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Vanishing Bees and Butterflies: it is The Time to Wake Up

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ABSTRACT

Honey bees are nature's ambassadors for carrying out noble cause of pollinating plants which has great ecological and economic significance. Their ecological role remains largely ignored as they are known more for producing honey than pollinating crops and a number of rare, endangered and threatened (RET) plant species in the forest. This nature's pollination army is in danger. The bees and butterflies are vanishing. Habitat destruction, cruel and unscientific method of honey extraction, cruel harvesting of bee hive for bee wax alongwith immature larvae, use of neonecotenoids, phenylpyrazoles, certain fungicides, herbicides, genetically modified crops (GMOs), electromagnetic radiations (EMR) emitted by mobile towers and cell phones, sticky disposable cups and dust bins, colony collapse disorder (CCD) in *Apis mellifera*, overactivation of pests like sac brood virus disease, *Nosema* fungus and Varrora mite etc. have been cited as the reasons for vanishing honey bees. Mass death of bees still remains a mystery. The cases of CCD are not being reported from India but there is growing evidence that CCD is happening in India as factors responsible for CCD exist in India as well. The forest plants loved by bees for nectar and pollens need to be protected and given preference in plantation programme. The mysterious disappearance of bees is a cause of great concern and needs immediate attention before it is too late.

Key words:

Bees, Butterflies, Colony Collapse Disorder, Neonecotenoides, Apis

A WORLD WITHOUT BEES

Imagine a world without bees and butterflies. The spring will be silent. You will not get to listen the lovely songs of bees amidst sweet scented aroma of a number of plants. You will not get to see the beautiful butterflies- the flowers on wings hovering around and silently jumping from flower to flower. The yield of many cultivated and wild plants will reduce drastically and many plants will face extinction. This will have domino effect and it will ultimately affect the whole ecology and economy. We will lose many things. Yes, that is the

importance of bees and butterflies. Renowned scientist Albert Einstein had said, "If the bees disappeared off the surface of the globe then man would only have four years of life left. No more bees, no more pollination, no more plants, no more animals, no more man." The literature further reveals that Albert Einstein's statement and calculations were based on literature published on bees in Canadian Bee Journal" in 1941 and a statement of this type made by the major literary figure Maurice Maeterlinck in his work "The Life of the Bee" in 1901.

The symbiosis that exists

The relationship between bees and plants is as old as the history of appearance of life on the earth. According to various estimates, the life appeared on the earth about fifty million years ago and the plants were first to appear because they were autotrophs. But they needed the help of pollinators to regenerate them. And so, soon after the plants, the honey bees appeared on the planet earth to pollinate the plants. The relationship between the plants and honey bees has been continuing since then. The honey bees, bumble bees, butterflies and few other insects pollinate plants of ecological and economic importance. However, their role has not been widely appreciated. There exists a symbiotic relationship between ecology and honey bees. Most of our cultivated crops and wild forest plants are pollinated by honey bees. The seeds and fruits produced by the plants after the pollination are eaten by human beings and birds. Many vegetarian birds will not survive in the absence of the bees and butterflies. And this will disturb the whole food chain because birds also perform many ecological functions. The honey bees benefit mankind in a number of ways. The most important is the pollination of the plants. The role of honey bees as pollinators of plants has been recognized for thousand of years. Globally, about more than fifty percent of cultivated crop plants and more than eighty percent trees in forests are pollinated by mainly by bees.

The irreplaceable role that the bees play

A large number of plants can't reproduce on their own. They need the assistance of pollinators to transfer the pollens from one part of the plant to another part of the same plant or from one plant to another plant of the same species as the male and female plants exist separately. Honey bees are the most efficient and celebrated pollinating engineers. In some cases, the plant species may be sterile and may not be able to use its pollen resource efficiently. Accordingly, in the case of self sterile crops, the presence of honey bees is must. It is a well established fact that self-sterile crops like tomato, almond, mustard, cucurbits, sunflower, niger, alfalfa, sesame, safflower, clovers and a number of horticulture tree crops give significantly high yields if the honey bee colonies are placed in field and orchards during their flowering period. Apple dear to all, can't fruit without the aid of bees. Accordingly, the bees pollinate a number of other food, vegetable and fruit crops. These include brinjal, potato, tomato, lady's finger (Okra), tomato, sunflower, cucumbers, cashew, onion, cabbage, rapeseed, almond, citrus, cherry, coffee, soyabean, cotton, mustard, sunflower, clovers, alfalfa, cucurbits, almond, Drumstick, emblic myrobalan (amla), Indian beech (karanj), soapnut, shikakai soap pod, chebulic myrobalan (harad), copper pod (Peltophorum), neem, and jamun etc. are all pollinated by bees. The honey bees play an irreplaceable role in environment and forest ecosystems. Unfortunately, not much information is available on the species wise role of honey bees in pollinating the forest plants. However, it is a well recognized fact that forest ecosystem will collapse without the pollinators (mainly the honey bees).

