

## Research on Radio Frequency Radiation and the Environment

### [A review of the ecological effects of radiofrequency electromagnetic fields](#)

(RF-EMF) Environment International Volume 51, January 2013, Pages 116–140

- A Review of 113 studies from original peer-reviewed publications. RF-EMF had a significant effect on birds, insects, other vertebrates, other organisms and plants in 70% of the studies. Development and reproduction of birds and insects are the most strongly affected endpoints.

**Balmori A. [Electrosmog and species conservation](#). Sci Total Environ. 2014 Aug 1;496**

- “Conclusion: At the present time, there are reasonable grounds for believing that microwave radiation constitutes an environmental and health hazard....Concerning the exposure to electromagnetic fields, the precautionary principle is needed and should be applied to protect species from environmental non-thermal effects (Zinelis, 2010). Controls must be introduced and technology rendered safe to the environment, since this new ubiquitous and invisible pollutant could deplete the efforts devoted to species conservation.”

Alfonso Balmori [Anthropogenic radiofrequency electromagnetic fields as an emerging threat to wildlife orientation](#). Science of The Total Environment, Volumes 518–519, 15 June 2015, Pages 58–60

- The growth of wireless telecommunication technologies causes increased electrosmog. Radio frequency fields in the MHz range disrupt insect and bird orientation.
- Radio frequency noise interferes with the primary process of magnetoreception. Existing guidelines do not adequately protect wildlife. Further research in this area is urgent.

### [Mobile phone mast effects on common frog \(\*Rana temporaria\*\) tadpoles](#)

Electromagnetic Biology and Medicine [2010, 29(1-2):31-35

- Eggs and tadpoles of the common frog were exposed to electromagnetic radiation from cell phone antennas for two months, from the egg phase until an advanced phase of tadpole prior to metamorphosis. Results indicate that radiation emitted by phone masts in a real situation may affect the frogs development and may cause an increase in mortality of exposed tadpoles. “This

research may have huge implications for the natural world, which is now exposed to high microwave radiation levels from a multitude of phone masts.”

**"The Report on Possible Impacts of Communication Towers on Wildlife Including Birds and Bees"** , Commissioned on 30th August, 2010 by the Ministry of Environment and Forest, Government of India.

- This report details the on impacts of communication towers on wildlife including birds and bees submitted to MoEF. It warns of harmful radiation and recommends special laws to protect urban flora & fauna from threats radiation emerging from mobile towers.

**Impacts of radio-frequency electromagnetic field (RF-EMF) from cell phone towers and wireless devices on biosystem and ecosystem – A Review**, S Sivani, D Sudarsanam, Department of Advanced Zoology and Biotechnology, Loyola College, Chennai, Tamil Nadu, India. *Biology and Medicine*, 4 (4): 202–216, 2012

- There is an urgent need for further research and “of the 919 research papers collected on birds, bees, plants, other animals, and humans, 593 showed impacts, 180 showed no impacts, and 196 were inconclusive studies”.
- “One can take the precautionary principle approach and reduce RF-EMF radiation effects of cell phone towers by relocating towers away from densely populated areas, increasing height of towers or changing the direction of the antenna.”

Malkemper EP, Eder SH, Begall S, Phillips JB, Winklhofer M, Hart V, Burda H. **Magnetoreception in the wood mouse (*Apodemus sylvaticus*): influence of weak frequency-modulated radio frequency fields.** *Sci Rep.* 2015 Apr 29;4:9917. doi: 10.1038/srep09917.

- Wood mice exposed to a 0.9 to 5 MHz frequency sweep changed their preference from north-south to east-west. In contrast to birds, however, a constant frequency field tuned to the Larmor frequency (1.33 MHz) had no effect on mouse orientation. In sum, we demonstrated magnetoreception in wood mice and provide first evidence for a radical-pair mechanism in a mammal. Open Access Paper: <http://bit.ly/1zh1J91>
- In sum, we show that wood mice possess a magnetic sense that they use to position their nests along the NNE-SSW axis relative to the magnetic field. The NNE-SSW preference was not altered by RF fields delivered at the Larmor frequency, but was shifted by approximately 90° by a RF frequency sweep (0.9–5 MHz repeated at 1 kHz) at an intensity of only ~5% that of the Larmor frequency stimulus.

