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RESEARCH ARTICLE

An Experimental Study on the Effects of Mobile Tower Radiation on Breeding of Birds

Premlal P.D[1], Reji.A.P[1]* and Eldhose.N.V[2]

[1]Department of Electronics, NSS College Rajakumary, Idukki Dist, Kerala, India.
[2]Department of Electronics, School of Technology and Applied Science, Edappally, Kochi, Kerala, India.

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***Address for Correspondence**
Reji.A.P
Department of Electronics,
NSS College Rajakumary,
Idukki Dist, Kerala, India.

ABSTRACT

Microwave radiation causes serious issues to humans, animals, birds, and other living organisms. In this study, we examined experimentally whether mobile tower radiation has any relevant relationships with the breeding of birds. Two methods are accustomed to determine the relation between the breeding of birds and cell tower radiation. In the first experiment, collected fertilized eggs of four birds - chicken, duck, quail, and crow. Repeated thrice at three locations in India and Finland. In the case of chicken and duck, no meaningful relation was found between their breeding and cell tower radiation. But mobile tower radiation plays a major role in damaging the eggs and embryos of quail and crow. Difficulties aroused in collecting large quantities of eggs of other bird species from the wild. Moreover, we never intended to disturb their lives. So we tried another method to look at the relationships in other birds. Shielding effectiveness measurement could be a proven scientific method to search out the capacity of an enclosure to scale back the share of penetration by microwave radiation. Collected broken egg shells after hatching from sixteen bird species and determined their shielding effectiveness. Compared with the primary experimental results. Our study confirmed that tiny birds having lesser egg shell thickness have lesser shielding effectiveness and their don't seem to be safe even at a distance of 1 km from a cell tower.

Keywords: Mobile tower radiation, birds, breeding , crow, microwave , radiation exposure, RF exposure.

INTRODUCTION

One of the foremost technologies of recent man is telecommunication. Among these, cellular technology is the one that has drastically changed the globe within the last twenty years. Higher bandwidth internet connections are now possible with the introduction of 4G and 5G. As of 2017, about 73% of the world's population is using cell phones [1]. A part of the radio frequency spectrum is utilised for cellular technologies, which comes under Non ionising

Radiations (NIR).NIR is also a part of the electromagnetic spectrum which has no power to expel electrons from the shells and ionise matter. It seems less harmful compared to ionising radiations. But long-term exposure to NIR also may cause serious effects on living things [2]. The latest note published by the International Commission on Non-Ionizing Radiation Protection (ICNIRP), constituted by World Health Organisation (WHO), on their website (ICNIRP Note 2019) [3] declares "clear evidence" that radio frequency is "carcinogenic". The results available are from two large animal studies investigating the long-term exposure to radiation from either mobile phones or base stations. These studies are from US National Toxicology Program (NTP) and Ramazzini Institute, Italy. The International Commission on Non-Ionizing Radiation Protection (ICNIRP) evaluates these studies and declares that these studies have "important Strengths" and have "Clear evidence". This is often the first time in its history that ICNIRP openly agrees on the harmfulness of long-term exposure from cell towers and base stations. A report named Bio initiative Report, prepared by thousands of scientists around the world, after careful studies on this subject, concluded that the prevailing RF exposure standards in the world are not sufficient to shield the globe from the ill effects of radiation[4]. Guidelines were issued by the ICNIRP to limit the radiation exposure from NIR under 300 GHz. The exposure effects on the living matter are of two types - thermal effects and non-thermal effects [2].

Thermal Effects

The heating of living matter by absorption of energy from the exposed microwave fields is termed thermal effects. When aanimate thing is placed under radio frequency exposure, it will absorb radiation, because the living matter constitution contains quite 70% of liquid. The radiation in the microwave range exerts a force on the electric dipoles of the water molecules. This force causes the molecules to vibrate at the applied frequency producing heat. This is the principle used in the microwave oven also.

