



MORPHOMETRIC TRAITS OF *Apis dorsata* WORKER BEES OF JOGIMATTI FOREST AND CHITRADURGA. KARNATAKA - INDIA

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AUTHORS' CONTRIBUTIONS

This work was carried out in collaboration among all authors. Author SGD designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors KR and KLN managed the analyses of the study. Author IR managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

A few selected morphological traits of *A. dorsata* worker bees were analysed after collecting worker bees from two different areas in Chitradurga District present in central part of Karnataka. A total of 13 phenotypic characters were measured in the collected samples. The antenna, tongue, fore wing, hind wing, fore leg, mid leg and hind leg showed significant length variation between the workers bees [$P < 0.05$]. However, the remaining morphological traits showed insignificant variation [$P > 0.05$]. Observations revealed that there is a considerable relationship between the some morphological traits and the location of *A. dorsata* worker bees collected from the study areas suspecting morphometric variations perhaps discriminate intraspecific groups of honeybee colonies. Morphometry a simple, basic tool of taxonomy provides foundation information in understanding honeybee biodiversity.

Keywords: *Apis dorsata*; worker bees; morphometry; Jogimatti; Chitradurga.

1. INTRODUCTION

Honeybees are eusocial insects with overlapping generations, cooperative brood care, and reproductive

castes [1-3] act as pollinating vectors of various plants of the world [4-8] which are necessary for ecosystem functioning with their products of economic importance to humans. At present nearly twenty

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thousand bees are known which were originated in tropical region long ago with cosmopolitan distribution [9-11] and are extensively observed and studied [12,13]. At present, *A. florea*, *A. dorsata*, *A. cerana* and *A. mellifera* are well known out of which, *A. dorsata* is least studied one. *A. dorsata* having heavy body builds single, open-air comb or nest [measuring in meters] in the trees, big rocks and big buildings [14]. *A. dorsata* are notorious for aggressive nature [15,16], nocturnal foraging behaviour [17,18] found in solitary nest or group of several nests some time exceeding 50 nests. Being one of the major insect pollinators, *A. dorsata* contributes heavily in pollinating innumerable tropical plants and other crops and holds major share of honey produced in Nepal, India and other south-east Asian countries [19-22]. Morphometric characterization is the process of describing an organism based on phenotypic observation [23] and is an effective tool in taxonomy to identify, draw and establish relation or variation with others [24,25]. Morphological identification now became accurate and reproducible under the support of new techniques [26]. Basic morphometry focuses on lengths, angles, and areas of selected morphological structures and Ruttner [27] used traditional morphometry to distinguish bees taking more than 30 characters including colour, nature of wing, hair, size of the head, mandible and basitarsus. In honey bee taxonomy, morphological characteristics as well as sizes of cells are important and can be distinct. Bees can be differentiated by cubital index and by measuring the width of ten continuous cells [28,29]. This type of detailed studies and reports of *A. dorsata* are limited in India with reports from Rajasthan, Himachal Pradesh, Maharashtra, Assam and Karnataka [30-34]. Furthermore, such report on honey bee of Jogimatti forest of Chitradurga is not available. Hence, an attempt was made to observe and document the morphological traits of *A. dorsata* worker bee in the selected area which is necessary to understand the bee diversity.

2. MATERIALS AND METHODS

2.1 Study Area

Jogimatti forest having 10,048 hectares area was declared as sanctuary in 2018 is located in the Chitradurga district of Karnataka state with latitude of 140 21 to 140 121 and longitude of 760 211 to 760 271. The forest is 13 km from the city Chitradurga, district headquarter. It has an average rainfall of 668mm. and temperature between 16°C to 35°C with relative humidity 45% to 60%. The general elevation of the area is between 500 m to 600m from MSL. The terrain is characterized by a series of stony hills with undulating plains. It contains scrub jungle vegetation

characterized by trees interspersed by bushes and open patches used by grazing animals. The diverse habitat is suitable for animal diversity [35]. Observation and documentation of selected morphological characters of *A. dorsata* worker bees was made in and around the Jogimatti area. Similarly, samples of *A. dorsata* worker bees were collected from the Chitradurga city area for documentation of selected morphological characters.