However, it is not that only the plants that are benefitted by the presence of pollinators and honey bees. Infact there exists a symbiotic relationship between the plants and honey bees. While the plants get pollinated and continue to regenerate, the honey bees get food in the form of sweet nectar and pollen grains. Nature has designed forest

composition in such a way that different categories of plants flower during different seasons of the year. On one hand, this ensures the year around supply of pollens and nectars to the bees, the plants are benefitted by getting pollinated.

The value of pollination

The contribution of bees in pollinating plants is immense. Food & Agriculture Organisation in 2005 estimated that estimated that bees render pollination services worth 20 million dollars in United Stated and worth 200 million Dollars in globally. Leave the sweet honey full of medicinal properties, bee pollens royal gelly full of minerals and vitamins and bee wax besides inspirational sweet songs they sing for poets and writers.

The insects that pollinate

Honey bees alone do not alone render pollination services. Infact there is a group of them. Besides honey bees bumble bees, butterflies and a number of insects which do this job but they are not appreciated as much as they deserve. These include honeybees, bumble bees, stingless bees and solitary bees. However, honey bees are most efficient and celebrated master pollinators of crops and forest plants. Amongst several factors attributing to increase in productivity of crops and plants, the most important is the number of bee pollinators (Sharmah et al; 2015). In India the honey bees belong to the genus Apis and there are four species under Apis. These are: *A. dorsata*, *Apis cerana indica*, *A. florea* and *A. andreniformes*. (Sharmah et al. 2015). *A. dorsata* is very ferocious and all attempts to domesticate have failed. *A. cerana indica* is semidomesticated. *A florea* is also not domesticated. *Apis mellifera* is exotic and fully domesticated species of bees.

Bumble bees- the unsung heroes

Perhaps the bumble bees are unsung heroes. They also render pollination services very efficiently but their contribution is not recognized much probably because they do not provide honey. Even role of honey bees is not appreciated in India as pollinators alone by farmers and common man because of lack of awareness. Says Mr. Kehar Singh Thakur- a bee keeper from Nagar village of Kullu district, " During winters when nothing is available for bees to feed upon in and around Nagar, I frequently transfer my bee hives to Rewari & Mahendergarh in Haryana and adjoining areas of Rajasthan to take advantage of mustard flowers. What to talk of paying for pollination services to me for the hard work of bees, farmers in Rajasthan blame me for spoiling their mustard crop".

After honey bees, the bumbe bees (perhaps butterflies are also equally important) are the most important pollinators. The species of bumble bees found in India are: *Bombus cornutus* (Cuckoo Bumble Bees), *B. parthenius*, *B. miniatus* and *B. morawitizianus haemorrhoidalis* and *B. tunicatus* (Carpenter bee), *Xylocopa aestuans* (Alkali bee) *Nomia curuipes* (Leaf cutter bee), *Megachile umbripennis* (Sweet bee), *Halictus albescens* (Drone flies) *Ishcodon (Scutellaris and Episyrphus balteatus)* (Sharmah et al; 2015). In some cases, especially the *Bombus* species are superior to honey bees and more desired for a kind of pollination called buzz pollination/ sonication in sterile crops like tomato and the bumble bees are the master architects of it.

