



BEE POLLINATORS DECLINE: PERSPECTIVES FROM INDIA

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ABSTRACT

One-third of the world's crops require pollination to set seeds and fruits and the great majority of them are pollinated by bees. These pollinators also provide an important ecosystem service that is essential for sustaining wild floral biodiversity. Concern over the pollinator declines followed by sudden disappearance of honey bee colonies are well-documented in North America and Europe but have not yet been well-researched in other parts of the world including India. The dramatic decline in overall pollinator populations is a critical issue for agriculture production but it is not yet on the top priority list for India. We all agree with the fact that pollinator population dwindling worldwide but how serious is this problem in India? Is it getting worst? In India, bees are well-known to the general public as honeybees but these are not the only pollinators, we don't know how many species of bees and other pollinators exists in India. There are no studies carried out to supports bee decline and intern asses its effects on agriculture productivity and sustainability. This review for the first time attempts to address this issue and aims to fill this knowledge gap about pollinators.

KEYWORDS: Crop Pollination, Pollinators, Pollinators Decline, Bees, India

INTRODUCTION:

1.1 What are pollinators?

Pollinators are animals that transfer pollen from the anthers to the stigma of a flower, enabling the flower to set seed and fruit (fertilization) and, through cross-fertilization, they play an important role in maintaining plant diversity. The important ecosystem service of pollination is provided by a variety of animals, chiefly insects. Bees, flies, butterflies, moths,

wasps, beetles, thrips and some other insect orders encompass the majority of pollinating species. Vertebrate pollinators include bats, non-flying mammals (several species of monkey, lemur, rodents, tree squirrel, coati, olingo and kinkajou) and birds (hummingbirds, sunbirds, honeycreepers and some parrot species). Among the insects, hymenopterans (largest and diversified assemblages of beneficial insects with nearly 2,50,000 described species) are highly evolved and constitute the most important group of pollinating insect.

1.2 Importance of pollinators: Why Do Bee Pollinators Matter?

Pollinators are crucial in the functioning of almost all terrestrial ecosystems including those dominated by agriculture because they are in the front line of sustainable productivity through plant reproduction (Kevan, 1999). Environmentally, 66 per cent of angiosperms require animal pollination for sexual reproduction (Greenleaf and Kremen, 2006). Worldwide an estimated 35 per cent of crop production is dependent on insect pollination (Klein *et al.*, 2007). Moreover, their populations and diversity also serve as bioindicators of the state of many environments (Kevan, 1999; Tylianakis *et al.*, 2004; Roubik *et al.*, 2005).

Among the pollinator groups, bees have been considered a priority group (Table 1). Bees are synonymous with insect pollinators and they are publicly shared assets, most species and populations belonging to nobody, yet benefiting all of us through pollination – a perfect example of 'positive externality', in economic parlance (Batra, 1995). In general, bees are the main pollinators of angiosperms (Nabhan and Buchmann, 1997). The Food and Agriculture Organisation (FAO) of the U.N. estimates that of the slightly more than 100 crop species that provide 90 percent of food supplies for 146 countries, 71 are bee-pollinated (mainly by wild bees), and several others are pollinated by thrips, wasps, flies, beetles, moths and other insects. In India, Honeybees (*Apis* spp.) are always valued for honey and wax, earning them due importance and never appreciated for pollination services. The value of bee pollination in Western Europe is estimated to be 30-50 times the value of honey and wax harvests in this region. In Africa, bee pollination is sometimes estimated to be 100 times the value of the honey harvest, depending on the type of crop. In a country like Denmark, about 3,000 tonnes of honey is harvested every year (with value of about €7.6 million). However, the value of oilseeds, fruits and berries created by the pollination work of bees is estimated to be between €200 and €400 million. The total economic value of crop pollination worldwide has been estimated at €156 billion annually (Gallai *et al.*, 2009). In India, no such estimates are available.

