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Effects of electromagnetic radiations on diversity and breeding biology of birds living near power lines and mobile towers at Ludhiana, Punjab



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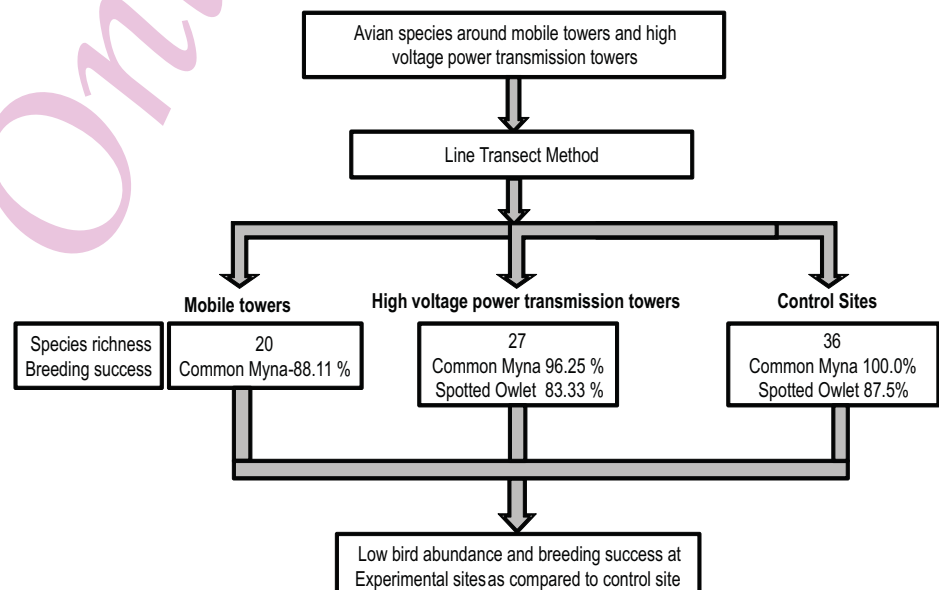
Abstract

Aim : Mobile towers and high voltage power transmission towers are ubiquitous in the developed world and in urban areas of many developing countries. The present study was undertaken to monitor relative abundance of avian species in relation to mobile towers and high voltage power transmission towers.

Methodology : Point count method was used for the survey. The observations were recorded from January to December 2014 at selected eleven sites *i.e.*, five in relation to mobile towers; five with respect to high voltage power transmission towers and one control site, respectively, at the campus of Punjab Agricultural University (PAU), Ludhiana.

Results : Species richness of 20, 27 and 36 bird species were observed at the selected sites near mobile towers, near high voltage power transmission towers and control site, respectively. The breeding success of Common Myna was 88.11 % in the artificial nests installed near mobile towers. Breeding success of 96.25 % and 83.33 % was recorded by Common Myna and Spotted Owlet in the artificial nests installed near high voltage power transmission towers. The breeding success of Common Myna and Spotted Owlet was 100.0% and 87.5% in artificial nests installed at control site.

Interpretation : Preliminary findings of this study revealed that there was low bird abundance and breeding success near mobile towers and high voltage power transmission towers as compared to control site. It may be possible due to the clandestine effect of electromagnetic radiations along with the other unforeseen factors.



Introduction

Rapid development of telecommunication devices in last decade has caused enhancement of human interference with nature. Similar to every device that carries an electric current, power lines and cell tower antenna emit electric and magnetic fields that are collectively called electromagnetic fields (EMFs). Before the 1990's, electromagnetic radiations were emitted from few radio and television transmitters located in remote areas and/or high elevations. Since then, mobile base stations masts have been spreading across urban centres and have increased electromagnetic pollution (Balmori and Hallberg, 2007). According to Kumar (2010), cell tower antennas transmit in the frequency range of 869-894 MHz (CDMA), 935-960 MHz (GSM900) and 1810-1880 MHz from (GSM1800). A continuous chronic exposure to a wide range of modulated radio frequency electromagnetic fields burdens all species and groups including humans across the globe (Yadav and Sharma, 2008). The strength of electromagnetic fields depends upon the current intensity carried through a conductor and the distance of exposure from the source (Ferne *et al.*, 2000). Both fields are highest immediately around a power line and diminish rapidly with distance away from the source (Ferne and Reynolds, 2005). The unseen electromagnetic radiation emitted from mobile towers, transmission lines and power lines induces undesirable impact on living beings in a multiple ways (Ferne *et al.*, 2000; Ferne and Reynolds, 2005; Everaert and Bauwens, 2007; Bhattacharya and Roy, 2013).