The vibrations that do buzz pollination / soniction

In some crops like tomato, the flowers love to have vibrations for the transfer of the pollens. It is a kind of pollination technique adopted by bumble bees to dislodge pollens which are more firmly held by the anthers of the flower. Infact the anther of the buzz pollinated species like tomato, potato and brinjal, is typically tubular which has opening only at one end. Smooth grained pollens remain firmly attached to the inside of the tubular anthers and are difficult to dislodge. Wind and honey bees are able to dislodge the pollen to some extent but they are not the masters of it. The bumble bees being the masters of buzz pollination, get on to the anthers quickly, move their flight muscles rapidly

and produce resonant vibrations in the flower and anther. The pollens get dislodged in the process of resonant vibration which brings about pollination. A number of plants in the world are pollinated by buzz pollination/sonication. What a significant contribution of bumble bees in pollinating RET species!

Bumble bees are masters of producing vibrations in flowers while transferring the pollens. Electric bees have been developed to carry out buzz pollination in polyhouses but vibration mechanism produced by the bumble bees is far superior to electric bees or any other manual alternative method. Not only this, the fact has to be accepted that the bumble bees are docile and will not leave the source of feeding until and unless it has been exhausted. So, they continue to render their services till the end. So, the bumble bees are sought after pollinators for buzz pollination/sonication in poly house cultures in India where tomato and other crops are being grown under controlled conditions. There are many species in forests are pollinated by buzz pollination but no information is available on that.

Nature' pollination army is in danger

But there is not good news for honey bees, bumble bees and other pollinators. This nature's pollination army is in danger. These nectarivores and pollenivores organisms playing irreplaceable role in pollinating and protecting forest, agriculture and horticulture ecosystems are vanishing. Their normal body functions are being impaired. Bee health is deteriorating and they are losing vigour. They are losing immunity to diseases and pathogens. It is becoming increasingly difficult for them to pass winter. They are unable to breed and continue their generations. They are disappearing mysteriously. *Apis mellifera* bees leave the colony in masse, leave queen, immature bees and plenty of food behind and do not return. The colonies of these nature's ecological soldiers are disappearing. The ecologists, entomologists, environmentalists and farmers are worried. The matter has reached to the govt. and policy makers. There are many reports that bee keepers in U.S. are losing bee colonies annually to the extent of thirty percent. In the process, over ten million beehives in United States have been wiped out, causing losses to the tune of two billion dollars during last decade. The disappearance has also been noticed throughout Europe.

It is not that the honey bees are invulnerable to pests, diseases and risks. It is not that they never fell sick. The problems were there. The history reveals that disappearances of honey bees have occurred throughout the history of bee keeping, Such disappearances were known by various names like spring dwindle, autumn collapse, disappearing disease, May disease, and fall dwindle disease). However, the problem was not severe. The bees are today disappearing at alarming rate; faster than ever recorded in history threatening ecology and life. Infact in 2006, as much as 80 percent of the bee hives in California, the center of the world almond industry, vanished. This caught the attention of bee keepers. The reports of mass scale deaths of bees also came from France, Belgium, Brazil, Canada many parts of the world. The experts have termed bee apocalypse as colony collapse disorder (CCD syndrome) in 2006. Now, the bees are disappearing from across the globe. There is no discussion on colony collapse disorder happening in India. But all evidences direct or indirect, point a finger towards the occurrence of CCD in India as well.

Why are bees disappearing?

That is a very big question. The answer to this question still remains a mystery. However, the scientists have come out with some possible answers. These include loss of habitat, cruel and unscientific method of honey extraction, cruel harvesting of bee hive for bee wax alongwith immature larvae, use of new generation insecticides, fungicides, herbicides, growing of genetically modified transgenic crops (Genetically

modified Organisms), electromagnetic radiations (EMR) emitted by mobile towers and cell phones, use of disposable cups, sac brood virus disease, stone brood caused by *Aspergillus flavus*, *Varrora* mite, crude method of honey extraction, deformed wings disorder caused by *Nosema* fungus etc.