- The results point to the involvement of a radical pair mechanism, the first such evidence for a mammal, although further research is needed to provide a more thorough characterization of the underlying mechanism.
- The RF magnetic fields applied here have peak intensities below the ICNIRP guidelines for general public exposure (63, i.e.,  $B_{rms} = 0.92 \mu T/f$  [MHz], or  $B_{peak} = 1.30 \mu T/f$  [MHz]) considered as harmless for human health. Yet, we show that they are sufficient to affect behaviour in a mammal.

## Radio Waves Affect Birds

Engels, S. et al. [Anthropogenic electromagnetic noise disrupts magnetic compass orientation in a migratory bird.](#) Nature 509, 353–356 (2014).

- Scientists found that migrating robins became disorientated when exposed to electromagnetic fields at levels far lower than the safety threshold for humans. “Here we show that migratory birds are unable to use their magnetic compass in the presence of urban electromagnetic noise...These fully double-blinded tests document a reproducible effect of anthropogenic electromagnetic noise on the behavior of an intact vertebrate.”

Balmori A. [Possible Effects of Electromagnetic Fields from Phone Masts on a Population of White Stork \(Ciconia ciconia\)](#) Electromagn Biol Med 2005; 24 (2): 109 - 119

- Interesting behavioral observations of the white stork nesting sites located within 100m of one or several cell site antennas were carried out. These results are compatible with the possibility that microwaves are interfering with the reproduction of white storks and would corroborate the results of laboratory research by other authors. In far away areas, where the radiation decreases progressively, the chronic exposure can also have long term effects [13, 49]. Effects from antennas on the habitat of birds are difficult to quantify, but they can cause a serious deterioration, generating silent areas without male singers or reproductive couples.

Kavokin K, Chernetsov N, Pakhomov A, Bojarinova J, Kobylkov D, Namozov B. [Magnetic orientation of garden warblers \(Sylvia borin\) under 1.4 MHz radiofrequency magnetic field.](#) J R Soc Interface. 2014 Aug 6;11(97):20140451. doi: 10.1098/rsif.2014.0451.

- “Birds in experimental cages, deprived of visual information, showed the seasonally appropriate direction of intended flight with respect to the magnetic

meridian. Weak radiofrequency (RF) magnetic field (190 nT at 1.4 MHz) disrupted this orientation ability.”

- “These results may be considered as an independent replication of earlier experiments, performed by the group of R. and W. Wiltschko with European robins (*Erithacus rubecula*). Confirmed outstanding sensitivity of the birds' magnetic compass to RF fields in the lower megahertz range demands for a revision of one of the mainstream theories of magnetoreception, the radical-pair model of birds' magnetic compass.”
- “As discussed above, the high sensitivity of the birds' magnetic compass to RF fields, found in [21,22,24] and now confirmed by us, is difficult to explain within the existing radical-pair theory ....”

#### [Ants can be used as bio-indicators to reveal biological effects of electromagnetic waves from some wireless apparatus](#) Electromagn Biol Med. 2013 Aug 26.

- “the linear and angular speed of ants are immediately altered by the presence of EMF/RF fields. Based on these results, the authors advise users to deactivate the WiFi function of their PC/laptop.”
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#### [Drosophila oogenesis as a biomarker responding to EMF sources.](#)

- A total of 280 different experiments were performed. Exposure to wireless devices such as WiFi, baby monitors, and phones created statistically significant effects regarding reproduction and cell death apoptosis induction, even at very low intensity levels (0.3 V/m bluetooth radiation), well below ICNIRP's guidelines.

