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Morphometric analysis on different species of honeybees in NEH region of India

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Abstract

Morphometric studies were carried out on different species of honeybees in North-East hill region of India and it was found that the longest mean tongue length was found in *A. dorsata* with a mean length of 4.19 ± 0.07 mm followed by *A. mellifera* (3.87 ± 0.12 mm) and shortest tongue length was found in *A. florea* with a mean length of 2.14 ± 0.05 mm. The length and breadth of forewing was longest in *A. dorsata* with a mean length of (12.5 ± 0.00 mm) and (4.32 ± 0.12 mm), respectively followed by *A. mellifera* (8.89 ± 0.14 mm) and (3.15 ± 0.06 mm) and the shortest length and breadth of forewing was found in *A. florea* with a mean length of (6.94 ± 0.28 mm) and (2.40 ± 0.06 mm), respectively. The longest cubital index was found in *A. dorsata* with a mean length of (2.88 ± 0.08 mm) followed by *A. mellifera* (2.80 ± 0.05 mm) and the shortest cubital index were found in *A. florea* (2.87 ± 0.09 mm). The number of wing hooks was highest in *A. dorsata* with a mean number of (27 ± 0.06) followed by *A. mellifera* (20 ± 1.25) and the minimum number of wing hooks was found in *A. florea* (11 ± 1.06). The width of 3rd and 4th tergite was found maximum in *A. dorsata* with a (2.72 ± 0.10 mm) and (2.79 ± 0.06 mm) and minimum width was found in *A. florea* with mean width of (1.49 ± 0.10 mm) and (1.40 ± 0.06 mm), respectively. Morphometrics of all eighteen morphological characters of different honey bee species was in the order: *Apis dorsata* (Manipur) > *Apis mellifera* (Assam) > *Apis cerana himalaya* (Assam) > *Apis cerana himalaya* (Manipur) > *Apis florea* (Manipur).

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Introduction

Honey bees (Hymenoptera: Apidae) is a social insect and also have the main role in pollination of plants. Morphologically, honey bee can be divided into three types: dwarf honeybees, medium sized honeybees, and giant honeybees. On the basis of their hive, it can be divided into two groups, open nesting

honeybees and cavity nesting honeybees. Manipur has a lot of diversity of honey bee species. Different species of honey bee in Manipur are *Apis dorsata*, *Apis florea*, *Apis cerana himalaya* and *Apis mellifera*. The first two species have an open nesting honey bee, while *A. mellifera* and *A. cerana himalaya* are cavity nesting honey bee. Honeybees also play

a key role in cultivated ecosystems. The bees are belonging to the order of Hymenoptera, the superfamily of Apoidea and its widest and specialized group of insect. This specialisation is the result of a long co-evolution between bees and angiosperms. Economically, honeybees are also producing products of commercial value such as honey, wax, royal jelly, bee venom, propolis *etc.* The study on the morphological traits of honey bees is highly important for their role in discrimination and conservation of different subspecies/races/ecotypes for accounting biodiversity. Due to difficult taxonomy of bees, lack of bee taxonomists and the relevant literature the studies on the bee diversity, pollination ecology and conservation of bee pollinators are hindered worldwide. This morphometric study provides reference data for future studies and also gives an idea of their interspecific variations as well as the ecological and geographical variations within a species. Thus, biometrical and morphological information is important to design and standardize bee keeping equipment and for other bee management practices. Morphometry uses numeric data resulting from exact measurements of morphological characters of body size, colour and pilosity. This is a pretty powerful biology research device which can be applied to deduce numerical data and graph the morphology of a species, knowing a certain kinship of a species, morphological variation of a species as well as species identification.