Keeping in mind the risk involved in relying on a single pollinator species, the role of wild bees are being increasingly recognized worldwide. It is likely that wild bee community is sufficient to provide services for multiple crops, including some that are not serviced by honeybees (Kremen *et al.*, 2002). It has also been reported that about 15 percent of the hundred principal crops are pollinated by domestic bees, while at least 80 per cent are pollinated by the wild bees. Wild bees can be more effective on particular crops than honeybees. A comparison between non-*Apis* bees and honeybees surprisingly revealed that the credit for the pollination of thousands of angiosperm species was mistakenly given to honeybees. Most of them perform this beneficial act so quickly that it remains almost invisible to a normal eye. Management of bees for commercial pollination (use of managed wild bees) began globally (mainly in developed countries) in the 1940s, following studies that showed bees are important in crop production through their pollinating activities. Currently, farmers who manage pollination on farms or in glasshouses rely on a mere 11 species of the 25,000 bees described worldwide. In north India bumble bees are utilized for commercial pollination of some vegetable and fruit crops.

Table 1. Different pollinators which play vital role in pollination (Source: Abrol, 2009)

Pollinators	% contribution
Bees	73%
Flies	19%
Bats	6.5%
Wasps	5%
Beetles	5%
Birds	4%
Butterflies	4%

1.3 Crops benefited by bee pollination in India

In India, most of the food crops need insect (mainly bee) pollinators for sufficient successful pollination. Oil seeds (such as Sunflower, niger, safflower), vegetables (Cucurbitaceous Vegetable Crops, legume crops) and many fruit crops are profoundly reliant on pollinators. A list of crops pollinated by bees is as follows (Source: TNAU, agritech portal)

Fruits and nuts: Almond, apple, apricot, peach, strawberry, citrus and litchi.

Vegetable and Vegetable seed crops: Cabbage, cauliflower, carrot, coriander, cucumber, melon, onion, pumpkin, radish and turnip.

Oil seed crops: Sunflower, niger, rape seed, mustard, safflower, gingelly.

Forage seed crops: Lucerne, clover.

2.1 Taxonomic Diversity of Bees- World Vs India

Worldwide, there are around 25,000 different types of bee species described to date, and the vast majority of which are solitary (Michener, 2007) and this number is likely to continue to grow as biodiversity collections intensify. This huge number is divided into over 4,000 genera of bees, which are then further subdivided into just nine families of bees (Aguilar *et al.*, 2013). The Apidae family is perhaps the most well known family, with familiar members such as the honeybee, carpenter bee, and bumblebee. However, many people are unaware of non-*Apis* bees and their importance. In India, no estimates are available about the faunal composition of bees but an estimate of about 1000 species was considered to be somewhat sensible. In this study, data on number of bee genera and species belonging to each family from India is extracted from the pertinent literature (Ascher and Pickering, 2010; Gupta, 2010). Out of nine bee families (2 families are based on fossil insects), six families are present in India. Apidae is one of the most diverse families of bees, containing more tribes than any other family in world, however, the number of genera and species listed here for Apidae and Megachilidae is almost equal. This may be because of the lack of species level information on Apidae intern demands full pledge taxonomic studies on this pollinator group. Family Andrenidae, Colletidae and Melittidae are very rare group of bees in India (Fig. 1).

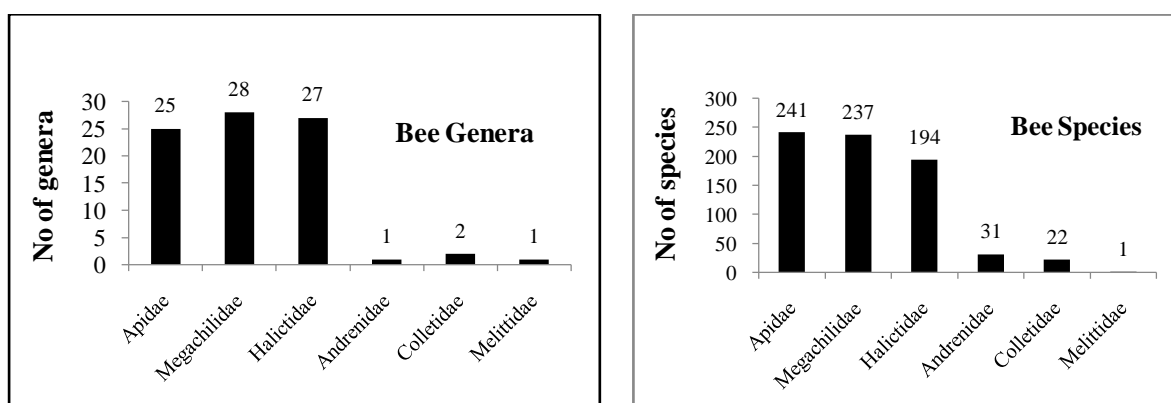


Figure 1. Number of genera and species in six families of bees in India. (Source: Ascher and Pickering, 2010; Gupta, 2010; Saini and Rathor, 2012)

3.1 Global Pollinator decline

Ironically, the importance of bees for mankind is very aptly summed up by the great physicist, Albert Einstein who remarked that, “If something eliminated bees from our planet, mankind would soon perish.”

