VANISHING HONEY BEES: THE FULCRUM OF OUR ECOSYSTEM

Dipali Gupta¹, Geetanjali Mishra², Omkar*³
Ladybird Research Laboratory, Department of Zoology, University of Lucknow, Lucknow-226007, U.P., India; Email: guptadipali770@gmail.com, geetanjalimishra@gmail.com,*Omkar.lkouniv@gmail.com.

https://doi.org/10.59094/emsj.v56i5-6.40

Summary

Despite the presence of large numbers of pollinators in flowering plants, honey bee plays the important role in pollination of different crops. Many social insects, including honey beedeclining in abundance in diversity. Pollutants such as heavy metals, pesticides and air born fine particulate matters from agricultural and industrial sources are responsible for this major threat. Therefore, we provide an overview of bee’s conservation in order to reduce the decline of honey bees.

“If the bee disappeared off the surface of the globe, then man would have only four years of life left. No more bees, no more plants, no more animals, no more man.”

Albert Einstein

Exquisite chemist, efficient engineer, amazing creatures! Bees have much to teach us, they fascinate us, they are beautiful and their importance to mankind is immense. Do you know how long have humans and bees shared a sweet relationship? Researchers have recently found traces of bee wax on pottery made between 7500 BC and 2000 BC. That means humans have been working with bees for at least 9,000 years. Also, if humans utilized beeswax, then they probably have enjoyed honey as well. To the layman, bees are probably just some whizzing buzzing insects that sting but also make honey. The complications of the bee life are basically a mystery to them, a mystery hidden behind the elaborate imposingbee hive hanging from trees and old buildings.

What most of us do not realize is that bees are an integral part of our agricultural and ecological systems pollinating our crops and producing products that are of great economical value to us. Also, what is known to us is that the “common honey bee” actually comes in more than 25,000 kinds across the world. Let us learn more about what makes honey bees interesting.

Life within a crowd

Like humans, honey bees are highly social organisms. A single colony of honey bee is a thriving metropolis with thousands of individuals. There are three different castes that share the space inside the colony; the queen bee, a peerless creature of hive, the only reproductive female which lays eggs; and the drones, consisting of male members of the colony which leave the hive to mate with queen; the workers, representing sterile female population of the
colony, and does all non-reproductive work. They all work together as “superorganism”, a highly connected group which functions like a single being. Being social comes with many benefits; it also imposes costs- the spread of disease. Humans place many honey bee colonies next to each other for agricultural purposes. This creates unnaturally densely populated "cities" of these superorganisms, where pests and diseases can spread rapidly.

Worker bees have immune systems which recognize invading pathogens and fight to get rid of them, but, some classes of pathogens are not recognized by the honey bee. For this threat they need a different strategy, they show cooperative behavioural effort to protect the colony. Worker bees remove the diseased and dead young ones from the colony reducing the likelihood of transmitting infections to other bees.

**Fascinating Facts**

There are some interesting and fascinating facts about honey bee. They can fly 15-20 miles per hour (21-28 km/hr) to collect the nectar, pollen and food and low as 6 miles per hour (11km/hr) and also visit up to 2,000 flowers per day. They can make nearly about 27 kg of honey from spring to autumn to maintain the entire colony over the winters. A queen honey bee can lay about 600-800 eggs each day, sometimes even 2000 eggs per day and live for about 2-3 years. Honey bees also maintain the temperature of their hive about 33°C in their central brood nest and when the temperature declines or low, forms a tight group to keep it warm. Worker bees come together around the queen to protect her from outside cold. One of the amazing facts about honey bee, they are the ultimate neat freaks; they maintain their hive and work to keep it clean.

**Small creatures, huge benefits**

Gardens and agricultural fields blooming with flowers are indicative of the selfless labours of these bees. The U.S Department of Agriculture claims that honey bees pollinate 80% of the United States crops, *i.e.* over $20 billion worth of crops each year. We would lead an almond-less life were it not for the pollination bees. Not only almonds, but many other crops depend on bee pollination to bear fruits. The decreasing number of wild honey bees owing to increased use of pesticides indicates the need to accelerate their conservation as well as stimulate the use of commercial bee hives. In the US and Europe, farmers are known to place honey bee hives in fields for a higher crop yield via successful pollination.