Body morphological measurement can be used for different reasons. It is use to characterize honey bee races and individuals (Ruttner 1988; Meixner et al. 2007), to

determine the degree of hybridization with foreign races (Radlof et al. 2003; Bienefeld et al. 1996) and discrimination between honey bee subspecies (Abou-Shaara & Al-Ghamdi 2012; Tofilski 2004). Multiple body characteristics, which include wing length, wing width and tongue length were used to differentiate between honey bee subspecies (Bucu et al. 1987; Rinderer et al. 1993; Crewe et al. 1994; Ftayeh et al. 1994; Diniz-Filho & Malaspina 1995; Szymula et al. 2010). It was found that tongue length was an indicator of geographical variation in some studies (Marghitas et al. 2008; Morimoto 1968; Souza et al. 2002). Thus, body characteristics may be used for indirect prediction of colony productivity or for selection of productivity where honey bees with bigger legs and wings have higher power light and could gather more pollen and nectar for brood rearing and consequently colony population (Mostajeran et al. 2006). Szabo and Lekovich (1988) found that honey production had significant and positive correlations with both fore and hind wing area. Mostajeran et al. (2002) found that honey production was related to tongue length, fore wing length and width, hind wing length, leg length, femur length, tibia length and metatarsus width. Waddington (1989) found a correlation between body size and colony productivity. Edriss et al. (2002) indicated that honey production can be improved through selection of the forewing width. Therefore, there is evidence that body morphological characteristics are very important and correlated with colony productive characteristics. However, it must be noted that these relations may attribute to

specific conditions rather than indicating general rules.

Materials and Methods

Present study was carried out at the College of Agriculture, CAU, Imphal situated in the valley of Manipur (24° 81'33" N, 93° 88'85" E, 784m MSL). A morphometric study was conducted on worker bees coming from *Apis cerana himalaya*, *Apis mellifera* and *Apis dorsata* and *Apis florea* from different places of Manipur region and composite samples of each species were made. Ten individuals were randomly selected for morphological studies for each species of honeybees. The sampled bees were killed with hot water (around 90°C) to obtain their stretched proboscis then they were preserved in 70% ethanol. Lateral images of the thorax and hairs on abdominal tergite were taken of each bee prior to dissection. Six different parts of each bee's body (forewings, hindwings, tongue, metatarsus, tergite and sternite) were dissected to facilitate imaging of the morphometric characteristics. Forewings and hindwings were removed from the thorax using forceps. The sternites and tergites were removed by tearing the connective tissue between them. The measurement was done according to the Ruttner's methods (1988), using a stereomicroscope with an ocular micrometre. Numbers presenting lengths or widths of various structures are in millimetres. Some important morphological characters were chosen and studied that characters includes: 1. tongue length, 2. length of forewing, 3. breadth of forewing, 4. cubital index, 5. length of hindwing, 6. breadth of hindwing, 7. number of wing hooks, 8. length of metatarsus, 9. breadth of metatarsus, 10. width

of third tergite, 11. width of 4th tergite, 12. breadth of 6th sternite 13. colour, 14. length of head, 15. length of abdomen, 16. Hhamuli of hindwing, etc. were studied.

We can also collect samples in a number of ways (i) from brood comb according to Padilla et al. (1992). (ii) by shaking bees, (iii) collecting only forager bees (iv) taking one-day old bees by placing sealed brood combs into incubators. Collected bees can be preserved in 95% ethanol until dissection (Arias et al., 2006) or in 70% ethanol (Adl et al. 2007) or killing by a deep-freezer and then dissected (Abou-Shaara et al. 2012). Also, the temporary preparation of the samples can be used (Miladenovic et al. 2011). Comb cell size has an impact on morphological characteristics (Ruttner 1988; McMullan & Brown 2006; Gencer & Firati 2005) workers that are emerged from large wax cells have larger morphological characteristics. Sample size and time of taking the samples affect comparisons between different data for body morphological characteristics. So, it is very important to take samples for morphological analysis at the same time for all studied replicates and it is better to take samples from new combs under the same condition of feeding as possible.

