International Journal of Advanced Research and Development
ISSN: 2455-4030; Impact Factor: RJIF 5.24
Received: 07-10-2018; Accepted: 09-12-2018
www.advancedjournal.com
Volume 4; Issue 1; January 2019; Page No. 42-45

Morphometric characterization of Honeybee *Apis dorsata* in Dehradun District, Uttarakhand

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Abstract
In Dehradun, the morphometric characters of *Apis dorsata* from different areas were studied using simple method. In the present study, 29 morphological characters of honey were studied viz., head length (HL), head width (HW), fore wing length (FWL), fore wing width (FWW), abdomen length (AL), abdomen width (AW), tounge length (TL), tounge width (TW), sting length (SL), antennae length (AnL), antennae width (AnW), hind wing length (HWL), hind wing width (HWW), total leg length (TL), femur length (FL), tibia length (TL), metatarsus length (MTL), metatarsus width (MTW), cubital index (CI), Distance DC, DD, CA and CB of fore wing didn't show significant variation (P>0.05). Moreover, fore wing angle A, B, C and in hind wing angle H1, H2 and hind H3 didn't show significant variation (P>0.05). The morphometric analysis of honey bee provides useful information for feature research and also provides information for biodiversity of honey bee.

Keywords: honey bee, *Apis dorsata*, worker bees, morphometric analysis, Dehradun district

1. Introduction

A honey bee is a social insect is members of order Hymenoptera and family Apidae [7]. According to Engel [13], Arias and Sheppard [5] ten species of honeybee belonging to the genus Apis are divided into three groups viz: cavity-nesting bees (*A. mellifera*, *A. cerana*, *A. koschevnikovi*, *A. nulensis*), giant bees (*A. dorsata*, *A. laboriosa*, *A. binghami*, *A. nigrocincta*), and dwarf bees (*A. florea*, *A. andreniformis*). *A. dorsata*, *A. florea*, *A. Indica* are commonly found in India. Bees are one of our most valuable insects; their pollination activities contribute too many fruits, vegetables, seeds and nuts produced, as well as flowers. Bees have physical traits characteristic of insect as well as structures that improve their ability to pollinate. The wellbeing of a honeybee colony is possible only if annual biological cycle is well adjusted to ecological parameters influencing it. Besides geographic variability, seasonal variations also influence the different morphological features of honeybee.

A. dorsata Fabricius, typically around 17-20 mm long in size giant honey bee or rock bee of South and Southeast Asia. *A. dorsata* mostly found in forest area of India, Srilanka, Pakistan, Nepal, Malaysia, Singapore and Geographical distribution extends to Philippines, China and Indonesia.and built a hive single or group in exposed places far off the ground in the air upto 3 to 25 meters [30]. However, workers of *A. dorsata* are able to fly at night and seasonally migrates to locations 100–200 Km distant every year. *A. dorsata* is the largest honeybees having two subspecies namely, *A. dorsata breviligula* (short tongue and medium fore wing length) and *A. dorsata binghami* (long tongue and long fore wing length) [4, 10]. *A. dorsata* is one of the major pollinators and also plays a major role in pollination for tropical plant and other crops species [8]. The length of tongue is the indicator of geographical variation [25, 24] and others characters showed correlations or differentiations between species [22, 28].

Rajak and Basavarajappa [27] studied 32 morphological characters of giant honeybee, *A. dorsata* worker bees of different areas of Mysore District, Karnataka, India. Moreover, Makhmoor and Ahmad [23] studied 16 morphological characters of *A. florea*, *A. mellifera*, *A. cerana* and *A. dorsata* from Jammu region of India.

In the present study, the morphometric characters and wing venations using simple techniques and tool are provide for the variations of the *A. dorsata* in all over the world. Moreover, there are low references or reports on the morphometric characters of *A. dorsata* honey bee in Dehradun district. Hence, the present study was conducted and also useful for further research.