Birds have been widely used to analyze the environmental significance of exposure to non ionizing radiation. The ability of birds to detect electromagnetic stimuli has been documented by several studies (Thalau *et al.*, 2005; Cucurachi *et al.*, 2013). The electric power lines and mobile towers are beneficial to birds as they provide additional sites for perching, roosting, hunting and nesting. Consequently, birds are exposed for longer duration to EMF generated by these sources (Ferne *et al.*, 2000). There are numerous examples of the detrimental effects of power lines in terms of birds that die through collision or electrocution (Ferne and Reynolds, 2005). Since birds are environmental indicator of ecosystem health because of their thin skull, feathers as dielectric receptor, high mobility and use of areas having high electromagnetic field (Ferne *et al.*, 2000; Bhattacharya and Roy, 2013), field studies of avifauna can reveal possible effects of long-term exposure to radiation from mobile towers and high voltage power transmission towers. The present study was carried out with an objective to investigate the effects of electromagnetic radiations on diversity and breeding success of birds that live intimately with power lines and mobile towers.

Materials and Methods

The observations were recorded at selected eleven sites *i.e.*, five sites each within 100 m radius of mobile towers and high voltage power transmission towers and one control site (having similar habitat and a minimum distance of 500 m from the mobile

towers and high voltage power transmission towers) to monitor avian diversity in the campus of Punjab Agricultural University, Ludhiana. The point count method was followed for the survey (Javed and Kaul, 2002) and observations were taken twice a week. All birds sighted or heard, perching on towers, including those in flight in transect area were counted for record. The birds in study area were observed with naked eye or through Bushnell Binocular (8X42) from a long distance in order to avoid interference and identification were based on keys (Ali, 2002). Standardized common and scientific names of birds were described as per Manakadan and Pittie (2001). Total number of bird species and their relative abundance were estimated. Relative abundance (%) was calculated as: $(ni/N) \times 100$, where ni is the number of birds of i^{th} species and N is the total number of birds of all species. To record breeding success, artificial nests @ five/site were installed within 50 m radius of mobile towers and high voltage power transmission towers at selected sites. Breeding success was calculated by recording the successful hatching (% age) of egg laid in the artificial nest. Artificial nests were also installed at selected control site.

Results and Discussion

Species richness of 20 and 27 bird species were observed at the selected sites near mobile towers and high voltage power transmission towers as compared to 36 bird species at control site, including common species recorded at all locations (Table 1, 2, 3). The most abundant bird species near mobile towers was Common Pariah Kite, where as House Crow was found abundant near high voltage power transmission towers and Common Myna was most abundant bird species at control site (Table 1, 2, 3). Common Myna was found to occupy artificial nests installed near mobile towers, high voltage power transmission towers and at control sites, while Spotted Owlet occupied the artificial nests installed near high voltage power transmission towers and at control sites only (Table 4).

Common Myna was observed to breed in eight artificial nests out of total 25 artificial nests installed at sites near mobile towers. The occupation rate of artificial nests by Common Myna was 32% near mobile towers with 92.5 % overall breeding success in occupied artificial nests. Individual site specific breeding success of Common Myna ranged from 55.55% - 100.0 % at the selected sites (Table 3). Repeat egg laying was recorded in all the artificial nests occupied by Common Myna near mobile towers (Table 4). Breeding of Common Myna was observed in eleven artificial nests out of total twenty five artificial nests installed at five selected sites near high voltage power transmission towers. The occupation rate of artificial nests by Common Myna was 44% near high voltage power transmission towers. The overall breeding success of Common Myna was 96.25 % in artificial nests. Individual site specific breeding success of Common Myna in artificial nests ranged from 81.25% to 100.0% at five selected sites (Table 4). There was noted repeat egg laying in the occupied artificial nests by Common Myna at one site. The breeding success of Spotted Owlet was 81.25% in

Table 1 : Relative abundance of different bird species near mobile towers at selected five locations, PAU, Ludhiana, Punjab

