International Journal of Current Advanced Research
ISSN: O: 2319-6475, ISSN: P: 2319-6505, Impact Factor: 6.614
Available Online at www.journalijcar.org
Volume 7; Issue 4(K); April 2018; Page No. 12025-12029
DOI: http://dx.doi.org/10.24327/ijcar.2018.12029.2105

Research Article

FORE AND HIND WINGS MORPHOMETRY OF *APIS DORSATA* WORKER HONEYBEES (HYMENOPTERA:APIDAE) OF GEOGRAPHICALLY DISTINCT AREAS OF SOUTHERN KARNATAKA, INDIA

Bidisha R and Basavarajappa S*

DOS in Zoology University of Mysore, Manasagangotri, Mysore-570 006, India

A R T I C L E I N F O

Article History:

Received 12th January, 2018
Received in revised form 24th February, 2018 Accepted 10th March, 2018
Published online 28th April, 2018

Key words:

Wing morphometry, *Apis dorsata*, geographically distinct areas, southern Karnataka

A B S T R A C T

In southern Karnataka, geographically distinct five places were selected randomly to record the wing traits in moribund or dead *A. dorsata* worker bees by following standard methods. Altogether, 41 wing traits i.e., 25 traits in fore wing and 16 traits in hind wing were observed and data revealed interesting results. Around 29 traits, in both fore wing and hind wing have indicated significant differences among samples collected from geographically distinct areas namely: arid, semi-arid, malnad and city environment of southern Karnataka. Moreover, number of hamuli in both right and left side wings showed considerable differences compared to earlier published reports. Obviously, all these findings help us to presume the existence of eco-race or sub-species of *A. dorsata* amidst geographically distinct areas of southern Karnataka. This has instigated us to conducted further in depth studies especially on genetic analysis that could strongly support and confirm the species variation if any in Southern Karnataka. On this line, in depth study has been initiated in this laboratory to provide data on genetic details to confirm the species variation if any and results of such observations will published elsewhere.

INTRODUCTION

India is blessed with three native *Apis* species (Hymenoptera: Apidea) namely, *Apis dorsata* Fabricius, *A. florea* Fabricius and *A. cerana* Fabricius (Maa, 1953; Ruttner, 1988). Among them, *A. dorsata* is known for its giant body size, voracious foraging, pollination activities (Lawal and Banjo, 2010), and considered as one of the key stone species of agro-ecosystem. Moreover, *A. dorsata* produce huge quantity of multifloral honey which is harvested by many tribes and apiculturists to obtain supplementary income during different seasons in Karnataka. Obviously, *A. dorsata* become one of the beneficial insects of commercial importance. However, its morphometric details are fragmentary (Basavarajappa, 1998 and 2011). As, morphometric traits are useful while identifying the taxonomy of eco-races or sub-species of *A. dorsata,* which is distributed at diversified agro-ecosystems and becomes economically important both in terms of pollination and honey production.

Ruttner *et al*. (1978) have made very first attempt to classify honeybee sub-species based mainly on color and size. In addition to it, insect wings have been increasingly used in morphological studies since 1970 (Gumiel *et al.,* 2003; Aytekin *et al.,* 2007). Because, insect (e.g. honeybee) wings are rigidly articulated or solid structures become very useful for geometric morphometric studies (Aytekin *et al.,* 2007).

Corresponding author:* **Basavarajappa S
DOS in Zoology University of Mysore, Manasagangotri, Mysore-570 006, India

Wing morphology analysis in honeybees has provided good information while identifying the species, sub-species and even at the population level (Mendes *et al.,* 2007: Francoy *et al.,* 2008). Abdellatif *et al.* (1977), Ruttner *et al.* (1978) have studied the wing morphometry of honeybee races at different parts of the world. It has gained much importance due to the unique venation system in the wings of honeybee species. However, published reports on *A. dorsata* wing morphometry are poor. Since, fore and hind wings are important while classifying different races, strains and ecotypes of honeybees, it is considered as a powerful tool for the identification and discrimination of honeybee races (Rattanawannee *et al.,* 2010; Francoy *et al.,* 2006; Bouga and Hatjina, 2005; Kekecoglu *et al.,* 2007; Masemola and Kryger, 2011). Hence, present study was undertaken to reveal the differences if any among the population of *A. dorsata* found at geographically distinct areas of southern Karnataka.