2. Materials and Methods

The *A. dorsata* is collected from different area of Dehradun district (30.3165° N, 78.0322° E). For morphometric analysis samples were collected from Vijay colony (30.3436° N, 78.0438° E), Garhi Cantt (30.3625° N, 78.0481° E), Kaulagarh (30.3518° N, 78.0095° E), Dalanwala (30.3150° N, 78.0566° E), Sewala Khurd (30.2852° N, 77.9937° E), Sahastrdhara (30.3884° N, 78.1294°E), Jakhan (30.3627° N, 78.0666° E), Raipur (30.306°N, 78.098°E) area from Dehradun. Samples of honey bee workers were collected from brood combs and few were collected from flowers with the help of hand net and subsequently killed at 0°C. The body parts were dissected using forceps, micro scissors and measured in units of (cm). Separated wings were scanned with the help of HP scanner at 1200 dpi to obtain wing images then the following investigations were performed. For the study total 29 morphometric characters were analysis and the characteristics can be divided according to body parts viz., head length (HL), head width (HW), fore wing length (FWL), fore wing width (FWW), abdomen length (AL), abdomen width (AW), tounge length (TL), tounge width (TW), sting length (SL), antennae length (AnL), antennae width (AnW), hind wing length (HWL), hind wing width (HWW), total leg length (TL), femur length (FL), tibia length (TL), metatarsus length (MTL), metatarsus width (MTW), cubital index (CI), distance DC, DD, CA, CB were measured by Scan Photo method according to Eid *et al.* [11], Klingenberg [21], Abou

Shaara, Al-Ghamdi [2], Abou-Shaara *et al.* [1, 3] and Uniyal *et al.* [29] Fore wing angle A, fore wing angle B, fore wing angle C, hind wing angle H1, hind wing angle H2 and hind wing angle H3 measured by ScanPhoto method according to Goetze [15], Gomeh *et al.* [16], and El-AW *et al.* [12] with slightly modifications.

The separated body parts of worker bees were put on glass slides and covered with another glass slides. The slides were scanned and moved into the computer as images. The images were opened on the Photoshop program and characters were measured with measuring tools. The steps of using the Scan Photo Method

3. Results and Discussion

In the present study, a total 32 morphometric characters studied of *A. dorsata* worker honey bee form 8 sites of Dehradun region. However, unfortunately there is no available literature for confirming honey bee from selected area. The means and standard deviations were computed for each morphometric character from 15 honey bee sample per sites (Table 1).

Table 1: Mean and standard deviations of morphometric characters in honey bee *Apis dorsata* populations (Mean ± SD)

