PC 2-8-18
#3
2 pages

Serena Carter <serena.carter@edcgov.us>

Fwd: Conditional Use Permit S17-0016/AT7T CAF4

1 message

Char Tim <charlene.tim@edcgov.us> Thu, Feb 1, 2018 at 12:43 PM
To: Serena Carter <serena.carter@edcgov.us>

Please include this email and it's attachment with Public Comments submitted today for S17-0016/AT&T CAF4. Thank you.

---------- Forwarded message ----------
From: **EDC COB** <edc.cob@edcgov.us>
Date: Thu, Feb 1, 2018 at 11:44 AM
Subject: Fwd: Conditional Use Permit S17-0016/AT7T CAF4
To: Char Tim <charlene.tim@edcgov.us>, Roger Trout <roger.trout@edcgov.us>

fyi

Office of the Clerk of the Board
El Dorado County
330 Fair Lane, Placerville, CA 95667
530-621-5390

---------- Forwarded message ----------
From: **Sierra Person** <sierradperson@yahoo.com>
Date: Thu, Feb 1, 2018 at 11:29 AM
Subject: Conditional Use Permit S17-0016/AT7T CAF4
To: bosthree@edcgov.us
Cc: edc.cob@edcgov.us

Dear Brian Veerkamp,

I am writing to ask for your understanding and support. AT&T (Epic Wireless) has proposed to build a 160 foot monopine wireless communications tower on Clouds Rest Rd. I do not oppose the construction of a new or upgraded monopine tower but do take issue with the chosen location. Placing it in close proximity to several homes and infringing on the views of many others. I am not opposed to cell towers, however they need to be in safe locations where they will not destroy wildlife habitats, historical sites and ecological preserves. Demand AT&T to responsibly place their towers in better locations that will not hurt the people of our county or our environment.

While I am aware of the telecommunications Act of 1996, that effectively silenced the American people, i still feel it pertinent to bring up some of the health risks. The research i have sent to the planning department has me greatly concerned for the safety of my children. I have a two month old daughter and a 3 1/2 year old son. Would you be willing to put a cell tower next to your home within the vicinity of your children or grandchildren? Give homeowners within a quarter mile radius of the proposed tower the choice to make this decision that could potentially affect our health and well being. We have lived in our house for 35 years and would hate to have to move due to the building of this tower. I have also attached information pertaining to cell tower fires. In the event of a fire we would have no escape route. Please protect our home and children.

We have great service provided by Verizon Wireless. Has AT&T made their best effort to expand their coverage by co-owning on an existing tower? There are many towers already in the area just a few miles away.

I ask that you deny the requested use permit. Please protect the residents, uphold the county codes and ensure that future construction of wireless infrastructure be completed intelligently and responsibly where the needs of the residents, not the telecommunication companies, come first. Thank you for your time and understanding in this matter.

Sincerely,

Sierra Pearson
4221 Clouds Rest Rd
Placerville, CA 95667
530-409-3128

--

Char Tim
Clerk of the Planning Commission

County of El Dorado
Planning and Building Department
2850 Fairlane Court
Placerville, CA 95667
(530) 621-5351 / FAX (530) 642-0508
charlene.tim@edcgov.us

Guidelines for Installation of the Mobile Towers.pdf
437K

PC 2-8-18

HughesNet Webmail **debbiemcm@hughes.net**

Proposed cell tower on APN 087-181-10

2018 FEB -1 PM 3:03
RECEIVED
PLANNING DEPARTMENT

From : DebandGrrrls McMurdie <debbiemcm@hughes.net> Wed, Jan 31, 2018 12:35 AM
Subject : Proposed cell tower on APN 087-181-10
To : Gary miller <Gary.miller@edcgov.us>
Cc : bostwo@edcgov.us

Dear Planning Department

We are writing in regards to the letter we received about our neighbors intent on allowing AT&T to put a cell tower on their property. 7140 Dragon Point Road. We are strongly opposed to the approval of this plan.

We moved out here in 2010 to get away from the city, and into a quiet, rural area. With the beautiful rolling hills, trees, and streams. Without traffic signals, street lights, and other "city" noise and eye sores. Where this tower is to be installed, is right across the street from us. Destroying the reason we moved out here. And when the generator kicks on, if the power goes out, which it does fairly often, or if it's being tested, is certainly a noise we do not want echoing throughout here. Sound carries like you wouldn't believe!
We also know that our property value will be negatively impacted. And that having a cell tower nearby is a "disclosure" when selling a home, and folks don't want to buy near one of these towers.
We also live on a private road. One that we, along with our neighbors, maintain with our own money. The additional traffic and heavy equipment will cause damages at our expense.
We are also very concerned about the health risks of being constantly exposed to EMF being emitted from this tower. It has not been proven that there is no health risk being so close, and we are not interested in taking that chance for our family. And not just our family, but also the wildlife, and the livestock that also live out here. What is the impact on them?
We are also worried about once one company comes in, how many others will come after???

No, we say. We moved out here to get away from all the commercial buildings, and the homes that are built practically on top of each other. And to have our view of the beautiful hills, and the peace and quiet. We want to keep it this way.

So, yes. We are strongly opposed to allowing the installation of the AT&T cell tower on APN 087-181-10

Sincerely,

Mark and Debbie McMurdie

APN 087-181-15

PC 2-8-18
#3
2 pages

January 30, 2018

2018 FEB -1 PM 3:04

RECEIVED
PLANNING DEPARTMENT

El Dorado County
Planning Services
2850 Fairlane Court
Placerville CA 95667

RE: Proposed Cellphone Tower Installation at Site 5-Latrobe

Dear Planning Services:

We are writing you this letter to express our strong opposition to the proposed cellphone tower installation at Site 5-Latrobe.

We were informed of this proposal by our neighbors and never received a written notification from the county which we believe is required by law.

We chose to relocate from Sacramento County to our Dragon Point Road residence due to its rural allure and our love of nature.

Installing a cellphone tower in such close proximity of residents will negatively impact our property values in addition to the aesthetics of our location. Dragon Point Road is a private road, which is currently maintained with all costs incurred by its residents. Allowing a cellphone tower to be installed will produce unwanted degradation to our road and potential conflict over easement access.

Added to our concerns are the health risks associated with EMF emissions as well as the environmental impact. We have not seen any written documentation addressing the environmental impact published by the county if a document does exist.

We are also very concerned with the noise pollution and the fire hazard risk of installation on a piece of property with several potential non-permitted structures already in existence.

Lastly, all the residents on Dragon Point Road, with the exception of the resident who is having the tower installed for personal financial gain, are opposed to the installation.

We believed in the mission statement of the planning services department which states the county's desire to maintain a unique quality of life and protection of the environment and public safety.

Your thoughtful consideration is respectfully requested.

Sincerely,

Patrick R. O'Malley Débra McClure

Patrick O'Malley and Débra McClure

7240 Dragon Point Road
Shingle Springs, CA 95682
Parcel #: 087-181-14-100

PC 2-8-18
#3
2 pages

Paul and Jodi Sandell
7260 Dragon Point Road
Shingle Springs, CA 95682
512-508-0602 sandellp@hotmail.com

January 17, 2018

El Dorado County
Planning Department
Placerville, CA

Dear Planning Department,

We are writing in regards to learning of our neighbors' intent to allow an installation of an AT&T cell tower on their property at 7140 Dragon Point Road. We strongly oppose the approval of this tower due to a number of reasons.

We moved onto Dragon Point Road back in 2003, as it provided a quiet rural location away from the commercial and housing expansions happening in El Dorado Hills. We want to keep it that way! Dragon Point Road is made of essentially 9 @ 20 acre parcels. Although the parcels appear large, all the houses are built along the high ridge of the topography, which runs right along Dragon Point. Therefore, all the houses are pretty close together in relationship to the overall space. With that, we oppose the cell tower being proposed as it will be extremely close to ours and the other neighbors' houses. Installation of this tower will totally destroy the rural attractiveness of our community and negatively impact ours and my neighbors' property values.

We all live on a private road, the improvements of which were privately paid for by myself and the neighbors. Allowing this cell tower will bring additional traffic and wear and tear to our private road. We are already having issues with one neighbor bringing heavy equipment loads across our road and damaging the surface at everyone's future expense. The cell tower will aggravate this situation. One neighbor will gain and take advantage of the equity road maintenance split at the expense of all the other neighbors.

In addition, we are especially concerned with the potential health risks associated with EMF emitted from this tower as insufficient research has been published to truly identify our personal risks from constant exposure to a cell tower. Again, with the houses situated as they are along Dragon Point, there will be 6 residents all with homes within 2 tenths of a mile of the tower! That is way too close for a commercial operation to be established within our rural location, exposing our residents to EMF without our consent!

We are concerned as well with the impact to the environment we live in. Has an environmental impact report been published to understand the impact of this tower installation? If not, we request seeing an impact report so we can better understand all the risks.

Finally, although only one carrier is apparently starting this process, we feel it would not end there. If a tower was installed, we fear it would not be long until Verizon and other carriers also start mounting additional devices on the structure, further increasing the EMF exposure and visibility to the tower. We understand the allure to a potential revenue stream for our neighbors, but at devastation to our rural community along with the potential personal health implications, we are strongly against it.

Sincerely,

Paul and Jodi Sandell

PC 2-8-18
#3

243 pages

El Dorado County Planning Commision

Re: Conditional Use Permit S17-0016/AT&T CAF4

2018 FEB -1 PM 4:17

RECEIVED
PLANNING DEPARTMENT

Dear Commission Members,

I am writing to request a negative vote on the proposed project for construction of an AT&T Mobility facility to be constructed at Snows Rd. and Clouds Rest Rd. in the Newtown Area. I have never considered myself an alarmist, but the more data I read concerning exposure to Low Intensity Electromagnetic Radiation, the more worried I become for the potential exposure of all of us within 1000 meters of the site. The Negative Declaration cites no ill effects to any living organisms, no effect on the birds and bees, or any effects to bat populations, but nowhere do they address the voluminous reports of other scientists that have noted serious health risks to many nesting birds associated with close proximity to Cell Tower Masts and Towers. In the recent past, we have been aware of a nesting pair of Eagles on property adjoining the parcel in the proposal. Also many hawks and owls and other nesting birds inhabit the area proposed as the site for the cell tower. Migrating ducks and geese also frequently are found in the immediate area during the Fall and Spring migrations.

Also of concern to me is the growing body of evidence that points to increased risks of a number of neurological problems, and increased cancer risks to humans in close proximity to Cell Tower Sites. Many studies have produced undeniable results of EMR as a health risk, and the World Health Organization has classified radiofrequency electromagnetic fields as a carcinogen in the same category as lead, DDT, and asbestous. Another disturbing result of Cell Towers is the decrease in property values on adjoining parcels after construction and operation of cell sites. It has been widely reported that a drop in values of as much as 20% is common, and it is combined reasons of aesthetic disturbance, and the perceived health dangers associated with the Cell Sites. Who will compensate the neighbors for loss of value in their property?

I have four beautiful grandchildren, two of them living with me on my property at Clouds Rest Rd. that I absolutely adore and love. It is a very disturbing thought that they will be growing up in an environment that will increase the risks to their health that are being documented and corroborated with numerous studies reported in many medical journals and research papers by world renown scientists and doctors. I ask what the need for this tower is based on, and I ask if the concerns of negative impacts have been adequately addressed. Please look into the growing body of evidence that EMR (Electromagnetic Radiation) is detrimental to the health of almost every living organism, and especially those in close proximity to the radiation emitted by Cell Towers!

Bruce M. Person Bruce M. Person

4221 Clouds Rest Rd.

Placerville, Ca. 95667

Concerns regarding placement of cell tower at Clouds Rest Rd.

The survey monuments for the parcel where the tower is proposed are not clearly marked, and may even be missing. If the markers are not clearly identified, how can setbacks be properly measured. It appears that one of the survey monuments may have been disturbed during prior grading on the parcel. If the maker has been disturbed, it is the responsibility of the owner to have the markers re-surveyed and replaced by a licensed land surveyor.

This area of Newtown has had a significant historical importance in El Dorado County. There are numerous accounts of mining activities during the Gold Rush in this immediate area. Tunnels and mine shafts riddle the area along with evidence of a significant canal system and hydraulic mining. At one time there were over 5000 people living in this immediate area, and prior to that the area was inhabited by large populations of Native Americans. Years ago I requested the presence of Mr. George Peabody, a noted County Historian to visit this area in an effort to bring more notice to the early inhabitants of this area. When he arrived and explored the many sites of Native Americans, he told me had been looking for this significant site for almost 40 years! He called this area "Greystone" which had been mentioned in many historical accounts that Mr. Peabody had heard or read during his historical investigations in El Dorado County. He was very excited and relieved to finally have this key piece of the historical puzzle in place. He mentioned that for many hundreds of years, possibly more than a thousand years based on his assay of the sites, the tribes from the plains would come to trade with the local tribes (Nisenan, Miwok, and Maidu). The legends told of the shelter caves and canyons, springs and readily available food sources, and Mr. Peabody determined that "Greystone" was right here near Clouds Rest!

As a cell phone user I am not against cell towers if they are not located in residential areas! When I was an ATT customer I was disappointed with the level of service provided by ATT. My option was to seek a provider that gave me better service at my home. I noticed that my friends with Verizon had very good coverage at my home, so I opted to sign up with Verizon. My service now is excellent! My question is why does Verizon work so well at my location with the existing towers, and yet ATT has not made attempts to place their facilities on the existing towers? Other Counties have denied the applications for cell towers based on the fact that existing towers are available, and providers are not trying to use those towers to provide better coverage. Has ATT attempted to negotiate with existing tower locations to better serve their clients?