MATERIALS AND METHODS

Study area: Geographically distinct places such as Manasagangotri – educational institute with neatly maintained good vegetation (12.31^0 N latitude and 76.62^0 E longitude) and Devaraj flower market - very disturbed urban environment (12.30^0 N latitude and 76.64^0 E longitude) in Mysore, T. Narasipura – agriculture landscape with semi-arid climate (12^0 12^1 36^{11} N longitude and 76^0 54^1 23^{11} E latitude), Periyapatna – agriculture landscape with malnad climate (12°20^1 14.5 ^{11} N longitude and 76°51'55.14 ^{11}E latitude) and Chamrajanagar –

agriculture landscape with arid climate ($11^{o}\ 40^{1}\ 22^{11}$ – $12^{0}\ 01^{1}37^{11}$ longitude and $76^{o}\ 43^{1}\ 49^{11}$ N – $77^{0}\ 01^{1}\ 99^{11}$ latitude) were selected randomly. The agriculture landscapes of T. Narasipura, Chamrajanagar and Periyapatna are grown with paddy, ragi, jowar, bajra, maize, groundnut, sunflower, sugarcane, tobacco and cotton crops, which supply good forage to *A. dorsata* during different seasons.

***Methodology*:** The moribund or dead *A. dorsata* worker bees were collected nearby its natural hive and preserved in 70% alcohol and brought to the laboratory for morphometric studies as per Adl *et al.* (2007). The fore and hind wings were dissected from the thorax of worker bees under Lieca Stereozoom Microscope with the help of surgical needles and forceps. Dissected fore and hind wings were separately measured for their morphometric traits with the help of Leica EZ4 Stereozoom Microscope Axion Vision ref: 4.8 software along with high speed digital wire live camera and LAS measurement module at Institute of Excellence, University of Mysore, Manasagangotri, Mysore. The parameters namely: forewing length and width, radial cell length and breadth, Cubital vein 'A' length (Cu A), Cubital vein 'B' length (Cu B), cubital index (CI), medio cubital cross vein (M+Cu), cubital vein (Cu), anal vein (A), first anal vein (A1), cubital anal cross vein (cu-a), second brunch of cubitus (Cu2), cubitus vein (Cu), first medio cubital vein (1m-cu), media basal vein (M), radial sector (Rs), first radio medial cross vein (1r-m), second sub marginal cross vein (2r-m), second medio cubital cross vein (2m-Cu), median vein (M), costal vein (C) were measured in fore wing. In hind wing, the length and breadth, hamuli number, vannal vein (V), medio cubital cross vein (M+Cu), cubital vannal cross vein (Cu-v), cubitus vein (Cu), media (basal) vein (M), radial sector vein (Rs) second radio median cross vein (2r-m) radial cross vein (r-m), extension of radial sector vein (A), extension of median vein (B) and costal vein (C) were measured as per Porporato *et al.* (2014). The images of fore wing and hind wing traits were taken carefully after measurement and collected data was analyzed by using ANOVA.

RESULTS

Altogether, 41 wing traits in *A. dorsata* worker bees were observed for their measurements (Tables 1 and 2, Fig. 1 and 2).

Fore wing traits: The fore wing length and breadth, radial cell length and breadth, Cu 'A' length, Cu 'B' length, cubital index (CI), medio cubital cross vein (M+Cu), cubital vein (Cu), anal vein (A), first anal vein (A1), cubital anal cross vein (cu-a), second brunch of cubitus (Cu2), cubitus vein (Cu), first media vein cubitus (1m-cu), media basal vein (M), radial sector (Rs), first radio medial cross vein (1r-m), second sub marginal cross vein (2r-m), second medio cubital cross vein (2m-Cu), median vein (M), costal vein (C) are presented in Table 1 and Figure 1. Length and breadth of fore wing showed a significant difference respectively F=6.676; P>0.05 and F= 4.472; P>0.05. Interestingly, in fore wing, the radial cell length and width, cubital vein A, Cubital vein B, cubital index, medio cubital cross vein, anal vein (19-20), first cubital nnal vein (20-24), first medio cubital vein, radial sector, first radio medial cross vein, second radio medial cross vein, second medio cubital cross vein, median vein (9-10), medial vein (7-18), cubital vein (16-17) and costal vein showed significant difference between geographically distinct places in southern Karnataka (Table 1).

