

New record of bumble bee, *Bombus breviceps* Smith as a pollinator of large cardamom

T. N. Deka^{1,*}, M. R. Sudharshan^{1,2} and K. A. Saju¹

¹Indian Cardamom Research Institute, Regional Station, Spices Board, Tadong 737 102, India

²Present address: Indian Cardamom Research Institute, Spices Board, Myladumpara, Kailasanadu 685 553, India

Large cardamom (*Amomum subulatum* Roxb.) belonging to the family Zingiberaceae, is the main cash crop and spice cultivated in the sub-Himalayan state of Sikkim, and Darjeeling District, West Bengal, India. It is essentially a cross-pollinated crop due to the heterostyly nature of its flowers, though they are self-fertile. Effective cross pollination occurs with the help of bumble bees due to their compatible body size within the cavity of the floral tube (corolla), bringing the upper part of the thorax in contact with the stigma and anther of the flower. The thorax carries the pollen from distant flowers. Here we report the bumble bee *Bombus breviceps* Smith as an effective pollinator of large cardamom during the initial flowering period at different altitudes of cultivation.

Keywords: *Amomum subulatum*, *Bombus breviceps*, heterostyly flowers, pollinator.

LARGE cardamom (*Amomum subulatum* Roxb.) is also called Greater, Indian or black cardamom. It belongs to Zingiberaceae, the largest family of the order Scitamineae, and is found throughout the tropics but is predominant in Asia. This family consists of important spices which are mostly aromatic. Large cardamom is indigenous to the moist, deciduous and evergreen forest of the sub-Himalayan tracts. It is the main cash crop cultivated in Sikkim, and Darjeeling District, West Bengal, India. The crop has also spread to other North Eastern states and neighbouring countries like Nepal and Bhutan^{1,2}. The plant is a perennial herb having subterranean rhizomes which give rise to leafy shoots and inflorescences. Leafy shoots, also called pseudostems, are formed by long sheath-like stalks (petiole) encircling one another. The height of mature pseudostem ranges from 1.5 to 3.0 m. Inflorescence is a condensed spike on a short peduncle bearing 40–50 flower buds in an acropetal succession.

Large cardamom is essentially a cross-pollinated crop due to its heterostyly (pin-type) nature of flowers, though they are self-fertile. Natural pollination takes place with the help of bees. Flowering starts from March–April at lower altitudes and continues up to July at mid and high

altitudes depending on the weather condition and type of cultivars (Table 1). Though each spike bears 40–50 flowers, only 10–15 capsules are formed per spike. The flowers remain viable for about 14 h after opening. Anthesis starts at 8.00 a.m. and ends at 8.30 a.m. on sunny days and from 9.15 to 9.30 a.m. on cloudy and rainy days. The stigma is receptive for 24 h on rainy and cloudy days, and is limited to 2 h on sunny days, from 1.00 to 3.00 p.m. only³. Preliminary studies on the role of honey bees (*Apis dorsata*) on productivity of large cardamom showed that increase in production was directly related to increase in honey-bee colonies⁴. However, further studies showed bumble bee, *Bombus haemorrhoidalis* Smith as the only effective pollinator and *Apis cerana* as the pollen robber⁵. It has been mentioned that major flower adaptations for pollination by the bumble bee are the length of the nectar tube, which is not accessible to short-tongued bees, and a narrow passage in the fresh flower between the anther–stigma column and the labellum. The narrow passage forces the bumble bee to push the anther–stigma column to enter the flower, which brings the body of the bumble bee in contact with the anther and the stigma, and thus effects pollination. The body of *A. cerana* does not come in contact with the stigma during pollen foraging and hence is unable to bring about pollination⁵. Foraging activity of bumble bees was maximum during 5.00–6.00 a.m. on clear days and their activity became less or even nil on rainy days^{6,7}.

In this study, we investigated the taxonomic identity of different pollinators of large cardamom at various altitudes of cultivation for three years. Native bees were identified at the family, genus or species level, and honey bees were recorded separately. General notes were also taken on other types of flowering plants adjacent to the large cardamom garden and bees that visited them. Representative bee collections were made and sent to taxonomic experts for identification. Voucher bee species were pinned, labelled and stored in special insect collection boxes at the Indian Cardamom Research Institute (ICRI), Regional Station, Tadong.

