

Diversity of Bee Pollinators – Global and Indian Perspective

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Bees are important diverse group of pollinators that contribute to pollination and reproductive success of many angiosperms. Of the hundred principal crops that accounts for world's food supply, only 15 % was pollinated by domestic bees (honeybees and bumble bees) and 80% are pollinated by wild non-apis bees (leaf cutter bees, sweat bees, digger bees). Honeybees, bumble bees and stingless bees were social in habit with typical caste system (queen, drones and workers) and division of labour. Seven different species of honeybees were reported from India viz., *Apis mellifera*, *A. cerana*, *A. florea*, *A. dorsata* and *A. labriosa*. Among the different species of honeybees, *A. mellifera* and *A. cerana* were domesticated in India for the honey production. Native bees like leaf cutter bees, sweat bees, digger bees were solitary in habit and constructs their habit in hollow cavities, pithy stems and underground. The native bees buzz pollinates plants with typical floral morphology results in increased fruit/pod set and yield in different crops.

Pollination

Pollination is an ecosystem process that has evolved over millions of years to benefit both flowering plants and pollinators. Pollinators visit flowers for many reasons, including feeding, pollen collection and for gaining warmth. When pollinators visit flowers, pollen rubs or drops onto their bodies. The pollen is then transferred to another flower or a different part of the same flower as the pollinator moves from one location to the next. This process is a vital stage in the life cycle of all flowering plants and is necessary to start seed and fruit production in flowers. Not only do pollinators provide essential services in nature, they are also necessary for healthy, productive agricultural ecosystems as they ensure the production of full-bodied fruit and fertile seed sets in many crops.

Contribution of Bee pollinators to agriculture

Pollination services in economic terms was valued to the tune of about \$219 billion per year contributing to 9.5% of global crop value (Calderone, 2011) both the services provided by managed honeybees and wild non-apis bees. Native bees complement the role of honeybees in many crops contributing substantially to the crop pollination.

Melittophily-Bees as Pollinators

Diversity of Bee Pollinators

Bees are important group of pollinators with around 20,000 described species worldwide (Michener, 2007).

Apidae is the well distributed first largest family that includes honeybees, bumble bees and carpenter bees with around 5700 species reported worldwide. The family Apidae comprises of three major subfamilies viz., Apinae, Xylocopinae and Bombinae with around 25 genera of bees (Pannure, 2016). The native solitary bees belong to the families Megachilidae (leaf cutter bees), Halictidae (sweat bees), Colletidae (minner bees) and Melittidae (digger bees).

Honeybees

Honeybees are major group of insect pollinators that belongs to the genus *Apis*, family Apidae and order Hymenoptera. Seven different species of honeybees were reported from Asia viz., European honeybee *Apis mellifera*, Indian honeybee *A. cerana*, dwarf or little honeybee *A. florea*, rock bee or giant bee *A. dorsata* and giant mountain honeybee *A. labriosa* (Yadav et al., 2017).

Apis mellifera

This is a domesticated bee species with habits similar to Indian honeybee *A. cerana indica* except for the behaviour of construction of parallelly arranged multiple combs with a uniform bee space. This species of honeybee is widely domesticated in America, Australia, Asia, Europe and Africa. Across the continents of distribution of this species of bee, *A. mellifera* around 20 subspecies or races were designated globally due to the tremendous variations in the species. Based on the morphometric and

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genetic analysis supported with ecological, physiological and behavioural traits, four major groups of *A. mellifera* was reported (Franck *et al.*, 2001; Miguel *et al.*, 2011). The four reported races of *A. mellifera* includes group A that comprised of all subspecies throughout Africa; group M that includes subspecies from Western and Northern Europe; group C includes subspecies from Eastern Europe and group O includes species from Turkey and Middle East.

The Africanized bees were reported to be hybrid species of *A. mellifera* often referred as ‘killer bees’ have a habit of aggressive stinging with a habit of chasing the intruders over greater distances during the instances of miss handling and excitation (Nogueira-Neto, 1964; Rinderer & Hellmich, 1991). This aggressive race of *A. mellifera* were reported to establish when *A. mellifera* from South Africa mated with Brazilian population and this strain was first reported in Brazil in the 1950s later deducted through America.

Apis cerana

This species commonly referred as Indian honeybee of Asian honeybee is native to Asia. This is widely domesticated species in India with gentle temperament and easy to handle. *A. cerana* has a strong tendency of swarming and absconding. The honey yield is less compared to the Western honeybee, *A. mellifera* but with wider adaptability for domestication. This species is relatively resistant to all pest and diseases infesting the colonies. In India, two races of *A. cerana* was reported (Kapil 1956; Narayanan et al. 1960a&b) viz., black ‘hill’ morph adapted to thrive in higher elevations and yellow ‘plain’ morph in lower elevations. Three subspecies of honeybees were also reported by International Centre for Integrated Mountain Development (ICIMOD) from India *A. cerana indica* found in plains, *A. cerana cerana* in the north-west Himalayas, parts of Pakistan and Nepal and *A. cerana himalaya* in hills of Nepal, Uttar Pradesh, the north-east Himalayas and Bhutan.

Apis florea

This species of bee commonly referred as ‘little bee’ or ‘dwarf bee’ construct nests with single small sized comb (Vaudo *et al.*, 2012). Similar to *A. dorsata* they have an open nesting habit usually nesting in trees or shrubs or branches. They are highly prone to swarm with gentle in temperament. The honey yield of this bees is very low and due to its higher swarming behaviour, this species of bee is not domesticated in India.

