

Morphometric studies on bumble bee, *Bombus haemorrhoidalis* Smith

AVINASH CHAUHAN, BS RANA, SAPNA KATNA and KIRAN RANA

Department of Entomology

Dr YS Parmar University of Horticulture and Forestry, Nauni, Solan 173230 HP, India

Email for correspondence: avi_shimla@hotmail.com

ABSTRACT

Bumble bees are important pollinators because of their more working hours, buzz pollination of crops, short flight range and cold hardiness. These have three different castes (queen, drone and worker) with specific division of labour. Morphometric studies of *Bombus haemorrhoidalis* Smith were undertaken to know the differences for the identification of different castes. Total measurements recorded on twenty five characters were pertaining to tongue, mandible, antennae, fore wings, hind wings and legs of all castes. Data revealed that queen bee was bigger in size than both worker and drone. The average body length of queen, drone and worker was 26.40 ± 0.26 , 18.13 ± 0.35 and 20.22 ± 0.22 mm respectively. The antennal length was found to be 7.02 ± 0.07 , 12.04 ± 0.10 and 5.20 ± 0.09 mm in queen, drone and worker respectively. The flagellum had ten segments in all the castes of bumble bee. Queen had longer tongue (14.08 ± 0.29 mm) than worker and drone. Queen consumed less food (2.0 g) (nectar + pollen) as compared to worker (2.09 g) and drone (2.03g). However pollen consumption was more in queen (0.76 g) than worker (0.54 g) and drone (0.24 g) respectively.

Keywords: *Bombus haemorrhoidalis*; castes; morphometrics; food consumption

INTRODUCTION

Bumble bees are important pollinators and are widely known throughout the globe for pollination services they deliver. *Bombus haemorrhoidalis* is a dominant species found mainly under subtropical and sub-temperate regions in India. Artificial rearing methods have been developed for their year round rearing (Chauhan et al 2014) but their caste differentiation is not completely known. Bumble bees have three different castes viz queen (foundress of

colony), drones (males) and workers (working force). Dayal and Rana (2004) described the workers and queen morphometrics of bumble bees. Drones remained unidentified morphologically and morphometrically till 2011. Sometimes bumble bee colonies only produce drones which are mis-assumed as workers. This leads to the destruction of colonies in the early season (June-July) since these drones do not gather food for the colony and hence colony gets dwindled. Keeping in view the importance of caste differentiation in

bumble bees for their successful rearing, present studies were conducted to know the morphological, morphometrical and food consumption differences in different castes of *B haemorrhoidalis*.

MATERIAL and METHODS

Morphometrics studies of *B haemorrhoidalis* were made on queen, drone and worker. Colonies of bumble bees were reared as per the earlier methods (Thakur et al 2005, Chauhan 2011) with some modifications. Bees were collected from the colonies having all the three castes. These isolated bees were anaesthetized with formalin in killing bottle, killed and preserved in 70 per cent ethyl alcohol as per the method of Ruttner et al (1978). All the parts to be measured were carefully taken out and placed on a clean slide for measurement. All measurements were recorded under stereomicroscope equipped with an ocular micrometer. Total measurements recorded on twenty five characters were pertaining to tongue, mandibles, antennae, forewings, hind wings and legs of all castes. These measurements were recorded as per the methods followed by Mattu and Verma (1984) and Dayal and Rana (2007).

RESULTS and DISCUSSION

Morphometrics of bumble bee

Queens and workers of *B haemorrhoidalis* have black pigmented body with yellow band on the dorsal side

of abdomen. Queen bee is bigger in size than worker. Drone bears yellow or white pubescence on its head (vertex), thorax (lateral sides) and sometimes also on legs, have third antennal segment longer than that of worker and queen. Drone does not sting as it does not bear sting apparatus. The average body length of queen, drone and worker was 26.40 ± 0.26 , 18.13 ± 0.35 and 20.22 ± 0.22 mm respectively. The flagellum had ten segments in all the castes of bumble bee. The size of mandible in worker (1.64 ± 0.04 , 0.82 ± 0.01 mm) was smaller as compared to queen (2.41 ± 0.03 , 1.09 ± 0.04 mm) but bigger than drone (1.32 ± 0.02 , 0.79 ± 0.03 mm). The antennal length was found to be 7.02 ± 0.07 , 12.04 ± 0.10 and 5.20 ± 0.09 mm in queen, drone and worker respectively. Tongue length in queen, drone and worker was recorded as 14.08 ± 0.29 , 10.22 ± 0.31 and 11.44 ± 0.57 mm. The hind legs of queen and worker were corbiculated and surrounded by a fringe of hairs and also bore a row of stiff spines at inner margin of tibia (Table 1). Data on morphometric studies of local bumble bee revealed that queen bee was bigger in size than both worker and drone (26.40 , 18.1 and 20.22 mm). The flagellum had ten segments in all the castes. The size of mandible in worker (1.64 , 0.82 mm) was smaller as compared to queen (2.41 , 1.09 mm) but bigger than drone (1.32 , 0.79 mm). The antennal length was found to be 7.02 , 12.04 and 5.20 mm and tongue length 14.08 , 10.22 and 11.44 mm in queen, drone and worker