Bruce M. Person Bruce M. Person

4221 Clouds Rest Rd.

Placerville, Ca. 95667

Springer Link

Mobile phone-induced honeybee worker piping

Apidologie

May 2011, Volume 42, Issue 3, pp 270–279 | Cite as

- Daniel Favre (1) (2) Email author (daniel_favre@yahoo.com)

1. Scientific collaborator in the Laboratory of Cellular Biotechnology (LBTC), Swiss Federal Institute of Technology (EPFL), Lausanne, Switzerland
2. Apiary School of the City of Lausanne, Chemin du Bornalet 2, Épalinges, Switzerland

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Abstract

The worldwide maintenance of the honeybee has major ecological, economic, and political implications. In the present study, electromagnetic waves originating from mobile phones were tested for potential effects on honeybee behavior. Mobile phone handsets were placed in the close vicinity of honeybees. The sound made by the bees was recorded and analyzed. The audiograms and spectrograms revealed that active mobile phone handsets have 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.

Keywords

worker bee acoustic communication mobile phone handset worker piping induction

Manuscript editor: Yves Le Conte

1 Introduction

Honeybees are essential partners for the success of agriculture. The economical role of honeybees in worldwide pollination has been valued to be around 153 billion euros in the year 2005 (Gallai et al. 2009). Bee losses have been recorded for more than a century (Hart 1893; Aikin 1897; Beuhne 1910; Wilson and Menapace 1979). Scientists suspect many factors to be responsible for the killing of the bees, of which the varroa mite, pesticides, viruses, farming practices, monoculture, hygiene in the hive, and climatic factors are the most widely cited possibilities. Starting in 2003–2004, bee colonies worldwide suddenly began to show symptoms of the so-called colony collapse disorder (CCD). CCD initially affects the worker bees, which desert the hive. The queen bee is usually abandoned in the hive with the young brood and with an abundance of honey, so that the colony can survive for a very short time. However, without the worker bee population, the colony becomes unsustainable and dies out. Never before have honeybees disappeared globally and at such a high rate.

Current theories about the potential cause(s) of CCD essentially include increased losses due to the invasive varroa mite (Donzé et al. 1998). Pesticide poisoning (through exposure to pesticides applied for crop pest control), potential immune-suppressing stress on bees (caused by one or a combination of several factors such as apiary overcrowding, pollination of crops with low nutritional value, pollen or nectar dearth), drought, monocultural practices, migratory stress (brought about by the moving of the bees in long distances), and increased transmission of pathogens have also been usually cited as a cause of CCD (U.S.D.A. 2007). Other causes might include genetically modified crops (Malone and Pham-Delegue 2001) and exceptionally cold winters.

Recent efforts have been made to study another potential cause responsible for bee losses: man-made electromagnetic fields. The results obtained to date have been highly controversial. In *princeps* studies performed by using digitally enhanced cordless telephones located in the bottom of beehives, it has been shown that exposed honeybees were perturbed in their returning behavior to the hive after foraging (Harst et al. 2006; Diagnose-Funk 2007; Stever et al. 2007).

Honeybees possess magnetite crystals in their fat body cells and they present magnetic remanence (Gould et al. 1978; Keim et al. 2002). These magnetite structures are active parts of the magnetoreception system in honeybees (Hsu and Li 1994; Hsu et al. 2007). Honeybees can be trained to respond to very small changes in the constant local geomagnetic field intensity (Walker and Bitterman 1989a). They can also communicate through chemical and acoustical means (Winston 1991; Tautz 2008). Therefore, the analysis of the sound features of bee colonies was a method of choice in the present study, since it can be correlated with the activity of the bees (Esch 1967; Michelsen et al. 1986; Donahoe et al. 2003; Pierce et al. 2007; Ferrari et al. 2008).

To my knowledge, no systematic studies have been conducted on potential effects of electromagnetic radiation from mobile phones on honeybee behavior. Here, I present results from corresponding original experiments I have carried out with honeybee populations exposed to active mobile phone radiation. The goal of these experiments was to identify potential effects of mobile phone communications on honeybee behavior and to establish simple methodology to enable other beekeepers to reproduce the experiments.

2 Materials and methods

2.1 Sound recording and analysis

An acoustical method based on sound analysis for classification was employed to identify the changes triggered by mobile phone handsets on the behavior of the honeybee *Apis mellifera carnica*. The sounds produced by the bees in their normal activities were recorded as negative control (with or without inactive mobile phones in the hive); activity of the bees was also recorded with active mobile phones in the hive (see below). Five healthy hives (either Dadant-Blatt or Swiss Bürki types) were monitored for sound during several recordings performed between February and June 2009. During the previous autumns and winters, the bees had been treated against the varroa mite *Varroa destructor* with formic acid and oxalic acid, as recommended elsewhere (Charrière et al. 2004). Beehives were located either in the beekeeping and apiary school of the city of Lausanne (altitude, 749 m) or in a second site used by beekeepers north of the city of Morges (altitude, 510 m; both locations in Switzerland). The recording device consisted of a bidirectional compact microphone (Olympus ME-31) with frequency response from 70 to 14,000 Hz connected to a vocal recorder (Olympus LS-10). The use of omnidirectional microphones such as the ECM 3005 (Monacor) or the electret condenser 33-3013 (Radio Shack) is also possible, as described elsewhere (Ferrari et al. 2008; Rangel and Seeley 2008). The recorded signal was digitized as a Waveform audio file format sound file with 160 kbps. The computer program Adobe Audition 1.5 was employed for the manual analysis of the sound files and for the generation of the audiograms (also called sonograms) and spectrograms (oscillograms), as described elsewhere (Ferrari et al. 2008).

In this pilot study, more than 80 different sound recordings were performed in five different hives throughout the assay period starting early February and ending June 2009. In the geographic area where the experiments took place, the bees usually begin to forage to collect nectar and pollen in early March, depending on the weather conditions.

Sounds made by honeybees were recorded in the two conventional models of hives (Swiss Bürki and Dadant-Blatt) that are found in Switzerland.

2.2 Mobile phone experimental arrangement

Two mobile phone handsets were randomly chosen from a selection of four different apparatus having specific energy adsorption rate (SAR) values of either 0.271, 0.62, 0.81, or 0.98 W/kg (tissue) and 900 MHz GSM roaming (Global System for Mobile communications, originally from *Groupe Spécial Mobile*). The sum of the two random SAR values was always below the 2-W/kg maximum upper limits recommended in the guidelines of the International Commission on Non-Ionizing Radiation Protection (I.C.N.I.R.P 1998). Four different subscriber identity module cards unrelated to the experimenter were randomly used.

For negative controls, the two apparatus were not present in the hive during the recording of the natural background sounds made by the bees. For undisturbed control experiments ("sham" experiments), the two mobile phone handsets were either shut down or kept in the standby mode. The basic setup of the experiments is schematically shown in Figure 1.

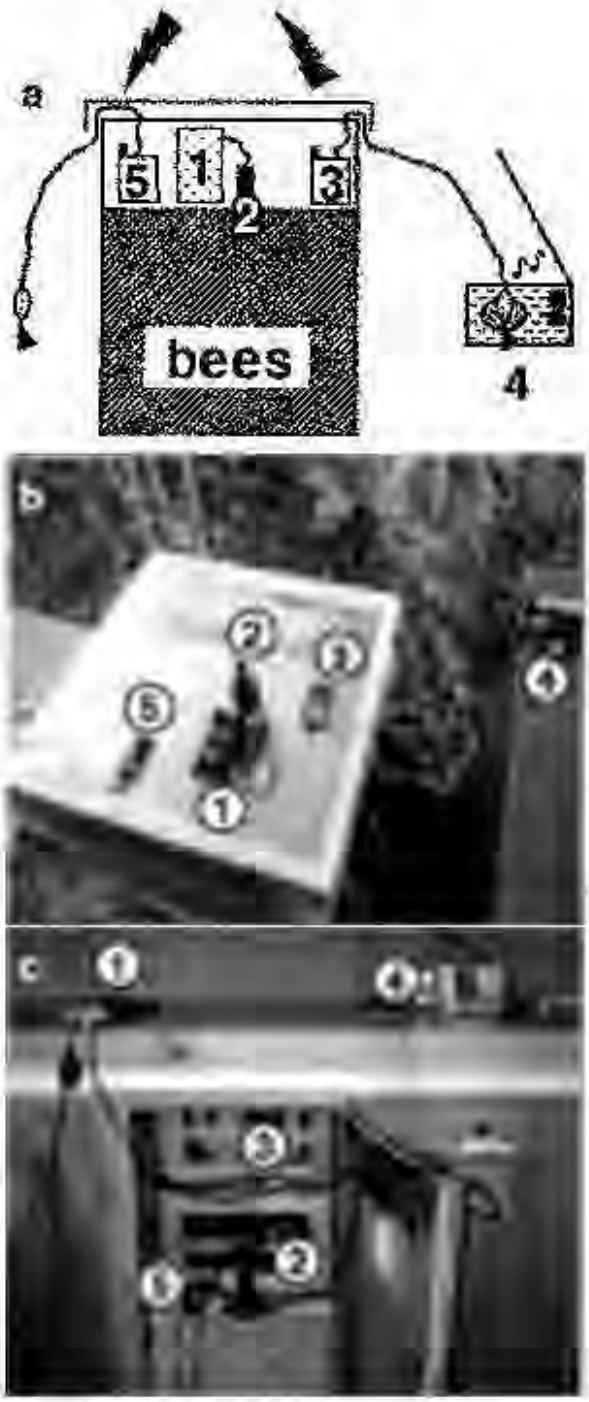

Figure 1.

Apparatus positioning in the different hives. **a** Schematic drawing. Sound recorder *1* was connected to a microphone *2*, the latter was placed in the close vicinity of the bees in the hive. The first (emitting) mobile phone *3* was connected with hands-free kit, the latter having its small microphone maintained on the loudspeaker of a radio apparatus *4*. A second (receiving) mobile phone *5*, also having a hands-free kit, was also kept inside the hive. The use of the radio apparatus is intended to allow a permanent communication between the two mobile phone handsets, in order to avoid unwanted disconnection after a while. **b** Image of a Dadant-Blatt model of

beehive. The microphone is placed through the upper nourishing hole. **c** Image of a Swiss Bürki model of beehive. The microphone was placed behind a board having a grid instead of a glass plate. During the experiments, the door of the Bürki hive was closed and the Dadant-Blatt hive was covered with the roof. A similar positioning can be easily performed with other types of beehives.

In order to establish whether inactive mobile phone handsets perturbed the behavior of the bees, two mobile phone handsets were placed in the hive in close vicinity of the honeybees. In a first series of experiments (negative control; $n = 8$), two inactive ("off" mode) mobile phone handsets were placed in the hive for up to 24 h. In a second series of experiments (sham experiments, "standby" mode; $n = 10$), the two mobile phone handsets were kept in the hive in the standby mode, for prolonged periods of time (4 to 24 h). As positive control experiments, the two mobile phone handsets were employed in an active communication mode. The first mobile phone was placed in the hive and was supplemented with a hands-free kit, the mini microphone of which was held in front of a radio apparatus maintained outside the hive (≈60 cm away, so that it does not interfere with the recording performed by the microphone near the bees) and constantly playing the France info program (output of the small radio loudspeaker, −18 ± 2 dB at 1 cm). This enables a permanent signal to be sent from this first to a second telephone, otherwise without this signal the communication is automatically interrupted after a period of time. To generate a mobile phone communication near the bees, the first mobile phone was triggered to call a second mobile phone that was also placed in the hive. The communication was established after a ringing signal lasting from 5 to 10 s. This second apparatus was also supplemented with a hands-free kit. The sum of the SAR values of the two mobile phones was always below the recommended limit of 2 W/kg, as mentioned above. Several independent experiments ($n = 12$) with the presence of actively communicating mobile phone handsets in the hive were performed. The established active mobile phone communication could be controlled at any time in two different ways: by direct hearing of the communication using the hands-free kit from the second mobile phone, or by controlling the functional state of the communication by calling—from a third independent telephone—one of the two active mobile phone handsets involved in the experiment.

For each experiment, local weather parameters (temperature, wind, precipitation, atmospheric pressure, and duration of sunshine) were obtained from the Office Fédéral de Météorologie et de Climatologie (MétéoSuisse).

3 Results

3.1 Background control experiments

The analysis of the sound files revealed similar characteristics and events that were not dependent on the model of the beehive (Figure 2). Beehives undisturbed by a mobile phone apparatus revealed the same sound characteristics as previously reported for other

honeybee colonies (see "Discussion"). The fundamental frequency of *A. mellifera carnica* was in the range of 450 to 500 Hz. Slightly less activity of the bees was recorded during the night than during the day. More sound intensities were recorded during spring and early summer than during winter, thus probably reflecting the number of the active bees present in the hives.