Hind wing traits: The hind wing traits such as length and breadth, hamuli number, vannal vein (V), medio cubital cross vein (M+Cu), cubital vannal cross vein (Cu-v), cubitus vein (Cu), media basal vein (M), radial sector vein (Rs) second radio median cross vein (2r-m) and costal vein (C) are depicted in Table 2 and Fig 2.

Table 1 Morphometric details of fore wing traits of *Apis dorsata* worker bee population of geographically distinct areas of southern Karnataka (n=50)

Sl. No.	Morphometric Traits (in mm)	Geographically distinct areas of southern Karnataka					'F' Value
		Manasagangotri	Devaraj Market	Piriyapatna	T.Narasipura	Chamrajnagar	
1.	Forewing Length	12.70 ± 0.24^{b}	12.67 ± 0.28^{b}	12.50 ± 0.32^{a}	12.75 ± 0.24^{b}	12.77 ± 0.29^{b}	6.676 S
	Forewing Breadth	4.26 ± 0.21^{a}	4.27 ± 0.34^{a}	4.36 ± 0.16^{ab}	4.47 ± 0.11^{c}	4.30 ± 0.14^{ab}	4.472 S
2.	Radial cell length	4.90 ± 0.12^{b}	4.90 ± 0.13^{b}	4.75 ± 0.15^{a}	4.88 ± 0.09^{b}	4.81 ± 0.08^{a}	6.845S
3.	Radial cell width	0.74 ± 0.05^{a}	0.79 ± 0.05^{b}	0.71 ± 0.04^{a}	0.73 ± 0.05^{a}	0.69 ± 0.19^{a}	3.982S
4.	Cubital vein A	1.15 ± 0.06^{bc}	1.18 ± 0.07^{c}	1.13 ± 0.05^{ab}	1.15 ± 0.05^{bc}	1.12 ± 0.03^{a}	4.042 S
5.	Cubital vein B	0.14 ± 0.01^{a}	0.15 ± 0.02^{a}	0.14 ± 0.03^{a}	0.14 ± 0.01^{a}	0.17 ± 0.03^{a}	7.496 S
6.	Cubital Index	7.95 ± 1.17^{b}	7.90 ± 1.33^{b}	6.8 ± 1.27^{a}	8.07 ± 0.98^{b}	6.51 ± 1.24^{a}	8.942S
7.	M+CU (22-24)	3.47 ± 0.20^{a}	3.46 ± 0.24^{a}	3.41 ± 0.17^{a}	3.76 ± 0.44^{b}	3.34 ± 0.25^{a}	8.006S
8.	M+CU (13-24)	0.57 ± 0.07^{ab}	0.56 ± 0.04^{a}	0.57 ± 0.14^{ab}	0.62 ± 0.07^{ab}	0.58 ± 0.11^{b}	1.795 NS
9.	Cu (13-14)	2.07 ± 0.06^{a}	2.12 ± 0.09^{a}	2.09 ± 0.09^{a}	2.09 ± 0.09^{a}	2.08 ± 0.07^{a}	1.433 NS
10.	A (20-21)	3.50 ± 0.17^{a}	3.48 ± 0.11^{a}	3.43 ± 0.43^{a}	3.64 ± 0.69^{a}	3.46 ± 0.14^{a}	1.139 NS
11.	A (19-20)	2.56 ± 0.19^{a}	2.68 ± 0.14^{b}	2.55 ± 0.15^{a}	2.72 ± 0.14^{b}	2.55 ± 0.12^{a}	6.530 S
12.	1Cu-a (20-24)	0.52 ± 0.09^{a}	0.50 ± 0.06^{a}	0.51 ± 0.11^{a}	0.60 ± 0.17^{b}	0.52 ± 0.17^{a}	2.381 S
13.	Cu2	0.51 ± 0.05^{a}	0.52 ± 0.06^{a}	0.49 ± 0.05^{a}	0.51 ± 0.04^{a}	0.52 ± 0.04^{a}	1.067 NS
14.	Cu (14-15)	0.58 ± 0.04^{a}	0.61 ± 0.05^{a}	0.59 ± 0.05^{a}	0.60 ± 0.05^{a}	0.58 ± 0.06^{a}	1.848 NS
15.	1m-cu	0.77 ± 0.06^{ab}	0.79 ± 0.07^{b}	0.77 ± 0.05^{b}	0.76 ± 0.06^{ab}	0.75 ± 0.03^{a}	2.162 S
16.	M (12-13)	1.28 ± 0.14^{a}	1.25 ± 0.08^{a}	1.26 ± 0.17^{a}	1.24 ± 0.15^{a}	1.26 ± 0.10^{a}	0.327 NS
17.	Rs	0.79 ± 0.08^{a}	0.87 ± 0.12^{b}	0.86 ± 0.14^{b}	0.99 ± 0.18^{b}	0.81 ± 0.09^{ab}	2.250 S
18.	1r-m	1.22 ± 0.08^{ab}	1.27 ± 0.09^{bc}	1.19 ± 0.07^{a}	1.31 ± 0.16^{c}	1.21 ± 0.05^{ab}	4.153 S
19.	2r-m	1.33 ± 0.07^{b}	1.36 ± 0.07^{b}	1.26 ± 0.18^{a}	1.39 ± 0.11^{c}	1.32 ± 0.10^{ab}	4.555S
20.	2m-cu	1.39 ± 0.11^{a}	1.56 ± 0.16^{c}	1.67 ± 0.18^{d}	1.53 ± 0.22^{c}	1.27 ± 0.06^{a}	22.972 S
21.	M (9-10)	1.74 ± 0.42^{b}	1.69 ± 0.19^{b}	1.77 ± 0.09^{b}	1.58 ± 0.27^{a}	1.78 ± 0.07^{b}	4.508 S
22.	M (7-18)	1.39 ± 0.17^{a}	1.43 ± 0.16^{ab}	1.51 ± 0.12^{b}	1.55 ± 0.22^{ab}	1.39 ± 0.08^{a}	4.713 S
23.	Cu (16-17)	1.39 ± 0.28^{b}	1.16 ± 0.08^{a}	1.21 ± 0.14^{a}	1.22 ± 0.11^{a}	1.17 ± 0.06^{a}	10.278 S
24.	C	6.79 ± 0.42^{b}	6.70 ± 0.47^{b}	6.45 ± 0.49^{a}	6.71 ± 0.22^{b}	6.70 ± 0.26^{b}	2.339 S