Table 1. Comparative morphometric data of different castes of bumble bee, *B. haemorrhoidalis*

Character	Queen (Mean $\pm$ SE)	Drone (Mean $\pm$ SE)	Worker (Mean $\pm$ SE)
Total body length (mm)	26.40 $\pm$ 0.26	18.13 $\pm$ 0.35	20.22 $\pm$ 0.22
Tongue (mm)			
Length of pre-mentum	4.05 $\pm$ 0.04	2.92 $\pm$ 0.05	2.99 $\pm$ 0.12
Breadth of pre-mentum	1.14 $\pm$ 0.02	0.68 $\pm$ 0.01	0.77 $\pm$ 0.04
Length of post-mentum	1.25 $\pm$ 0.02	0.82 $\pm$ 0.04	0.84 $\pm$ 0.03
Length of glossa	7.90 $\pm$ 0.23	6.07 $\pm$ 0.11	6.34 $\pm$ 0.33
Total length of tongue	14.08 $\pm$ 0.29	10.22 $\pm$ 0.31	11.44 $\pm$ 0.57
Mandible (mm)			
Length	2.41 $\pm$ 0.03	1.32 $\pm$ 0.02	1.64 $\pm$ 0.04
Breadth	1.09 $\pm$ 0.04	0.79 $\pm$ 0.03	0.82 $\pm$ 0.01
Antenna (mm)			
Length of scape	2.57 $\pm$ 0.02	2.07 $\pm$ -0.04	1.92 $\pm$ 0.02
Length of pedicel	0.42 $\pm$ 0.01	0.39 $\pm$ 0.02	0.29 $\pm$ 0.01
Length of flagella	5.10 $\pm$ 0.04	9.88 $\pm$ 0.04	3.99 $\pm$ 0.05
Total length of antenna	7.02 $\pm$ 0.07	12.04 $\pm$ 0.10	5.20 $\pm$ 0.09
Forewing (mm)			
Length	21.56 $\pm$ 0.03	13.83 $\pm$ 0.09	15.98 $\pm$ 0.04
Breadth	7.09 $\pm$ 0.11	4.88 $\pm$ 0.12	5.42 $\pm$ 0.21
Hind wing (mm)			
Length	14.75 $\pm$ 0.06	9.39 $\pm$ 0.04	11.59 $\pm$ 0.12
Breadth	4.68 $\pm$ 0.04	3.00 $\pm$ 0.01	2.95 $\pm$ 0.04
Number of hamuli	21.62 $\pm$ 0.32	25.05 $\pm$ 0.14	25.97 $\pm$ 0.07
Legs (mm)			
Length of coxa	2.82 $\pm$ 0.02	1.86 $\pm$ 0.04	1.98 $\pm$ 0.01
Length of trochanter	1.90 $\pm$ 0.03	1.64 $\pm$ 0.03	1.66 $\pm$ 0.03
Length of femur	4.44 $\pm$ 0.02	3.96 $\pm$ 0.03	1.53 $\pm$ 0.02
Length of tibia	3.29 $\pm$ 0.09	3.02 $\pm$ 0.10	1.16 $\pm$ 0.02
Length of tarsus	6.00 $\pm$ 0.21	5.54 $\pm$ 0.23	2.88 $\pm$ 0.04
Length of metatarsus		6.23 $\pm$ 0.15	2.48 $\pm$ 0.07
Breadth of metatarsus		6.43 $\pm$ 0.09	2.96 $\pm$ 0.04
		4.44 $\pm$ 0.12	5.07 $\pm$ 0.21
		2.07 $\pm$ 0.03	6.52 $\pm$ 0.13
			2.90 $\pm$ 0.02
			1.23 $\pm$ 0.07

respectively. Earlier Dayal and Rana (2007) have reported the body size of queen and worker of the same species as 26.42 and 18.03 mm. Similarly flagellum had 10 segments in both castes. They also found that the mandibles in worker (1.63 mm) were smaller as compared to queen (2.37 mm).