Non thermal Effects

The heating of living matter by absorption of energy from the exposed microwave fields is termed thermal effects. The effects due to the coupling of electric and magnetic fields inside a living matter are termed non-thermal effects. Living matter could be a good conductor. The exposed field will induce voltage and currents in living things by electromagnetic induction. It also forms electric dipoles inside the body or reorients the existing dipoles in living matters. The electric field forces charges in the conducting tissues to move. The magnitude of these effects will depend on the electric conductivity and permittivity of the body tissues, the type of tissues, and their orientation towards the exposure fields. The induced current inside the body parts will depend on the size and shapes of the exposing body parts and their orientation to the exposure fields. The coupling of magnetic fields induces electric fields and circulating electric currents (Eddy Currents) inside the exposed living matter. Eddy currents are currents, circulating in conducting loops, induced by a time-varying magnetic field, according to Faraday's law of Induction. Eddy current flows in closed loops within the exposed conductors in the plane perpendicular to the applied magnetic field. Eddy current, in turn, creates another magnetic field, which opposes the applied field according to Lenz's law and Ampere's circuital law. The transfer of nutrition from blood to the tissues is through narrow capillary walls. The force exerted by the exposure fields may damage these walls. Also, the induced voltages and currents may affect the communication through the nerves in the human body. Many studies confirmed the ill effects of microwave radiation. The brain is protected from the blood by a blood-brain barrier (BBB), which selectively allows the nutrients to pass through it, from blood to brain, but keeps toxic substances out [5],[6]. But experiments in the Young lab found that the cell phone radiations open the BBB, which allows the albumin to come in to in appropriate places in the brain. A study by BahriyeSirav and NesrinSeyhan of Gazi University (2016) found a significant increase in albumin in the brain of rats after giving them a sufficient amount of RF exposure [3]. Other studies which also concluded with similar results are [7], [8], [9] made a clear analysis on the exposure effects on the brain and suggested some effective methods for prevention using antioxidants [7] also refers to the same issue. There are so many other studies that also reported the same fact. Some of them are included in the reference [10] – [14],[16],[37]-[42].

It has been found in several studies that electromagnetic fields release calcium ions bound to the cell membranes and can develop temporary pores and leaks. The leaked calcium ions in the cytosol fluid which stimulate growth and

healing it also cause brain tumuors. The ions degrade the signal-to-noise ratio of the brain to respond to the weak stimuli. This also leads to neurological disorders in the brain. The recent studies that reported these findings include Dimitris 2019 [15] and [17] - [29].

Microwave frequencies even below the ICNIRP and FCC standards can affect and damage the DNA. Studies reported that RF exposure causes single and double-strand breaks in DNA. [30] – [35]. The electromagnetic field causes membrane leakage due to the loss of calcium ions. Leaks in the lysosomes (small tissue containing digestive enzymes which can destroy DNA) cause breaks in DNA [36]. Microwave radiation causes serious issues to humans, animals, birds, and other living organisms[37]-[43]. Nair Sravan Surendran, Nihal Anwar S, etc. reveals the radiation's harmful effects on Sparrows, Pigeons, Swans, etc [45]. Devendra Kumar Durgam, Shweta Sao, and R. K. Singh found the effect of mobile tower radiation on birds in Bijapur district, India [46]. R.Bhattacharya and R. Roy described the impact of mobile tower pollution on local birds[47]. Nyirenda, V.R., Namukonde, N., Lungu, E.B. et al. studied the effects of phone mast-generated electromagnetic radiation gradient on the distribution of terrestrial birds and insects in a savanna protected area[48].Alfonso Balmori, in his article , describes electromagnetic pollution as a possible explanation for the decline of house sparrows in interaction with other factors[49].

Aim of the study

This study aims to examine whether mobile tower radiation has any relevant relationships with the breeding of birds. Many of the above-mentioned studies pointed out the impact of tower radiation on the disappearance of many species of birds from different geographical parts. This paper tries to examine the suspected relation experimentally.

METHODOLOGY

Two methods are used to experimentally find out the relation between the hatching of eggs and the cell tower radiation.

- Hatching Experiment
- Shielding Effectiveness test

The preferred temperature range of birds' egg hatching is between 35 to 40.5°C (84.5 - 104.9°F). The optimum temperature for hen is 37.5 °C. The optimum temperature of some small birds is found to be 35 or 36°C. Above this temperature, the hatch will be reduced. No embryos will survive after 40.5 °C (104.9°F). The specific heat capacity of a material is defined as the energy required to raise the temperature of 1 kg of the material by 1 °C. The specific heat capacity of water is found to be 4200 J/kg°C. That means 4200 Joule is required to raise the temperature of 1 Kg of water by 1 °C. The energy required to raise the temperature of 1 gram of water by 1 °C is 4,2 Joules approximately. We can calculate the time required to raise the temperature of a specific mass with a given power.

t = $\frac{mST}{P}$

t – time required in seconds

m – mass of the substance

S – specific heat capacity

P – the given power

T – temperature difference in °C

Let us examine the power available from a mobile tower at a particular distance. In India, 20 watts antenna is suggested for a cell tower. The table (1) shows the power density at various distances.

P_D - Power Density at a distance R meter

G_T – Gain of the antenna

R - The Distance from the antenna in meters.