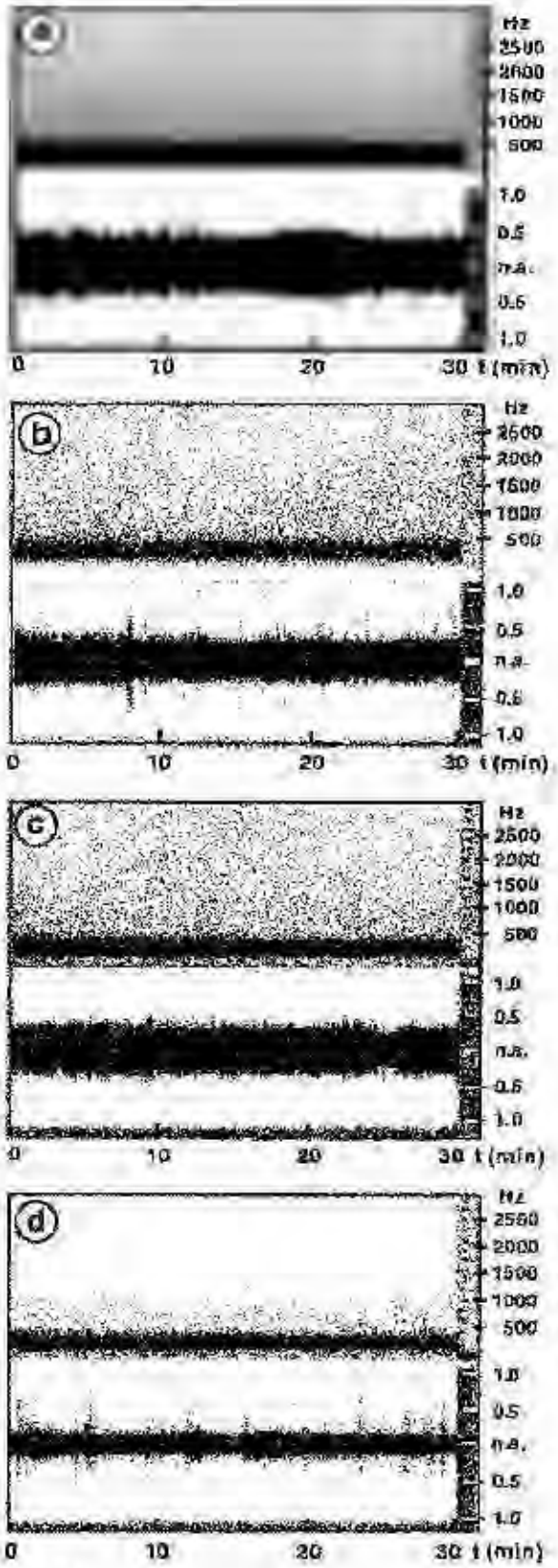

Fig. 2

Spectrograms and audiograms of hive sounds. **a**, **c** Swiss Bürki model. **b**, **d** Dadant-Blatt model. **a**, **b** without any mobile phones in the hive. **c**, **d** with two mobile phones kept in standby mode in the hives. Intensity values of

audiograms might vary between beehives, depending on the microphone positioning and the number of bees in the undisturbed hive. Spectrograms are reported in hertz (*Hz*); audiograms are normalized (*n.a.* −1 to +1). Time (*t*) is indicated in minutes

3.2 Mobile phone handsets in standby mode in the hive

The analysis of the various sound files revealed that the bees were not disturbed by these inactive or standby mobile phone handsets, since no dramatic changes in the fundamental intensity and frequency patterns of the sounds produced in the hive were recorded (Figure 2c, d), as compared to the background experiments performed without any mobile phone handsets (Figure 2a, b).

3.3 Mobile phone handsets activated in the hive

A result from a typical sound recording experiment is shown in Figure 3a. Mobile phone handsets in the hive were initially kept for a while (around 25 min) in standby mode and then put in an active communication mode. Sound analysis in the beehive revealed that the bees initially remained calm after the onset of the communication mode, but started to produce sounds that were higher in both frequency and amplitude after about 30 min of communication of the mobile phone handsets. After about 15 additional minutes, the mobile phone handset communication was interrupted. The bees returned to a quiet state after 2 to 3 min, since the frequency and intensity in the hive had returned to the basal values recorded in the beginning of the experiment. Negative control runs showed that the radio itself did not induce any changes in bee behavior with mobile handsets deactivated.

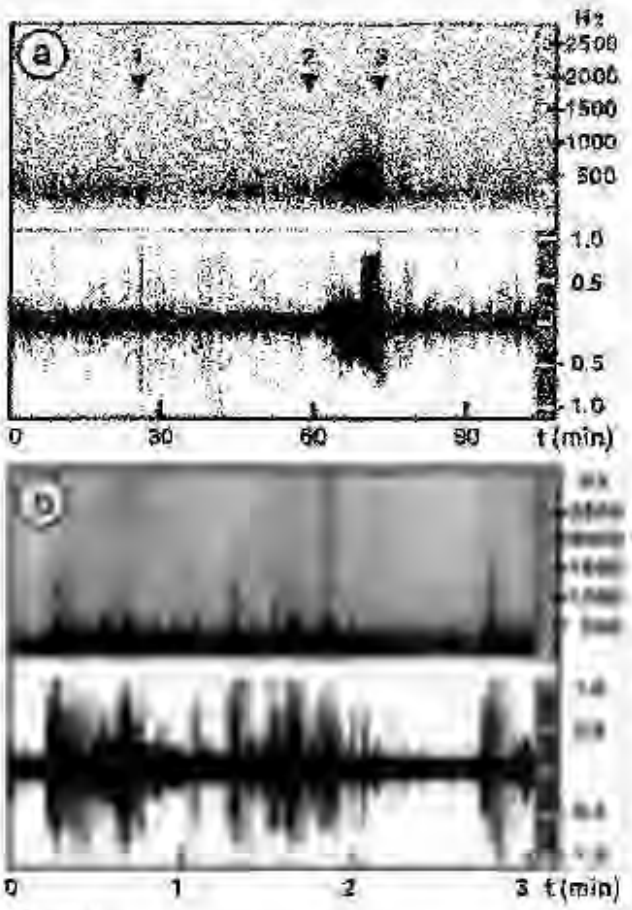

Figure 3.

Induction of honeybee worker piping by mobile phone handsets. **a** standby mobile phone handsets in the hive were activated 25 min. after the onset of the experiment (*1*). The beginning of increased noise and frequency in the hive was observed ca. 35 min later (*2*) and is indicated by a *longer arrow*. The cessation of the mobile phone communication is indicated (*3*). **b** Recording of bee noise in a hive submitted to prolonged (20 h) active mobile phone handsets. Spectrograms are reported in hertz (*Hz*); audiograms are normalized (*n. a.* −1 to +1). Time (*t*) is indicated in minutes.

In order to assess how much time the bees would need to return to a basal sound status after mobile phone communication, experiments were performed by placing in the hive actively communicating mobile phone handsets for prolonged periods of time ranging up to 20 h. Sound analysis revealed that the bees' sound values increased in both the intensity and amplitude ranges throughout the experimental period, as compared to background values prior to onset of the mobile phone communication. In each of the independent experiments, both the sound intensity and the frequency increased about 25 to 40 min after the onset of the mobile phone communication. Twelve hours after the cessation of the mobile phone communication in the hive, the bees were still producing more sound in both intensity and frequency as compared to the initial background mode, suggesting that the behavior of the bees remained perturbed for up to 12 h after the end of a prolonged mobile phone communication. Analysis of a shorter period of time lasting 3 min is presented (Figure 3b).

When the sound produced by honeybees in hives containing active mobile phone handsets was analyzed in more detail, it was determined that the bees were producing the so-called "worker piping" (Figure 4a). Spectrograms obtained in the present study revealed various modes of worker piping. First, bimodal pipes having a fundamental frequency of around 150–250 Hz and a duration of about 200 ± 51 ms (n = 60 pipes) and 430 ± 103 ms (n = 30 pipes) were recorded throughout the experiment involving mobile phone handsets communication in the hive. The harmonic nature of each pipe, as compared to results presented elsewhere (Seeley and Tautz 2001), was also evident. Another shorter type of worker piping, having a fundamental frequency of around 400–500 Hz and a duration of about 9 ± 2 ms (n = 50 pipes), was also recorded as a prolonged succession of pulses lasting together up to 2 s (Figure 4b). This short piping signal was also presenting harmonic features ranging up to several thousand hertz. Two other types of signals were also recorded; however, less often than the two signals described above, a strong harmonic piping signal with a basal frequency of 500 ± 50 Hz and lasting 75 ± 15 ms (Figure 4c; n = 10) and a signal with a basal frequency of around 2,250 ± 250 Hz and lasting 225 ± 50 ms (n = 10; Figure 4d). Analysis of some recordings presented a mixture of the signals mentioned above (Figure 4e). All these different signals were recorded solely in beehives that were subjected to the influence of actively communicating mobile phone handsets, irrespective of both the location and the season when the experiments were performed. Moreover, the observations of worker piping were also independent of the weather conditions prevailing during the experiments.

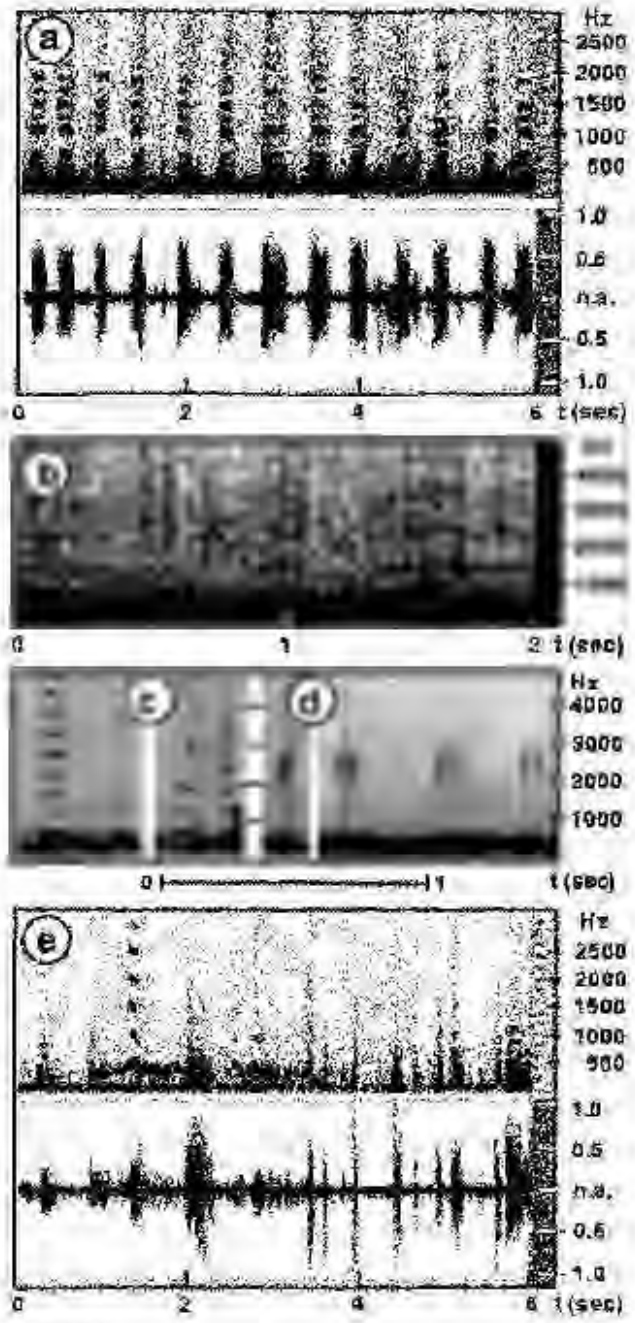

Figure 4.

Mobile phone-induced honeybee worker piping. Various modes of worker piping (**a**–**e**) were recorded in the presence of actively communicating mobile phone handsets in the hive. Spectrograms are reported in hertz (*Hz*); audiograms are normalized (n.a. −1 to +1). Time (*t*) is indicated in seconds.

4 Discussion

The results of the present pilot study clearly show that the presence of actively communicating mobile phone handsets in the close vicinity of honeybees had a dramatic effect, namely the induction of worker piping which was regularly observed about 25 to 40 min after the onset of the mobile phone communication. This observation means that: (1) honeybees are sensitive to pulsed electromagnetic fields generated by the mobile telephones and (2) under these circumstances, observable changes in the behavior of the bees are not artificial, but can be proven to occur reproducibly. Although mobile phones are not present in the close vicinity of honeybees in real life, this study provides elements for the establishment of further experiments involving such apparatus placed at increasing distances from the bees. Potential consequences of these observations are discussed below in more detail.

4.1 Rationale of the experimental design

The experimental design employed was set up in order to enable beekeepers and researchers in the field to easily reproduce the experiments with the use of conventional materials and user-friendly computer programs. Honeybees are usually not living in the close vicinity of electromagnetic fields induced by mobile phone handsets in the hive. However, the conditions employed in the present experiments have biological significance, since the sum of the SAR values from the two mobile phone handsets were always below the 2-W/kg maximal value recommended for this frequency (I.C.N.I.R.P 1998). It seems likely that a similar effect on bees can occur with relatively low-dose exposure over a prolonged period of time. In this context, it should be emphasized that radio frequency electromagnetic fields (RF-EMF) have increased by an order of magnitude over the last 20 years in Switzerland; a mean weekly exposure of 0.13 mW/m^2 (83.8% of all emitting RF-EMF) has been reported (Frei et al. 2009). Since both randomly visited outdoor locations and the proximity to mobile phone base stations showed a mean RF-EMF exposure of 0.21 mW/m^2, experiments employing two mobile phone handsets in the hive were finally chosen for practical reasons. The experiments described in this article might therefore be applicable everywhere, since nearly all countries in the world today are readily covered with GSM networks (GSM roaming, coverage maps).