The role of insecticides

As regards insecticides neonecotenoids (commonly called neonics) and pheynlpyrazoles have been reported to devastate honey bee populations. Neonicotinoid insecticides act as 'agonists' of the acetylcholine receptor. This means that they are able to mimic the action of the neurotransmitter that naturally occurs in the insect body, acetylcholine (ACh), on some of its neuronal receptors (known as 'nicotinic receptors'). The reports reveal that neonecotenoids force *A. mellifera* bees to leave hive empty which they normally do not do during the winter. Noeonics have also been reported to cause in them neurological functions, specifically memory, cognition, or behaviour, as the results of the chronic sub-lethal exposure to neonics. Reports also suggest that neonics weaken immune system of bees making them susceptible to diseases, pathogens and parasites. Imidachloropid neonic which is largely blamed for CCD in *A. mellifera*, was first registered for use as insecticide in U. S. in 1994. It was sysnthesized to mimic nicotine, a compound found in tobacco (*Nicotiana tobacum)*, and is toxic to many insects. Imidacloprid is widely used to control sucking insects, termites and some soil insects. In crops, it is used for seed treatment by impregnating it on seed. It is considered comparatively safe to human beings and its dermal LD 50 values in rats was estimated at greater than 5000 and mg/ kg. The oral LD 50 value however, varied from 170 to 500 mg/ kg in male and female rats. It is a systemic insecticide that rapidly gets translocated through plant tissues and goes to flowers pollens and nectars. It acts on several types of post-synaptic nicotinic acetylcholine receptors in the nervous system. In insects, these receptors are located only within the central nervous system. Following binding to the nicotinic receptor, nerve impulses are spontaneously discharged at first, followed by failure of the neuron to propagate any signal. Sustained activation of the receptor results from the inability of acetylcholinesterases to break down the pesticide. This binding process is irreversible (Gervais et al. 2010). In another study sub-lethal exposure of neonicotinoids, imidacloprid or clothianidin, affected the winterization of healthy colonies that subsequently leads to CCD (Chensheng et al. 2014). Phenylpyrazoles -newly developed class of pesticides have also been reported to destroy honey bees. Phenylpyrazoles act by exerting direct excitatory effects on the nervous system (Sjaak et al. 1991). Among the fungicides Chlorothalonil has been found toxic to honey bees. Exposure to sublethal levels of exposure leaves bees more vulnerable to *Nosema* (Kim 2013).

Cruel Harvesting that is devastating bee colonies

In the past, the honey harvesters were taught by their ancestors to harvest honey in such a way that they touch only the front portion of the hive containing honey only. They were strictly asked to leave some portion of the honey for feeding young ones. The rest of the hive containing young ones was not touched. But now wax has found a number of phermaceuticals and industrial applications. It has a number of medicinal properties. Besides its use in lowering cholesterol and relieving pain, it is used for polishing, thickening, as emulsifier, for stuffing and making soaps and perfumes fragrant. As result of this, the entire bee hive is brutally cut leaving the bees homeless. Experts in India opine that cruel harvesting of honey bee hives for honey and wax is the main reason for the declining honey bee population in India.

Genetically Modified Organisms

Some reports link/suspect Genetically Modified Organisms (GMO) and 'Terminator

Seeds' for the demise of bees. Terminator seeds are genetically engineered to produce only infertile seeds, which farmers cannot replant. The bees that visit crops raised from terminator seeds have been found to have digestive and circulatory diseases. There is complete shut down of the digestive system as the bees fall prey to digestive tract diseases such as amoebiosis and *Nosema* diseases. They are unable to pass on the hard material present in their digestive tract which compromises immune system. This ultimately leads to their death. The intestinal tract of such affected bees gets discoloured compared to healthy bees (Brit Amos 2011).

The herbicides

Among the herbicides glyphosate has been reported to affect honey bees. Herbert et al. 2014) concluded that Glyphosate at concentrations found in agro-ecosystems as a result of standard spraying can reduce sensitivity to nectar reward and impair associative learning in honeybees.

The EMRs

Many recent studies have linked the electromagnetic radiations (EMR) to the demise of bees. EMRs are used in mobile towers and modern communication industry. Cell phones also emit EMRs. Expert say that many living organisms including human beings and honey bees are unable to detect the presence of EMR. The EMRs have been have been found to hinge cytochromes (blue light receptors that mediate various light-induced responses in plants and animals) in honey bees. They use it to sense the direction of the earth's magnetic field when they are foraging and returning to the colony. EMRs however, disrupt their ability to do this and they do not find their way back to hive. In a study conducted at Punjab University in Chandigarh, fitted cell phones to a hive and powered them up for two to fifteen-minute periods each day. After three months, it was found that the bees stopped producing honey, egg production by the queen bee halved, and the size of the hive dramatically reduced.