P_T = 20 W, G_T = 17 dB = 50

This is for a single carrier, single operator. But the actual case is different. The table (2) shows the power available at various distances, if the number of carriers is 5 and the number of operators sharing the same tower is 5. We can

calculate the time required to raise the temperature of an egg by 1 °C if it is placed 500 meters from a cell tower. Available power density at 500 meters – 4.77 mW/m^2 The mass of an average chicken egg – 50 grams (it contains 80% of water). The energy required to raise the temperature of 1 gram of water by 1 °C is 4,2 Joules approximately.
S – 4.2 J/g°C.
T - 1 °C.
The time required to raise the temperature of the egg by 1°C can be calculated as 12,2 hours. Considering the heat dissipation, and the presents of other materials, it may take 18 hours to raise the egg temperature by1 °C. Considering the average incubation period of 10-18 days it may be a serious threat. Even if a bird incubated its eggs at a distance above 500 meters from a cell tower, the average hatching percentage may be drastically affected by the thermal effect of radiation.

Experimental Method– 1 (Hatching Experiment)
Considered a method to experimentally verify the above theoretical facts. Collected fertilised eggs of some birds which are easily available in abundance. Fifty percent of them are exposed to a radiation power density of 10mW/m^2 for 10 days. Other eggs are stored separately in unexposed conditions. Incubated them together artificially and compare the hatching percentages. Repeated the experiment three times and the average value is taken into consideration. Experiment with two places in India (Chalakkudi, Rajapalayam) and two places in Finland(Tampere, Porvoo).

RESULT AND DISCUSSIONS

Collected fertilized eggs of four birds - Chicken, duck, quail, and crow. Repeated three times at three locations. Table (3) shows the results at Rajapalayam, table (4) shows that of Chalakkudi, and table (5) describes the experiment at Tampere and Porvoo. The average value of three rounds is taken into consideration. We cannot find any relevant relationships between the hatching percentage and the radiation exposure in the case of chicken and duck. But in the case of quail and crow, our observation is that the radiation exposure reduces the percentage of hatching seriously. It can also be observed that quail and crow have lesser egg shell thickness compared to chicken and duck. This may allow more radiation to penetrate inside the shell.

Experimental Method – 2 (Shielding Effectiveness test)
For the previous hatching experiment, a large quantity of eggs is required to produce exact results. But it is very difficult to collect the eggs of wild birds in larger quantities. Moreover, it may badly affect many species. To bypass the above difficulties, we tried another method that never affect their lives.

Shielding Effectiveness (SE)
Shielding Effectiveness is the degree of isolation provided by an enclosure from electromagnetic radiation.

$$SE = 10log\left(\frac{P_0}{P_1}\right)$$

P_0 - Power density measured without the enclosure
P_1 - Power density measured with the enclosure
There are several factors like frequency, polarisation, the thickness of the enclosure, hole dimensions, material permittivity, permeability, and conductivity, which can affect the shielding Effectiveness.. It is usually expressed in dB. The attenuation of EM field is mainly due to two different mechanisms.
1. Absorption
2. Reflection

$$SE_A = 20Log_{10}\left|Exp\left(\frac{t}{\delta}\right)\right|$$

$$\delta = \frac{0.066}{\sqrt{f\sigma\mu_r}}$$

$$SE_R = 20Log_{10}\left|\frac{1}{4}\sqrt{\frac{\sigma}{\mu_r f}}\right|$$

where, t – thickness in meters

δ – depth of penetration

σ – conductivity of the material

μ_r – relative permeability

$$SE = SE_A + SE_R$$

Here we tried to find out the shielding effectiveness of eggshells of different kinds of bird species (figure 1). Sixteen species were examined. Collected the broken hatched eggshells from the wild and hatcheries. The experiment contains an anechoic chamber, MECHO's radiation meter, signal generator 9KHz – 3 GHz, 12dBi high gain omni directional SMA male antenna and eggshell samples. Samples were collected from various places in India and Finland.

RESULT AND DISCUSSIONS

From the previous hatching experiment, we can find that the microwave radiation does not affect chicken and duck, but will affect quail and crows. When comparing the SE values (table 6), the first two have values above 10 dB and the other two have values below 10 dB.So we can find out a value of around 10 dB above which all are almost safe (figure 2). Some small birds having a lower eggshell thickness and lesser SE will be in great trouble. Even at a distance of 1 Km from a mobile tower, their eggs are not safe at all. The figure () shows the comparison.