4.2 Mobile phone handsets and induced honeybee worker piping

It is known that honeybees possess magnetite crystals in their fat body cells and that they present magnetic remanence (Gould et al. 1978; Keim et al. 2002). These magnetite structures are active parts of the magnetoreception system in honeybees (Hsu and Li 1994; Hsu et al. 2007). Importantly, it has been shown that honeybees can be trained to respond to very small changes in the constant local geomagnetic field intensity (Walker and Bitterman 1989a). In that study, magnetic anomalies as low as 26 nT (nanoTesla) were responsible for changes in the foraging behavior. Moreover, attached magnets impair magnetic field discrimination by honeybees (Walker and Bitterman 1989b). Therefore, it remains to be established which minimal level in variations of the local

pulsed electromagnetic fields induced by mobile phone handsets and base stations might trigger changes in the bees' behavior, such as the induction of honeybee worker piping shown here. It is known for several decades that worker piping is associated with disturbance of the hive by, for example, intruders or jarring (Wenner 1964). The latter author recorded sounds that were called "croaking" and "bipping." This may present one explanation for the present observations assuming that mobile phone handsets triggered disturbances in the hive in a similar way (see Figure 4).

The experiments presented in this pilot study should be reproduced in hives totally protected or not with additional copper or aluminum Faraday cages. Additional clues for the ferromagnetic transduction hypothesis (Kirschvink and Gould 1981) and a plausible mechanism for the sensitivity of honeybees to localized electromagnetic anomalies might therefore be obtained. Such behavioral changes cannot only be analyzed at the behavioral level with sound analysis, but also at the molecular level by studying the gene expression profiles using microarrays, as it was done for the infestation of honeybees with the varroa mite (Navajas et al. 2008).

Although worker piping can be associated with foraging in undisturbed queenright colonies of honeybees (Pratt et al. 1996), it is usually a signal that is produced shortly before takeoff of a swarm (Seeley and Tautz 2001; Rangel and Seeley 2008). Worker piping in a bee colony is not frequent, and when it occurs in a colony, that is not in a swarming process, no more than two bees are simultaneously active (Pratt et al. 1996). The induction of honeybee worker piping by the electromagnetic fields of mobile phones might have dramatic consequences in terms of colony losses due to unexpected swarming. The present study suggests that active mobile phone handsets in beehives noticeably induce the rate of worker piping. However, no evidence for piping of the laying queen (see Schneider and Lewis 2004) was observed.

In the present study, no swarming process was initiated after 20 h of exposure to mobile phone handsets, even though the piping signal was observed. It should therefore be hypothesized that although the piping signal is serving as a primer for swarm exodus other modalities and/or signals (e.g., the shaking and buzz-run signals or chemical components) may be required in the complex swarming process (Rangel and Seeley 2008). The "buzz-run" or "*Schwirrlauf*" rate is perhaps the required crucial signal that appears 15 min before the massive exodus of honeybees during the swarm departure process (Seeley and Tautz 2001; Rangel and Seeley 2008). Moreover, it might be possible that a more prolonged exposure (>20 h) of the honeybees to the actively communicating mobile phone handsets is required for the complete induction of the swarming process. Recently, a study suggested that cell phones and cellphone towers near beehives interfere with honeybee navigation: in one experiment, it was found that when a mobile phone was kept near a beehive it resulted in collapse of the colony in 5 to 10 days, with the worker bees failing to return home, leaving the hives with just queens, eggs and hive-bound immature bees (Sahib Pattazhy 2009). To minimize harm to the bees, it was decided to limit their continuous exposure to mobile phone communications to a maximum of 20 h in the present study.

Further confirmation of the current results and their implications regarding a direct correlation between erratic honeybee behavior and mobile phone-generated electromagnetic fields would substantiate one more explanation for the "disappearance" of bee colonies around the world. This phenomenon accounts for 43% of all bee losses, apart from overwintering (39%), mite disease, (15%) and pesticides (3%) as recently described in a national survey performed in the United States (Bee Alert Technology 2007). Experiments should be undertaken to establish the correlation between the time necessary for the onset of worker piping and the intensity of the electromagnetic fields present in the vicinity of the beehive. For future experiments, in complement to the present original study and in order to reach more "natural" conditions, mobile phone apparatuses should be placed at various increasing distances away from the hives. Video recordings showing the modifications in the bees' behavior in the hive should also be performed.

Notes

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Son émis par les ouvrières en réaction à la proximité d'un téléphone portable

Ouvrière / communication accoustique / téléphone portable / stimulus

Mobiltelefon induzierte Piepstöne von Arbeiterinnen der Honigbiene. In den letzten Jahren häufen sich Berichte über einen weltweiten Schwund an Honigbienen in Folge einer Völkerverlustkrankheit (colony loss disease, CCD), bei der Völker massiv und plötzlich eingehen, ohne dass es vorhergehende Anzeichen einer Krankheit oder Parasitenbefall gibt. CCD hat schwerwiegende Auswirkungen für den Anbau vieler Früchte und Gemüse, die auf Bestäubung durch Insekten angewiesen sind Milbenbefall, Pestizide, eine reduzierte Immunität, bakterielle und virale Infektionen, genetisch modifizierte Feldfrüchte und Anbaupraktiken stehen im Verdacht, eine Rolle beim Schwund der Bienenvölker zu spielen. Berichten in wissenschaftlichen und allgemeinen Medien zufolge besteht auch die Möglichkeit, dass Mobiltelefone hierzu beitragen können, da Bienen Schwierigkeiten bei der Heimfindung hatten, wenn Basisstanionen für schnurlose Telefone unter den Völkern installiert waren. Mikrowellen könnten demzufolge einen Teil der Verantwortung für das CCD-Syndrom tragen. In dieser Arbeit untersuchte ich die potentiellen Effekte von konventionellen Mobiltelefonen produzierten elektromagnetischen Feldern auf Honigbienen. Hierzu wurden zwei Geräte

im aktiven Modus und mit einer Summe an spezifischen Energieabsorptionsraten unterhalb der offiziellen internationalen Maximalwerte (2 Watt pro Kilo Gewebe) in der Nähe von Bienen aufgestellt und die von Bienen produzierten Piepstöne aufgezeichnet und analysiert. Dies zeigte, dass sich Bienen durch die aktiv kommunizierenden Mobiltelefone im Volk gestört fühlten und zum Senden von Piepstönen angeregt wurden. Unter natürlichen Bedingungen sind solche Piepstöne ein Signal für die Schwarmvorbereitung oder eine Reaktion auf Störungen im Volk. Das Senden von Piepstönen setzte nicht sofort nach Einschalten der Mobiltelefone ein, sondern erst nach 25 bis 40 Minuten. Diese Beobachtungen weisen darauf hin, dass die Bienen für pulsierende elektromagnetische Felder empfänglich sind und sensibel auf Verhaltensänderungen reagieren. Ein Schwund an Bienenvölkern wird v.a. in Erdteilen beobachtet (Nordamerika, Europa, Australien, Südbrasilien, Taiwan und Japan), in denen Mobiltelefone weit verbreitet sind. Es stellt sich daher die Frage, ob der Zusammenhang von CCD und einer intensiven Nutzung von Mobiltelefonen noch als reine Spekulation angesehen werden kann.

Arbeiterinnen / akustische Kommunikation / Mobiltelefon / Arbeiterinnenpiepstöne

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Personalised recommendations

Electromagnetic Radiation Safety

Scientific and policy developments regarding the health effects of electromagnetic radiation exposure cell phones, cell towers, Wi-Fi, Smart Meters, and other wireless technology

Wednesday, September 13, 2017

Cell Tower Health Effects

Federal regulations protect the public only from the thermal (i.e., heating) risk due to short-term exposure to high intensity, cell tower radiation. The Federal regulations ignore the hundreds of studies that find harmful bio-effects from long-term exposure to non-thermal levels of cell phone radiation.

The Telecommunications Act of 1996 does not allow communities to stop the siting of cell towers for health reasons. Nevertheless, landlords may be liable for any harm caused by cell phone radiation emitted by towers situated on their property.

Localities need to organize and change the Federal law to protect public health and wildlife from exposure to microwave radiation emitted by mobile phone base stations.

Following are some resources regarding the health effects of exposure to cell tower radiation. I will occasionally update this page.

Related posts

Major newspaper editorials oppose 5G "small cell antennas

Is 5G Cellular Technology Harmful to Our Health?

Electromagnetic Hypersensitivity

Wireless Radiation TV News

Impact of radiofrequency radiation on DNA damage and antioxidants in peripheral blood lymphocytes of humans residing in the vicinity of mobile phone base stations

Zothansiama, Zosangzuali M, Lalramdinpuii M, Jagetia GC. Impact of radiofrequency radiation on DNA damage and antioxidants in peripheral blood lymphocytes of humans residing in the vicinity of mobile phone base stations. Electromagn Biol Med. 2017 Aug 4:1-11. doi: 10.1080/15368378.2017.1350584.

Abstract

Radiofrequency radiations (RFRs) emitted by mobile phone base stations have raised concerns on its adverse impact on humans residing in the vicinity of mobile phone base stations. Therefore, the present study was envisaged to evaluate the effect of RFR on the DNA damage and antioxidant status in cultured human peripheral blood lymphocytes (HPBLs) of individuals residing in the vicinity of mobile phone base stations and comparing it with healthy controls.
The study groups matched for various demographic data including age, gender, dietary pattern, smoking habit, alcohol consumption, duration of mobile phone use and average daily mobile phone use.

The RF power density of the exposed individuals was significantly higher ($p < 0.0001$) when compared to the control group. The HPBLs were cultured and the DNA damage was assessed by cytokinesis blocked micronucleus (MN) assay in the binucleate lymphocytes. The analyses of data from the exposed group (n = 40), residing within a perimeter of 80 meters of mobile base stations, showed significantly ($p < 0.0001$) higher frequency of micronuclei (MN) when compared to the control group, residing 300 meters away from the mobile base station/s.

The analysis of various antioxidants in the plasma of exposed individuals revealed a significant attrition in glutathione (GSH) concentration ($p < 0.01$), activities of catalase (CAT) ($p < 0.001$) and superoxide dismutase (SOD) ($p < 0.001$) and rise in lipid peroxidation (LOO) when compared to controls. Multiple linear regression analyses revealed a significant association among reduced GSH concentration ($p < 0.05$), CAT ($p < 0.001$) and SOD ($p < 0.001$) activities and elevated MN frequency ($p < 0.001$) and LOO ($p < 0.001$) with increasing RF power density.

https://www.ncbi.nlm.nih.gov/pubmed/28777669

My note

All of the recorded RFR power density values in this study were well below the Federal Communication Commission's maximum permissible exposure limits in the U.S. for the general population. These limits are are 6,000 mW/m^2 [milliwatts per square meter] for 900 MHz and 10,000 mW/m^2 for 1800 MHz radiofrequency radiation. In contrast, the highest recorded value in this study was 7.52 mW/m^2 of RFR. The "exposed individuals" who resided within 80 meters of a cell antenna received an average of 5.00 mW/m^2 of RFR in their bedrooms.

Excerpts

Joel M. Moskowitz, Ph.D.
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RFR may change the fidelity of DNA as the increased incidence of cancer has been reported among those residing near mobile phone base stations (Abdel-Rassonl et al., 2007; Bortkiewicz et al., 2004; Cherry, 2000; Eger et al., 2004; Hardell et al., 1999; Hutter et al., 2006; Wolf and Wolf, 2004). RFR emitted frommobile base stations is also reported to increase the DNA strand breaks in lymphocytes of mobile phone users and individuals residing in the vicinity of a mobile base station/s (Gandhi and Anita, 2005; Gandhi et al., 2014). Exposure of human fibroblasts and rat granulosa cells to RFR (1800 MHz, SAR 1.2 or 2 W/kg) has been reported to induce DNA single- and double-strands breaks (Diem et al., 2005). Irreversible DNA damage was also reported in cultured human lens epithelial cells exposed to microwave generated by mobile phones (Sun et al., 2006). The adverse health effects of RFR are still debatable as many studies indicated above have found a positive correlation between the DNA damage and RFR exposure; however, several studies reported no significant effect of RFR on DNA strand breaks and micronuclei formation in different study systems (Li et al., 2001; Tice et al., 2002; McNamee et al., 2003;Maes et al., 2006). The potential genotoxicity of RFR emitted by mobile phone base stations can be determined by micronucleus (MN) assay, which is an effective tool to evaluate the genotoxic or clastogenic effects of physical and chemical agents. This technique has also been used to quantify the frequencies of radiation-induced MN in human peripheral blood lymphocytes (HPBLs) (Fenech and Morley, 1985; Jagetia and Venkatesha, 2005; Prosser et al., 1988; Yildirim et al., 2010).

Six mobile phone base stations, operating in the frequency range of 900 MHz (N = 2) and1800MHz (N = 4), erected in the thickly populated areas of Aizawl city were selected for the present study... The power output of all the base stations is 20 W, with their primary beam emitting radiation at an angle of 20°. Power density measurements (using HF-60105V4, Germany) were carried out in the bedroom of each participant where they spent most of the time and hence have the longest constant level of electromagnetic field exposure. Power density measurement was carried out three times (morning, midday and evening), and the average was calculated for each residence around each base station. The main purpose of the measurement of power density was to ensure that RFR emission from each site did not exceed the safe public limits and to determine any difference in power density between selected households that were close to (within 80 m) and far (>300 m) from the mobile phone base stations. The safety limits for public exposure from mobile phone base stations are 0.45 W/m^2 for 900 MHz and 0.92 W/m^2 for 1800 MHz frequency as per Department of Telecommunications, Ministry of Communications, Government of India, New Delhi guidelines (DoT, 2012).