2.2 Methodology

A. dorsata worker bees at the stage of death which were found near their hive were collected from the selected sites of forest and city. A total of 200 bees out of which 100 bees from forest and 100 bees from city were collected for selected morphological traits observation. The samples were preserved separately in 70% alcohol [36]. The morphometric analysis of body parts particularly, head, antenna, tongue, thorax, abdomen, wings, and legs were made. The measurement was made in millimetre. All the observations were documented. The observed traits of forest bees were compared with that of city bees for statistical differences [$P < 0.05$] using Karl Pearson Chi square test [37].

3. RESULTS

A total of 13 parts of the body viz., head, thorax, abdomen, overall body length, antenna, maxilla, labial palp, tongue, fore wing, hind wing, fore leg, mid leg and hind leg of *A. dorsata* worker bees collected from Jogimatti forest and Chitradurga city were observed for morphometric analysis. The mean values of morphometric observations are documented in the Tables 1, 2 and 3.

The mean data of head, thorax, abdomen and overall body length of *A. dorsata* worker bees collected from both the area is shown in Table 1. Worker bee group of Jogimatti, the length of the head is 3.91 ± 0.34 mm and width is 4.22 ± 0.25 mm. Thorax has a length 5.19 ± 0.39 mm and width 4.28 ± 0.48 mm with Abdomen having 10.31 ± 1.64 mm length and 4.39 ± 0.36 mm width. Overall body length of the bee is 19.21 ± 1.96 mm. Similarly, the worker bee group from Chitradurga showed, 3.87 ± 0.31 mm head length with 4.20 ± 0.21 mm width. Thorax measured a length of 5.16 ± 0.43 mm and 4.31 ± 0.52 mm width. Abdomen length is 10.27 ± 1.38 mm with width 4.42 ± 0.32 mm. The overall body size is 18.92 ± 1.72 mm. The head, thorax, abdomen and overall body length have shown insignificant variation [$P > 0.05$] when compared.

Antenna and mouth parts [maxilla, labial palp and tongue] measured data are shown in Table 2. Antenna

length of Jogimatti worker bee group is 4.38 ± 0.21 mm and Antenna length of Chitradurga city worker bee group is 3.91 ± 0.24 mm. the values show significant difference when compared [$P < 0.05$]. Maxilla length is 1.82 ± 0.39 mm and 1.61 ± 0.35 mm in Jogimatti worker bee group and Chitradurga city worker bee group respectively. Labial palp of Jogimatti worker bee group has 2.71 ± 0.18 mm length and Chitradurga city worker bee group has 2.63 ± 0.24 mm length. Maxilla and Labial palp length has insignificant variation when statistically compared [$P > 0.05$]. However, is the tongue length of Jogimatti worker bee group 4.26 ± 0.26 mm when compared with that of Chitradurga city worker bee group i.e 3.92 ± 0.32 mm, there is a significant difference [$P < 0.05$].

In Table 3 measured values for wing and leg morphometry are depicted. Fore wing of worker bee

group of Jogimatti is with a length of 12.52 ± 0.69 mm and width of 4.24 ± 0.24 mm. The hind wing length is 8.78 ± 0.72 mm and width is 2.52 ± 0.41 mm. The fore wings length of worker bee group of Chitradurga city is 11.98 ± 0.46 mm and width is 4.01 ± 0.13 mm. The hind wings length is 8.32 ± 0.54 mm and width is 2.48 ± 0.13 mm. With respect to wing length there is a significant variation [$P < 0.05$] but not with wing width [$P > 0.05$]. In case of worker bee group of Jogimatti, the fore leg, mid leg and hind leg has 8.86 ± 0.53 mm, 10.82 ± 0.74 mm and 13.76 ± 0.26 mm length respectively. Likewise, worker bee group of Chitradurga city has length of 8.57 ± 0.49 mm, 10.80 ± 0.83 mm and 12.95 ± 0.34 mm for foreleg, mid leg and hind leg respectively. All the legs of two groups showed significant variation when compared [$P < 0.05$].