## Bees and Butterflies

Research shows that Birds, Bees and Butterflies are sensitive to electromagnetic fields. Their behavior is disrupted by exposures to this radiation.

#### [A magnetic compass aids monarch butterfly migration.](#) Nature Communications 5(4). 24 June 2014

- “Here we use flight simulator studies to show that migrants indeed possess an inclination magnetic compass to help direct their flight equator ward in the fall. Another vulnerability to now consider is the potential disruption of the magnetic compass in monarchs by human-induced electromagnetic noise, which can apparently disrupt geomagnetic orientation in a migratory bird.”

**Mobile phone induced honeybee worker piping** Apidologie (2011) 42:270-279

- Electromagnetic waves originating from mobile phones had a dramatic impact on the behavior of the bees, namely by inducing the worker piping signal. In natural conditions, worker piping either announces the swarming process of the bee colony or is a signal of a disturbed bee colony.

**Birds, Bees and Mankind** by Dr. Ulrich Warnke

- Bees pollinate approximately 1/3 of all crops and they are disappearing by the millions. Warnke raises the concern that the dense, energetic mesh of electromagnetic fields from wireless technologies may be the cause.
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**Changes in honeybee behaviour and biology under the influence of cell phone radiations.** Current Science 98 (10): 1376 – 1378.

- We have compared the performance of honeybees in cell phone 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.”
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**Briefing Paper on the Need for Research into the Cumulative Impacts of Communication Towers on Migratory Birds and Other Wildlife in the United States**  
**Division of Migratory Bird Management (DMBM), U.S. Fish & Wildlife Service** 2009

- Of concern to DMBM are the potential impacts of radiation on bird populations. For example, preliminary research on wild birds at cellular phone tower sites in Spain showed strong negative correlations between levels of tower-emitted microwave radiation and bird breeding, nesting, and roosting in the vicinity of the electromagnetic fields.

**Can electromagnetic exposure cause a change in behaviour? Studying possible non-thermal influences on honey bees – an approach within the framework of educational informatics.** Acta Systemica-IIAS International Journal 6(1):1-6.

- A pilot study on honeybees testing the effects of non-thermal, high frequency electromagnetic radiation on beehive weight and flight return behavior. In exposed hives, bees constructed 21% fewer cells in the hive frames after 9 days than those unexposed.

Sainudeen Sahib.S, [Electromagnetic Radiation \(EMR\) Clashes with Honey Bees](#), INTERNATIONAL JOURNAL OF ENVIRONMENTAL SCIENCES Volume 1, No 5, 2011

- Recently a sharp decline in population of honey bees has been observed in Kerala. Although the bees are susceptible to diseases and attacked by natural enemies like wasps, ants and wax moth, constant vigilance on the part of the bee keepers can overcome these adverse conditions. The present plunge in population ( $< 0.01$ ) was not due to these reasons. It was caused by man due to unscientific proliferation of towers and mobile phones.”
- Six colonies of honeybees ( *Apis mellifera* ) were selected. Three colonies were selected as test colonies (T1,T2&T3) and the rest were as control (C1,C2&C3). The test colonies were provided with mobile phones in working conditions with frequency of 900 MHz for 10 minutes for a short period of ten days. After ten days the worker bees never returned hives in the test colonies. The massive amount of radiation produced by mobile phones and towers is actually frying the navigational skills of the honey bees and preventing them from returning back to their hives.
- The study concludes, “More must also be done to compensate individuals and communities put at risk. Insurance covering diseases related to towers, such as cancer, should be provided for free to people living in 1 km radius around the tower. Independent monitoring of radiation levels and overall health of the community and nature surrounding towers is necessary to identify hazards early. Communities need to be given the opportunity to reject cell towers and national governments need to consider ways of growing their cellular networks without constantly exposing people to radiation.”

