Wingspan (LSD)	1.00 -1.34	1.11	0.09	0.95-1.23	1.08	0.12
26	Rear Wing Length (PSB)	1.34-2.27	1.95	0.26	2.00-2.12	2.06	0.06
27	Rear Wingspan (LSB)	0.29-0.66	0.49	0.09	0.49-0.57	0.52	0.03
28	Jumlah Hamuli	5			5		
29	Long*Femur* Rear (PJB)	0.63-1.00	0.86	0.08	0.82-1.02	0.92	0.08
30	Long *Tibia* Rear (PTB)	0.81-1.29	1.09	0.11	1.17-1.28	1.22	0.05
31	Rear Tibia Width (LTB)	0.29-0.50	0.40	0.04	0.36-0.42	0.39	0.03
32	Long *Basitarsus* Rear (UN)	0.30-0.53	0.42	0.05	0.38-0.51	0.47	0.06
33	Wide *Basitarsus* Rear (LBB)	0.16-0.39	0.23	0.05	0.21-0.26	0.23	0.02

CONCLUSION

Based on the formulation of the problem, objectives, and results of observations, it can be concluded that the same characteristics of bee morphology *Trigona fusco balteata and Trigona clypearis* in KRPL are almost the same. However, some differences include the color of the abdomen, venation of the wings, and the hair pattern on the wings*mesoscuted*Abdomen and venation of bee wings*Trigona fusco balteata* yellowish brown. Meanwhile, abdomen and wing venation *Trigona clypearis* blackish brown. The Hairband pattern (*hairbands)* on *mesoscutum Trigona fusco balteata* clearer than *Trigona clypearis.* The variation in morphometric characteristics can be seen from the standard deviation value. The highest standard deviation within the species *Trigona fusco balteata* was found in hind wing length (SD±0.26), body length (SD±0.23), forewing length from tegula (SD±0.19), and forewing length (SD±0.18). Meanwhile. on species *Trigona clypearis.* The highest standard deviations were found in body length (SD±0.20), forewing length from tegula (SD±0.15), and forewing length (SD±0.27).

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REFFRENCES

[1] Ngongeh. L. A., Idika, I. K., & Ibrahim Shehu, A. R. (2014). Climate change/global warming and its impacts on parasitology/entomology. *Open Parasitology Journal*, *5*(1), 1–11. https://doi.org/10.2174/187442140140501000 1.

[2] Adedeji, O., Reuben, O., & Olatoye, O. (2014). Global Climate Change.*Journal of Geoscience and Environment Protection*, *2*(2), 114–122.

[3] Saptana, N., Sunarsih, N., & Friyatno, S. (2013). Prospects of the Model-Area of Sustainable Food Homes (M-KRPL) and KRPL Development Replication.*Agro-Economy Research Forum*, *31*(1), 67. https://doi.org/10.21082/fae.v31n1.2013.67-87.

[4] Hamza, A., & Lestari, S. U. (2016). Organic sustainable food houses as a solution to increase family income.*Indonesian Service Access Journal*, *1*(1), 65–72.

[5] Sunarti, Endriani, & Ajidirman. (2015). Technology-Based Community Empowerment Model of Sustainable Food Houses in Kumpeh Ulu District.*Journal of Community Service*, *30*(1), 1–9.

[6] Ilhamdi, M.L. (2012). Diversity of Insects in Soil at Endok Beach, West Lombok.*Mipa Incandescent Journal*, *7*(2), 55–59. https://doi.org/10.29303/jpm.v7i2.95.

[7] Quezada-Euán, J. J. G. (2018). Stingless Bees of Mexico. in*Stingless Bees of Mexico*. https://doi.org/10.1007/978-3-319-77785-6.

[8] Yanto, S. H., Yoza, D., & Budiani, E. S. (2016). Feed Potential of Trigona spp. In the Traditional Prohibition Forest of Rumbio Village, Kampar Regency.*JOY Faperta UR*, *3*(2), 1–7.

[9] Aulani, F., Artayasa, I. P., & Ilhamdi, M. L. (2013). The Effect of Eucalyptus Oil (Melaleuca leucadendron L.) and Serei Oil (Cymbopogon nardus L.) and Their Mixture on Bactocera Fruit Fly Catches.*Journal of Tropical Biology*, *13*(1), 19–28.