Note: All the variable are represent in Mean ± S.D. Mean value with same superscript letter in the given column are not significantly different whereas those with different superscript letter are significantly difference (p<0.05) as judged by Duncan multiple range test (DMRT).

Length and breadth of hind wing showed a significant difference respectively F=7.519; P>0.05 and F= 2.822; P>0.05. Moreover, in hind wing, the hamuli number (Fig. 3) in left and right side, medio cubital cross vein (4-5), basal vein, radial sector vein, radial cross vein, extension of median vein and costal vein showed significant difference between the worker bees collected from geographically distinct areas of southern Karnataka (Table 2).

DISCUSSION

Altogether, 19 traits of fore wing and 10 traits of hind wing showed significant differences between the *A. dorsata* workers bees collected from geographically distinct areas in southern Karnataka.

Table 2 Morphometric details of hind wing of *Apis dorsata* worker bee population of geographically distinct areas of southern Karnataka (n=50)

Sl. No.	Morphometric Traits (in mm)		Manasagangotri	Devaraj Market	Piriyapatna	T.Narasipura	Chamrajnagar	'F' Value
1.	Hind wing	Length	8.56 ± 0.27^{b}	8.59 ± 0.24^{bc}	8.43 ± 0.30^{a}	8.65 ± 0.27^{bc}	8.69 ± 0.21^{c}	7.519 S
		Breadth	2.48 ± 0.11^{a}	2.50 ± 0.19^{ab}	2.47 ± 0.10^{a}	2.54 ± 0.10^{b}	2.49 ± 0.09^{ab}	2.822 S
2.	Hamuli number	Left	25 ± 1.58^{a}	25 ± 2.49^{a}	25 ± 2.00^{a}	24 ± 1.45^{b}	25 ± 2.01^{a}	4.692 S
		Right	25 ± 2.04^{a}	25 ± 2.40^{a}	25 ± 2.00^{a}	23 ± 1.35^{b}	25 ± 2.03^{a}	8.247 S
3.	V		2.68 ± 0.23^{ab}	2.69 ± 0.14^{ab}	2.56 ± 0.33^{a}	2.70 ± 0.26^{ab}	2.71 ± 0.18^{b}	1.679 NS
4.	V1		1.32 ± 0.11^{a}	1.44 ± 0.14^{b}	1.39 ± 0.13^{ab}	1.43 ± 0.23^{ab}	1.39 ± 0.08^{ab}	1.749 NS
5.	M-Cu (3-4)		$2.36\ 0.24^{ab}$	2.39 ± 0.24^{ab}	2.29 ± 0.28^{a}	2.52 ± 0.36^{b}	2.37 ± 0.32^{ab}	1.973 NS
6.	M-Cu (4-5)		1.77 ± 0.13^{ab}	1.78 ± 0.07^{ab}	1.80 ± 0.09^{ab}	1.84 ± 0.12^{b}	1.75 ± 0.14^{a}	2.047 S
7.	Cu-V		0.41 ± 0.03^{a}	0.42 ± 0.07^{a}	0.39 ± 0.09^{a}	0.42 ± 0.05^{a}	0.43 ± 0.10^{a}	0.521NS
8.	Cu		1.79 ± 0.09^{a}	1.74 ± 0.07^{a}	1.74 ± 0.06^{a}	1.76 ± 0.13^{a}	1.74 ± 0.08^{a}	1.612 NS