J Huss, Council of Europe Parliamentary Assembly, The Committee on the Environment, Agriculture and Local and Regional Affairs Report, 6 May 2011.

[Electromagnetic radiation: influences on honeybees](#) (*Apis mellifera*). Institute Environmental Sciences,

- 39.7% of the non-irradiated bees had returned to their hives while only 7.3% of the irradiated bees had.

[Detection and Learning of Floral Electric Fields by Bumblebees](#) (2013) Science 5 April 2013

- "We report a formerly unappreciated sensory modality in bumblebees (*Bombus terrestris*), detection of floral electric fields. Because floral electric fields can

change within seconds, this sensory modality may facilitate rapid and dynamic communication between flowers and their pollinators."

[Migratory Monarch Butterflies 'See' Earth's GeoMagnetic Field – Living the Scientific Life \(Scientist, Interrupted\)](#)

[Antennae Key to Butterfly Navigation - Scientific American](#)

EM emissions associated with pheromones as studied by Callahan

*Callahan agreed, pointing out that the chances of a chemical molecule landing on the male antenna are far less than the chances of the antenna passing through the electromagnetic field emitted by the pheromone. Callahan took Laithwaite's antenna analogy a step further, by recognizing that the shape of the moth antenna resembles that of a direction finder (Figure 2). Perhaps the insects are homing in on signals they detect by moving from side to side off the main beam, like pilots follow a directional beacon to an airport. **Perhaps the zigzag flights of moths and butterflies are simply a scanning process, using direction-finding antenna arrays. Callahan found a variety of correspondences between the structures of various insect antennas and radio and microwave antennas.***

Electromagnetic communication and olfaction in insects.

[Read More Research on Wildlife Here.](#)

## **RF Radiation Stresses Plants and Trees**

[Adverse Influence of Radio Frequency Background on Trembling Aspen](#)

[Seedlings](#)

International Journal of Forestry Research Volume 2010 (2010), Article ID 836278,

- “This study suggests that the RF background may have strong adverse effects on growth rate and fall anthocyanin production in aspen, and may be an underlying factor in aspen decline.”

**Watch a [Video](#) of an Expert Conference on the damaging effects of EMFs on Trees.**



Malka N. Halgamuge, See Kye Yak and Jacob L. Eberhardt. Reduced growth of soybean seedlings after exposure to weak microwave radiation from GSM 900 mobile phone and base station. Bioelectromagnetics. Article first published online: Jan 21, 2015. DOI: 10.1002/BEM.21890

- The aim of this work was to study possible effects of environmental radiation pollution on plants. The association between cellular telephone (short duration, higher amplitude) and base station (long duration, very low amplitude) radiation exposure and the growth rate of soybean (*Glycine max*) seedlings was investigated.
- The exposure to higher amplitude ( $41 \text{ V m}^{-1}$ ) GSM radiation resulted in diminished outgrowth of the epicotyl. The exposure to lower amplitude ( $5.7 \text{ V m}^{-1}$ ) GSM radiation did not influence outgrowth of epicotyl, hypocotyls, or roots. The exposure to higher amplitude CW radiation resulted in reduced outgrowth of the roots whereas lower CW exposure resulted in a reduced outgrowth of the hypocotyl. Soybean seedlings were also exposed for 5 days to an extremely low level of radiation (GSM 900 MHz,  $0.56 \text{ V m}^{-1}$ ) and outgrowth was studied 2 days later. Growth of epicotyl and hypocotyl was found to be reduced, whereas the outgrowth of roots was stimulated.
- Our findings indicate that the observed effects were significantly dependent on field strength as well as amplitude modulation of the applied field.

**Nanometer-scale elongation rate fluctuations in the *Myriophyllum aquaticum* (Parrot feather) stem were altered by radio-frequency electromagnetic radiation.**

- Statistically significant changes to this plant from a non thermal effect.