Measurements	*Apis dorsata* (Mean ± SD)							
	Vijay Colony	**Garhi Cantt**	**Kaulagarh**	**Dalanwala**	**Sewla Khurd**	**Sahastradhara**	**Maldevta**	**Raipur**
Head length (HL)	0.32±0.01	0.32±0.01	0.31±0.01	0.31±0.01	0.32±0.01	0.31±0.01	0.32±0.01	0.32±0.01
Head width (HW)	0.31±0.01	0.32±0.01	0.31±0.01	0.32±0.01	0.32±0.01	0.31±0.01	0.32±0.01	0.32±0.01
Fore wing length (FWL)	1.25±0.01	1.26±0.01	1.24±0.01	1.24±0.01	1.25±0.01	1.24±0.01	1.26±0.01	1.25±0.01
Fore wing width (FWW)	0.43±0.01	0.43±0.01	0.45±0.01	0.43±0.01	0.44±0.01	0.43±0.01	0.46±0.01	0.43±0.01
Abdomen length (AL)	2.31±0.0	2.31±0.0	2.32±0.0	2.31±0.0	2.31±0.0	2.32±0.0	2.31±0.0	2.31±0.0
Abdomen width (AW)	0.47±0.01	0.46±0.01	0.47±0.01	0.46±0.01	0.46±0.01	0.47±0.01	0.46±0.01	0.46±0.01
Tounge length (TL)	0.43±0.01	0.42±0.01	0.42±0.01	0.42±0.01	0.42±0.01	0.42±0.01	0.41±0.01	0.42±0.01
Tounge width (TW)	0.02±0.00	0.02±0.00	0.02±0.00	0.02±0.00	0.02±0.00	0.02±0.00	0.02±0.00	0.02±0.00
Sting length (SL)	0.01±0.00	0.01±0.00	0.01±0.00	0.01±0.00	0.01±0.00	0.01±0.00	0.01±0.00	0.01±0.00
Antennae length (AnL)	0.43±0.01	0.43±0.01	0.41±0.01	0.42±0.01	0.43±0.01	0.41±0.01	0.42±0.01	0.43±0.01
Antennae width (AnW)	0.01±0.00	0.01±0.00	0.01±0.00	0.01±0.00	0.01±0.00	0.01±0.00	0.01±0.00	0.01±0.00
Hind wing length (HWL)	0.81±0.05	0.83±0.05	0.83±0.05	0.80±0.05	0.82±0.05	0.83±0.05	0.80±0.05	0.82±0.05
Hind wing width (HWW)	0.21±0.00	0.21±0.00	0.22±0.00	0.22±0.00	0.22±0.00	0.23±0.00	0.22±0.00	0.22±0.00
Total leg length (TL)	1.18±0.01	1.2±0.01	1.21±0.01	1.17±0.01	1.17±0.01	1.21±0.01	1.24±0.01	1.17±0.01
Femur length (FL)	0.31±0.01	0.30±0.01	0.33±0.01	0.31±0.01	0.31±0.01	0.33±0.01	0.34±0.01	0.31±0.01
Tibia length (TL)	0.36±0.03	0.39±0.03	0.36±0.03	0.36±0.03	0.35±0.03	0.36±0.03	0.36±0.03	0.35±0.03
Metatarsus length (MTL)	0.51±0.01	0.51±0.01	0.52±0.01	0.50±0.01	0.51±0.01	0.52±0.01	0.54±0.01	0.51±0.01
Metatarsus width (MTW)	0.1± 0.00	0.1± 0.00	0.1± 0.00	0.1± 0.00	0.1± 0.00	0.1± 0.00	0.1± 0.00	0.1± 0.00
Cubital index (CI)	0.01±0.00	0.01±0.00	0.01±0.00	0.01±0.00	0.01±0.00	0.01±0.00	0.01±0.00	0.01±0.00
DC	0.31±0.01	0.31±0.01	0.32±0.01	0.31±0.01	0.31±0.01	0.31±0.01	0.33±0.01	0.31±0.01
DD	0.52±0.01	0.51±0.01	0.51±0.01	0.51±0.01	0.51±0.01	0.51±0.01	0.52±0.01	0.51±0.01
CA	0.43±0.01	0.42±0.01	0.43±0.01	0.42±0.01	0.42±0.01	0.43±0.01	0.42±0.01	0.42±0.01
CB	0.21±0.00	0.22±0.00	0.23±0.00	0.22±0.00	0.22±0.00	0.23±0.00	0.23±0.00	0.22±0.00
Fore wing Angle A	40±0.00	40±0.00	40±0.00	40±0.00	40±0.00	40±0.00	40±0.00	40±0.00
Fore wing Angle B	88±0.00	88±0.00	88±0.00	88±0.00	88±0.00	88±0.00	88±0.00	88±0.00
Fore wing Angle C	79±0.00	79±0.00	79±0.00	79±0.00	79±0.00	79±0.00	79±0.00	79±0.00
Hind wing Angle H1	29±0.00	29±0.00	29±0.00	29±0.00	29±0.00	29±0.00	29±0.00	29±0.00
Hind wing Angle H2	38±0.00	38±0.00	38±0.00	38±0.00	38±0.00	38±0.00	38±0.00	38±0.00
Hind wing Angle H3	80±0.00	80±0.00	80±0.00	80±0.00	80±0.00	80±0.00	80±0.00	80±0.00

(*P*>0.05): No significant differences were found between workers bee.