Long after this remark we are in real danger of facing the serious threat of losing bees. The loss of bee pollinators is becoming a reality as reports all over the world have pointed out that most pollinator populations have declined to levels that cannot sustain their pollination services in both agro-ecosystems and natural habitats. European honeybees in North America have suffered dramatic declines (up to 50% of managed colonies) (Kraus and Page, 1995). In western countries the decline is rapid over recent years and drivers of decline includes, intensive agriculture (Bjorklund *et al.*, 1999; Kremen *et al.*, 2002), use of pesticides (Kevan, 1999), habitat fragmentation (Cane *et al.*, 2006), climate change (Hegland *et al.*, 2009), also to a lower extent lack of floral diversity, urbanization (Kearns and Oliveras, 2009), human disturbance, competition from non-native species, diseases, predators and parasites and of course the impact of pesticides and microwave radiation from mobile towers (Sharma and Kumar, 2010). Unlike the western countries, the bees that pollinate Indian crops are almost all wild honey bees and other non- *Apis* pollinators. As a result, very little research has been done on their decline. According to Gallai *et al.*, 2009, more than 40 % of honey bees have been disappeared during last 25 yrs in India. However, this is only reliable data on decline on honey bees in India and the fate of other wild pollinators is unknown.

3.2 Wild pollinators are also at risk

Solitary bees and other insect pollinators play a great role in the pollination of wild plants. They also pollinate many cultivated plants. There is a lack of data on many invertebrate species that act as pollination agents. Many pollinator species that were relatively rare in the past are becoming rarer, while more common species have become widespread. Threats to certain invertebrate pollinator populations were reported in Europe as early as 1980, and confirmed in the 1990s. A British and Dutch study showed that in the United Kingdom (UK) and the Netherlands alone, since the 1980s a 70% drop in wild flowers requiring insect pollination has been recorded, as well as a shift in pollinator community composition. Another study, from 2011, found that four bumblebee species have “declined substantially” over the last 20 to 30 years in the U.S. The suspected reasons for this decline have included parasites and shrinking habitat, as well as disease, which studies have shown can move from

managed honeybees to native bees. One species, the rusty patched bumblebee, is threatened with extinction. It was also found that 71% of butterfly species have decreased and 3.4% became extinct over the past 20 years, illustrating the highest net loss compared to native flowering plants (28% decrease in 40 years) and birds (54% decrease over 20 years) in the same UK region. Unlike the managed honeybees causes of decline are terrible and too complicated to understand in case of these wild pollinators.

4.1 Threat to Agriculture, nutritional security and Biodiversity

One of every three bites of food eaten worldwide depends on pollinators, especially bees, for a successful harvest. Bees are particularly important pollinators for many agricultural crops (Nabhan and Buchman, 1997) and their absence often results in lower yields and less marketable products. In western countries, where they fully depend on managed honey bee colonies experiencing 40-50 % losses in yield. Economic vulnerability of each crop to the loss of pollinators was found to vary widely across crop categories. Globally, vulnerability was high for fruits (23%), vegetables (12%), nuts (31%), edible oil crops (16%) and stimulants (39%), lower for pulses (4%) and spices (3%) and 0% for cereals, roots and tubers and sugar crops (Gallai *et al.*, 2009). Whereas staple crops, being primarily wind-pollinated, have low vulnerabilities, those crops providing much of the proteins, vitamins and minerals in human diets are more reliant on biotic pollination. Vulnerability values were heterogeneous across the globe, with some regions more at risk of pollinator loss than were others. There are lots of studies on pollination and pollinator composition of particular crop in India, but they are not adequate and reliable. There is still a lack of basic information about how species diversity, and the abundance and community composition of pollinating insects, contributes to seed and fruit yield and quality in most crops in India.