... some residences are located horizontally with the top of the towers from which RFR are emitted, making it possible to get an exposure at a short distance of 1–20 m, despite being erected on the rooftop or in the ground. A minimum of two individuals were sampled from each household and at least five individuals were sampled around each mobile base station. Individuals sampled around each base station were matched for their age and gender (Table 1). The exposed group consisted of 40 healthy individuals who fulfilled the inclusion criteria of being above 18 years of age and residing in the vicinity of mobile phone base stations (within 80 m radius). The control group comprised of 40 healthy individuals matched for age and gender who had been living at least 300 m away from any mobile phone base stations.... Sampling was also done only from those residences who did not use microwave oven for cooking, Wifi devices and any other major source of electromagnetic field as they are known to cause adverse effects (Atasoy et al., 2013; Avendaño et al., 2012).

The groups matched for most of the demographic data such as age, gender, dietary pattern, smoking habit, alcohol consumption, mobile phone usage, duration of mobile phone use and average daily mobile phone use (Table 2). A highly significant variation ($p < 0.0001$) was observed for the distance of household from the base station (40.10 ± 3.02 vs. 403.17 ± 7.98 in m) between exposed and control groups.

The RF power density of the exposed group (2.80–7.52 mW/m^2; average 5.002 ± 0.182 mW/ m^2) was significantly higher ($p < 0.0001$) when compared to the control group (0.014–0.065 mW/m^2; average 0.035 ± 0.002 mW/m^2). The highest power density was recorded at a distance of 1–20 m (6.44 ± 0.31 mW/m^2), which is significantly higher ($p < 0.0001$) than those at a distance of 21–40 m (4.79 ± 0.33), 41–60 m (4.48 ± 0.22) and 61–80 m (4.61 ± 0.10).

The highest measured power density was 7.52mW/m^2. Most of the measured values close to base stations (Table 1) are higher than that of the safe limits recommended by Bioinitiative Report 2012 (0.5mW/m^2), Salzburg resolution 2000 (1 mW/m^2) and EU (STOA) 2001 (0.1 mW/m^2). However, all the recorded values were well below the current ICNIRP safe level (4700 mW/m^2) and the current Indian Standard (450 mW/m^2).

The exact mechanism of action of RFR in micronuclei induction and reduced antioxidant status is not apparent. The possible putative mechanism of generation of DNA damage may be the production of endogenous free radicals due to continuous exposure. RFR has been reported to produce different free radicals earlier (Avci et al., 2009; Burlaka et al., 2013; Barcal et al., 2014; Kazemi et al., 2015). Cells possess a number of compensatory mechanisms to deal with ROS and its effects. Among these are the induction of antioxidant proteins such as GSH, SOD and CAT. Enzymatic antioxidant systems function by direct or sequential removal of ROS, thereby terminating their activities. An imbalance between the oxidative forces and antioxidant defense systems causes oxidative injury, which has been implicated in various diseases, such as cancer, neurological disorders, atherosclerosis, diabetes, liver cirrhosis, asthma, hypertension and ischemia (Andreadis et al., 2003; Comhair et al., 2005; Dhalla et al., 2000; Finkel and Holbrook, 2000; Kasparova et al., 2005; Sayre et al., 2001; Sohal et al., 2002). Because of the significant decrease in endogenous antioxidants and increased LOO among the exposed group, the extra burden of free radicals is unlikely to get neutralized, and these surplus ROS may react with important cellular macromolecules including DNA forming either DNA adducts or stand breaks, which may be later expressed as micronuclei once the cell decides to divide. The decline in the antioxidant status may be also due to the suppressed activity of Nrf2 transcription factor which is involved in maintaining the antioxidant status in the cells.

The present study has reported that [radiofrequency radiation] increased the frequency of [micronuclei] and [lipid peroxidation] and reduced [glutathione] contents, [catalase] and [superoxide dismutase] activities in the plasma of the exposed individuals. The induction of [micronuclei] may be due to the increase in free-radical production. The present study demonstrated that staying near the mobile base stations and continuous use of mobile phones damage the DNA, and it may have an adverse effect in the long run. The persistence of DNA unrepaired damage leads to genomic instability which may lead to several health disorders including the induction of cancer.

Biological effects from exposure to electromagnetic radiation emitted by cell tower base stations and other antenna arrays

Levitt BB, Lai H. Biological effects from exposure to electromagnetic radiation emitted by cell tower base stations and other antenna arrays. Environmental Reviews.18: 369–395 (2010) doi:10.1139 /A10-018.

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Abstract

The siting of cellular phone base stations and other cellular infrastructure such as roof-mounted antenna arrays, especially in residential neighborhoods, is a contentious subject in land-use regulation. Local resistance from nearby residents and

landowners is often based on fears of adverse health effects despite reassurances from telecommunications service providers that international exposure standards will be followed.

Both anecdotal reports and some epidemiology studies have found headaches, skin rashes, sleep disturbances, depression, decreased libido, increased rates of suicide, concentration problems, dizziness, memory changes, increased risk of cancer, tremors, and other neurophysiological effects in populations near base stations.

The objective of this paper is to review the existing studies of people living or working near cellular infrastructure and other pertinent studies that could apply to long-term, low-level radiofrequency radiation (RFR) exposures. While specific epidemiological research in this area is sparse and contradictory, and such exposures are difficult to quantify given the increasing background levels of RFR from myriad personal consumer products, some research does exist to warrant caution in infrastructure siting. Further epidemiology research that takes total ambient RFR exposures into consideration is warranted.

Symptoms reported today may be classic microwave sickness, first described in 1978. Nonionizing electromagnetic fields are among the fastest growing forms of environmental pollution. Some extrapolations can be made from research other than epidemiology regarding biological effects from exposures at levels far below current exposure guidelines.

Excerpts

[Note: As of July 9, 2017, www.antennasearch.com, an industry website, reports 646,000 towers and 1.89 million cell antennas in the U.S.]

In lieu of building new cell towers, some municipalities are licensing public utility poles throughout urban areas for Wi-Fi antennas that allow wireless Internet access. These systems can require hundreds of antennas in close proximity to the population with some exposures at a lateral height where second- and third-story windows face antennas. Most of these systems are categorically excluded from regulation by the U.S. Federal Communications Commission (FCC) or oversight by government agencies because they operate below a certain power density threshold. However, power density is not the only factor determining biological effects from radiofrequency radiation (RFR).

An aesthetic emphasis is often the only perceived control of a municipality, particularly in countries like America where there is an overriding federal preemption that precludes taking the "environmental effects" of RFR into consideration in cell tower siting as stipulated in Section 704 of *The Telecommunications Act of 1996* (USFCC 1996). Citizen resistance, however, is most often based on health concerns regarding the safety of RFR exposures to those who live near the infrastructure. Many citizens, especially those who claim to be hypersensitive to electromagnetic fields, state they would rather know where the antennas are and that hiding them greatly complicates society's ability to monitor for safety.

Industry representatives try to reassure communities that facilities are many orders of magnitude below what is allowed for exposure by standards-setting boards and studies bear that out (Cooper et al. 2006; Henderson and Bangay 2006; Bornkessel et al. 2007). These include standards by the International Commission on Non-Ionizing Radiation Protection (ICNIRP) used throughout Europe, Canada, and elsewhere (ICNIRP 1998). The standards currently adopted by the U.S. FCC, which uses a two-tiered system of recommendations put out by the National Council on Radiation Protection (NCRP) for civilian exposures (referred to as uncontrolled environments), and the International Electricians and Electronics Engineers (IEEE) for professional exposures (referred to as controlled environments) (U.S. FCC 1997). The U.S. may eventually adopt standards closer to ICNIRP. The current U.S. standards are more protective than ICNIRP's in some frequency ranges so any harmonization toward the ICNIRP standards will make the U.S. limits more lenient.

All of the standards currently in place are based on RFRs ability to heat tissue, called thermal effects. A longstanding criticism, going back to the 1950s (Levitt 1995), is that such acute heating effects do not take potentially more subtle non-thermal effects into consideration. And based on the number of citizens who have tried to stop cell towers from being installed in their neighborhoods, laypeople in many countries do not find adherence to existing standards valid in addressing health concerns. Therefore, infrastructure siting does not have the confidence of the public (Levitt 1998).

The intensity of RFR decreases rapidly with the distance from the emitting source; therefore, exposure to RFR from transmission towers is often of low intensity depending on one's proximity. But intensity is not the only factor. Living near a facility will involve long-duration exposures, sometimes for years, at many hours per day. People working at home or the infirm can experience low-level 24 h exposures. Nighttimes alone will create 8 hour continuous exposures. The current standards for both ICNIRP, IEEE and the NCRP (adopted by the U.S. FCC) are for whole-body exposures averaged over a short duration (minutes) and are based on results from short-term exposure studies, not for long-term, low-level exposures such as those experienced by people living or working near transmitting facilities. For such populations, these can be involuntary exposures, unlike cell phones where user choice is involved.

The U.S. FCC has issued guidelines for both power density and SARs. For power density, the U.S. guidelines are between 0.2–1.0 mW/cm^2....

At 100–200 ft (about 30–60 meters) from a cell phone base station, a person can be exposed to a power density of 0.001 mW/cm^2 (i.e., 1.0 $\mu W/cm^2$)....

For the purposes of this paper, we will define low-intensity exposure to RFR of power density of 0.001 mW/cm^2

Many biological effects have been documented at very low intensities comparable to what the population experiences within 200 to 500 ft (~60–150 m) of a cell tower, including effects that occurred in studies of cell cultures and animals after exposures to low-intensity RFR. Effects reported include: genetic, growth, and reproductive; increases in permeability of the blood–brain barrier; behavioral; molecular, cellular, and metabolic; and increases in cancer risk....

Ten years ago, there were only about a dozen studies reporting such low-intensity effects; currently, there are more than 60. This body of work cannot be ignored. These are important findings with implications for anyone living or working near a transmitting facility. However, again, most of the studies in the list are on short-term (minutes to hours) exposure to low-

intensity RFR. Long-term exposure studies are sparse. In addition, we do not know if all of these reported effects occur in humans exposed to low-intensity RFR, or whether the reported effects are health hazards. Biological effects do not automatically mean adverse health effects, plus many biological effects are reversible. However, it is clear that low-intensity RFR is not biologically inert. Clearly, more needs to be learned before a presumption of safety can continue to be made regarding placement of antenna arrays near the population, as is the case today.

... The previously mentioned studies show that RFR can produce effects at much lower intensities after test animals are repeatedly exposed. This may have implications for people exposed to RFR from transmission towers for long periods of time.

... The conclusion from this body of work is that effects of long-term exposure can be quite different from those of short-term exposure.

Since most studies with RFR are short-term exposure studies, it is not valid to use their results to set guidelines for long-term exposures, such as in populations living or working near cell phone base stations.

Numerous biological effects do occur after short-term exposures to low-intensity RFR but potential hazardous health effects from such exposures on humans are still not well established, despite increasing evidence as demonstrated throughout this paper. Unfortunately, not enough is known about biological effects from long-term exposures, especially as the effects of long-term exposure can be quite different from those of short-term exposure. It is the long-term, low-intensity exposures that are most common today and increasing significantly from myriad wireless products and services.

People are reporting symptoms near cell towers and in proximity to other RFR-generating sources including consumer products such as wireless computer routers and Wi-Fi systems that appear to be classic "microwave sickness syndrome," also known as "radiofrequency radiation sickness." First identified in the 1950s by Soviet medical researchers, symptoms included headache, fatigue, ocular dysfunction, dizziness, and sleep disorders. In Soviet medicine, clinical manifestations include dermographism, tumors, blood changes, reproductive and cardiovascular abnormalities, depression, irritability, and memory impairment, among others. The Soviet researchers noted that the syndrome is reversible in early stages but is considered lethal over time (Tolgskaya et al. 1973).

The present U.S. guidelines for RFR exposure are not up to date. The most recent IEEE and NCRP guidelines used by the U.S. FCC have not taken many pertinent recent studies into consideration because, they argue, the results of many of those studies have not been replicated and thus are not valid for standards setting. That is a specious argument. It implies that someone tried to replicate certain works but failed to do so, indicating the studies in question are unreliable. However, in most cases, no one has tried to exactly replicate the works at all.... In addition, effects of long-term exposure, modulation, and other propagation characteristics are not considered. Therefore, the current guidelines are questionable in protecting the public from possible harmful effects of RFR exposure and the U.S. FCC should take steps to update their regulations by taking all recent research into consideration without waiting for replication that may never come because of the scarcity of research funding. The ICNIRP standards are more lenient in key exposures to the population than current U.S. FCC regulations. The U.S. standards should not be "harmonized" toward more lenient allowances. The ICNIRP should become more protective instead. All standards should be biologically based, not dosimetry based as is the case today.