Bird species	Site I		Site II		Site III		Site IV		Site V	
	Tower	Surroundings	Tower	Surroundings	Tower	Surroundings	Tower	Surroundings	Tower	Surroundings
Black Drongo (<i>Dicrurus macrocercus</i>)	-	-	-	-	-	-	-	-	-	6.25
Blue Rock Pigeon (<i>Columba livia</i>)	-	2.63	-	30	-	23.08	-	-	-	-
Cattle egret (<i>Bubulcus ibis</i>)	-	-	-	-	-	7.69	-	-	-	6.25
Common babbler (<i>Turdoides caudata</i>)	-	31.58	-	-	-	-	-	11.57	-	18.75
Common Golden backed woodpecker (<i>Dinopium javanense</i>)	-	2.63	-	-	-	-	-	-	-	-
Common Hoopoe (<i>Upupa epops</i>)	-	-	-	-	-	-	-	-	-	6.25
Common Myna (<i>Acridotheres tristis</i>)	-	26.32	-	25	-	26.92	-	24.79	50.0	18.75
Common Pariah Kite (<i>Milvus migrans</i>)	75.0	13.16	-	-	75.0	11.54	100.0	34.71	50.0	6.25
Common peafowl (<i>Pavo cristatus</i>)	-	-	-	-	25.0	-	-	12.4	-	-
Eurasian Collared-Dove (<i>Streptopelia decaocto</i>)	-	-	-	-	-	-	-	-	-	12.5
House Crow (<i>Corvus splendens</i>)	25.0	18.42	-	20	-	-	-	9.92	-	12.5
Indian Pond-Heron (<i>Ardeola grayii</i>)	-	-	-	-	-	7.69	-	-	-	-
Jungle Babbler (<i>Turdoides striatus</i>)	-	-	-	10	-	-	-	-	-	-
Lesser Coucal (<i>Centropus bengalensis</i>)	-	2.63	-	-	-	-	-	-	-	-
Purple Sunbird (<i>Nectarinia asiatica</i>)	-	-	-	-	-	-	-	-	-	12.5
Red-vented Bulbul (<i>Pycnonotus cafer</i>)	-	2.63	-	-	-	-	-	-	-	-
Red-wattled Lapwing (<i>Vanellus indicus</i>)	-	-	-	10	-	-	-	1.65	-	-
Rose-ringed Parakeet (<i>Psittacula krameri</i>)	-	-	-	5	-	11.54	-	3.31	-	-
Spotted Munia (<i>Lonchura punctulata</i>)	-	-	-	-	-	11.54	-	-	-	-
Yellow-legged Green-Pigeon (<i>Treron phoenicoptera</i>)	-	-	-	-	-	-	-	1.65	-	-

occupied artificial nests installed near high voltage power transmission towers. The breeding success of Common Myna and Spotted Owllet was 100.0% and 87.5% in artificial nests installed at control site (Table 4).

More species richness at control site as compared to site near mobile towers and high voltage power transmission towers may be due to the preference of control sites by the bird species. Similar findings have earlier been reported by Everaert and Bauwens, 2007; Balmori, 2005. It was reported that microwaves (1 MHz to 3 GHz) may affect the productivity of White Stork, *Ciconia ciconia* (Balmori, 2005). Many workers have reported decrease in bird species richness in urban areas having high level of electromagnetic radiation, which is correlated with the increasing number of cell towers (Rajashakar and Venkatesha 2008, 2011, 2015; Shaw *et al.*, 2008; Khera *et al.*, 2010; Bhattacharya *et al.*, 2011). In the present study less species richness was found within 100 m radius of mobile towers and high voltage power transmission towers. Bird species diversity decreased due to transmission line corridors, sparrows were observed to avoid transmission lines (Balmori and Hallberg, 2007). Disappearance of sparrows from urban areas and installation of GSM towers (GSM 900 MHz and DCS 1800 MHz)

are interrelated, and electromagnetic pollution either by itself or in combination with other factors is responsible for decline of common birds like House Sparrow (Balmori and Hallberg, 2007).

In the present study, the breeding success of Common Myna and Spotted Owllet was recorded to be more in the artificial nests installed at control site as compared to experimental sites, which might be due to the clandestine effect of electromagnetic radiations along with the other unforeseen factors. Though electromagnetic field is transient in nature, but it may induce serious hazards during breeding season due to long term exposure. Similar findings were also recorded by other workers, where abundance and breeding success was more at control site as compared to experimental sites (Peach *et al.*, 2008; Balmori, 2009; Anders *et al.*, 2011; Kaur *et al.*, 2016). A few number of natural nests of local birds have been found near the vicinity of mobile tower (Dongre and Verma, 2009; Kaur *et al.*, 2016). Exposure to electromagnetic radiation affects nest building, egg fertility, clutch size, hatching and survival of chicks (Balmori, 2009). Different studies have concluded that the mobile towers emit electromagnetic radiations (frequency of 900–1800 MHz) which affect the nervous system, navigational skills, foraging ability and breeding success of bird species