In nature most wild plant species (80%) are directly dependent on insect pollination for fruit and seed set. Generally obligate cross pollinating plants decline with the decline in their pollinator population. Thus specialized pollinator and wild plant systems are at the higher rate of risk (Spira, 2001). Thus, efforts for conservation and management of the diversified group of bees especially non-*Apis* bees and other insect pollinators should be seriously made to utilize their potential as crop pollinators and overall biodiversity conservation.

5.1 Global Pollinator Initiatives- Where does India stand?

Both managed and wild pollinators play important roles in ecosystem services, food security, and the economy. Concerns about the worldwide decline of pollinators have gained the interest of many countries and resulted in the formation of specific initiatives related to pollinator management and conservation at national and global level. When Colony Collapse Disorder swept through American and European bee populations in 2007, the western world was alerted. These countries started several action plans to save bees, the initiatives includes North American Pollinator Protection Campaign (NAPPC), Brazilian Pollinator Initiative (BPI), Canadian Pollinator Conservation 2013 and European Pollinator Initiative (EPI, 2000). Even developing countries like Africa (African Pollinator Initiative) and Sri Lanka (Pollinator Conservation Action Plan for Sri Lanka) have pollination conservation strategies, no such actions are taken to conserve pollinators in India.

On a global level, the Convention on Biological Diversity has identified the importance of pollinators with the establishment of the International Initiative for the Conservation and Sustainable Use of Pollinators (also known as the International Pollinators Initiative-IPI) in 2000, facilitated and coordinated by FAO. International Pollinators Initiative includes a project involving seven nations (including India) with the aim of identifying practices and building capacity in the management of pollination services.

6.1 Pollinators: Areas of Uncertainty in India

Research activities in India on bees or on other pollinators are in a state of neglect. Despite the global worry, no study had been done to assess directly the scale of the decline in natural pollinators. The crucial role of bees as providers of pollination services in developing countries like India cannot be ignored, although this service is mainly feral here. Most of small-scale farmers are not aware of the value of pollination services crops they grow. Farmers have very limited knowledge on pollination and pollinators; they often take pollinators for granted. In western countries, pollination has been industrialized; bee keepers ship their hives from one place to other to meet the needs of the fruit and vegetable demands. It is only in plantations, in some areas, where farmers have colonies of *Apis cerana* and *Apis mellifera* (in north India) for pollination purposes and rarely seen in south India regions. This is done even without determining whether this bee species is the most effective pollinator for those crops or not. In India at present, one hundred and fifty million colonies are needed to meet the pollination requirement of around 50 million hectare bee dependant crops but there are only 1.2 million colonies present (TNAU agritech portal). No attention has been given to

bee keeping as such compared to other countries even though there is a wide scope for beekeeping in India. As many growers are not aware of the contribution of wild pollinators towards production of their crops and farm profitability active participation of researcher and extension specialist is needed to educate them about the benefits of pollinator and consequence of their decline.

In recent past drastic decline in honeybee populations because of colony collapse disorder in some parts of the world led concern over pollination shortfalls. Considering this potential risk of sole reliance on honeybees for agricultural pollination several countries have speeded up the management and conservation of non-*Apis* bees. We do not really know what is happening to natural pollinator populations in India. Very few institutions are engaged in research on bee and other pollinators and that too most of the interest started very recently. In Indian context, Very few species have been studied mainly honeybees and that too some aspects of pollination biology (Aluri, 1990). The knowledge about the right pollinators for most crops is not available. Remarkably very little is known about the status of bee pollinators in the wild and their population dynamics, life history, habitat requirements, pollinator interactions with other elements of crop and crop associated biodiversity, the ecology of pollinators, or the ultimate consequences of their decline. There have been few attempts in India towards assessing bee diversity, their documentation and conservation action. Before conservation aspects, it becomes necessary to evaluate the bee assemblage of a particular local habitat. We cannot assess the magnitude of a decline of pollinators and pollinator services if we cannot correctly identify them, we are inviting a risk of not really knowing what it is we are trying to conserve. The taxonomic literature is scarce for many bee taxa and lacks expertise in the field, further impairing initiatives to provide complete regional assessments of the bee fauna. Even countries like Sri Lanka have taken the lead over India in carrying out detailed studies on non-*Apis* bees and other pollinators.

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