9.	M		2.17 ± 0.19^{c}	1.96 ± 0.07^{ab}	2.07 ± 0.26^{bc}	1.89 ± 0.29^{a}	1.94 ± 0.11^{a}	7.439 S
10.	r-m		0.21 ± 0.10^{ab}	0.20 ± 0.03^{a}	0.16 ± 0.02^{a}	0.26 ± 0.17^{b}	0.17 ± 0.03^{a}	4.431S
11.	Rs		2.23 ± 0.22^{a}	2.39 ± 0.09^{a}	2.26 ± 0.30^{a}	2.60 ± 0.62^{b}	2.32 ± 0.07^{a}	4.421S
12.	B		0.54 ± 0.13^{a}	0.53 ± 0.13^{a}	0.59 ± 0.17^{a}	0.82 ± 0.48^{b}	0.63 ± 0.17^{a}	5.419S
13.	A		1.62 ± 0.08^{a}	1.62 ± 0.09^{a}	1.64 ± 0.09^{a}	1.66 ± 0.19^{a}	1.62 ± 0.10^{a}	0.696NS
14.	C		4.37 ± 0.29^{ab}	4.33 ± 0.17^{ab}	4.22 ± 0.53^{ab}	4.16 ± 0.50^{a}	4.44 ± 0.19^{b}	2.216 S

Note: All the variable are represent in Mean ± S.D. Mean value with same superscript letter in the given column are not significantly different whereas those with different superscript letter are significantly difference ($p<0.05$) as judged by Duncan multiple range test (DMRT).

In general, both fore wing and hind wing traits have indicated considerable variation among samples collected from geographically distinct places in southern Karnataka (Tables 1 and 2). Thus, 18 traits in fore wing, 10 traits in hind wing showed significant variations. However, medio cubital cross vein (13-24), cubitus, anal vein (20-21), second cubitus, didn't show significant difference in fore wing. While, the vannal vein (7-8), vannal vein (8-9), medio cubital vein (3-4), cubital vannal cross vein, cubitus, anal vein in hind wing didn't show significant difference between the worker bees collected from geographically distinct areas in southern Karnataka (Table 2). Further, hamuli number varied considerably and they were in the range of 21 to 34. Interestingly, the worker bees collected from Devaraj Market, Manasagangotri Campus, Periyapatna and Chamrajanagar has 22 to 29, but the hamuli number was 21 to 27 in worker bee collected at T. Narsipura.

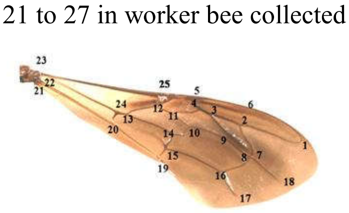

Fig.1. Forewing traits: 1-2-3-4-5-6= Radial cell, 1-4= Radial cell length, 2-6= Radial cell width, 2-7= 2r-m, 3-9= 1r-m, 8-9= Cu A, 7-8= Cu B, Cubital Index= Cu A/ CuB, 9-10= M, 7-18= M, 16-17= Cu, 8-16= 2m-cu, 15-16= Cu1, 10-14= 1m-cu, 14-15= Cu, 15-19= Cu2, 20-21= A, 19-20= A1, 22-24= M+Cu, 13-24= M+Cu1, 13-14= Cu, 20-24= Cu-a, 12-13= M, 5-12= Rs, 23-24= C.