Table 2 : Relative abundance of different bird species near high voltage power transmission towers at selected five locations, PAU, Ludhiana, Punjab

Bird species	Site I			Site II			Site III			Site IV			Site V		
	Tower	Surround-ndings	Tower	Surround-ndings	Tower	Surround-ndings	Tower	Surround-ndings	Tower	Surround-ndings	Tower	Surround-ndings	Tower	Surround-ndings	
Asian Pied Starling (<i>Sturnus contra</i>)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Bank Myna (<i>Acridotheres ginginianus</i>)	-	-	-	1.30	-	-	-	-	8.33	-	-	-	-	-	
Black Drongo (<i>Dicrurus macrocercus</i>)	2.86	-	-	-	8.11	-	-	-	8.33	-	-	-	7.13	-	
Black Ibis (<i>Pseudibis papillosa</i>)	2.86	-	-	-	-	17.24	-	-	-	-	-	-	-	-	
Black Red Start (<i>Phoenicurus ochruros</i>)	-	-	-	-	-	1.72	-	-	-	-	-	-	-	-	
Blue Rock Pigeon (<i>Columba livia</i>)	-	-	-	-	-	-	-	16.67	-	-	-	-	-	6.25	
Cattle Egret (<i>Bubulcus ibis</i>)	-	-	-	1.30	-	-	-	-	-	-	-	-	-	6.25	
Common Tailor Bird (<i>Orthotomus sutorius</i>)	-	1.75	-	-	-	-	-	-	-	-	-	-	-	-	
Common Hoopoe (<i>Upupa epops</i>)	-	-	-	1.30	-	-	-	-	-	-	-	-	-	12.5	
Common Myna (<i>Acridotheres tristis</i>)	11.43	15.79	10.53	6.49	27.03	5.17	16.67	29.41	8.33	14.29	12.5	-	-	-	
Common Pariah Kite (<i>Milvus migrans</i>)	-	7.02	21.05	-	10.81	3.45	-	-	-	-	-	-	-	-	
Eurasian Collared-Dove (<i>Streptopelia decaocto</i>)	31.43	-	-	3.90	8.11	5.17	33.33	-	-	14.29	-	-	-	-	
Eurasian Starling (<i>Sturnus vulgaris</i>)	-	-	-	-	16.22	-	-	-	-	-	-	-	-	-	
Green leaf warbler (<i>Phylloscopus trochiloides</i>)	-	-	-	-	-	5.17	-	-	-	-	-	-	-	-	
House Crow (<i>Corvus splendens</i>)	51.43	66.67	63.16	81.82	29.73	25.86	8.33	11.76	43.75	-	-	-	-	-	
Indian Grey Hornbill (<i>Ocyroceros birostris</i>)	-	-	-	-	-	3.45	-	-	-	-	-	-	-	6.25	
Indian Roller (<i>Coracias benghalensis</i>)	-	-	-	-	-	1.72	-	-	-	-	-	-	-	-	
Indian Tree pie (<i>Dendrocitta vagabunda</i>)	-	-	-	-	-	6.90	-	-	-	-	-	-	-	-	
Large Indian Parakeet (<i>Psittacula eupatria</i>)	-	-	-	-	-	-	-	5.88	-	-	-	-	-	6.25	
Large pied Wagtail (<i>Motacilla maderaspatensis</i>)	-	-	-	-	-	1.72	-	-	-	-	-	-	-	-	
Red-vented Bulbul (<i>Pycnonotus cafer</i>)	-	-	-	-	-	1.72	-	-	-	-	-	-	-	-	
Red-wattled Lapwing (<i>Vanellus indicus</i>)	-	1.75	-	2.60	-	5.17	-	-	-	-	-	-	-	-	
Rose-ringed Parakeet (<i>Psittacula krameri</i>)	-	1.75	-	-	-	5.17	-	-	-	-	-	-	-	-	
Rufous Backed Shrike (<i>Lanius schach</i>)	-	-	-	-	-	1.72	-	-	-	-	-	-	-	-	
Shikra (<i>Accipiter badius</i>)	-	-	5.26	-	-	-	-	-	-	-	-	-	-	-	
White wagtail (<i>Motacilla alba</i>)	-	-	-	1.30	-	-	-	-	-	-	-	-	-	6.25	
White-throated Munia (<i>Lonchura malabarica</i>)	-	5.26	-	-	-	-	-	-	-	-	-	-	-	-	