Table 1. Body size of *A. dorsata* worker bee collected from Jogimatti forest and Chitradurga

Site of collection	Head, thorax and abdomen morphometry						
	Head		Thorax		Abdomen		Overall size
	Length	Width	Length	Width	Length	Width	Body Length
	[in mm]	[in mm]	[in mm]	[in mm]	[in mm]	[in mm]	[in mm]
Jogimatti Forest	3.91±0.34	4.22±0.25	5.19±0.39	4.28±0.48	10.31±1.64	4.39±0.36	19.21±1.96
Chitradurga City	3.87±0.31	4.20±0.21	5.16±0.43	4.31±0.52	10.27±1.38	4.42±0.32	18.92 ±1.72

All the observed values showed insignificant difference [$P > 0.05$]

Table 2. Antenna and Mouth parts size of *A. dorsata* worker bee collected from Jogimatti forest and Chitradurga

Site of collection	Antenna and mouth morphometry			
	Antenna length [in mm]	Maxilla length [in mm]	Labial palp length [in mm]	Tongue length [in mm]
Jogimatti Forest	4.38 ± 0.21	1.82 ± 0.39	2.71 ± 0.18	4.26 ± 0.26
Chitradurga City	* 3.91 ± 0.24	1.61 ± 0.35	2.63 ± 0.24	* 3.92 ± 0.32

** Observed values showed significant difference [$P < 0.05$]*

Table 3. Wing and Leg size of *A. dorsata* worker bee collected from Jogimatti forest and Chitradurga

Site of collection	Wing and leg morphometry						
	Fore wing		Hind wing		Fore leg	Middle leg	Hind leg
	Length [in mm]	Width [in mm]	Length [in mm]	Width [in mm]	Length [in mm]	Length [in mm]	Length [in mm]
Jogimatti Forest	12.52±0.69	4.24±0.24	8.78±0.72	2.52±0.41	8.86±0.53	10.82±0.74	13.76±0.26
Chitradurga City	*11.98±0.46	4.01±0.13	*8.32±0.54	2.48±0.13	*8.57±0.49	*10.80±0.83	*12.95±0.34

**Observed values showed significant difference [$P < 0.05$]*

4. DISCUSSION

Morphological analysis is the basic technique in taxonomy by describing morphological characters through measurement and calculation [23]. The method is a powerful device because as it can be applied to deduce numerical data and graph the morphology of a species, knowing kinship, variation of a species along with identification [38-41]. The Phenotypic traits could be used as simple indicators to identify and for estimating fluctuations in genetic and productive characteristics of bees [42-44]. As single wing cell carried enough information to discriminate racial groups of bee, the wing morphology and its molecular analysis could confirm a new species [42,45]. Attempts were made to differentiate honeybee groups depending on morphological traits namely: the body size, antenna length, proboscis length, hair length, metatarsus length and width, wing angle, wing length and width with geographical variation [46-55]. Antenna is the centre of odour perception [56] and is bigger in size at higher altitude bees for better sense perception to cope with the environmental disturbances [57]. Tongue length is an important character upon which depends the quality of the nectar gathered from flowers and location [58,59]. The hamuli count and their arrangement have high heritability and can be modified by genetic selection, which can be seen at population level [60]. The observed differences in some traits such as tongue length, leg length, wing size and antenna length among the worker bees of selected population may be attributed to environmental influence such as flora, latitudinal and longitudinal effect. Furthermore, we can draw that some phenotypic variations make base to discriminate intraspecific groups within a populations.

5. CONCLUSION

The observed differences and similarities in morphological traits of the selected honey bee workers from the selected location can be studied in detail with the environment of bees using the support of available computer aided morphometric analysis to understand the honeybee biodiversity.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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