The flowers were visited by bumble bees (*B. breviceps*, *B. haemorrhoidalis*) and honey bees (*A. cerana*, *A. dorsata*), unidentified insects and ants. Among these, *B. breviceps* Smith (Hymenoptera; Apidae, Bombini) was recorded as an early season pollinator. We observed that bumble bees are effective pollinators due to their compatible body size within the cavity of the corolla while entering the floral tube, thus bringing the upper part of their thorax in contact with the stigma and anther of the flower. The thorax carries the pollen from distant flowers. The bees enter the flower for sucking honey which is present at the base of the floral tube and the pollination is a passive process (Figure 1 a and b). The bees were also found to visit ornamental flowers grown in the vicinity of the large cardamom plantation during off-season (Figure 1 c).

*For correspondence. (e-mail: tikendeka07@yahoo.co.in)



Figure 1. *a*, Full view of *Bombus breviceps*. The size and abdominal colouration are important taxonomic characters. *b*, *B. breviceps* entering the floral cavity and collecting honey. The thorax of the bee which carries pollen from distant flowers is seen touching the stigma. *c*, *B. breviceps* visiting flowers of ornamental plants grown in the vicinity of a large cardamom plantation.

Table 1. Bee species visiting large cardamom flowers as recorded at various altitudes of cultivation

Altitude (m amsl)	Flowering period	Pollinators recorded	Period of occurrence of pollinators
High (> 1515)	May–July	<i>Bombus breviceps</i> <i>Bombus haemorrhoidalis</i> <i>Apis</i> spp.	Initial flowering period Mid and late flowering period Throughout the flowering period
Mid (970–1515)	April–June	<i>B. breviceps</i> <i>B. haemorrhoidalis</i> <i>Apis</i> spp.	Initial flowering period Mid and late flowering period Throughout the flowering period
Low (<970)	March–May	<i>B. breviceps</i> <i>B. haemorrhoidalis</i> <i>Apis</i> spp.	Initial flowering period Mid and late flowering period Throughout the flowering period

Table 2. Comparative morphometry of *Bombus breviceps* and *Bombus haemorrhoidalis*

Appendage	<i>B. breviceps</i>		<i>B. haemorrhoidalis</i>	
	Length (mm)	Width (mm)	Length (mm)	Width (mm)
Head	8.2 (7.2–9.4)	6.5 (6.2–6.7)	6.1 (5.0–7.2)	4.5 (4.2–5.1)
Thorax	8.6 (7.5–9.4)	9.7 (9.4–10.2)	5.6 (5.3–6.2)	6.1 (6.0–6.3)
Abdomen	17.1 (16.9–17.4)	10.4 (9.2–11.5)	9.3 (8.4–10.3)	5.6 (5.2–5.9)
Forewing	23.2 (22.2–24.0)	7.3 (7.1–7.6)	12.5 (12.0–13.2)	4.6 (4.5–4.9)
Hindwing	15.4 (14.9–16.2)	4.5 (4.2–5.1)	9.2 (8.5–9.7)	2.2 (2.1–2.4)
Foreleg	17.1 (15.9–18.2)	1.4 (1.2–1.6)	10.3 (9.2–11.5)	1.3 (1.2–1.4)
Midleg	21.0 (19.4–22.3)	1.8 (1.4–2.5)	10.4 (9.6–11.4)	1.9 (1.7–2.3)
Hindleg	31.2 (30.0–32.2)	2.6 (2.3–3.1)	13.4 (12.6–14.2)	2.0 (1.7–2.6)
Antenna	6.5 (5.9–7.1)	0.06 (0.05–0.07)	4.7 (4.5–5.1)	0.04 (0.03–0.04)
Proboscis	15.2 (14.3–16.2)	–	14.4 (13.6–15.1)	–

Data represent mean of three observations. Values in parenthesis are range.

Bumble bees were observed during early flowering season at all altitudes. Large cardamom continues to bloom for about 45–60 days, and sometimes up to 90 days (Table 1). Initially, for about 20–30 days, flowering is less in gardens in all altitudes. In low altitudes, peak flowering starts during May, whereas in medium and high altitudes it starts during June–July.