The head length in worker bees of *A. dorsata* is 0.31 ± 0.01 to 0.32 ± 0.01 and breadth is 0.41± 0.01 to 0.42 ± 0.01. No significant differences was observed in the head length and breadth of *A. dorsata* collected from selected sites of Dehradun region and the similar result was observed by Rajak and Basavarajappa [27]. Moreover, the result of length of tongue or proboscis is 0.41 ± 0.01 to 0.43 ± 0.01 and width is 0.02 ± 0.00 (P>0.05). The proboscis length is importance for honey production because honey bee with long proboscis can work on flower, short proboscis cannot work properly [20]. The antennae of insect contain many sensory perceptions [17] and the length of antennae is 0.041 ± 0.01 to 0.043 ± 0.01 and width is 0.02 ± 0.00 (P>0.05) and no significant difference was observed in the length and width of antennae [27].

However, the length of abdomen of *A. dorsata* varies from 2.31 ± 0.00 to 2.32 ± 0.00 and width 0.46 ± 0.01 to 0.47 ± 0.01. And the total length of sting varies from 0.01 ± 0.00 to 0.02 ± 0.00 (P>0.05). The wing morphometric analysis is simple and most important for classification of honey bee races [19]. The length of forewing is 1.24 ± 0.1 to 1.26 ± 0.1 and width is 0.43 ± 0.1 to 0.46 ± 0.1 and the length of hind wing varies from 0.80 ± 0.05 to 0.83 ± 0.05 and width is 0.21 ± 0.00 to 0.23± 0.00 (P>0.05). In this result there is no significant difference was found and the fore wing length of *A. dorsata* was almost similar to the Rajak and Basavarajappa [27], Uniyal *et al*. [29] and Bidish and Basavarajappa [6].

The morphological characteristics could provide information as an indicator for estimating genetic fluctuations in characteristics of honeybee [22]. The cubital index, distance of DC, DD, CA, CB of *A. Dorsata* fore wing is varies 0.01 ± 0.00, 0.31±0.01to 0.33±0.0, 0.51±0.01to 0.52±0.01, 0.42 ± 0.01 to 0.43 ± 0.01, 0.21±0.00 to 0.23±0.00 respectively. The length of cubital index and distance of DC, DD, CA, CB in fore wing didn't show significant difference (P<005) and the result is similar as compared to the result of Uniyal *et al*. [29]. The angle A, B and C in the forewing of honeybee of *A. dorsata* is 40°, 88° and 79° respectively. And the angle H1, H2 and H3 in the hind wing is 29°, 38° and 80° respectively.

The similar result was observed by Uniyal *et al.* [29]. The angle A, B and C in the forewing and the angle H1, H2, H3 in the hind wing of *A. dorsata* collected from selected sites did not show any significant differences (P>0.05). The information of wing morphometric characters and molecular analysis is helpful for identification for new species [14].

The total length of leg of *A. dorsata* varied 1.32 ± 0.01 to 1.38 ± 0.01 out of which length of coxa is 0.11 ± 0.00 to 0.14 ± 0.00, trochanter is 0.03 ± 0.00. femur varies 0.30 ± 0.01 to 0.34 ± 0.01 to, length of tibia is 0.35 ± 0.03 to 0.39 ± 0.03 and the length of metatarsus is 0.51 ± 0.01 and width of coxa, trochanter, femure, taibia and metatarsus is 0.20± 0.00, 0.01± 0.00 0.12± 0.00, 0.12± 0.00, 0.1± 0.00 and 0.1± 0.00 respectively. And the result of total leg length, coxa, trochanter, femur, tibia, and metatarsus of *A. dorsata* did not show any significant differences (P>0.05). However, the result was approximately similar as compared by Uniyal *et al.* [29]. The length of honey bee is higher in hilly region as compared to plain region [9]. However, references on *A. dorsata* wing venation and morphological characteristics are very low. The morphometric characters viz. fore and hind wings classify races of honey bee [6].

In the present study, the methodology used for metamorphic study of *A. dorsata* is simple and time consuming. Moreover, more depth studies are required to decide the races of *A. dorsata* of Dehradun district. The study of morphometric analysis of the body parts, the wing geometric morphometric of wings angle provide data or useful information and provide more information for honey bee biodiversity.

4. Conclusion

The result of morphological characters of *A. dorsata* from regions of Dehradun using simple standard method showed slightly discrimination between different areas. Methodology is useful to identifications of honeybee species with addition characters provide useful information for honeybee biodiversity for further research.

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