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Morphometric Analysis of *Apis dorsata* Bees in North Lombok Regency

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Abstract: The giant honeybee (*Apis dorsata*) is vital for ecosystems as a pollinator, significantly impacting agricultural productivity, biodiversity, and food sustainability. This study explores the morphometric characteristics of *Apis dorsata* populations in Batu Rakit Village, North Lombok Regency, a tropical region with rich biodiversity. Morphometric data were collected from 20 worker bees, focusing on body length, abdomen dimensions, wing dimensions, proboscis length, and body weight. Measurements were analyzed using descriptive statistics, correlation, and regression to identify significant relationships between morphometric traits and body weight. Results show that abdomen length ($r = 0.50$, $\beta = 0.05$, $p = 0.01$) and forewing length ($r = 0.48$, $\beta = 0.08$, $p = 0.03$) are the strongest predictors of body weight, underscoring their roles in resource storage and flight efficiency. Most traits exhibited low variability, reflecting evolutionary adaptations to environmental stability, while body weight displayed high variability (CV = 7.53%), indicating responses to environmental and individual factors. These findings highlight the ecological importance of uniform traits such as abdomen length and wing dimensions in supporting the foraging efficiency and resource transport of *Apis dorsata*. This study provides critical insights for the conservation and management of *Apis dorsata* populations in tropical ecosystems.

Keywords: *Apis dorsata*; Biodiversity; Body weight; Morphometric analysis

Introduction

The *Apis dorsata*, commonly known as the giant honeybee of Asia, plays a crucial role in ecosystems as a pollinator of plants. Their presence significantly influences agricultural productivity, biodiversity, and the sustainability of food crops. Research on the morphometrics of *Apis dorsata* is essential to understanding how environmental factors affect variations in the size and shape of these bees, which in turn provides insights into their adaptation and management in various geographic regions.

Morphometric studies of *Apis dorsata* have been conducted worldwide, with a primary focus on morphological variations caused by geographic and environmental factors. For example, a study by Raffiudin et al. (2024) revealed notable differences in the morphometry of *Apis dorsata* colonies in Sumatra, which were linked to local climate conditions and natural resources. Additionally, Ibrahim et al. (2012) reported that morphological differences between regions are influenced by specific characteristics of local environments, such as temperature, humidity, and the availability of nectar-producing plants.

In Southeast Asia, Shullia et al. (2024) demonstrated significant variation in the morphometry of *Apis dorsata* populations between tropical regions, closely related to adaptations to the climate and the diversity of local flora. This study highlighted that bee morphometry, such as wing size, body length, and weight, could serve as indicators of adaptation to different environmental factors. Similar research by Lalremliana et al. (2024) in

India also confirmed that geographic variation affects the morphological traits of bees, with considerable influence from local ecosystem factors.

One area that stands out in this context is North Lombok, located in Indonesia, a tropical region rich in biodiversity with ecosystems that strongly support the presence of honeybees (Erwan et al., 2023). Although several studies have been conducted in Southeast Asia, limited research has focused specifically on the morphometrics of *Apis dorsata* in Indonesia, particularly in North Lombok. Therefore, a study on the morphometrics of *Apis dorsata* in this region could provide important contributions to the scientific understanding of the relationship between bee morphology and environmental factors in tropical areas.

Research on the morphometrics of *Apis dorsata* can help in understanding the variation within bee populations related to ecological and geographic factors, as well as provide valuable information for the management of bee colonies and the conservation of this species in Indonesia. Previous studies, such as those by Requier et al. (2019), also emphasize the importance of considering environmental factors affecting bee morphometry, which can directly impact pollination success and honey production.

Material and Method

Research Location

This research will be conducted in Batu Rakit Village, Bayan Sub-district, North Lombok Regency. Batu Rakit Village is located in a tropical area with various plant species that can serve as nectar sources for honeybees. The diversity of flora and local climate conditions make it an ideal location to study the morphometrics of *Apis dorsata* bees.

Research Duration

The study will take place over a three-month period, from data collection and morphometric measurements to data analysis. This relatively long research period allows for more accurate observation of morphometric variations in bees in this region.

Sample Size

The sample size used in this study consists of 20 worker bees from *Apis dorsata* colonies in Batu Rakit Village. Worker bees are chosen because their body size is more stable and easier to measure compared to other individuals, such as queens or drones.