Exposure of the general population to RFR from wireless communication devices and transmission towers should be kept to a minimum and should follow the "As Low As Reasonably Achievable" (ALARA) principle. Some scientists, organizations, and local governments recommend very low exposure levels — so low, in fact, that many wireless industries claim they cannot function without many more antennas in a given area. However, a denser infrastructure may be impossible to attain because of citizen unwillingness to live in proximity to so many antennas. In general, the lowest regulatory standards currently in place aim to accomplish a maximum exposure of 0.02 V/m, equal to a power density of 0.0001 $\mu W/cm^2$, which is in line with Salzburg, Austria's indoor exposure value for GSM cell base stations. Other precautionary target levels aim for an outdoor cumulative exposure of 0.1 $\mu W/cm^2$ for pulsed RF exposures where they affect the general population and an indoor exposure as low as 0.01 $\mu W/cm^2$ (Sage and Carpenter 2009). In 2007, *The BioInitiative Report, A rationale for a biologically based public exposure standard for electromagnetic fields (ELF and RF)*, also made this recommendation, based on the precautionary principle (Bioinitiative Report 2007).

Citizens and municipalities often ask for firm setbacks from towers to guarantee safety. There are many variables involved with safer tower siting — such as how many providers are co-located, at what frequencies they operate, the tower's height, surrounding topographical characteristics, the presence of metal objects, and others. Hard and fast setbacks are difficult to recommend in all circumstances. Deployment of base stations should be kept as efficient as possible to avoid exposure of the public to unnecessary high levels of RFR. As a general guideline, cell base stations should not be located less than 1500 ft (~500 m) from the population, and at a height of about 150 ft (~50 m). Several of the papers previously cited indicate that symptoms lessen at that distance, despite the many variables involved. However, with new technologies now being added to cell towers such as Wi-Max networks, which add significantly more power density to the environment, setback recommendations can be a very unpredictable reassurance at best. New technology should be developed to reduce the energy required for effective wireless communication.

In addition, regular RFR monitoring of base stations should be considered....

Table 1. List of studies reporting biological effects at low intensities of radiofrequency radiation (RFR)

Reference	Frequency	Form of RFR	Exposure duration	SAR (W/kg)	Power density ($\mu W/cm^2$)	Effects reported
Balmori (2010) (in vivo) (eggs and tadpoles of frog)	88.5–1873.6 MHz	Cell phone base station emission	2 months		5.25	Retarded development
Belyaev et al. (2005) (in vitro)	915 MHz	GSM	24–48 h	0.037		Genetic changes in human white blood cells
Belyaev et al. (2009) (in vitro)	915 MHz, 1947 MHz	GSM, UMTS	24–72 h	0.037		DNA repair mechanism in human white blood cells
Blackman et al. (1980) (in vitro)	50 MHz	AM at 16 Hz		0.0014		Calcium ion efflux in brain of chickens
Bortkiewicz et al. (2001) (in vivo) (human whole body)	500 kHz–3 GHz	TV broadcast			0.5	Immunological system in women
Campisi et al. (2010) (in vitro)	900 MHz	CW (CW: no effect observed) AM at 50 Hz	14 days, 5, 10, 20 min per day		26	DNA damage in human glial cells
Capri et al. (2004) (in vitro)	900 MHz	GSM	1 h/day, 3 days	0.07		A slight decrease in cell proliferation when human amniotic cells were

						significance with incidents and a slight increase in the number of cells with altered distribution of phosphatidylserine across the membrane
Chiang et al. (1989) (in vivo) (human whole body)	Lived and worked close to AM radio and radar installations for more than 1 year				10	People lived and worked near AM radio antennas and radar installations showed deficits in psychological and short-term memory tests
de Pomerai et al. (2003) (in vitro)	1 GHz		24, 48 h	0.015		Protein damages
D'Inzeo et al. (1988) (in vitro)	10.75 GHz	CW	30–120 s	0.008		Operation of acetylcholine-related ion channels in cells. These channels play important roles in physiological and behavioral functions
Dutta et al. (1984) (in vitro)	915 MHz	Sinusoidal AM at 16 Hz	30 min	0.05		Increase in calcium efflux in brain cancer cells
Dutta et al. (1989) (in vitro)	147 MHz	Sinusoidal AM at 16 Hz	30 min	0.005		Increase in calcium efflux in brain cancer cells
Fesenko et al. (1999) (in vitro) (mouse; wavelength in mm range)	From 8.15–18 GHz		5 h to 7 days; direction of response depended on exposure duration		1	Change in immunological functions
Fragopoulou et al. (2006) (in vivo) (mouse whole body)	1800 MHz	GSM, 217 Hz pulses, 576 μs pulse width	2 h/day, 10 days	0.018		Increase in serum testosterone
Guler et al. (2010) (in vivo) (rabbit whole body)	1800 MHz	AM at 217 Hz	15 min/day, 7 days		52	Oxidative lipid and DNA damages in the brain of pregnant rabbits
Hjollund et al. (1997) (in vivo) (human partial or whole body)	Military radars				10	Sperm counts of Danish military personnel, who operated mobile ground-to-air missile units that use several RFR emitting radar systems, were significantly lower compared to references
Ivaschuk et al. (1997) (in vitro)	836.55 MHz	TDMA	20 min	0.026		A gene related to cancer
Jech et al. (2004) (in vivo) (human partial body exposure; narcoleptic patients)	900 MHz	GSM—217 Hz pulses, 577 μs pulse width	45 min	0.56		Improved cognitive functions
Kesari and Behari (2009) (in vivo) (rat whole body)	50 GHz		2 h/day, 45 days	0.0008		Double strand DNA breaks observed in brain cells
Kesari and Behari (2010) (in vivo) (rat whole body)	50 GHz		2 h/day, 45 days	0.0008		Reproductive system of male rats
Kesari et al. (2010) (in vivo) (rat whole body)	2450 MHz	50 Hz modulation	2 h/day, 35 days	0.11		DNA double strand breaks in brain cells
Kwee et al. (2001) (in vitro)	900 MHz	GSM	20 min	0.0021		Increased stress protein in human epithelial amnion cells
Lebedeva et al. (2000) (in vivo) (human partial body)	912.4 MHz	GSM	20 min		60	Brain wave activation
Lerchl et al. (2008) (in vivo) (hamster whole body)	385 MHz 900 and 1800 MHz	TETRA GSM	24 h/day, 60 days	0.08		Metabolic changes
Magras and Xenos (1997) (in vivo) (mouse whole body)	"Antenna park"	TV and FM radio	Exposure over several generations		0.168	Decrease in reproductive function
Mann et al. (1998) (in vivo) (human whole body)	900 MHz	GSM pulse modulated at 217 Hz, 577 μs width	8 h		20	A transient increase in blood cortisol
Marinelli et al. (2004) (in vitro)	900 MHz	CW	2–48 h	0.0035		Cell's self-defense responses triggered by DNA damage
Markova et al. (2005) (in vitro)	915 and 905 MHz	GSM	1 h	0.037		Chromatin conformation in human white blood cells
Navakatikian and Tomashevskaya (1994) (in vivo) (rat whole body)	2450 MHz 9300 MHz	CW (no effect observed) Pulse-modulated 2 μs pulses at 4000 Hz	Single (0.5–12 hr) or repeated (15–60 days; 7–12 hr/day) exposure CW: no effect	0.0027		Behavioral and endocrine changes, and decreases in blood concentrations of testosterone and insulin
Nittby et al. (2008) (in vivo) (rat whole body)	900 MHz,	GSM	2 h/week, 55 weeks	0.0006		Reduced memory functions
Novoselova et al. (1999) (in vivo) (mouse whole body – wavelength in mm range)	From 8.15–18 GHz		1 s sweep time – 16 ms reverse, 5 h		1	Functions of the immune system
Novoselova et al. (2005) (in vivo) (mouse whole body; wavelength in mm range)	From 8.15–18 GHz		1 s sweep time/16 ms reverse, 1.5 h/day, 30 days		1	Decreased tumor growth rate and enhanced survival
Panagopoulos et al. (2010) (in vitro) (fly whole body)	900 and 1800 MHz	GSM	6 min/day, 5 days		1–10	Reproductive capacity and induced cell death
Panagopoulos and Margaritis (2010a) (in vivo) (fly whole body)	900 and 1800 MHz	GSM	6 min/day, 5 days		10	Window' effects of GSM radiation on reproductive capacity and cell death
Panagopoulos and Margaritis (2010b) (in vivo) (fly whole body)	900 and 1800 MHz	GSM	1–21 min/day, 5 days		10	Reproductive capacity of the fly decreased linearly with increased duration of exposure
Partecke and Trosic (2006) (in vitro)	864 and 935 MHz	CW	1–3 h	0.08		Growth affected in Chinese hamster V79 cells
Perez-Cuevjon et al. (2009) (in vitro)	9.6 GHz	90% AM	24 h	0.0004		Increased proliferation rate in human astrocytoma cancer cells
Persson et al. (1997) (in vivo) (mouse whole body)	915 MHz	CW and pulse-modulated (217 Hz, 0.57 ms; 50 Hz, 6.6 ms)	2–360 min; CW more potent	0.0004		Increase in permeability of the blood–brain barrier
Phillips et al. (1998) (in vitro)	813.5625 MHz 836.55 MHz	iDEN TDMA	2, 24 h 2, 24 h	0.0024		DNA damage in human leukemia cells
Pologea Marcu et al. (2002) (in vitro)	2.45 GHz		1 h		35	Change in membrane of cells in the retina
Pyrpasopoulou et al. (2004) (in vivo) (rat whole body)	9.4 GHz	GSM (50 Hz pulse, 20 μs pulse length)	1–7 days postpartum	0.0005		Exposure during early gestation affected kidney development
Roux et al. (2008a) (in vivo) (tomato whole body)	900 MHz				7	Gene expression and energy metabolism
Roux et al. (2008b) (in vivo) (plant whole body)	900 MHz				7	Energy metabolism
Salford et al. (2003) (in vivo) (rat whole body)	915 MHz	GSM	2 h	0.02		Nerve cell damage in brain
Sarimov et al. (2004) (in vitro)	895–915 MHz	GSM	30 min	0.0054		Human lymphocyte chromatin affected similar to stress response
Schwartz et al. (1990) (in vitro)	220 MHz	CW and sinusoidal modulation at 0.5 and 16 Hz, effect only observed at 16 Hz modulation	30 min	0.00015		Calcium movement in the heart
Schwartz et al. (2008) (in vitro)	1950 MHz	UMTS	24 h	0.05		Genes in human fibroblasts
Somosy et al. (1991) (in vitro)	2.45 GHz	CW and 16 Hz square modulation; modulated field more potent than CW		0.024		Molecular and structural changes in cells of mouse embryos
Stagg et al. (1997) (in vitro)	836.55 MHz	TDMA duty cycle 3.6%	24 h	0.0059		Glioma cells showed significant increases in thymidine incorporation, which may be an indication of an increase in cell division
Stankiewicz et al. (2006) (in vitro)	900 MHz	GSM 217 Hz pulses, 577 μs width		0.024		Immune activities of human white blood cells
Tattersall et al. (2001) (in vitro)	900 MHz	CW	5–15 min	0.0016		Function of the hippocampus
Velizarov et al. (1999) (in vitro)	960 MHz	GSM 217 Hz square-pulse, duty cycle 12%	30 min	0.000021		Decrease in proliferation of human epithelial amnion cells
Veyret et al. (1991) (in vivo) (mouse whole body)	9.4 GHz	1 μs pulses at 1000 pps, also with or without sinusoidal AM between 14 and 41 MHz; response only with AM, duration of response dependent on AM frequency		0.035		Functions of the immune system
Vian et al. (2006) (in vivo) plant	900 MHz				7	Stress gene expression
Wolke et al. (1996) (in vitro)	900, 1300, 1800 MHz 900 MHz	Square-wave modulated at 217 Hz CW, 16 Hz, 50 Hz, and 30 kHz modulations		0.201		Calcium concentration in heart muscle cells of guinea pig
Yurekli et al. (2006) (in vivo) (rat whole body)	915 MHz	GSM, 217 Hz pulse-modulation	3 h/day, 8 days	0.013		Free radical chemistry

Notes: These papers gave either specific absorption rate (SAR) or power density (mW/cm²) of exposure. Studies that did not contain these values were excluded. AM, amplitude modulated or amplitude modulation; CW, continuous wave; GSM, global system for mobile communication; iDEN, integrated digital enhanced network; TDMA, time division multiple access; TETRA, terrestrial trunked radio; UMTS, universal mobile telecommunications system.

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Resources

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Center for Municipal Solutions. Excellent resource re: regulation of cell towers & wireless facilities. http://bit.ly/1GX4mPY

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> "Stating that the current level of radiation (electromagnetic field, EMF) emitted by mobile phone towers was still high, Girish Kumar, Professor, Department of Electrical Engineering, IIT Bombay, on Saturday, urged the Centre to reduce the radiation level further.
> The mobile tower radiation had been reduced [in India] from 45,000 milliwatt per square metre to 450 milliwatt a few years ago. It should be reduced to 10 milliwatt, he said ...."
>
> Note: The FCC allows the American general public to be exposed to up to 5,800 milliwatts per square meter.

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Labels: antenna, base station, cell tower, FCC, health effects, ICNIRP, Kumar, mobile phone, regulations, research, SB 649

Newer Post Home Older Post

What are the Dangers of Living Near Cell Phone Towers?

by www.SixWise.com

Over 190 million cell phones are in use in the United States, with users often scrambling to another room, building or street to get better reception. As consumers, it is frustrating when your cell phone reception gets dropped or is too garbled to hear. But beyond "Can you hear me now?" is another considerably more important question:

Are the cell towers and antennas popping up all over the country - -the very ones that we depend on for clear reception and a wide coverage area -- safe?