Results

To summarize the data on different morphological characters of four species of honey bees. The length of forewing was 6.94±0.28 in *A. florea* (Manipur), 7.88±0.16 in *A. cerana himalaya* (Manipur), 8.04±0.06 in *A. cerana himalaya* (Assam), 8.89±0.14 in *A. mellifera* (Assam) and 12.50±0.29 in *A. dorsata* (Imphal). The breadth of forewing was 2.40±0.06 in *A. florea* (Manipur),

2.78±0.05 in *A. cerana himalaya* (Manipur), 2.84±0.10 in *A. cerana himalaya* (Assam), 3.15±0.06 in *A. mellifera* (Assam) and 4.32±0.12 in *A. dorsata* (Imphal). The cubital index was 2.87±0.09 in *A. florea* (Manipur), 2.83±0.06 in *A. cerana himalaya* (Manipur), 2.82±0.10 in *A. cerana himalaya* (Assam), 1.22±1.05 in *A. mellifera* (Assam) and 1.39±0.10 in *A. dorsata* (Manipur). The length of hindwing in *A. florea* (Manipur), *A. cerana himalaya* (Manipur), *A. cerana himalaya* (Assam), *A. mellifera* (Assam) and *A. dorsata* (Manipur) were 4.77±0.13, 5.68±0.09, 5.82±0.62, 1.87±0.08, respectively. The breadth of hindwing was shortest in *A. florea* (Manipur) with 1.46±0.07, 1.62±0.07 in *A. cerana himalaya* (Manipur), 1.58±0.06 in *A. cerana himalaya* (Assam), 2.57±0.12 in *A. mellifera* (Assam) and the longest breadth was 2.57±0.06 in *A. dorsata* (Manipur). The number of wing hooks was 11±1.06 in *A. florea* (Manipur), 17±1.08 in *A. cerana himalaya* (Manipur), 18±0.74 in *A. cerana himalaya* (Assam), 20±1.25 in *A. mellifera*

(Assam) and 27±1.57 in *A. dorsata* (Manipur). The mean tongue length was found 2.14±0.05 in *Apis florea* (Manipur), 2.97±0.21 in *A. cerana himalaya* (Manipur), 3.12±0.69 in *A. cerana himalaya* (Assam), 3.87±0.12 in *A. mellifera* (Assam) and 4.19±0.07 in *A. dorsata* (Manipur). The width of 3rd tergite was 1.49±0.10, 1.82±0.06, 1.87±0.10, 2.27±0.05 and 2.72±0.10 in *A. florea* (Manipur), *A. cerana himalaya* (Manipur), *A. cerana himalaya* (Assam), *A. mellifera* (Assam) and *A. dorsata* (Manipur), respectively. The width of 4th tergite was 1.40±0.06, 1.62±0.11, 1.75±0.12, 2.17±0.07 and 2.79±0.06 in *A. florea* (Manipur), *A. cerana himalaya* (Manipur), *A. cerana himalaya* (Assam), *A. mellifera* (Assam) and *A. dorsata* (Manipur), respectively. The length of 3rd sternite in *A. florea* (Manipur) was the shortest with 2.69±0.07, 4.06±0.06 in *A. cerana himalaya* (Manipur), 4.02±0.13 in *A. cerana himalaya* (Assam), 4.22±0.19 in *A. mellifera* (Assam) and the longest was in *A. dorsata* (Manipur) with 5.40±0.13 (Table 1).

Table 1. Biometric characteristic on some species of honeybees in NEH region of India

Parameters	<i>A. florea</i> (Manipur)		<i>A. cerana himalaya</i> (Manipur)		<i>A. cerana himalaya</i> (Assam)		<i>A. mellifera</i> (Assam)		<i>A. dorsata</i> (Manipur)	
	Range (mm)	Mean (mm) ±S.D.	Range (mm)	Mean (mm) ±S.D.	Range (mm)	Mean (mm) ±S.D.	Range (mm)	Mean (mm) ±S.D.	Range (mm)	Mean (mm) ±S.D.
Length of forewing	6.50-7.25	6.94±0.28	7.62-8.12	7.88±0.16	8.0-8.12	8.04±0.06	8.87-9.12	8.89±0.14	10.25-3.20	12.50±0.29
Breadth of forewing	2.37-2.50	2.40±0.06	2.75-2.87	2.78±0.05	2.75-3.00	2.84±0.10	3.12-3.25	3.15±0.06	4.12-4.37	4.32±0.12
Cubital Index	2.74-3.0	2.87±0.09	2.73-2.90	2.83±0.06	2.70-2.95	2.82±0.10	2.69-2.88	2.80±0.05	2.85-3.03	2.88±0.08
Length of hindwing	4.62-4.87	4.77±0.13	5.62-5.87	5.68±0.09	5.75-5.87	5.82±0.62	1.75-2.12	1.87±0.08	8.62-8.87	8.74±0.08
Breadth of hindwing	1.37-1.50	1.46±0.07	1.50-1.75	1.62±0.07	1.5-1.62	1.58±0.06	2.50-2.62	2.57±0.12	2.50-2.62	2.57±0.06
No. of wing	10-13	11	15-19	17	17-19	18	18-22	20	24-28	27