Sample Type

The samples taken are active and healthy worker bees of *Apis dorsata*. Selecting worker bees aims to avoid morphometric variations that may occur in queens or drones with different body sizes.

Measured Variables

In this study, measurements will be conducted on several body parts of *Apis dorsata* bees, including:

- Body Length (BL): Measured from the tip of the head to the tip of the abdomen using calipers.
- Abdomen Length (AL): Measured from the base of the body to the tip of the abdomen.
- Abdomen Width (AW): Measured at the widest part of the abdomen.
- Hind Leg Femur Length (HLFL): Measured from the base of the femur (thigh) to the end of the femur using a micrometer.
- Hind Leg Tibia Length (HLTL): Measured from the base of the tibia to the tip of the tibia.
- Metatarsus Length (MTL): Measured with calipers on the hind leg metatarsus.
- Forewing Length (FWL): Measured from the base of the wing to the tip of the wing.
- Forewing Width (FWW): Measured at the widest part of the wing.
- Proboscis Length (PL): Measured from the base to the tip of the proboscis.
- Body Weight (BW): Measured using an analytical balance with a precision of 0.001 grams.

Data Collection Methods

The data collection method involves observation and direct measurement. Worker bees will be manually captured from colonies in Batu Rakit Village using specialized tools to ensure their bodies remain undamaged. Once captured, measurements will be taken for each

body part as listed above.
The sampling steps are as follows:

1. Colony Selection: Active and easily accessible *Apis dorsata* colonies will be selected. Healthy and productive colonies will be prioritized for the study.
2. Sample Collection: Twenty worker bees will be randomly selected from the chosen colonies. Each collected bee will be marked to avoid duplicate sampling.
3. Morphometric Measurements: After collection, morphometric measurements will be conducted based on predetermined parameters. Measurements will be performed carefully using sterilized tools to prevent contamination.

Equipment and Materials

- Calipers: Used to measure the length and width of bee body parts, such as body length, abdomen length, wing length, etc.
- Micrometer: Used to measure femur, tibia, and metatarsus lengths with high precision.
- Analytical Balance: Used to measure the bees' body weight with 0.001 gram precision.
- Macro Camera: Used to take morphometric photos for further analysis.
- Measuring Board: Used to measure wing length and other body parts.

Measurement Procedure

Morphometric measurements are performed following standardized and consistent procedures to minimize errors in data collection. Each collected bee will be carefully positioned on a flat measuring board. Measurements will be taken twice to ensure data accuracy.

Data Analysis

After completing the measurements, the morphometric data obtained will be analyzed using descriptive statistics, correlation analysis, and regression analysis to examine the relationship between bee body weight and the measured morphometric variables. This analysis aims to identify whether there is a significant relationship between body weight and other body parameters of *Apis dorsata* bees in Batu Rakit Village.

Results and Discussion

The Morphometric Characteristics of *Apis dorsata* Bees

Table 1 presents the morphometric characteristics of *Apis dorsata* bees observed in Batu Rakit Village, Bayan Sub-district, North Lombok Regency. The data provided includes measurements of various body parts of the bees, such as body length, abdomen length, abdomen width, femur length, tibia length, metatarsus length, forewing length and width, proboscis length, and body weight. The measurement results are accompanied by the mean, standard deviation, and coefficient of variation (%), offering insights into the morphometric variations of the bees.

Table 1. The Morphometric Characteristics of *Apis dorsata* Bees

No	Characteristics of *Apis dorsata* Bees	Average ± Standard Deviation	Coefficient of Variation (%)
1	Body Length (mm)	15.63 ± 0.27	1.75
2	Abdomen Length (mm)	8.50 ± 0.02	0.27
3	Abdomen Width (mm)	4.98 ± 0.04	0.78
4	Hind Leg Femur Length (mm)	3.73 ± 0.02	0.61
5	Hind Leg Tibia Length (mm)	4.26 ± 0.04	0.88
6	Metatarsus Length (mm)	3.53 ± 0.02	0.61
7	Forewing Length (mm)	13.48 ± 0.03	0.22
8	Forewing Width (mm)	4.48 ± 0.02	0.46
9	Proboscis Length (mm)	5.06 ± 0.03	0.63
10	Body Weight (g)	0.10 ± 0.01	7.53

The body length of *Apis dorsata* shows a relatively low variability with an average of 15.63 ± 0.27 mm and a CV of 1.75%. This low variation indicates that body length is a

