Changes in honeybee behaviour and biology under the influence of cellphone radiations

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Increase in the usage of electronic gadgets has led to electropollution of the environment. Honeybee behaviour and biology has been affected by electrosmog since these insects have magnetite in their bodies which helps them in navigation. There are reports of sudden disappearance of bee populations from honeybee colonies. The reason is still not clear. We have compared the performance of honeybees in cellphone radiation exposed and unexposed colonies. A significant ($p < 0.05$) decline in colony strength and in the egg laying rate of the queen was observed. The behaviour of exposed foragers was negatively influenced by the exposure, there was neither honey nor pollen in the colony at the end of the experiment.

Keywords: Colony strength, electromagnetic field, foraging behaviour, honeybees.

RECENTLY a new phenomenon of sudden disappearance of bees with little sign of disease or infection has been reported from the world over. Bees simply leave the hives and fail to return[1,2]. Colony collapse disorder (CCD) is the name given to this problem. Bee colony collapse was previously attributed to viruses, parasitic mites, pesticides, genetically modified crop use and climate change. On the basis of widely reported influences on honeybee behaviour and physiology, electromagnetic field is emerging as a potent culprit[3].

The decimation of bees is seen as a grave risk to the delicate equilibrium of the ecosystem. There is an urgent need to understand the complicity of interaction involved in the influence of electromagnetic radiations particularly due to cellphones on honeybee biology and to work out a strategy of development with minimal environmental implications.

Four colonies of honeybees, *Apis mellifera* L, were selected in the apiary of the Zoology Department, Panjab University, Chandigarh. Two colonies T_1 and T_2 were marked as test colonies. These were provided with two functional cellphones of GSM 900 MHz frequency. The average radiofrequency (RF) power density was 8.549 $\mu W/cm^2$ (56.8 V/m, electric field). The cellphones were placed on the two side walls of the bee hive in call mode. Electromotive field (EMF) power density was measured with the help of RF power density meter (Figure 1). Blank colony (B) was equipped with dummy cellphones, while the control colony (C) had no cellphones.

The exposure given was 15 min, twice a day during the period of peak bee activity (1100 and 1500 h). The experiment was performed twice a week extending over February to April and covering two brood cycles.

The following biological aspects were recorded during observations.

Brood area: The total area under brood comprising eggs, larvae and sealed brood was measured in all the experimental colonies with the help of a 1 sq. cm grid mounted on a comb frame[4].

Queen prolificacy: This was measured in terms of egg laying rate of the queen. In order to determine the number of eggs laid by the queen per day, the total brood area measured was multiplied by a factor of 4 to calculate the total number of cells containing the brood (there are 4 cells per sq. cm of comb). This number was divided by 21 (as the average time taken for an egg to change into an adult worker is 21 days) to get the egg laying rate of the queen[5].

The queen prolificacy was calculated as:

$$\mathrm{QP} = \frac{\text{Total brood area (cm}^2) \times 4}{21}.$$

The following behavioural aspects were observed.

Foraging: (i) Flight activity measured as number of worker bees leaving the hive entrance per minute: before exposure and during exposure. (ii) Pollen foraging efficiency measured as number of worker bees returning with pollen loads per minute: before exposure and during exposure. (iii) Returning ability determined by counting the

Figure 1. Experimental colony showing placement of mobile phones and power density meter.

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Table 1. Changes in foraging behaviour of *Apis mellifera* exposed to cellphone radiations

Parameter	Control (mean ± SD)	Treated (15 min exposure) (mean ± SD)
Flight activity		
(No. of workers bees leaving the hive entrance/min)		
Before exposure	35.9 ± 13 (12–61)	34.1 ± 10 (18–48)
During exposure	37.2 ± 12 (12–72)	22.8 ± 6 (13–34)
Returning ability		
(No. of worker bees returning to the hive/min)		
Before exposure	39.6 ± 13 (12–61)	36.4 ± 11 (21–58)
During exposure	41.3 ± 11 (14–78)	28.3 ± 8 (16–48)
Pollen foraging efficiency		
(No. of worker bees returning with pollen loads/min)		
Before exposure	7.0 ± 2 (4–9)	6.3 ± 2 (4–10)
During exposure	7.2 ± 2 (4–11)	4.6 ± 2 (2–7)

Table 2. Changes in colony status of *Apis mellifera* exposed to cellphone radiations

Parameter	Control (mean ± SD)	Treated (15 min exposure) (mean ± SD)
Bee strength		
Start	7 frame	7 frame
End	9 frame	5 frame
Brood (cm^2)		
Total brood		
Start	2033.76 ± 182.6 (7–532)	2866.43 ± 169.0 (0–574)
End	1975.44 ± 138.8 (0–427)	760.19 ± 111.0 (0–348)
Prolificacy (egg laying rate/day)		
Start	387.24	545.9
End	376.20	144.8
Honey stores (cm^2)	3200	400
Pollen stores (cm^2)		
Start	230.5 ± 21.60 (198–305)	218.2 ± 17.48 (141–241)
End	246.7 ± 16.94 (195–289)	154.7 ± 7.30 (142–168)

number of worker bees returning to the hive per minute: before exposure and during exposure.