B. breviceps was recorded from low altitude (Dzongu, North Sikkim; during April), mid altitude (Assam Lingzey and Pakyong, East Sikkim) and high altitude (Kabi, North Sikkim, 1800 m amsl, April–May; Pangthang, East

Sikkim, 2120 m amsl, June–July) in the early flowering period. During the initial period of flowering, *B. breviceps* dominates as the sole pollinator, and during the mid and late flowering period, *B. haemorrhoidalis* is seen predominantly pollinating the flowers. It was observed that peak flowering season can have relatively high abundance of bee population.

B. breviceps is bigger in size than *B. haemorrhoidalis*. The comparative morphometry of different body parts of both the species was recorded and compared (Table 2). They belong to the family Apidae, order Hymenoptera.

Morphologically, they are hairy black and yellow whose size ranges from 1.88 to 3.75 cm, similar to carpenter bee. However, bumble bees have fuzzy abdomen, whereas carpenter bees have a smooth abdomen. There are about 200 different types of bumble bees in the world. They are social bees like the honey bee. Long and branched setae cover their entire body giving a fuzzy appearance. Female bee hind legs are modified to corbicula, which is a shiny concave surface that is bare, but surrounded by a fringe of hairs used to transport pollen. They are able to work in cold climate as long hair coats help them stay warm⁸⁻¹⁰. *B. breviceps* nest in the ground. Soil characteristics, where the nesting is found, such as composition, texture, compaction, slope and exposure are important factors for bee habitat maintenance.

A literature survey reveals that, *B. haemarrhoidalis* has been recorded as the sole pollinator of large cardamom. However, the present study reveals *B. breviceps* as the pollinator of large cardamom, especially during early flowering season at different altitudes of cultivation.

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Recent records of the endemic Kerala mud snake, *Enhydris dussumierii* (Duméril, Bibron & Duméril, 1854) from India

A. Biju Kumar^{1,*} and Ashok Captain²

¹Department of Aquatic Biology and Fisheries, University of Kerala, Thiruvananthapuram 695 581, India

²No. 3/1 Boat Club Road, Pune 411 001, India

A rare, little known and endangered species of mud snake, *Enhydris dussumierii* (Duméril, Bibron & Duméril, 1854), has been reported from Vellayani Lake, Kerala, India. Some taxonomic characters are redescribed, with notes on its colour pattern, diet and occurrence.

Keywords: Diet, homalopsidae, *Enhydris dussumierii*, taxonomic characters, Vellayani Lake.

THE genus *Enhydris* Sonnini and Latreille, 1802 is a highly diverse, enigmatic clade of homalopsid snakes with 23 species. The genus is represented in India by four species – the Kerala mud snake *Enhydris dussumierii* (Duméril, Bibron & Duméril, 1854), the Rainbow mud snake *Enhydris enhydris* (Schneider, 1799), Boie's mud snake *Enhydris plumbea* (Boie, 1827) and Siebold's mud snake *Enhydris sieboldii* (Schlegel, 1837)¹. The homalopsids are one of the five basal caenophidian clades that form the sister clade to all of the Colubroidae in the phylogeny proposed by Vidal *et al.*². Little is known about snakes of the family Homalopsidae, despite the fact that they are widespread and abundant in some habitats³, using both lotic and lentic aquatic ecosystems.

E. dussumierii is named after Jean-Jacques Dussumier (1792–1883), a French nobleman, mariner and naturalist, who collected fish and other vertebrate specimens from many parts of Asia. The two syntypes (MNHN 3751 and MNHN 3752) are located in the Museum National d'Histoire Natural (MNHN), Paris. The species was first described by Duméril *et al.*⁴ as *E. dussumieri* [sic]. Till date, two museum specimens exist, fide Gyi^{3,5}. A possible third specimen (*Hypsirhina malabarica*) in the Hamburg Museum was destroyed during World War II. Though Smith⁶ synonymized *H. malabarica* with *E. dussumierii*, Murphy³ doubts the synonymy based on differing tail/snout-vent length ratios, and the number of scale rows at the midbody, suggesting another species may be present. *E. dussumierii* is endemic to Kerala, and there are only a few published reports on its occurrence, distribution and biology^{3-5,7-9}. The first photograph of this species in life, taken by Ingrid Simpson in Kerala, was published by Murphy³.

*For correspondence. (e-mail: abiju@rediffmail.com)