This may have been a moot issue in the past when the towers were sparse and limited to obscure cornfields and hilltops. But the number of these cell "sites," as they're called, has increased tenfold since 1994. Among the more than 175,000 cell sites in the United States are antennas on schools, churches, firehouses, cemeteries and national parks. There's even a cell tower near Old Faithful in Yellowstone.

Health, not aesthetics, is the primary reason why residents oppose cell phone towers in their towns.

"Don't Put That Tower Here"

"Our companies are always running into this conundrum, which is, 'We want cell phone service, but don't put that tower here.' When you're dealing with communications through the air, you have to have antennas and towers," said Joe Farren, a spokesman for CTIA-The Wireless Association, the industry's trade group.

Aesthetics aside, the primary reason most people don't want cell sites near their homes and communities is because they're afraid of the potential health effects.

Already, more than 500 cases have sprung up across the country in which people have tried to stop cell phone sites from being constructed, according to Washington attorney Ed Donohue, who represents several cell phone companies.

Most of the time, the cell phone companies win because, as it stands, federal law does not allow rejection of a tower based on health risks.

Cell Phone Towers: Risky or Not?

If you ask the government, no studies have shown conclusive evidence that radio-frequency emissions, a form of electromagnetic radiation (EMR), from cell towers are harmful.

According to the Food and Drug Administration:

> "RF [Radio frequency] exposure on the ground is much less than exposure very close to the antenna and in the path of the transmitted radio signal. In fact, ground-level exposure from such antennas is typically thousands of times less than the exposure levels recommended as safe by expert organizations. So exposure to nearby residents would be well within safety margins."

Cell phone companies also maintain that no risks exist from the towers. "There are no health risks posed by the towers. Independent scientific panels around the world have reached this conclusion," said Russ Stromberg, senior manager of development at T-Mobile.

But other studies seem to tell a different story, with findings such as:

The government and cell phone companies maintain cell towers (and phones) are safe.

- A study by Dr. Bruce Hocking in Australia found that children living near three TV and FM broadcast towers (similar to cell towers) in Sydney had more than twice the rate of leukemia than children living more than seven miles away.
- Says Dr. Neil Cherry, a biophysicist at Lincoln University in New Zealand:
    - "Public health surveys of people living in the vicinity of cell site base stations should be being carried out now, and continue progressively over the next two decades. This is because prompt effects such as miscarriage, cardiac disruption, sleep disturbance and chronic fatigue could well be early indicators of the adverse health effects. Symptoms of reduced immune system competence, cardiac problems, especially of the arrhythmic type, and cancers, especially brain tumor and leukemia, are probable."
- Biomedical engineer Mariana Alves-Pereira says exposure to cell phone towers can lead to vibroacoustic disease. "From what I understand, some of the complaints are similar in what is seen in vibroacoustic disease patients, which are people who develop a disease caused by low frequency noise exposure," she said. Symptoms can include mood swings, indigestion, ulcers and joint pain.
- Dr. Gerard Hyland, a physicist who was nominated twice for the Nobel Prize in medicine, says, "Existing safety guidelines for cell phone towers are completely inadequate ... Quite justifiably, the public remains skeptical of attempts by governments and industry to reassure them that all is well, particularly given the unethical way in which they often operate symbiotically so as to promote their own vested interests."
- According to the Mount Shasta Bioregional Ecology Center, "Studies have shown that even at low levels of this radiation, there is evidence of damage to cell tissue and DNA, and it has been linked to brain tumors, cancer, suppressed immune function, depression, miscarriage, Alzheimer's disease, and numerous other serious illnesses."
- According to Dr. W. Löscher of the Institute of Pharmacology, Toxicology and Pharmacy of the Veterinary School of Hannover in Germany, dairy cows that were kept in close proximity to a TV and cell phone tower for two years had a reduction in milk production along with increased health problems and behavioral abnormalities. In an experiment, one cow with abnormal behavior was taken away from the antenna and the behavior subsided within five days. When the cow was brought back near the antenna, the symptoms returned.

Incentives for Cell Phone Towers

Why would a church, school or other private property allow a cell phone antenna to be placed on the grounds? Cell phone companies pay "rent" for their placement that can range anywhere from $800 to $2,000 a month. This can mean all the difference for an under-funded school district or church.

Still, many people are wary that the incentives do not come close to matching the potential risk involved. This includes the International Association of Fire Fighters who, in 2004,

came out against the use of firehouses for cell antennas "until a study with the highest scientific merit" can prove they are safe.

These sentiments are echoed by residents of St. Louis where T-Mobile plans to put a cell site on an 89-year-old church. "That revenue is in exchange for our potential well-being, our peace of mind and our property values," said resident David O'Brien. "None of us are willing to take that risk."

Recommended Reading

Noise Pollution: How Bad is it, How Bad Could it Get, What are the Effects?

Bottled Water: Which City's Tap Water System is Making a Flood of Cash off of You?

Sources

Food and Drug Administration: Cell Phone Facts

Health Effects Associated With Mobile Base Stations in Communities

Are Cell Phone Towers Making You Sick?

Mount Shasta Bioregional Ecology Center

Wired News: Cell Phone Tower Debate Grows

Extraordinary Behaviors in Cows in Proximity to Transmission Towers

"There are no current, relevant public safety standards for pulsed RF involving chronic exposure of the public, nor of sensitive populations, nor of people with metal and medical implants..."

— **Poki Stewart Namkung, MD,** M.P.H., Santa Cruz County Public Health

AREN'T WE ALREADY EXPOSED TO MANY OTHER SOURCES OF RADIATION?

Yes, *and that's already too much!* We need to reduce current exposures, not add more.

HOW WILL STOPPING THE ADDITIONAL ANTENNAS AFFECT OUR CELLPHONE RECEPTION?

It will not change existing reception in Sebastopol.

WHAT CAN WE DO TO PROTECT OURSELVES?

All wireless technology emits radiation, therefore, reduce or avoid all wireless devices, especially cell phones, DECT phones, wi-fi, and refuse or remove Smart Meters. Use corded landlines and wired alternatives.

Children playing in Laguna de Santa Rosa

Egrets in Laguna de Santa Rosa

Protect our natural environment now...

HOW CAN I HELP?

1. **The EMF Safety Network** has filed a lawsuit to stop the Sebastopol cell tower expansion.

   DONATE NOW. Send checks to:

   EMF Safety Network
   PO Box 1016
   Sebastopol CA 95473

2. **Contact local officials.** Let them know you oppose additional cell towers and antennas; demand that elected officials represent our concerns.

3. ***Learn more:*** Educate yourself, your family, friends and neighbors about the hazards of wireless technologies.

EMF SAFETY NETWORK

www.emfsafetynetwork.org
Phone: 707-824-0824

Sebastopol
Cell Tower Radiation Q & A

I have no doubt in my mind that at the present time, the greatest polluting element in the earth's environment is the proliferation of electromagnetic fields.

—Dr. Robert O. Becker, two-time nominee for the Nobel Prize and author of *Cross Currents* and *The Body Electric*

Educate yourself, your family, friends and neighbors about the hazards of wireless technologies.

EMF SAFETY NETWORK

www.emfsafetynetwork.org
707-824-0824

WHAT ARE THE CELL TOWER CHANGES PLANNED BY VERIZON?

Verizon plans to add 3G and 4G antennas for a total of nine cell antennas on the tower located at City Hall in downtown Sebastopol.

WHY SHOULD WE BE CONCERNED ABOUT THIS?

The World Health Organization's International Association for Research on Cancer has classified radiofrequency electromagnetic fields (RF or wireless) as a carcinogen, in the same category as lead, DDT and asbestos. Verizon's calculations predict 20 times or more RF increase in Sebastopol, with highest levels at two and three story elevations.

Studies indicate serious risk to public and environmental health within 1,000 feet of a cell tower. There are no safety studies specific to 4G antennas, but their frequencies and power levels are known to better penetrate buildings and affect biological systems more adversely than existing technology.

WHAT ARE THE HEALTH RISKS?

In addition to cancer, RF health impacts include headaches, sleep disruption, ringing in the ears, heart rhythm disturbances, dizziness, nausea, skin rashes, loss of concentration, memory and learning problems, depression, immune system suppression, and DNA damage.

"There is now sufficient scientific data about the biological effects of EMF, in particular about radiofrequency (RF) radiation to argue for precautionary measures. We can state unequivocally that EMF can cause single and double strand DNA breakage at exposure levels that are considered safe under the FCC guidelines in the USA."

— **Martin Blank, PhD,** Columbia University Professor of Physiology and Cellular Biophysics.

Cell Tower

"We have seen clinical evidence that electropollution affects the normal functioning of the electrically sensitive heart, including the rate and rhythm, and other systems of the body."

— **Stephen Sinatra, MD,** Cardiologist, Fellow in the American College of Cardiology and founder of Heart MD Institute.

WHO WOULD BE AFFECTED BY THIS INCREASE IN RADIATION?

All members of the population, especially children and downtown residents. Children are more vulnerable due to their smaller size, thinner skulls and developing bodies. Businesses, schools, the library, the senior center, city hall offices, tourists, customers, pets, wildlife and the environment would all be impacted.

IS WIRELESS RADIATION HARMFUL TO ANIMALS?

Yes. *"...microwave and radiofrequency pollution constitutes a potential cause for the decline of animal populations and deterioration of health of plants living near phone masts."*

— **Alfonso Balmori,** Electromagnetic Biology and Medicine (2005; 24:109–119)

WHO PROTECTS US FROM THESE HAZARDS?

No one. Just like the tobacco industry of the 1950s, Big Telecom has bought the science and influenced our government. With billions of dollars at stake, the wireless industry protects their profits rather than our health.

"Only 25% of studies funded by the wireless industry show some type of biological effect from microwave radiation, while among independently funded studies, 75% show a bioeffect."

— **Henry Lai, PhD,** Department of Bioengineering, University of Washington

BioInitiative 2012

A Rationale for Biologically-based Exposure Standards for Low-Intensity Electromagnetic Radiation

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Updated Research Summaries
December 15, 2017

BioInitiative Report: Medical concerns intensify over deadly brain tumors from cell phone use/Orebro University Hospital, Sweden
November 17, 2017

Electromagnetic Fields, Pulsed Radiofrequency Radiation, and Epigenetics: How Wireless Technologies May Affect Childhood Development
May 15, 2017

Effects of Mobile Phones on Children's and Adolescents' Health: A Commentary
May 15, 2017

Comment to the FCC on Docket 16-421 on Streamlining for Small Cell (Antenna) Rollout By Relaxing the Rules for Siting
February 1, 2017

THE BIOINITIATIVE REPORT 2012

A Rationale for Biologically-based Public Exposure Standards for Electromagnetic Fields (ELF and RF)

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WHO WE ARE

The BioInitiative 2012 Report has been prepared by 29 authors from ten countries, ten holding medical degrees (MDs), 21 PhDs, and three MsC, MA or MPHs. Among the authors are three former presidents of the Bioelectromagnetics Society, and five full members of BEMS.

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CONCLUSIONS

Bioeffects are clearly established to occur with very low exposure levels (non-thermal levels) to electromagnetic fields and radiofrequency radiation exposures.

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Reported Biological Effects

Henry Lai's Research Summaries

These are invaluable sets of abstracts (data-based to be searchable) covering the RFR scientific literature, as well as collections of scientific abstracts on oxidative effects (from both RFR and ELF), and a set specific to Electrosensitivity. New comet assay abstracts for RFR and ELF are added in 2017.

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WHY WE CARE?

DO WE KNOW ENOUGH?

RF Color Charts

The RF Color Charts summarize many studies that report biological effects and adverse health effects relevant for cell towers, WI-FI, 'smart' wireless utility meters, wireless laptops, baby

The stakes are very high. Human beings are bioelectrical systems. Our hearts and brains are regulated by internal bioelectrical signals. Environmental exposures to artificial EMFs can interact with fundamental *biological processes in the human* body.

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There is more evidence than we need. The last five years worth of new scientific studies tell us the situation is much worse than in 2007 and yet people around the world have so much more daily exposure than even *five years ago.*

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monitors, cell phones and cordless *phones.*

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BioInitiative 2012

A Rationale for Biologically-based Exposure Standards for Low-Intensity Electromagnetic Radiation

Why We Care?

The stakes are very high.

Human beings are bioelectrical systems. Our hearts and brains are regulated by internal bioelectrical signals. Environmental exposures to artificial EMFs can interact with fundamental biological processes in the human body. In some cases, this may cause discomfort, or sleep disruption, or loss of wellbeing (impaired mental functioning and impaired metabolism) or sometimes, maybe it is a dread disease like cancer or Alzheimer's disease. It may be interfering with ones' ability to become pregnant, or carry a child to full term, or result in brain development changes that are bad for the child. It may be these exposures play a role in causing long-term impairments to normal growth and development of children, tipping the scales away from becoming productive adults. We have good evidence these exposures can damage our health, or that of children of the future who will be born to parents now immersed in wireless exposures.