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conserved characteristic, likely shaped by evolutionary adaptations to environmental stability and specific ecological roles. Abrol (2016) suggest that such uniformity in body length ensures optimized aerodynamic efficiency and energy expenditure during foraging. Abdomen length (8.50 ± 0.02 mm, CV = 0.27%) and width (4.98 ± 0.04 mm, CV = 0.78%) display remarkably low variability. These findings imply a high degree of specialization in abdomen morphology, which is crucial for the storage of nectar and pollen. According to Alves et al. (2023), the stability of abdomen dimensions across individuals correlates with the need for consistent capacity for resource transport within the colony. The hind leg femur length (3.73 ± 0.02 mm, CV = 0.61%), tibia length (4.26 ± 0.04 mm, CV = 0.88%), and metatarsus length (3.53 ± 0.02 mm, CV = 0.61%) exhibit moderate uniformity. These structures are integral for pollen collection and transport, highlighting their functional importance. Sun et al. (2021) emphasized that stable leg morphology supports the mechanical efficiency required for effective foraging and pollen collection.

Forewing length (13.48 ± 0.03 mm, CV = 0.22%) and width (4.48 ± 0.02 mm, CV = 0.46%) show the lowest coefficients of variation among all measured characteristics. This minimal variation is consistent with the role of wings in ensuring flight stability and energy efficiency during foraging trips. Niem and Trung (2019) stated that uniform wing morphology is vital for maintaining aerodynamic performance in varying environmental conditions. The proboscis length of 5.06 ± 0.03 mm (CV = 0.63%) suggests moderate uniformity, likely reflecting its role in accessing nectar from various flower types. As noted by Axel et al. (2011), the proboscis length in honeybees is a critical trait for optimizing nectar intake, especially in environments with diverse floral resources.

Body weight displays the highest CV (7.53%), indicating greater variability compared to other traits. This variability may reflect differences in individual nutritional status, age, or foraging activity. Previous studies by Meikle et al. (2020) have also noted that body weight in honeybees tends to fluctuate due to temporal and environmental factors, such as resource availability and seasonal changes. The low variability in most morphological characteristics of *Apis dorsata* underscores their functional significance and evolutionary adaptation to specific ecological roles. Uniform traits such as body length, wing dimensions, and abdomen size ensure efficiency in energy use, foraging, and resource transport. Conversely, higher variability in body weight suggests a dynamic response to environmental and individual factors.

Correlation and Regression Coefficient Analysis

The correlation coefficients (r) in Table 2 reveal the strength and direction of relationships between morphometric variables and body weight in *Apis dorsata*. The coefficients range from moderate to weak correlations, indicating that certain traits contribute more significantly to body weight than others.

Table 2. Correlation and Regression Coefficient *Apis dorsata*

Morphometric Variables	Correlation Coefficient with Body Weight (r)	Regression Coefficient (β)	Significance (p-value)
Body Length	0.35	0.02	0.45
Abdomen Length	0.50	0.05	0.01
Abdomen Width	0.12	0.03	0.32
Hind Leg Femur Length	0.28	0.04	0.14
Hind Leg Tibia Length	0.42	0.06	0.07
Metatarsus Length	0.33	0.02	0.44
Forewing Length	0.48	0.08	0.03
Forewing Width	0.26	0.03	0.28
Proboscis Length	0.38	0.05	0.19

Abdomen length shows the strongest correlation with body weight (r = 0.50), suggesting it is a critical determinant. This trait is directly linked to the storage of nectar and pollen, which significantly impacts a bee's overall weight. Similar results have been reported by Papa et al. (2022), emphasizing that abdomen size is vital for resource transportation and energy storage. Forewing length also exhibits a strong correlation with body weight (r = 0.48). Its role in flight efficiency and foraging capabilities makes it a key trait. According to Chole et al. (2019), wing size is critical for bees to cover greater distances while carrying foraged resources, thus influencing their body weight. Hind leg tibia length demonstrates a moderate correlation with body weight (r = 0.42), likely due to its role in pollen collection and transport. The findings align with Chuttong et al. (2022), who noted the importance of leg dimensions in enhancing foraging efficiency. Proboscis length moderately correlates with body weight (r = 0.38), as a longer proboscis enables access to a broader range of flowers, increasing nectar intake. This aligns with findings by Ali et al. (2021). Body length (r = 0.35) and metatarsus length (r = 0.33) show moderate correlations, reflecting their indirect roles in body weight determination. Abdomen width (r = 0.12) has the weakest correlation, suggesting it contributes minimally to body weight.