[10] Saepudin, R. (2013).*Bees: Area-Based Cultivation* (1st ed.). Tellon Media.

[11] Wahyuni, N., & Anggadhania, L. (2020). The characteristic of stingless bee's products (Tetragonula spp.) in Lombok Island. *IOP*.

[12] Erniwati. (2013). Biological Study of Stingless Bees (Apidae: Trigona) in Indonesia.*Indonesian Fauna*, *12*(1), 29–34.

[13] Suriawanto, N. (2016).*Diversity and nesting sites of stingless bees (Hymenoptera: apidae) in Central Sulawesi*. Bogor Agricultural Institute.

[14] Kerr, N. Z., Crone, E. E., & Williams, N. M. (2019). Integrating vital rates explains optimal worker size for resource return by bumblebee workers. *Functional Ecology*, *33*(3), 467–478. https://doi.org/10.1111/1365-2435.13251

[15] Chole, H., Woodard, S. H., & Bloch, G. (2019). Body size variation in bees: regulation, mechanisms, and relationship to social organization. *Current Opinion in Insect Science*, *35*, 77–87. https://doi.org/10.1016/j.cois.2019.07.006.

[16] Suryawan, I. G., Mahrus, & Karnan. (2016). Study of Morphometric Characteristics of Julung-Julung Fish (Hemiramphus Archipelagicus) in the Intertidal Area of Ekas Bay.*Journal of Tropical Biology*, *16*(2), 37–42.

[17] Dollin, A. E., Dollin, L. J., & Rasmussen, C. (2015). Australian and new guinean stingless bees of the genus austroplebeia moure (hymenoptera: Apidae) - A revision. In *Zootaxa* (Vol. 4047, Issue 1).

[18] Sakagami, Smichi F. (1978). Tetragonula Stingless Bees of the Continental Asia and Sri Lanka (Hymenoptera, Apidae). *J. Fac. Sci. Hokkaido University, Zoology*, *21*(2), 165-247.

[19] Smith D.R. 2012. Key to Workers of Indo-Malayan Stingless Bees, International Conference of the Asian Apicultural Association, 1(1): 1-42.

[20] Riendriasari, S.D., & Krisnawati, K. (2017). Production of Raw Propolis (Raw Propolis) by Trigona spp Honey Bees on Lombok Island.*ULIN: Journal of Tropical Forests*, *1*(1), 71–75. https://doi.org/10.32522/u-jht.v1i1.797.

[21] Kerisna, V., Diba, F., & Wulandari, R. S. (2019). Identification of Bee Types*Trigona* Spp. In the Menua Sadap Village Forest Utilization Zone, Embaloh Hulu District, Kapuas Hulu District.*Tengkawang Journal*, *9*(2), 82–91.

[22] Quezada-Eua´n, J. J. G., Lo´pez-Velasco, A., Pe´rez-Balam, J., Paxton, H. M.-V., Velazquez-Madrazo, A., & J., R. (2011). Body size differs in workers produced across time and is associated with variation in the quantity and composition of larval food in Nannotrigona perilampoides (Hymenoptera , Meliponini). *Social Insects*, *58*, 31–38. https://doi.org/10.1007/s00040-010-0113-2.

[23] Araújo, E. D., Costa, M., Chaud-Netto, J., & Fowler, H. G. (2004). Body Size And Flight Distance In Stingless Bees (Hymenoptera: Meliponini): Inference Of Flight Range And Possible Ecological Implications. *Braz. J. Biol*, *64*(3), 563–568. Https://Doi.Org/10.1111/J.1530-0277.1996.Tb01638.X.

[24] Greenleaf, S. S., Williams, N. M., Winfree, R., & Kremen, C. (2007). Bee foraging ranges and their relationship to body size. *Ecology*, *153*, 589–596. https://doi.org/10.1007/s00442-007-

 ISSN 1907-1744 (Print)
ISSN 2460-1500 (Online)

0752-9.
[25] Veiga, J.C., Menezes, C., Venturieri, G.C., & Contrera, A.L. (2013).*The bigger, the smaller: Relationship between body size and food stores in the stingless bee Melipona flavolineata*. *May*.