Sticky disposable cups act as death traps

Other reason contributing to the mass death of bees in India is the use of disposable cups. These cups act as 'death traps' for the bees as they fall into the cups and get enmeshed in the syrupy residues, thereby becoming unable to fly out (Sandilyan 2014).

The role of bulbs and tubes

So, the list of possible causes for the destruction of bees is long. However, what has not been reported anywhere is the role of electric light tubes and bulbs. Thousands of dead bees are seen throughout the country near certain type of electric tubes and bulbs. It needs to be studied as to what is it in the tubes and bulbs that attracts bees but does not let them go. Whether there is any link between EMRs, cytochrome hinge and compounds present in certain type of bulbs and tubes.

Honey bees are vanishing globally and India is not an exception. The factors/ causes responsible for colony collapse disorder in honey bees exist/are happening in India as well. The insecticides, fungicides, herbicides responsible for CCD are being used in India as well. But the cases of CCD are not being reported. There are evidences coming in this direction. Says a senior scientist working with a renowned seed company at Naggar near Manali in Himachal Pradesh , “The honey bees leave our hives but do not return. We are treating it as theft cases”. In another case, the honey collection from *Apis dorsata* (though illegal) from Saraswati forest in Kurukshetra and Kaithal districts of Haryana was over eighty quintals per year. There used to be hundreds of rock bee hives in the jungle. The honey collection has declined to less than ten kgs and the bee hives are rarely seen. According to another report, honey collection in the Kutch region of Gujarat in 2010 fell to 50 tonnes from the usual 300 tonnes in previous years because of the fall in the number of honey bees. Despite best efforts, the decrease in production in certain crops like mango, date

palms, lemon and papaya has been registered. In Malda, West Bengal, mango honey was once good business, but farmers say bees are now avoiding mango trees. According to govt. reports of states and Union of India, the yield of oilseeds and pulses is not increasing inspite of best practices and inputs. And India is facing acute shortage of honey bees. Say the scientists of Indian Council of Agriculture Resaerch, India has only 1.2 million bee colonies as against 7 million bee colonies urgently required just to pollinate 12 major crops that need insect pollination. On the other hand experts are of the view that the kind of floral diversity Indian forests and agriculture harbor, we can have 150 million bee colonies. Why we have meager population of bees left? It needs to be investigated.

The strategy to save the pollinators

There is no doubt left that the bees and pollinators are vanishing. We need to have a strategy in place to saving bees and life on planet earth. Worried United States and its President Mr. Barrack Obama has constituted "Pollinator Health Task Force" in May, 2015 and announced national strategy to promote the health of honey bees and other pollinators. The strategy aims to protect and promote the health of honey bees including other pollinators like Monarch Butterfly simply by pumping more money for bee research on issues like habitat improvement and development. The overarching goals of the strategy are to reduce overwintering honey bee colony mortality by 50% within ten years, increase the Eastern wintering population of the monarch butterfly to 225 million butterflies in five years, and restore/enhance 7 million acres of land for pollinators over the next 5 years through Federal actions and public/private partnerships (The White House 2015).

Lot of confusion prevails as regards bee apocalypse. Habitat destruction and pesticides are only big part of the problem. The role of neonics in CCD of *Apis mellifera* is becoming more and more confusing. Europeon Union countries in December, 2013, had banned the use of neonics for two years. But recent reports indicate that even after about one and half year of ban, the bee health is not improving. The reports further reveal that in the absence of neonics, new serious pests are invading. Some Europeon Union countries are now considering lifting ban on honey bees. In depth study is required for the role of neonics and pesticides on the subject.