hooks		±1.06		±1.07		±0.74		±1.25		±1.57
Tongue Length	2.12-2.25	2.14	2.62-3.25	2.97	2.72-3.35	3.12	3.75-4.0	3.87	4.12-4.25	4.19
Width of 3 rd tergite	1.37-1.62	1.49	1.75-1.87	1.82	1.75-2.00	1.87	2.25-2.37	2.27	2.62-2.87	2.72
Width of 4 th tergite	1.37-1.5	1.40	1.47-1.73	1.62	1.68-1.93	1.75	2.12-2.25	2.17	2.75-2.87	2.79
Length of 3 rd sternite	2.62-2.75	2.69	4.0-4.12	4.06	3.87-4.12	4.02	4.0-4.37	4.22	5.25-5.50	5.40

The body length of *A. florea* (Manipur) was 11.47±0.74. It was 12.64±0.10, 11.70±1.51 and 14.56±0.71 in *A. cerana himalaya* (Manipur), *A. cerana himalaya* (Assam) and *A. mellifera* (Assam), respectively. The longest body length was found in *A. dorsata* (Manipur) with 19.22±0.54. The length of head in *A. florea* (Manipur) was found to be 2.38±0.10, 3.17±0.07 in *A. cerana himalaya* (Manipur), 3.07±0.06 in *A. cerana himalaya* (Assam), 3.72±0.10 in *A. mellifera* (Assam) and 4.37±0.06 in *A. dorsata* (Manipur). The length of thorax was 3.67±0.22, 4.09±0.15, 3.90±0.16, 4.49±0.17 and 5.82±0.28 in *A. florea* (Manipur), *A. cerana himalaya* (Manipur), *A. cerana himalaya* (Assam), *A. mellifera* (Assam) and *A. dorsata* (Manipur), respectively. The length of abdomen was 5.72±0.61, 5.37±0.20, 5.22±0.65, 6.29±0.60 and 9.07±0.47 in *A. florea* (Manipur), *A. cerana himalaya* (Manipur), *A. cerana himalaya* (Assam), *A. mellifera* (Assam) and *A. dorsata* (Manipur), respectively. The

hamuli of hindwing in *A. florea* (Manipur) was 11±1.06, 17±1.08 in *A. cerana himalaya* (Manipur), 18±0.74 in *A. cerana himalaya* (Assam), 20±1.25 in *A. mellifera* (Assam) and 27±1.57 in *A. dorsata* (Manipur). The length of metatarsus in *A. florea* (Manipur) was 0.72±0.05, 1.05±0.05 in *A. cerana himalaya* (Manipur), 1.07±0.06 in *A. cerana himalaya* (Assam), 1.22±0.05 in *A. mellifera* (Assam) and 1.39±0.10 in *A. dorsata* (Manipur). The breadth of metatarsus was 0.25±0.05 in *A. florea* (Manipur), 0.28±0.06 in *A. cerana himalaya* (Manipur), 0.29±0.06 in *A. cerana himalaya* (Assam), 0.37±0.09 in *A. mellifera* (Assam) and 0.50±0.11 in *A. dorsata* (Manipur) (Table 2). Considering all the morphological characters of the four species of honeybees prevalent in NEH region, the sizes were in the descending order of *Apis dorsata* (Manipur) > *Apis mellifera* (Assam), > *Apis cerana himalaya* (Assam) > *Apis cerana himalaya* (Manipur) > *Apis florea* (Manipur).