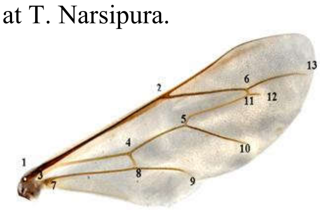

Fig.2. Hind wing traits:1-2= C, 3-4= M+Cu, 4-5= M+Cu1, 5-11= M, 7-8= V, 8-9= V1, 4-8= Cu-v, 5-10= Cu, 6-11= 2r-m, 2-6= Rs, 6-13 = extension of radial sector cell (A), 11-12= extension of median vein (B).

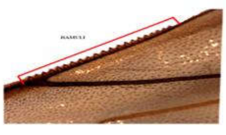

Fig.3. Hamuli in hind wing

Interestingly, six traits each in fore wing (e.g. M+Cu (13-24), Cu (13-14), A (20-21), Cu2, Cu (14-15) and M (12-13) and hind wing (e.g. V, V1, M+Cu (3-4), Cu-v, Cu and 'A' didn't show any differences among these areas. Cao *et al.* (2012) have reported fore wing length of *A. dorsata* worker bees collected from different regions of China. Similarly, Niem *et al*. (1999) have reported the fore wing length of *A. dorsata* worker bees collected in Vietnam and Thailand. 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 Barour *et al.* (2005). Hence, wing traits analysis becomes an important tool, used to characterize and discriminate the honeybee species and sub-species (Gumiel *et al*., 2003; Aytekin *et al*., 2007; Abou Shara and Al-Ghamdi, 2012). However, cubital index was differed considerably from the *A. dorsata* worker bees of Vietnam and Thailand as reported by Niem *et al*. (1999) and Cao *et al*. (2012). However, the cubital vein 'A' of *A. dorsata* worker bee population of geographically distinct areas in southern Karnataka didn't show much difference excepting in *A. dorsata* population of Chamarajanagar. Similar type of observations was made by Cao *et al.* (2012) at three different regions in China. Similarly, in *A. cerana*, *A. mellifera* including bumble bee species by using wing morphometrics was reported by Aytekin *et al.* (2007). Moreover, three racial groups of *A. mellifera* viz., Africanized, Italian and Carniolan honeybees were discriminated with a fidelity level of nearly 99% by considering a single wing cell by Francoy *et al.* (2006). Similarly, Asian honeybee species were discriminated by Rattanawanee *et al*. (2010). Moreover, various wing traits viz., wing angle, venation and length in *A. mellifera* and *A. cerana* are varying. Further, the number of hamuli and their linear extent to the edge of the hind wing of honeybees has higher heritability values and are readily modified by genetic selection (Hepburn and Radloff, 2004). However, Hepburn and Radloff (2004) have showed difference in hamuli number in the worker bees of *A. dorsata* in India. The hamuli number was ranged between 20 and 30 with a mean of 25.31 as reported by Hepburn and Radloff (2004). Interestingly, during the present investigation, the hamuli number was ranged between 22 and 29 with a mean 25 ± 2.01. This data clearly indicated the hamuli number was within the range compared to previous reports published by Hepburn and Radloff (2004). Moreover, both right and left wing hamuli numbers in *A. dorsata* worker bee population of geographically distinct areas in southern Karnataka has differed considerably in *A. dorsata* worker bees. This type of observation in *A. dorsata* worker bee wing traits is first of its kind publishing from this laboratory and it is nowhere else published till date. However, all these findings clearly demonstrated the considerable variation with reference to few wing traits in *A. dorsata.* Since, *A. dorsata* population spread over two Districts of southern Karnataka amidst varied agro-ecosystems clearly revealed the existence of distinct morphoclusters. Perhaps, to acclimatize to the prevailed varied agro-ecological conditions of southern Karnataka, *A. dorsata* might have undergone the process of microevolution in its wing traits modification. However, it is inappropriate to decide the eco-races or sub-species of *A. dorsata* at this juncture, unless the data of cytogenetic or molecular studies obtained from these areas of southern Karnataka. Because, honeybee races identification and characterization could be determined by genetic analysis after morphometry including wing traits (Abou-Shaara, 2013). Similar type of observations was made by Barour *et al*. (2005) in peninsular region of India. Hence, on this line more in depth studies on genetic analysis are required to decide the eco-races or sub-species of *A. dorsata* of geographically distinct areas of southern Karnataka. Such type of studies is initiated in this laboratory to provide data on genetic details to confirm the species variation if any and results of such observations will be published elsewhere.