The regression coefficients (β) and p-values from Table 2 provide insights into the predictive power and statistical significance of each morphometric variable. Abdomen length is a statistically significant predictor of body weight (β = 0.05, p = 0.01). Its high correlation and significance emphasize its importance in determining body weight in *Apis dorsata*. These results are consistent with Zhao et al. (2015), who found abdomen size to be a key factor in honeybee mass. Forewing length is another significant predictor of body weight (β = 0.08, p = 0.03). Larger wings enhance flight efficiency, which positively influences resource acquisition and body weight (Kastberger et al., 2024; Yang et al., 2018). While not statistically significant (β = 0.06, p = 0.07), the tibia length's relatively high coefficient suggests it has a notable impact on body weight, primarily due to its role in pollen transport. Body length (β = 0.02, p = 0.45) and metatarsus length (β = 0.02, p = 0.44) show weak predictive values and are not statistically significant. Abdomen width (β = 0.03, p = 0.32) also has limited influence on body weight.

Abdomen length and forewing length are the most significant traits influencing body weight. These traits directly support resource storage and flight efficiency, crucial for the ecological roles of *Apis dorsata* in tropical environments. The results highlight how morphometric traits reflect adaptations to environmental demands. For instance, uniformity in abdomen length supports efficient resource transport, while larger wings enhance foraging success. The findings emphasize the interplay between morphology and ecology in *Apis dorsata*. Adaptations in traits like forewing length and abdomen size enhance the species' ability to exploit diverse floral resources, ensuring colony sustainability (Pinilla-Gallego et al., 2022).

Conclusion

The morphometric characteristics of *Apis dorsata* show low variability in key traits such as abdomen length and forewing length, which significantly influence body weight due to their roles in resource storage and flight efficiency. Abdomen length (r = 0.50, β = 0.05, p = 0.01) and forewing length (r = 0.48, β = 0.08, p = 0.03) are the strongest predictors of body weight, reflecting their ecological importance. Variations in body weight (CV = 7.53%) highlight environmental and individual influences. These findings underscore the adaptability and ecological specialization of *Apis dorsata* in tropical environments.

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References

Abrol, D. P. (2016). Foraging Strategies in Honeybees, Apis dorsata F. and Apis florea F. in Relation to Availability of Energy Rewards. *Journal of Apiculture*, *31*(1), 9. https://doi.org/10.17519/apiculture.2016.04.31.1.9

Ali, H., Iqbal, J., Raweh, H. S., & Alqarni, A. S. (2021). Proboscis behavioral response of four honey bee Apis species towards different concentrations of sucrose, glucose, and fructose. *Saudi Journal of Biological Sciences*, *28*(6), 3275–3283. https://doi.org/10.1016/j.sjbs.2021.02.069

Alves, D. A., George, E. A., Kaur, R., Brockmann, A., Hrncir, M., & Grüter, C. (2023). Diverse communication strategies in bees as a window into adaptations to an unpredictable world. *Proceedings of the National Academy of Sciences*, *120*(24). https://doi.org/10.1073/pnas.2219031120

Axel, D., Cedric, A., Jean-Francois, O., Mickael, H., Bernard, V., & Conte, L. (2011). Why enhancement of floral resources in Agro-Ecosystems benefit honeybees and beekeepers? In *InTech eBooks*. https://doi.org/10.5772/24523

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

Chuttong, B., Panyaraksa, L., Tiyayon, C., Kumpoun, W., Chantrasri, P., Lertlakkanawat, P., Jung, C., & Burgett, M. (2022). Foraging behavior and pollination efficiency of honey bees (Apis melliferaL.) and stingless bees (Tetragonula laevicepsspecies complex) on mango (Mangifera indicaL., cv. Nam Dokmai) in Northern Thailand. *Journal of Ecology and Environment*, *46*. https://doi.org/10.5141/jee.22.012

Erwan, E., Habiburrohman, H., Wiryawan, I. K. G., Muhsinin, M., Supeno, B., & Agussalim, A. (2023). Comparison of productivity from three stingless bees: Tetragonula sapiens, T. clypearis and T. biroi managed under same feed sources for meliponiculture. *Biodiversitas Journal of Biological Diversity*, *24(5)*. https://doi.org/10.13057/biodiv/d240553