Though their buzzing and painful stings which may sometime turn lethal is often cause for apiphobia, bees actually do more good than harm. These tiny, buzzing creatures carry the weight of the whole world on their backs.

Benefits other than pollination that we garner from bees are honey, wax, propolis, and bee pollen. Man has recognized these benefits centuries ago and has successfully harnessed bees as mini factories for the production of these goods. Honey is natural and beneficial in health due to its antibacterial properties and used as ingredients in meals, baking, and drinks are useful for soothing sore throats. Beeswax is used in furniture wax, beauty products, lip balm, chewing gum, in polishes, hair products and the waxy coating on rounds of cheese and also used as natural preservative in products that may spoil quickly. Honey and beeswax contain a by-product called propolis that is an anti-bacterial agent. Propolis, generally known as ‘bee glue’ (*Papa et al., 2022*) and bee pollen also have anti-inflammatory and anti-oxidant properties due to presence of high concentrations of flavonoids and phenolic compounds,
beneficial in the battle against bacterial infection. Apart from these, melittin is major pain producing substance produced by honey bee venom which has therapeutic values and recently used in Chemotherapy-induced peripheral neuropathy (CIPN) (Tender et al., 2021).

**Pollutants making honey bees sick**

Bees are getting increasingly threatened by human activities. The Intergovernmental Science – Policy Platform on Biodiversity and Ecosystem Services, 2016 report lists “land use change, intensive agricultural management and pesticide use, environmental pollution, invasive alien species, pathogens, and climate change” as major threats to the abundance, diversity and health of the bees.

Honey Bees can cope up with low levels of environmental stress through their wisdom, such as decreasing the natural mortality of foragers and increasing queen’s egg laying rate. Bees are affected by two types of stresses: Biotic and Abiotic stress. Biotic stress includes fungi, bacteria, virus and parasites which can infect different developmental stages of honey bees and produce various diseases. Apart from biotic stresses, abiotic stresses also play an important role in declining honey bee population. It can be activated by multiple factors such as temperature, pesticides, heavy metals and air borne fine particulate matter (Neovet et al., 2019, Li et al., 2018) which interact with physiology of bees, especially the immune system. Honey bees take up these pollutants into their bodies (into their gut) and distribute them within the colony during food transfer. Such pollutants negatively affect the learning abilities, like disorientation in searching food and other colonial activities.

Pesticides used in agriculture gained most attention because pollinators visiting agricultural crops are exposed to these chemicals at time of food collection. Most pesticides are neurotoxins, such as organophosphates or methyl carbamates which affect learning ability and memory in honey bees, also reduces foraging efficiency, navigation ability and social behaviour in the nest. It negatively affects the nutritional status of colonies. Neonicotinoid weakens the immune system of social insects resulting in a reduction of haemocyte density and antimicrobial activity. Pesticides show higher susceptibility to parasites and pathogens. After exposure to sublethal doses of pesticides, the mortality of honey bees was found higher when infected with parasite like Nosema ceranae (Gut parasite) and Nosema apis. Besides pesticides, some medicines used to kill pathogens in honey bee colonies can also activate stress response in honeybees. For example, formic acid used by beekeepers to kill Varroa mite has a negative impact on brood survival and reduces honey bee longevity. It also contaminates the honey and other hive products (Belsky and Joshi, 2019, Feldhaar and Otti, 2020).

Heavy metals are threatening social insects in both agricultural and industrial areas. Major sources of heavy metal contamination are industrial processes, such as metal ore, coal mining and refining, phosphate extraction for fertilizers manufacturing (Costa et al., 2019). Heavy metals take over from plants and migrate from the soil into food sources, like nectar or pollen. Three heavy metals have been detected at higher levels in the environment are cadmium, copper and lead (Burden et al., 2019). Honey bee fed with contaminated food with sublethal concentrations of heavy metals, like Cadmium oxide (CdO) and Lead oxide (PbO) show cellular damage in the midgut tissue and disruption of the peritropic membrane.
Bees are able to monitor heavy metal environmental pollution. Pollution level in pollen stores of bees are positively correlated with heavy metal pollution as well as heavy metal content in the bodies of bees. So, these are the bioindicators of environmental pollution.