CONCLUSION

Among 41 wing traits of *A. dorsata* worker bee, 29 traits clearly showed the significant differences between geographically distinct areas in southern Karnataka. Further, number of hamuli in hind wing showed differences compared to previous reports. Furthermore, in present investigation, both right and left wing hamuli numbers in *A. dorsata* worker bee population revealed considerable variation. Obviously, all these findings help us to reveal the existence of eco-race or sub-species of *A. dorsata* amidst geographically distinct areas of southern Karnataka. However, on this line more in depth studies on genetic analysis are required to decide the eco-races or sub-species of *A. dorsata.*

Acknowledgement

First author (BR) is thankful to the UGC, New Delhi for granting her RGN Fellowship to conduct this work. Part of this work is benefitted from the grants of UGC-SAP-CAS Phase-I, New Delhi, granted to DOS in Zoology, University of Mysore, Mysore. Authors are thankful to the Chairperson, DOS in Zoology, University of Mysore, Manasagangotri, Mysore for laboratory facilities and encouragement.

References

1. Abdellatif, M. A., Asou-Elnaga, A. M., Au, M. H., Shakir, P. M. and Ar- Jalili, M. K. 1977. Biometrical studies on Iraqi honeybees. *J. Apicult. Res*., 16: 143-144.
2. Abou-Shaara, H. F. and Al-Ghamdi, A. A. 2012. Studies on wings symmetry and honey bee races discrimination by using standard and geometric morphometrics. *Biotechnol. Animal Husbandry*. 28: 575-584.
3. Abou-Shaara, H. F. 2013. Wing Venation Characters of Honey Bees*. J. Apicult*., 28: 79-86.
4. Adl, M. B. F., Gencer, H. V. Firati, C. and Bahreini, R. 2007. Morphometric characterization of Iranian (*Apis mellifera* meda), Central Anatolian (*Apis mellifera* anatoliaca) and Caucasian (*Apis mellifera* caucasica) honeybee populations. *J. Apicult. Res*., 46: 225-231.
5. Aytekin, M. A., Terz, M., Rasmont, P. and Nese, C. 2007. Landmark based geometric morphometric analysis of wing shape in Sibiricobombus Vogt (Hymenoptera: Apidae: Bombus Latreille). Annales de la Société entomologique de France (N. S.). 43: 95-102.
6. Basavarajappa, S. 1998. Status of natural colonies of *Apis dorsata* in maidan region of Karnataka. *Indian Bee J.,* 60: 143-146.
7. Basavarajappa, S. 2011. UGC Major Research Project Final Report, New Delhi. Pp.1-100.
8. Barour, C., Tahar, A. Radloff, S. E. and Hepburn, H. R. 2005. Multivariate analysis of honeybees, *Apis mellifera* Linnaeus (Hymenoptera: Apidae) of the northeastern and southern regions of Algeria. *African Entomol*., 13: 17-23.
9. Bouga, M. and Hatjina, F. 2005. Genetic variability in Greek honeybee (*A. mellifera* L.) populations using geometric morphometrics analysis. Proceedings of the Balkan scientific conference of biology in Plovdiv (Bulgaria) Heterozygosity. *Genetica*. 97: 211-224.
10. Baskaran, M. 2016. Variation in the morphological characters of the Indian honey bee *Apis cerana indica* (Fabr.) from northern to southern India. J. *Apicult. Res., 55*: 221-227.
11. Cao, L. F., Zheng, H. Q., Chen, X., Niu, D. F., Hu, F. L. and Hepburn, H. R. 2012. Multivariate morphometric analyses of the giant honey bees, *Apis dorsata* F. and *Apis laboriosa* F. in China. *J Apicult. Res*., 51: 245-251.
12. Francoy, T. M., Prado, P. R. R., Gonçalves, L. S., Costa, L. D. F. and De Jong, D. 2006. Morphometric differences in a single wing cell can discriminate *Apis mellifera* racial types. *Apidologie*. 37*:* 91-97.
13. Francoy, T. M., Wittmann, D., Drauschke, M., Muller, S., Steinhage, V., BezerraLaure, M. A. F., De Jon, D. and Goncalves. L. S. 2008. Identification of Africanized honey bees through wing morphometrics: Two fast and efficient procedures. *Apidologie*. 39: 488-494.
14. Gumiel, M., Catala, S., Noireau, F., Rojas De Arias, A., Garcia, A. and Dujardin, J. P., 2003. Wing geometry in Triatoma infestans (Klug) and T. melanosoma Martinez, Olmedo and Carcavallo (Hemiptera: Reduviidae*). Syst. Entomol.*, 28: 173-179
15. Hepburn, H. R and Radloff, S. E. 2004. The wing coupling apparatus and the morphometric analysis of honeybee populations. *S. African J. Sci*., 100: 567-570.