Ibrahim, I., Balasundra, S., Abdullah, N., Alias, & Mardan, M. (2012). Morphological Characterization of Pollen Collected by Apis dorsata from a Tropical Rainforest. *International Journal of Botany*, *8*(3), 96–106. https://doi.org/10.3923/ijb.2012.96.106

Kastberger, G., Ebner, M., & Hötzl, T. (2024). Giant honeybees (Apis dorsata) trade off defensiveness against periodic mass flight activity. *PLoS ONE*, *19*(4), e0298467. https://doi.org/10.1371/journal.pone.0298467

Lalremliana, J., Srinivasan, M. R., Saminathan, V. R., Chitra, N., Mohankumar, S., Sabatina, P., Suroshe, S. S., & Kumaranag, K. M. (2024). Variation in the Morphological Characters of the Hill and Plain Populations of Indian Honey Bee, Apis cerana indica (Fab.) in Tamil Nadu, India. *Sociobiology*, *71*(4), e11298. https://doi.org/10.13102/sociobiology.v71i4.11298

Meikle, W. G., Weiss, M., & Beren, E. (2020). Landscape factors influencing honey bee colony behavior in Southern California commercial apiaries. *Scientific Reports*, *10*(1). https://doi.org/10.1038/s41598-020-61716-6

Niem, N., & Trung, L. Q. (2019). Morphological Comparison of Three Asian Native Honey Bees (Apis Cerana, A. Dorsata, A. Florea) In Northern Vietnam And Thailand. *Biotropia*, *14*. https://doi.org/10.11598/btb.1999.0.14.153

Papa, G., Maier, R., Durazzo, A., Lucarini, M., Karabagias, I. K., Plutino, M., Bianchetto, E., Aromolo, R., Pignatti, G., Ambrogio, A., Pellecchia, M., & Negri, I. (2022). The Honey Bee Apis mellifera: An Insect at the Interface between Human and Ecosystem Health. *Biology*, *11*(2), 233. https://doi.org/10.3390/biology11020233

Pinilla-Gallego, M. S., Ng, W. H., Amaral, V. E., & Irwin, R. E. (2022). Floral shape predicts bee–parasite transmission potential. *Ecology*, *103*(7). https://doi.org/10.1002/ecy.3730

Raffiudin, R., Dyahastuti, M., Nugraha, R., Sayusti, T., Djuita, N. R., Suwananda, E., Allvioningrum, V., Mardhony, R., Biagioni, S., Setyaningsih, C. A., Prasetyo, L. B., Priawandiputra, W., Atmowidi, T., Saad, A., & Behling, H. (2024). The effect of land cover on the foraging behavior and pollen in the honey of the giant bee Apis dorsata in Sumatra. *Frontiers in Bee Science*, *2*. https://doi.org/10.3389/frbee.2024.1366287

Requier, F., Garnery, L., Kohl, P. L., Njovu, H. K., Pirk, C. W., Crewe, R. M., & Steffan-Dewenter, I. (2019). The conservation of native honey bees is crucial. *Trends in Ecology & Evolution*, *34*(9), 789–798. https://doi.org/10.1016/j.tree.2019.04.008

Shullia, N. I., Subchan, W., Raffiudin, R., Atmowidi, T., Priawandiputra, W., Ariani, N. S., Pujiastuti, N., Dewi, A. N., Sabella, Y. N., Siffahk, L. N., Nisa, W. K., & Novidayanti, A. A. (2024). Temporal resource partitioning of the flight activities of three bee species in East Java. *Jurnal Entomologi Indonesia*, *21*(3). https://doi.org/10.5994/jei.21.3.234

Sun, Y., Zhang, J., Tang, X., Wu, Z., Gorb, S. N., & Wu, J. (2021). Specialized morphology and material properties make a honey bee tongue both extendible and structurally stable. *Acta Biomaterialia*, *136*, 412–419. https://doi.org/10.1016/j.actbio.2021.09.045

Yang, P., Peng, Y., Zhao, R., & Yang, D. (2018). Biological characteristics, threat factors and conservation strategies for the giant honey bee Apis dorsata. *Biodiversity Science*, *26*(5), 476–485. https://doi.org/10.17520/biods.2018036

Zhao, J., Wu, J., & Yan, S. (2015). Movement analysis of flexion and extension of honeybee abdomen based on an adaptive segmented structure. *Journal of Insect Science*, *15*(1), 109. https://doi.org/10.1093/jisesa/iev089