Food consumption in bumble bees

B haemorrhoidalis queen consumed more pollen (0.76 g) in comparison to worker (0.54 g) and drone (0.24 g) per day while drone utilized more sucrose (1.79 ml) than worker (1.55 ml) and queen (1.24 ml) (Table 2). Earlier Chauhan (2011) reported that the queen of the same species consumed about 0.78 g of pollen daily which is in close conformity with the present results. Similarly Pridal and Hofbaur (1998) observed that *B terrestris* queen consumed 0.62 g of pollen and 0.86 ml sucrose daily. These variations might be due to difference in the bumble bee species. The pollen consumption was reported to be increased rapidly in developing colonies (Dayal and Rana 2004). It has also been reported that adult bumble bees have

ongoing need for protein food throughout life and hence they eat pollen without subsequently feeding larvae for own needs (Smeets and Duchateau 2003).

CONCLUSIONS

B haemorrhoidalis queen bee (26.40 mm) was bigger in size than both worker and drone (18.1 and 20.22 mm respectively). The size of mandible in worker (1.64, 0.82 mm) was smaller as compared to queen (2.41, 1.09 mm) but bigger than drone (1.32, 0.79 mm). The antennal length was greater in drone (12.04) than queen (7.02 mm) and worker (5.20 mm). Tongue length in queen, drone and worker was recorded as 14.08, 10.22 and 11.44 mm. The hind legs of queen and workers were corbiculated. Similarly queen consumed more pollen while drones consumed more sucrose as compared to workers. These studies would help in understanding the morphometric differences in different castes of bumble bee species for their identification.

Table 2. Consumption of food (sucrose and pollen) by different castes of bumble bee, *B haemorrhoidalis* under laboratory conditions

Caste of bumble bee	Pollen (g)	Sucrose (ml)
Queen	0.76 ± 0.03	1.24 ± 0.2
Worker	0.54 ± 0.05	1.55 ± 0.13
Drone	0.24 ± 0.01	1.79 ± 0.04

ACKNOWLEDGEMENTS

The authors are thankful to Indian council of Agricultural Research, All India Coordinated Research Project on Honeybees and Pollinators for providing the financial assistance for the study.

REFERENCES

- Chauhan A 2011. Refinement of bumble bee rearing technology and its use in cucumber pollination. MSc thesis, Dr YS Parmar University of Horticulture and Forestry, Nauni, Solan, HP, India.
- Chauhan A, Rana BS and Katna S 2014. Successful rearing of bumble bee, *Bombus haemorrhoidalis* Smith year round in Himachal Pradesh in India. International Journal of Current Research **6(12)**: 10891-10896.
- Dayal K and Rana BS 2004. Record of domestication of *Bombus* species (Hymenoptera: Apidae) in India. Insect Environment **10(2)**: 64-65.
- Dayal K and Rana BS 2007. Morphometrics of queen and worker of the bumble bee, *Bombus haemorrhoidalis* (Hymenoptera: Apidae). Indian Bee Journal **69(1-4)**: 103-106.
- Mattu VK and Verma LR 1984. Comparative morphometric studies on the Indian honeybee of the northwest Himalayas. I: Tongue and antenna. Journal of Apicultural Research **22(2)**: 79-85.
- Pridal A and Hofbauer J 1998. Laboratory rearing and nutrition of young queens of bumble bee from emergence to diapauses. Sbornik Vedeckych Praci Vyzkumneho Ustavu Picinarsko v Troubsku **14**: 125-131.
- Ruttner F, Tassencourt L and Louveaux J 1978. Biometrical statistical analysis of the geographic variability of *Apis mellifera* L. I: materials and methods. Apidologie **9(4)**: 363-381.
- Smeets P and Duchateau M 2003. Longevity of *Bombus terrestris* workers (Hymenoptera: Apidae) in relation to pollen availability in the absence of foraging. Apidologie **32**: 333-337.
- Thakur RK, Gupta JK and Gupta PR 2005. Investigation on rearing of bumble bees (*Bombus* spp) in captivity. International Beekeeping Congress, 13-18 November 2005, Century Foundation and Mountain Research Development Associates (MRDA), FAO, Bangalore, Karnataka, India.

Received: 30.3.2015

Accepted: 12.10.2015