Table 2. Morphometric characterization on some species of honeybees in NEH region of India

Parameters	<i>A. florea</i> (Manipur)		<i>A. cerana himalaya</i> (Manipur)		<i>A. cerana himalaya</i> (Assam)		<i>A. mellifera</i> (Assam)		<i>A. dorsata</i> (Manipur)	
	Range (mm)	Mean (mm) ±S.D.	Range (mm)	Mean (mm) ±S.D.	Range (mm)	Mean (mm) ±S.D.	Range (mm)	Mean (mm) ±S.D.	Range (mm)	Mean (mm) ±S.D.
Colour morph	Abdomen orange		Body colour blackish, abdomen		Body colour blackish,		Body golden yellow, profusely		Head blackish, abdomen reddish-	

	anteriorly with white & black stripes posteriorly	with white & black stripes	abdomen with white & black stripes	hairy with faint black & yellow stripes posteriorly	yellow anteriorly & black at the tip
Body length	10.42-11.47	12.49-12.64	9.30-11.70	13.62-14.56	18.25-19.22
Length of head	2.30-2.50	3.12-3.25	3.00-3.12	3.62-3.87	4.25-4.37
Length of thorax	3.25-3.37	4.00-3.37	3.87-4.09	4.25-4.49	5.62-6.25
Length of abdomen	4.87-6.62	5.00-5.50	4.50-6.37	5.25-6.87	8.37-9.50
Hamuli of hindwing	10-13	15-19	17-19	18-22	24-28
Length of metatarsus	0.62-0.75	0.98-1.07	1.0-1.12	1.12-1.25	1.25-1.50
Breadth of metatarsus	0.20-0.29	0.22-0.31	0.23-0.32	0.31-0.42	0.40-0.55



Apis cerana himalaya



Apis florea



Apis mellifera



Apis dorsata

Figure 1. Different species of honeybees in NEH region of India

Discussions

Our morphometric results obtained compared with those obtained by several study especially Makhmoor et al., (1998), Mattu et al., (1984), Niem et al., (1999) in Asian native honeybees, Bouzeraa et al., (2016) on Algerian bees and Mannivannan et al., (2016) on Indian bees. The length of forewings in *A. florea* in our study was 6.94 ± 0.28 mm which is greater than 6.25 ± 0.03 mm as earlier reported by Makhmoor et al., (1998) and 6.76 ± 0.034 (Vietnam), 6.11 ± 0.117 (Thailand) as of Niem et al., (1999). The mean length of forewings in *A. cerana* (Manipur) was 7.88 ± 0.16 mm and *A. cerana* (Assam) 8.04 ± 0.06 mm which is less

than 8.83 ± 0.04 mm as earlier reported by Makhmoor & Hafeez Ahmad, (1998) for the Jammu region and 8.16 ± 0.27 mm and 7.93 ± 0.032 mm recorded for Thailand and Vietnam, respectively by Niem et al. (1999). The length of forewings in *A. mellifera* in our study was 8.89 ± 0.14 mm. It is high as compared those found by Usman H. Dukku, (2016) which is of the order of $7.98 \pm 0.10 - 8.51 \pm 0.13$ mm in Sub-Saharan Africa and Oleivera et al., (2000) which recorded 8.63 mm in Brazil. In case of *A. dorsata* the forewing length was recorded as 12.50 ± 0.32 mm by Bidisha et al. (2018) in Piriapatna, Southern Karnataka, which is more or less similar to our record, 12.5 ± 0.29 mm.

Comparison values (Mean±SD) of morphometric characters of some honeybee species from various sources