Colony growth: (i) *Bee strength*: measured as total number of bee frames per colony. (ii) *Honey stores*: the area containing ripe and unripe (sealed and unsealed) nectar was measured in sq. cm with the help of the grid[4]. (iii) *Pollen stores*: the portion of comb containing cells filled with stored pollen was measured by the grid method. It was expressed in sq. cm.

The results of the studies carried out on biological and behavioural aspects of the colonies exposed to cellphone radiations for a duration of 15 min are presented in Tables 1 and 2.

It was observed that the total bee strength was significantly higher in the control colony being nine comb frames as compared to only five in the treated colony at the end of the experiment. There were no dead bees in the vicinity of the hive which is a characteristic of this disorder reported by other workers[9,10]. The area under brood declined to 760.19 cm^2 which was significantly less than the control (1975.44 cm^2).

The queen exposed to cellphone radiations produced fewer eggs/day (144.8) compared to the control (376.2). It has previously been reported that there is queen loss in colonies exposed to high voltage transmission lines[11] or exposure of the queen bee to cellphone radiations stimulated her to produce only drones[12].

The number of returning bees declined. Another important finding was that the number of bees leaving the hive also decreased following exposure (Table 1). There was no immediate exodus of bees as a result of this interference, instead the bees became quiet and still or confused as if unable to decide what to do. Such a response has however not been reported previously.

As the total number of returning bees decreased (28.3 bees/min) so did the number of pollen foragers returning to the hive (4.6). This led to decrease in the area under pollen stores from 246.7 cm^2 in control to 154.7 cm^2 in the treated colonies.

The honey storing ability declined due to loss of returning bees and at the end of the experiment there was neither honey, nor pollen or brood and bees in the colony resulting in complete loss of the colony. Similar conditions have been observed by other workers in case of honeybees under the influence of high tension lines[13–15]. Bee hives located near high voltage power lines in fields as low as 4 Kv/m produced less honey and had high mortality rates. It was also observed that colonies exposed to strong electric fields produce less honey[16]. The present study therefore suggests that colony collapse does occur as a result of exposure to cellphone radiations.

Reports of such a colony collapse in nature in developing countries like India where electromagnetic radiation (EMR) based technologies are comparatively new are absent. It is possible that the electrosmog that prevails in the advanced countries of the world has not yet affected these countries. We are fortunate that the warning bells have been sounded and it is for us to timely plan strategies to save not only the bees but life from the ill effects of such EMR.

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Impact of tuna longline fishery on the sea turtles of Indian seas

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Longline fishery is exerting an impact on the sea turtle populations of the seas around India, as in the case of many longline fisheries operating in other parts of the world. During the tuna longline survey conducted by four research vessels of Fishery Survey of India, 87 sea turtles were caught incidentally from the Arabian Sea, Bay of Bengal and Andaman and Nicobar waters of the Indian exclusive economic zone (EEZ) during 2005–08, registering an overall hooking rate of 0.108 turtles per 1000 hooks operated. There were marked differences in the hooking rates of turtles recorded from these three regions of the Indian EEZ, the maximum hooking rate being recorded from the Bay of Bengal (0.302), followed by the Arabian Sea (0.068) and Andaman and Nicobar waters (0.008). The species of sea turtles recorded in the bycatch, in order of abundance, were olive ridley (*Lepidochelys olivacea*), green (*Chelonia mydas*) and hawksbill (*Eretmochelys imbricata*) turtles. This study provides quantitative data on the magnitude of sea turtle incidental catch of the tuna longline fishery in the Indian EEZ.

Keywords: Arabian Sea, Andaman and Nicobar waters, Bay of Bengal, hooking rate, longline.

SEA turtles are among the most extraordinary, charismatic and fascinating creatures, and are some of the world's greatest nomads, sometimes navigating thousands of miles between feeding and nesting grounds. Six of the

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