**Cell phones affect bees!**

Cell phones affect the sensory abilities of honey bees. Research conducted in Lausanne, Switzerland has shown that cell phones not only confuse the bees but also lead to their death. Bees were able to sense the signals transmitted when calls were received on these phones. They respond by making “piping sounds” and heavy buzzing noise during the calls, spreading the warning message throughout the colony. While calls act as an instinctive warning signal, the frequency confuses the bees, causing them to fly erratically.

The bee’s populations in U.S. and U.K. have decreased by almost half in the last 30 years due to popularization of cell phones. According to the Times of India, Kerala has recorded a similar phenomenon, as have other parts of the country, which has been named as ‘Colony Collapse Disorder’ (CCD). Such catastrophic colony losses affect the wild plant diversity, terrestrial ecosystem stability, crop production, global food supply and human welfare.

**Impact of pollutants on bee products and human health**

Honey is a natural product which is widely used for both nutritional and medicinal purposes. Microbial and nonmicrobial contaminants, which include pesticides, herbicides, antibiotics, heavy metals, were reported in various honey samples all over the world. Without knowing its source and safety, it might be dangerous for human health. Health authorities in all nations have to introduce laws that control honey production, handling and analysis to confirm its safety. Pollutants, like pesticide residues, cause genetic mutation and cellular degradation in humans via bee products and presence of antibiotics might increase resistance to human and animal’s pathogens. Local suppliers sell raw unprocessed honey in open areas that may have adverse effect on human health. So, it is important that honey bee products should be labelled in order to know its origin, composition, and also that it is free from any contamination.

**Honey bee’s importance and their conservation**

Many species of plants and animals would not survive in tropical forests, savannah woodlands, mangrove, and temperate deciduous forests, if bee goes missing. In the past two – three years, many reports were found from different countries about the decline of bees. In 2007, the *Bee movie*, gives a strong message about the exploitation of bees for honey and how critical they are in sustaining the world’s plant life. The UN acknowledged their contribution by introducing World Bee Day on 20 May and first World Bee Day was celebrated on 20 May, 2018. The theme of 2022 was “Bee engaged: Celebrating the diversity of bees and beekeeping systems” specifically focus on role of local bees which give their contribution in providing sustainable ecosystem. Conservation policies not only improve honey bee health but also help in improving the quality of water, soil and wildlife habitat. The U.S. EPA (Environmental Protection Agency) released its policy in January 2017 to combat the acute risks to bees from pesticides. In U.K, the British Beekeepers Association (BBKA), a non-governmental organization provides information to beekeepers for bee keeping and bee health. It works to promote a healthy environment, particularly for pollinators. In Switzerland, Swiss Bee Research Centre also provides information regarding
the use of pesticides and the risk of pesticides to honey bees. In India, researchers are also working to aware the farmers how to reduce the use of pesticides.

Honey bee is declining in nature due to habitat loss, emerging diseases, pesticides use, climate changes and other pollutants in atmosphere. We have to think about their future conservation strategies. Some future conservation strategies are: 1) minimising habitat loss, 2) making agricultural habitats bee friendly, 3) provide training to bee keepers and people in bee taxonomy and identification, 4) determining the impact of invasive plants, parasites and pathogens.

Bees play a crucial role in facilitating plant reproduction, ecological health, and agricultural production (Iwasaki and Hogendoorn, 2021). So we can say that there would be no flowering plants without bees and without flowering plants there would be no bees. It is a co-evolutionary relationship. Without bees, biodiversity would be affected because biodiversity is measured as the number of plant and animal species in a certain unit area.

Conclusions

If bees die, they will certainly take the whole humanity with them. Before it's too late, we need to focus on restricting human activities that may lead to their extinction. There is hope! If we dedicate more time and resources to studying bees, spreading awareness, and working toward positive coexistence with bees, we can help in saving honey bee populations. We know that we need bees, and they are in trouble. Therefore, we have to use the conservation strategies to cope up with this situation.

References