Character	Species	This study	Bidisha et al. (2018)	Niem et al. (1999)	Mattu et al. (1984)	Makhmoor et al. (1998)	Usman H. Dukker (2016)
Length of forewing	<i>A. florea</i>	6.94 ± 0.28	-	6.76 ± 0.034 (Vietnam) 6.11 ± 0.117 (Thailand)	-	6.25 ± 0.03	-
	<i>A. cerana</i>	7.88 ± 0.16 (Manipur) 8.04 ± 0.06 (Assam)	-	8.16 ± 0.027 (Vietnam) 7.93 ± 0.032	-	8.83 ± 0.04	-
	<i>A. mellifera</i>	8.89 ± 0.14	-	-	-	9.60 ± 0.05	-
	<i>A. dorsata</i>	12.5 ± 0.00	12.50 ± 0.32 (Karnataka)	12.96 ± 0.44 (Vietnam) 13.14 ± 0.041 (Thailand)	-	13.15 ± 0.06	$7.98 \pm 0.10 - 8.51 \pm 0.13$
Breadth of forewing	<i>A. florea</i>	2.40 ± 0.06	-	2.31 ± 0.010 2.24 ± 0.009	-	2.05 ± 0.01	-
	<i>A. cerana</i>	2.78 ± 0.05 2.84 ± 0.10	-	2.83 ± 0.011 2.78 ± 0.016	2.855 ± 0.019	3.00 ± 0.02	-
	<i>A. mellifera</i>	3.15 ± 0.06	-	-	-	3.25 ± 0.03	$2.71 \pm 0.04, - 2.89 \pm 0.05$
	<i>A. dorsata</i>	4.32 ± 0.12	4.36 ± 0.16	2.96 ± 0.044 3.14 ± 0.041	-	4.25 ± 0.04	-
Length of hindwing	<i>A. florea</i>	4.77 ± 0.13	-	-	-	4.25 ± 0.02	-
	<i>A. cerana</i>	5.68 ± 0.09 5.82 ± 0.62	-	-	5.937 ± 0.031	6.00 ± 0.06	-
	<i>A. mellifera</i>	1.87 ± 0.08	-	-	-	6.42 ± 0.07	-
	<i>A. dorsata</i>	8.74 ± 0.08	-	-	-	9.65 ± 0.07	-
Character	Species	This study	Bidisha et	Niem et al.,	Makhmoor	Bouzeraa et	Beata

			al. (2018)	(1999)	et al. (1998)	al. (2016)	Madras- Majewska et al. (2021)
Cubital index	<i>A. florea</i>	2.87±0.09	-	3.57±0.198 (Vietnam) 6.11±0.117 (Thailand)	1.75±0.00	-	-
	<i>A. cerana</i>	2.82±0.10 (Manipur) 2.83±0.06 (Assam)		3.492±0.099 (Vietnam) 2.973±0.125 (Thailand)	2.00±0.01		
	<i>A. mellifera</i>	2.80±0.05		-	2.60±0.02		
	<i>A. dorsata</i>	2.88±0.08	6.8±1.27	6.750±0.239 (Vietnam) 7.172±0.253 (Thailand)	3.00±0.02	-	1.664±0.254

Comparison values (Mean±SD) of morphometric characters of some honeybee species from various sources

Character	Species	This study	Mannivannan et al. (2016)	Mattu et al. (1984)	Makhmoor et al. (1998)	Bouzeraa et al. (2016)
Width of fourth tergite	<i>A. florea</i>	1.40±0.06	2.3 ± 0.83		1.80±0.01	
	<i>A. cerana</i>	1.62±4.69 1.75±0.00	2.3 ± 0.35	1.926 ± 0.015	2.00±0.02	
	<i>A. mellifera</i>	2.17±0.07			2.32±0.02	
	<i>A. dorsata</i>	2.79±0.06			2.61±0.02	
Length of 3 rd sternite	<i>A. florea</i>	2.69±0.07			2.15±0.02	-
	<i>A. cerana</i>	4.06±0.06 4.02±0.13			3.00±0.02	-
	<i>A. mellifera</i>	4.22±0.19			3.15±0.02	3.40±0.17 3.13±0.07 3.33±0.11
	<i>A. dorsata</i>	5.40±0.13				3.78±0.02
Number of wing hooks	<i>A. florea</i>	11.0±1.06	11.0±0.57	-	13.00±0.02	
	<i>A. cerana</i>	17.0±1.07 18.0±0.74	18.0±0.84	18.96±0.347	19.00±0.20	
	<i>A. mellifera</i>	20.0±1.25	-	-	21.55±0.25	
	<i>A. dorsata</i>	27.0±1.57	-	-	24.11±0.09	
Length of metatarsus	<i>A. florea</i>	0.72±0.05			1.50±0.01	
	<i>A. cerana</i>	1.12±2.34 1.07±0.06		2.007±0.010	1.83±0.01	
	<i>A. mellifera</i>	1.22±1.05			2.20±0.01	3.33±0.12 3.12±0.06 3.24±0.12
	<i>A. dorsata</i>	1.39±0.10			2.55±0.01	
Character	Species	This study	Niem et al.	Mattu et al.	Makhmoor	Bouzeraa et