CONCLUSION

Microwave radiation causes serious issues to humans, animals, birds, and other living organisms. In this study, we examined experimentally whether mobile tower radiation has any relevant relationships with the breeding of birds. Two methods are used to find out the relation between the breeding of birds and cell tower radiation. In the first experiment, collected fertilized eggs of four birds - chicken, duck, quail, and crow. Repeated three times at three locations in India and Finland. We cannot find any relevant relationships between the hatching percentage and the radiation exposure in the case of chicken and duck. But in the case of quail and crow, our observation is that the radiation exposure reduces the percentage of hatching seriously. It can also be observed that quail and crow have lesser egg shell thickness compared to chicken and duck. This may allow more radiation to penetrate inside the shell. In the hatching experiment, a large quantity of eggs is required to produce exact results. But it is very difficult to collect the eggs of wild birds in larger quantities. Moreover, it may badly affect many species. To bypass the above difficulties, we tried another method that never affect their lives. we tried to find out the shielding effectiveness of eggshells of different kinds of bird species. Sixteen species were examined. Collected the broken hatched eggshells from the wild and hatcheries. Some small birds having a lower eggshell thickness and lesser SE will be in great trouble. Even at a distance of 1 Km from a mobile tower, their eggs are not safe at all. We conclude that small birds are in great trouble with the current standards of mobile phone technology. But larger birds like chickens, ducks, storks, etc., are comparatively safe. It does not mean that they haven't any problems with the mobile radiation. Our

study aims to examine the relationships of microwave radiation with breeding only. Further studies are required to assess whether the radiation has any impact on other aspects of their lives like migration, navigational abilities, etc.

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Table(1) : Power density variation (single carrier, single operator)

Distance (m)	P_DmW/m^2
1	79600
3	8840
5	3180
10	796
50	31.8
100	8
500	0.318

Table (2) : Power density values (multi carriers, multi operators)

Distance (m)	P_D mW/m^2
1	1194000
3	126000
5	47700
10	11940
50	477
100	119.4
500	4.77

Table (3) : Hatching at Rajapalayam , Chicken :730, Duck : 314, Quail : 314, Crow : 36 Incubating temperature 37.5 degree Celsius.

Bird	Hatching % without RF exposure	Hatching % with RF exposure	Reduction in %
Chicken	73.89	74.01	-0.12
Duck	68.72	64.36	4.36
Quail	83.29	36.42	46.87
Crow	91.30	66.18	25.12

Table (4) : Hatching at Chalakkudi, Chicken : 517, Duck : 314, Quail : 314 Incubating temperature 37.5 degree Celsius.

Bird	Hatching % without RF exposure	Hatching % with RF exposure	Reduction in %
Chicken	83.65	79.18	4.47
Duck	66.13	70.34	-4.21
Quail	72.28	29.91	42.37

Table (5) : Hatching atTampere and Porvoo,Chicken : 1050, Duck : 1050, Quail : 1050, Crow : 60 Incubating temperature 38 degree Celsius.

Bird	Hatching % without RF exposure	Hatching % with RF exposure	Reduction in %
Chicken	91.31	89.39	1.92
Duck	88.06	92.14	-4.08
Quail	78.14	52.19	25.95
Crow	88.19	53.21	34.98

Table (6) : SE comparison of egg shells of various species.

BIRD	SHELL THICKNESS mm	SE dB
Chicken	0.31	10.83
Duck	0.38	12.37
Quail	0.24	7.45
Pigeon	0.26	7.13
Bustards	0.41	12.9
Woodpecker	0.25	8.19
Crow	0.21	6.12
Old world sparrow	0.16	3.69
House sparrow	0.14	4.89

King fisher	0.24	9.08
Myna	0.18	5.29
Honey bird	0.13	3.92
Little cormorant	0.43	16.1
Parrot	0.26	8.16
Stork	0.53	14.85
Great Egret	0.58	20.11

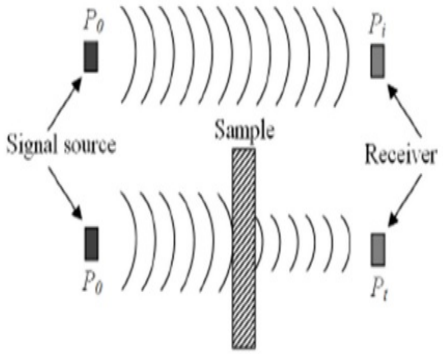
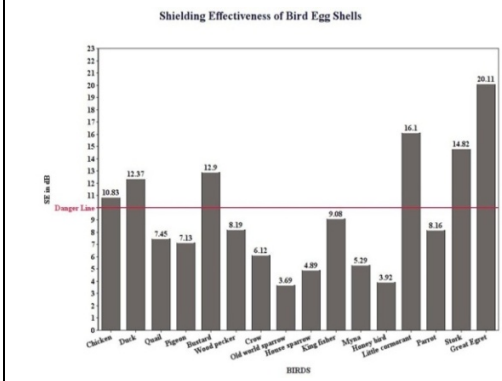


Figure (1): Experimental setup



Figure(2) : SE of different eggshells.