16. Kekecoglu, M., Bouga, M., Soysal, M. I. and Harizanis, P. 2007. Morphometrics as a tool for the study of genetic variability of honeybees. *J. Tekirdag Agri. Fac*., 4: 7-15.
17. Lawal, O. A. and Banjo, A. D. 2010. Appraising the beekeeping knowledge and perception of pest's problem in beekeeping business at different ecological zones in south- western Nigeria. *World J. Zool*., 5:137-142
18. Leelamma, P. J. 1988. Biometry of the Indian hive bee, *Apis cerana* F. of south India (PhD thesis).Himachal Pradesh Uni., Shimla, India.
19. Maa, T. C. 1953. An inquiry into the systematics of the tribus Apidini or honeybees (Hym.). *Treubia*. 21:525-640.
20. Masemola, A. R. and Kryger, P. 2011. Morphometric study of wings and hamuli as parameters to discriminate between *Apis mellifera capensis* and *Apis mellifera scutellata* worker bees. Proc. 37th Internat. Apicult. Congr. Durban, South Africa.
21. Mattu, V. K. 1982. Morphometric and behavioral studies on Indian honey bee (*Apis cerana indica* F.) (Ph. D Thesis). Himachal Pradesh Uni., Shimla, India.
22. Mendes, M. F. M., Francoy, T. M., Nunes-Silva, P. and Menezes, C. 2007. Intra-populational variability of Nannotrigona testaceicornes Lepeletier 1836 (Hymenoptera, Meliponini) using relative warps analysis. *Biosci. J.,* 23:147-152.
23. Niem, N. V. and Trung. L. Q. 1999. Morphological Comparison of Three Asian Native Honey Bees (*Apis cerana, A. dorsata, A. florea*) in Northern Vietnam and Thailand. *BIOTROPIA-The Southeast Asian J. Tropical Biol*., 14.
24. Porporato. M., Laurino. D., Balzola. L. and Manimo, A. 2014. Wing venation teratology in *Apis mellifera* L. *J. of Zool*., 97:157-163.
25. Rattanawanee, A., Chanchao, C. and Wongsiri, S. 2010. Gender and Species Identification of Four Native Honey Bees (Apidae: *Apis*) in Thailand Based on Wing Morphometric Analysis. *Ann. Entomol. Soc. America*. 103: 965-970.
26. Ruttner, F., Tassencourt, L. and Louveaux, J. 1978. Biometrical-statistical analysis of the geographic variability of *Apis mellifera* L. *Apidologie*. 9: 363-381.
27. Ruttner, F. 1988. Biogeography and taxonomy of honeybees. Springer Verlag, Berlin., Pp. xxii + 284.
28. Sherma, A. 1989. Biometry of Asian hive bees *Apis cerana* F. of central and western Himalayas. Ph.D. Thesis. Himachal Pradesh Uni. Shimla, India.

How to cite this article:

Bidisha R and Basavarajappa S (2018) 'Fore And Hind Wings Morphometry of Apis Dorsata Worker Honeybees (Hymenoptera:Apidae) of Geographically Distinct Areas of Southern Karnataka, India)', *International Journal of Current Advanced Research,* 07(4), pp. 12025-12029. DOI: http://dx.doi.org/10.24327/ijcar.2018.12029.2105

****