Apis dorsata

This species commonly referred as ‘rock bee’ or ‘giant honeybee’ distributed across India occurring commonly in foothills of mountains, forest areas and swarms of this bees often can be seen in urban dwellings. They construct open exposed nest with a single comb with a strong defensive behaviour (Woyke *et al.*, 2001; Liu *et al.*, 2007). Because of the higher migratory behaviour with aggressiveness, comb structure with a strong temperament during handling, the domestication of this species is meagrely attempted in India.

Apis labriosa

This species of bees was reported from Nepal, Bhutan, Sikkim and Yunnan between altitudes of 1200 and 1400 m. They are relatively larger in size compared to *A. dorsata* and were reported to be active in lower temperatures and greater heights (Gupta, 2014). They construct exposed single combs in mountainous areas.

Dammer Bees or Stingless Bees

Stingless bees belonging to the genus *Tetragonula* and *Melipona* are smaller in size, easily amenable for domestication; construct their nests of irregular combs of colonies using wax and resin in cracks, walls and other places (Leonhardt *et al.*, 2007; Kumar *et al.*, 2012). In Indian subcontinent, eight species of stingless bees were reported viz., *Lepidotrigona arcifera* (Cockerell), *Lisotrigona cacciae* (Nurse), *Lisotrigona mohandasi* Jobiraj & Narendran, *Tetragonula aff. laeviceps* (Smith), *Tetragonula bengalensis* (Cameron), *Tetragonula gressitti* (Sakagami), *Tetragonula iridipennis* (Smith), *Tetragonula praeterita* (Walker), and *Tetragonula ruficornis* (Smith) (Rasmussen 2013). Stingless bees have lesser absconding and swarming behaviour compared to honeybees and they are relatively more tolerant to diseases as their nests are made of resin/propolis. Stingless bees play a crucial role in the pollination of mango, strawberry, coconut, lablab, gooseberry and cucurbits.

Bumble Bees

Bumble bees belongs to the subfamily Bombinae are social in habit with typical caste system ie., queen, worker and drone like honeybees thrive in the higher elevations and temperate climatic conditions. In India, around 62 species of bumble bees were reported from the Himalayan regions (Williams, 2022). Bumble bees are commercially utilised buzz pollinators for enhancing

fruit/seed set in crops grown under protected cultivations like strawberry, tomato, brinjal and cucurbits.

Native Solitary Bees

Leaf Cutter Bees

Leafcutter bees are solitary in habit belonging to the family Megachilidae. Adult females of leaf cutting bees belonging to the genus *Megachile* sp uses leaf pieces/resin/soil particles/minute pebbles to construct nests in the pre-existing cavities, hollow stems, dead woods and manmade holes (Cane *et al.*, 2007). The genus *Megachile* with 1489 species is the largest in the family Megachilidae (Kunjwal *et al.*, 2020). In India, 237 megachilid bee species including 96 species of the genus *Megachile* are reported (Ascher & Pickering, 2018). These bees are specialised pollinators of plants with ‘papilionaceous flowers’ and they trip the flower to get the pollen reward (Abrol *et al.*, 1990). They are important commercially utilised pollinators of alfalfa (Pitts Singer & Cane, 2011), legumes (Amala & Shivalingaswamy, 2021) *etc.*

Sweat Bees

They are solitary in habit belongs to the family Halictidae with subterranean nesting habit. The world fauna counts over 250 species of halictid bees (Astafurova, 2013). These bees were attracted to human perspiration. Few species of Halictids, *viz.*, *Hoplonomia westwoodi*, *Nomia* sp, *Lasioglossum* sp were reported to be the buzz pollinators of solanaceous crops like tomato and brinjal (Amala & Shivalingaswamy, 2018).

Carpenter Bees

Carpenter bees belongs to the subfamily Xylocopinae are a widespread bee fauna actively foraging on wide range of crops plants (Michener, 2007), polylectic and were reported to be an efficient pollinator of wide range of crops temperate fruits and oilseed crops such as niger, safflower, mustard, linseed (Navatha & Sreedevi, 2015), apple, raspberry, cranberry, cosmos, sunflower, red gram, tomato, winged bean, mustard, alfalfa (Mattu & Kumar, 2016). Two groups of carpenter bees *viz.*, large carpenter bees (*Xylocopa* sp) construct their nests in hard woods like bamboos and other trees and small carpenter bees (*Ceratina* sp) construct their nests in plants with softwood pithy stems (Amala & Shivalingaswamy, 2019). Large carpenter bees are one of the world’s most diverse groups of solitary bees, with 373 described

species in the world of which 29 species are from India (Prasanth and Belavadi, 2016).

Digger Bees

Digger bees belongs to the subfamily Anthophorinae, families Colletidae, Melittidae and Andrenidae. Around 50 species of Melittid bees are reported in India (Saini *et al.*, 2019). Bees belonging to the genus, *Amegilla* (Anthophorinae) builds a solitary nest, in burrows in dried-up river banks, old clay homes, and mortar between bricks, but may also burrow in soft sandstone. Cells, at the end of tunnels, contain an egg with a pollen/nectar mixture for the larval food. *Amegilla* sp is reported to be an efficient buzz pollinator of Solanaceous vegetables across the globe (Hoogendorn *et al.*, 2007).

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