Forest ecosystems are the main habitats for honey bees. At present, bee management is not the part of forest management strategies in India. Practically, honey bees are not considered while chalking out strategies for ecosystem management and selecting species for plantation programme. At present, there is hardly any scope to direct plantation programme for protecting and promoting honey bees and their health as the concept of ecosystem management is going to take some more time in India. However, there is lot of scope to promote and protect honey bee health by making minor changes without compromising other objectives of the plantation programme and habitat management. The key lies in giving preference to species known to be bee friendly within the existing choice of species. So, the strategy lies in protecting some species and selecting others for plantation programmes. *Plectranthus* is a species which the bees love in the forest. It is a shrub species which is not planted in forests. However, protection of this species will ensure good habitat for bees, butterflies and other pollinators. Species like North Indian Soapnut (*Sapindus mukorossi*), Neem/Margosa Tree (*Azadirachta indica*), Eucalyptus, Kadamb (*Neolamarkia kadamba* (=*Anthocephalus kadamba*), Jamun (*Syzygium cumini*), Kaim/ Kadamba (*Mitragyna parviflora*) etc. are very good source of habitat (nectar/pollens) for bees. Giving preference to such species over others in plantation programme, will protect honey bees and other pollinators.

In view of the compulsion for producing more food, the pesticides will continue to be in use.

However, they need to be used judiciously. *Eucalyptus* is largely planted on the bunds of the fields under agroforestry systems. Bees love to suck its nectar. However, spraying of pesticides on crops like mustard put them in death trap. If the need be, the crops should be sprayed with pesticides when the bees have returned back home.

Electro Magnetic Radiation pollution will continue and likely to increase in the times to come. Mobile towers and cell phones can't be shut down. However, the radiations from them can be brought down to safe limit. Experts opine that it is possible to modify the signal coming from the cell phones and the base station in such a way that it doesn't produce the frequencies that disturb the cryptochrome molecules of honey bees.

Probably, we need to generate mass awareness about the role of honey bees in environment and our lives. The public will have to be taught to use close dust bins. The sticky disposable cups which act as death traps for bees as they get stuck to them, need to be collected then and there and either scientifically destroyed or recycled.

Bee keepers' problem to be addressed immediately. Bee keepers need to transport their bee hives from one state to others in different seasons for taking advantage of nectar and pollens. Their vehicles are frequently stopped for checking. This results into huge losses to them. Says Mr. Kehar Singh Thaku, bee keeper of Nagar, " As we are asked to stop for checking, our honey bees suffocate due to heat generated by them due to close proximity of hives. The vehicles carrying bee hives need to be driven uninterrupted for proper aeration. Even half an hour break results into death of many bees".

The bee keepers need to be encouraged in the country and they need to be given incentives. They need to be paid for ecosystem services (PES) their bees render to the environment. With kind of incentive, the farmers and orchahrdists will need bee services and pay to the owners for the pollination services of the bees.

CONCLUSION

Honey bees, bumble bees and butterflies are ecological soldiers that serve humanity by pollinating crops and a number of forest plants. We all need to thank them for their ecological services. These pollinators which are at the forefront of the food chain are in danger. Vanishing bees is an ecological disaster and as a result, the entire global food chain is in danger. Warning bells have already been rung for the crops. This is only part of the bigger problem that is going to happen as a result of disappearance of bees. The impact on ecological diversity is going to be manifolds as the role of honey bees in pollinating the herbs, shrubs and climbers in the forest is not documented in view of the focus on management of forest on trees for timber production and revenue generation in the past. Bees and butterflies (Except *Apis mellifera*) are covered under wildlife act and destruction of their hive amounts to destruction of habitat which is an offence. Hence, provisions of wildlife act should be strictly applied to bees. The role of neonecotenoids, phenylpyrazole and other pesticides have to be clearly established for collapse of honey bee population. Preference has to be given to the plant species within the existing choice of species in the plantation programme of the country. There is an urgent need to modify the frequency of mobile towers and cell phone so that the electro magnetic radiations emitted by them are safe to bees, butterflies, birds and human beings. Bee keepers have to be encouraged in their profession by solving their problems and giving them some incentives. They need to be paid for ecosystem services they render to the ecology and biodiversity. Farmers and common man have to be made aware about the role of honey bees they play in global food chain and ecology. Even farmers and orchardists have to be persuaded for paying to the beekeepers for pollination services their bees render. Lot of work is required to be done on habitat improvement and bee research to

ultimately save life on earth. There is an urgent need to chalk out action plan on the lines of US National Strategy to Promote the Heath of honey bees and other pollinators. Honey bees and other pollinators must not be lost forever.

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