Table 3 : Relative abundance of different bird species at selected control site, PAU, Ludhiana, Punjab

Bird species	Relative abundance	Bird species	Relative abundance
Ashy Prinia (<i>Prinia socialis</i>)	0.63	Greenish Leaf Warbler (<i>Phylloscopus trochiloides</i>)	1.90
Asian Koel (<i>Eudynamys scolopacea</i>)	0.63	Grey Francolin (<i>Francolinus pondicerianus</i>)	1.90
Asian Pied Starling (<i>Sturnus contra</i>)	1.27	House Crow (<i>Corvus splendens</i>)	12.66
Bank Myna (<i>Acridotheres ginginianus</i>)	6.33	Indian Hoopoe (<i>Upupa epops</i>)	0.63
Black Drongo (<i>Dicrurus macrocercus</i>)	1.90	Indian Pond Heron (<i>Ardeola grayii</i>)	1.90
Black Francolin (<i>Francolinus francolinus</i>)	0.63	Indian Roller (<i>Coracias benghalensis</i>)	1.27
Black Ibis (<i>Pseudibis papillosa</i>)	1.27	Lesser Coucal (<i>Centropus bengalensis</i>)	1.90
Black Redstart (<i>Phoenicurus ochruros</i>)	0.63	Little Brown Dove (<i>Streptopelia senegalensis</i>)	1.27
Black-winged Stilt (<i>Himantopus himantopus</i>)	2.53	Oriental Magpie-Robin (<i>Copsychus saularis</i>)	0.63
Blue Rock Pigeon (<i>Columba livia</i>)	4.43	Paddy Field Pipit (<i>Anthus rufulus</i>)	4.43
Brown-headed Barbet (<i>Megalaima zeylanica</i>)	0.63	Pied Bushchat (<i>Saxicola caprata</i>)	1.27
Cattle Egret (<i>Bubulcus ibis</i>)	3.16	Red-vented Bulbul (<i>Pycnonotus cafer</i>)	2.53
Common babbler (<i>Turdoides caudata</i>)	2.53	Red-wattled Lapwing (<i>Vanellus indicus</i>)	6.33
Common Myna (<i>Acridotheres tristis</i>)	15.19	Rose-ringed Parakeet (<i>Psittacula krameri</i>)	5.06
Common Pariah Kite (<i>Milvus migrans</i>)	0.63	Shikra (<i>Accipiter badius</i>)	0.63
Common Swallow (<i>Hirundo rustica</i>)	3.16	Spotted Munia (<i>Lonchura punctulata</i>)	2.53
Eurasian Collared-Dove (<i>Streptopelia decaocto</i>)	3.16	White-breasted Kingfisher (<i>Halcyon smyrnensis</i>)	1.27
Green Bee-eater (<i>Merops orientalis</i>)	1.90	Wire-tailed Swallow (<i>Hirundo smithii</i>)	1.27

Table 4 : Data recorded on different parameters of breeding ecology of birds utilizing artificial nests, PAU, Ludhiana, Punjab

Locations	Occupation of artificial nest (%) by Common Myna	No of clutches	Total eggs laid	Predation of eggs (%)	Total egg hatched	Breeding success (%)
Mobile tower						
Site I	40.0	5	21	0.0	21	100.0
Site II	40.0	5	23	0.0	23	100.0
Site III	40.0	3	15	6.67	14	93.33
Site IV	20.0	2	9	44.44	5	55.55
Site V	20.0	3	12	8.33	11	91.67
High voltage power transmission towers						
Site I	60.0	3	13	0.0	13	100.0
Site II	60.0	4	19	0.0	19	100.0
	40.0*	2	6	16.67	5	83.33
Site III	20.0	1	4	0.0	4	100.0
Site IV	60.0	3	16	18.75	13	81.25
Site V	20.0	1	4	0.0	4	100.0
Control	66.66	14	61	0.0	61	100.0
	20.0*	2	8	12.5	7	87.5

* Artificial nest occupied by Spotted Owllet

(Peach *et al.*, 2008; Anders *et al.*, 2011). Long term exposure to higher levels of radiations has been recorded to negatively affect the abundance or behaviour of House Sparrow in the wild (Everaert *et al.*, 2007; Pradha, 2015). It may be concluded from the present study that radiations interfere with the reproduction of avian species and to some degree adversely effect incubation during breeding season, as reflected by high

breeding success in control site than the sites located near mobile tower and high voltage power transmission towers.

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