**Influence of microwave frequency electromagnetic radiation on terpene emission and content in aromatic plants J Plant Physiol. 2014**

- Microwave irradiation resulted in thinner cell walls, smaller chloroplasts and mitochondria, and enhanced emissions of volatile compounds, in particular,

monoterpenes and green leaf volatiles (GLV). These data collectively demonstrate that human-generated microwave pollution can potentially constitute a stress to the plants.

The above is only a small sampling of the research showing biological effects at non thermal levels on living organisms.

### [Cows: A big model for EMF research, somewhere between Vet-Journals and “Nature”](#)

Maren Fedrowitz, The Bioelectromagnetics Society, Sep 5, 2014, *Department of Pharmacology, Toxicology, and Pharmacy, University of Veterinary Medicine Hannover, Germany*

Effects of electromagnetic fields (EMF) on cows have been frequently discussed in public media as well as in specialist journals and meetings with agricultural, veterinary or dairy backgrounds. Indeed, in view of the available literature, it does seem that cows show EMF susceptibilities and respond to environmental exposures of a broad range of frequencies and properties:

- Cows are sensitive to the Earth’s magnetic field. Bovine magnetoreception can be influenced by external EMF, e.g. powerlines.
- Several physiological alterations in dairy cows exposed to extremely low frequency (ELF) EMF were reported without major indications for adverse health effects. Notably, the observed effects seem to be dependent on the magnetic field component or on combined electric and magnetic fields rather than on electric field exposure alone.
- Cows are sensitive to earth currents (stray voltage) associated with transients in particular harmonics. Milk production, health, and behavior seem to be negatively affected.
- Bovine responses to radiofrequency (RF) exposure include avoidance behavior, reduced ruminating time, and alterations in oxidative stress. These findings indicate possible adverse health effects. However, most of the studies have critical points (one-herd-case report, logistic problems in study design, lack of appropriate exposure assessment) that confirmation of the observed RF effects is clearly needed, though studies in such big animals are time-, place-, and money-consuming, and exposure assessment and dosimetry are challenging issues.

- Overall, cattle seem to be affected by environmental EMF exposure. **Cows align to geomagnetic field lines and are influenced by ELF EMF**

[Zebrafish respond to the geomagnetic field by bimodal and group-dependent orientation](#), Scientific Reports

- In this study, we found that zebrafish, a model organism suitable for genetic manipulation, responded to a magnetic field as weak as the geomagnetic field.

[Radiation hazards of radio frequency waves on the early embryonic development of Zebrafish](#), Published in SPIE Proceedings Vol. 9112:

**[Sensing Technologies for Global Health, Military Medicine, and Environmental Monitoring IV](#)**

[Šárka O. Southern](#); [Mark A. Mentzer](#); [Isaac Rodriguez-Chavez](#); Virginia E. Wotring, Editor(s)

- This study observed the effects of RF radiation emitted from a cellular telephone on the embryonic development of zebra fish. The expression of the gene shha plays a key role in the early development of the fish. This gene has homologs in humans as well as in other model organisms. Additionally, several biomarkers indicative of cell stress were examined: including lactate dehydrogenase (LDH), superoxide dismutase (SOD), and lipid peroxidation (LPO).
- Results show a significant decrease in the expression of shha, a significant decrease in LDH activity. There was no significant increase in SOD and LPO activity.

**Li et al, [Extremely Low-Frequency Magnetic Fields Induce Developmental Toxicity and Apoptosis in Zebrafish \(\*Danio rerio\*\) Embryos](#)**

- In conclusion, the overall results demonstrated that ELF-MF exposure has detrimental effects on the embryonic development of zebrafish by affecting the hatching, decreasing the heart rate, and inducing apoptosis, although such effects were not mortal threat. The results also indicate that zebrafish embryos can serve as a reliable model to investigate the biological effect of ELF-MF.

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Investigations on the impact of exposure to electromagnetics fields from mobile phone base stations on health, production, and behavior of cattle

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