			(1999)	(1984)	et al. (1998)	al. (2016)
Tongue length	<i>A. florea</i>	2.14±0.05	3.45±0.026 3.57±0.020	-	4.00±0.01	-
	<i>A. cerana</i>	2.97±0.21 3.10±4.69	4.91±0.017 4.82±0.029	5.247±0.167	5.01±0.04	-
	<i>A. mellifera</i>	3.87±0.12	-	-	6.18±0.05	8.92±0.78 8.16±0.40 8.76±0.73
	<i>A. dorsata</i>	4.19±0.07	6.56±0.032 6.54±0.022	-	6.75±0.05	-

The mean value of the breadth of forewings in *A. cerana* (Manipur) was 2.78±0.05mm and this value is of the same order as recorded by Mattu et al. (1984) for Shimla region, 2.85±0.019mm and 2.78±0.01mm in Vietnam by Niem et al. (1999). The width of 3rd tergite in our study were 1.49±0.10, 1.82±0.16, 1.87±0.10, 2.27±0.05 and 2.72±0.10 mm for *A. florea* (Manipur), *A. cerana* (Manipur), *A. cerana* (Assam) and *A. dorsata* (Manipur), respectively. Manivannan et al. (2016) reported that it was 1.0±0.07 and 1.9±0.36mm for *A. florea* and *A. cerana*, respectively in Tamil Nadu. Niem et al., (1999) reported these to be 1.36±0.009, 1.68±0.007, 2.88±0.030mm in Thailand for *A. florea*, *A. cerana* and *A. dorsata*, respectively. The mean cubital index obtained for *A. mellifera* (Assam) is 2.80±0.05 and this is greater than those found by Bouzera et al., (2016) which is of the order of 2.08±0.20, 2.50±0.34 and 2.53±0.33 for Tahir, El-Ancer and Ziama of N.E. Algeria, respectively but greater than those obtained by Beata Madras-Majewska, (2021) as 1.66±0.254mm. Tongue length is an important character upon which depends the quality of the nectar gathered from flowers. Present study also revealed that tongue length was significantly longer in *A. dorsata* than *A. mellifera*, *A. cerana himalaya*

and *A. florea*. Size of fore wing is directly related to the flight ability of bees. Size of hind leg especially metatarsus affect the pollen carrying capacity of honeybee. Third and fourth tergites were taken as the indicators of abdominal size. Significant differences were observed in the length of third and fourth tergites. Present results showed that length of third and fourth tergites in *Apis dorsata* was greatest (2.72 and 2.79 mm, respectively) as compared to *A. florea* (1.49 and 1.40 mm, respectively) thus supporting the argument that bees have bigger abdominal size have longer tergites. The determined value for the length of forewing ranged from 6.50-7.25 mm in *A. florea*, with mean ± S.D. of 6.94±0.28mm. Makmoor et al. (1998) points out that the mean length of forewing in *Apis florea* was 6.25±0.03mm which corresponds with the values obtained in our study. Likewise the determined mean length of forewing was 7.88±0.16mm in *A. cerana himalaya* (Manipur) and 8.04±0.06mm in *A. cerana himalaya* (Assam). Altogether 16 traits showed significant differences between the four different species of honeybees in NEH region of India. From the results, it can be concluded that some variation was observed in the morphometric observations which might be due to geographical variation. During the

present study, fore wing length of *A. dorsata* was almost same compared to the reports of Niem et al. (1999) and Cao et al. (2012). Thus, our observations are on par with the earlier reports. Thus, wing size plays a very important role among the honeybee population found at varied longitudinal and latitudinal locations by Barour et al., (2005). Hence, wing traits analysis becomes an important tool, used to characterize and discriminate the honeybee species and sub-species (Aytekin et al. 2007; Abou Shara & Al-Ghamdi 2012).

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