In the United States, the deployment of wireless infrastructure (cell tower sites) to support cell phone use has accelerated greatly in the last decades. The spread of cell towers in communities, often placed on pre-school, church day-care, and school campuses means that young children can have thousands of times higher RF exposures in home and school environments than existed even 20-25 years ago. CTIA estimates that in 1997 there were only 36,650 cell sites in the US; but increased rapidly to 131,350 in June 2002; 210,350 in June 2007 and 265,561 in June 2012 (CTIA, 2012). About 220,500 cell sites existed in 2008. These wireless antennas for cellular phone voice and data transmission produce whole-body RFR exposures over broad areas in communities that are an involuntary and unavoidable source of radiofrequency radiation exposure. Further, the nearly universal switch to cordless and cell phones, and away from corded landline phones means close and repetitive exposures to both EMF and RFR in the home. Other new RFR exposures that didn't exist before come from WI-FI access points (hotspots) that radiate 24/7 in cafes, stores, libraries, classrooms, on buses and trains, and from personal WI-FI enabled devices (iPads, tablets, PDAs, etc). The largest single source of community-wide, pervasive RFR yet rolled out is the 'smart meter' infrastructure. This program places a wireless device (like a mini-mobile phone base station) on the wall, replacing the electromechanical (spinning dial) meter. They are to be installed on every home and classroom (every building with an electric meter). Utilities from California to Maine have installed tens of millions already, despite health concerns of experts and enormous public resistance. The wireless meters produce spikes of pulsed radiofrequency radiation 24/7, and in typical operation, will saturates living space at levels that can be much higher than already reported to cause bioeffects and adverse health effects (utilities can only say they are compliant with outdated federal safety standards, which may or may not always be true – see http://sagereports.com/smart-meter-rf). These meters, depending on where they are placed relative to occupied space in the home or classroom, can produce RFR exposure levels similar to that within the first 100 feet to 600 feet of a mobile phone base station (cell tower).

The cumulative RFR burden within any community is largely unknown. Both involuntary sources (like cell towers, smart meters and second-hand radiation from the use of wireless devices by others) plus voluntary exposures from ones' personal use of cell and cordless phones, wireless routers, electronic baby surveillance monitors, wireless security systems, wireless hearing aids, and wireless medical devices like implanted insulin pumps all add up. No one is tallying up the combined exposure levels. Billions of new RFR transmitters from

the smart meter rollout alone will raise the baseline RFR levels, and will significantly add to the existing RFR background.

Sometimes, science does not keep pace with new environmental exposures that are by-products of useful things we want to buy and use in society. So, the deployment runs ahead of knowledge of health risks. It is an old story. This is the case for EMF and RFR, and this Report underscores the critical need to face difficult questions, make mid-course corrections, and try to repair the damage already done in this generation, and to think about protecting future generations.

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BioInitiative 2012

A Rationale for Biologically-based Exposure Standards for Low-Intensity Electromagnetic Radiation

Do We Know Enough to Take Action?

There is more evidence than we need.

The last five years worth of new scientific studies tell us the situation is much worse than in 2007 and yet people around the world have so much more daily exposure than even five years ago. Exposures are linked to a variety of adverse health outcomes that may have significant public health consequences. When added across billions of people world-wide, no argument for the status quo can be persuasive now.

In twenty-one technical chapters of this 2012 update, the contributing authors discuss the content and implications of about 1800 new studies. Overall, there is reinforced scientific evidence of risk where there is chronic exposure to low-intensity electromagnetic fields and to wireless technologies (radiofrequency radiation including microwave radiation).

There is more evidence in 2012 that such exposures damage DNA, interfere with DNA repair, evidence of toxicity to the human genome (genes), more worrisome effects on the nervous system (neurology) and more and better studies on the effects of mobile phone base stations (wireless antenna facilities or cell towers) that report lower RFR levels over time can result in adverse health impacts. There has been a big increase in the number of studies looking at the effects of cell phones (on the belt, or in the pocket of men radiating only on standby mode) and from wireless laptops on impacts to sperm quality and motility; and sperm death (fertility and reproduction).

In other new studies of the fetus, infant and young child, and child-in-school – there are a dozen or more new studies of importance.

The 2007 BioInitiative Report was prepared by world- recognized experts in science and public health policy. Outside reviewers also contributed valuable content and perspective. It was concluded even in 2007 that existing public safety limits were inadequate to protect public health, and agreed that new, biologically-based public safety limits were needed five years ago. The public health cost of doing nothing was judged to be unacceptable in 2007. This did nothing to change the rules, nor roll back the technology tsunami of wireless-everywhere.

The levels of exposure we face in 2012 are higher, and have crept into every day life, even for children. The levels at which undesirable effects on health and well-being are seen is much lower. The levels of concern at have dropped lower in 2012 by 10s to 100s of times. There is much greater involuntary exposure, and it is nearly unavoidable even for people who choose not to 'go wireless' (second-hand radiation effects). Safe forms of communication by land-line telephone are being phased out without general public knowledge or agreement. There is no informed consent for consumers (warning labels on cell phones, for example, have been defeated by telecom industry lobby groups). It is still difficult or impossible for a consumer to get reliable information on levels of exposure from wireless devices, It is simply beyond the reach of people to identify where excessively high levels of exposure occur in their communities, and it is very rare for a county or state health department to accommodate requests for information or provide measurements.

Today the evidence is stronger than ever and it may be placing people at risk, but most people have no idea. There is little indication that cell phone users (whose numbers have risen from roughly 2 billion in 2006 to 6 billion users globally in 2012) are aware of the risks. In that time, whole-body exposures from other RFR sources like WI-FI, WI-MAX, smart grids using wireless utility meters, and vast commercial applications of wireless RFR (in commerce, transportation, in banking, in surveillance and monitoring, in medical imaging and ironically in health care record-keeping and learning environments for education – all these new

applications of wireless over wired communications and data transmission add to the RFR saturation in cities. Wireless laptops and wireless internet in schools, and home offices and for homework mean even more chronic exposures to RFR, a designated IARC 2B Possible Human Carcinogen (May 31, 2011).

The range of possible health effects that are adverse with chronic exposures has broadened. The most serious health endpoints that have been reported to be associated with extremely low frequency (ELF) and/or radiofrequency radiation (RFR) include childhood and adult leukemia, childhood and adult brain tumors, and increased risk of the neurodegenerative diseases, Alzheimer's and amyotrophic lateral sclerosis (ALS). Recent studies largely reinforce the potential risks to health (rather than reducing our concerns, or providing actual indications of safety). In addition, there are reports of increased risk of breast cancer in both men and women, genotoxic effects (DNA damage, chromatin condensation, micronucleation, impaired repair of DNA damage in human stem cells), pathological leakage of the blood–brain barrier, altered immune function including increased allergic and inflammatory responses, miscarriage and some cardiovascular effects. Insomnia (sleep disruption) is reported in studies of people living in very low-intensity RFR environments with WI-FI and cell tower-level exposures. Short-term effects on cognition, memory and learning, behavior, reaction time, attention and concentration, and altered brainwave activity (altered EEG) are also reported in the scientific literature. Biophysical mechanisms that may account for such effects can be found in various articles and reviews.

We could do otherwise. Each wireless need had a wired solution in counterpart that has none of the health effects that wireless RFR does, with the exception of cell phone use for talking directly to someone. It is time to re-think the wireless tsunami and educate people about health, privacy and security risks. It is past time to develop new safety standards. It is necessary now to look to less harmful ways to communicate, move ourselves from place to place, shop, sleep, recreate, save energy, and educate our children in school. It is time to rethink our global commerce, energy, banking, transportation and communications infrastructures so we are all committed to sustaining healthy living spaces and conserve safe sanctuary for all species on earth.

BioInitiative 2012

A Rationale for Biologically-based Exposure Standards for Low-Intensity Electromagnetic Radiation

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Cell Phone Radiation Study Confirms Cancer Risk

Cell Phone Radiation Study Confirms Cancer Risk

Orebro University, Sweden May 31, 2016

The National Toxicology Program under the National Institutes of Health has completed the largest-ever animal study on cell phone radiation and cancer. The results confirm that cell phone radiation exposure levels within the currently allowable safety limits are the "likely cause" of brain and heart cancers in these animals, according to Dr. John Bucher, Associate Director of the NTP. One in twelve (12) male rats developed either malignant cancer (brain and rare heart tumors) or pre-cancerous lesions that can lead to cancer. Tumors called schwannomas were induced in the heart, in the same kind of cells in the brain that have lead to acoustic neuromas seen in human studies. The NTP says it is important to release these completed findings now given the implications to global health. No cancers occurred in the control group.

Lennart Hardell, MD, PhD of Orebro University says *"(T)he animal study confirms our findings in epidemiological studies of an increased risk for glioma and acoustic neuroma among people that use wireless phones, both cell phones and cordless phones (DECT). Acoustic neuroma is a type of Schwannoma, so interestingly this study confirms findings in humans of increased risk for glioma and acoustic neuroma. In 2013 we called for upgrading the risk in humans to Group 1, the agent is carcinogenic to humans. It is now time to re-evaluate both the cancer risk and other potential health effects in humans from radiofrequency radiation and also inform the public"* says Hardell. *"This NTP evidence is greatly strengthening the evidence of risk, is sufficient to reclassify cell phone radiation as a known cancer-causing agent, and confirms the inadequacy of existing public safety limits."*

The World Health Organization's 10-year study of human use of mobile phones concluded there is an increased risk for malignant brain tumors among the heavier mobile phone users, particularly where it is used mostly on one side of the head. The 2010 Interphone mega-study of cancer in humans using mobile phones found higher cancer risk, but at that time there was little animal testing to support the risks identified in humans. Now, this NTP study has shown statistically significant risks with a dose-response relationship to the amount of exposure. It proves that non-ionizing radiation can plausibly cause cancer, not just ionizing radiation like x-rays and puts to rest the traditional scientific argument that cell phone radiation can't do harm.

Dr. Bucher said the animals' exposure was about the same as for people who are heavy users of cell phones. He also confirmed that the exposure of 1.5 W/Kg is lower than currently allowed under FCC public safety limits. Testing on rats is standard in predicting human cancers.

The BioInitiative Report (2014) documents nervous system effects in 68% of studies on radiofrequency radiation (144 of 211 studies). This has increased from 63% in 2012 (93 of 150 studies). Genetic effects

(damage to DNA) from radiofrequency radiation is reported in 65% (74 of 114 studies); and 83% (49 of 59 studies) of extremely-low frequency studies.

Dr. Christopher Portier, formerly with the NTP commented this is not just an associated finding—but that the relationship between radiation exposure and cancer is clear. *"I would call it a causative study, absolutely. They controlled everything in the study. It's [the cancer] because of the exposure. "This is by far—far and away—the most carefully done cell phone bioassay, a biological assessment. This is a classic study that is done for trying to understand cancers in humans".*

See: www.bioinitiative.org

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+ Cell Phone Radiation Study Confirms Cancer Risk (PDF)

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Cell Phone Radiation Study Confirms Cancer Risk/ Orebro University, Sweden May 31, 2016
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BioInitiative 2012

A Rationale for Biologically-based Exposure Standards for Low-Intensity Electromagnetic Radiation

What's New?

Updated Research Summaries

The Research Summaries by Dr. Lai include published scientific study references and abstracts that are updated to 2017, replacing the 2014 files. We have expanded the number of downloadable research summaries to include abstract collections on neurological effects and on comet assay studies, and provided new graphics on "Effect vs No Effect" studies. The new..

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BioInitiative Report: Medical concerns intensify over deadly brain tumors from cell phone use/Orebro University Hospital, Sweden

There is a consistent pattern of increased risk for glioma (a malignant brain tumor) and acoustic neuroma with use of mobile and cordless phones" says Lennart Hardell, MD, PhD, Orebro University, Sweden, according to publications through mid-2017. "Epidemiological evidence shows that radiofrequency should be classified as a Group 1 (Known) Human Carcinogen.....

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Electromagnetic Fields, Pulsed Radiofrequency Radiation, and Epigenetics: How Wireless Technologies May Affect Childhood Development

Announcing a Special Section of Child Development from © The Society for Research in Child Development, Inc. Contemporary Mobile Technology and Child and Adolescent Development, edited by Zheng Yan and Lennart Hardell, May 15, 2017 Article by Cindy Sage and Ernesto Burgio Abstract Mobile phones and other wireless devices that produce electromagnetic fields (EMF) and..

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Effects of Mobile Phones on Children's and Adolescents' Health: A Commentary

Announcing a Special Section of Child Development from © The Society for Research in Child Development, Inc. Contemporary Mobile Technology and Child and Adolescent Development, edited by Zheng Yan and Lennart Hardell, May 15, 2017 Article by Lennart Hardell Orebro University Abstract The use of digital technology has grown rapidly during the last couple of..

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Comment to the FCC on Docket 16-421 on Streamlining for Small Cell (Antenna) Rollout By Relaxing the Rules for Siting

The FCC is proposing to 'streamline' the permitting process for small wireless facilities, without completing its investigation of RF health effects of low-intensity radio frequency radiation. This fact alone argues against the FCC speeding and easing the approval of millions of new 'small cell' wireless antenna sites under Docket 16-421. It also argues against permitting thousands of new..

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BioInitiative Working Group Suggests New Members to Replace the Existing WHO RF EHC Core Group and Advisors Committee

A list of highly qualified replacement members for the WHO Core Group and Advisors was transmitted to Dr. Emilie van Deventer, WHO EMF Program Director in a letter dated January 24, 2017....

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BioInitiative Working Group Issues a "No Confidence" Letter to the WHO EMF Program Manager

The BioInitiative Working Group has advised the World Health Organization's Dr. Emilie van Deventer that the membership composition of the RF Environmental Health Criteria Core Group is unacceptable. WHO is urged to make changes to the WHO RF EHC Core Group membership to more fairly reflect membership and expertise of the 2011 IARC RF Working..

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Cell Phone Radiation Study Confirms Cancer Risk

Cell Phone Radiation Study Confirms Cancer Risk Orebro University, Sweden May 31, 2016 The National Toxicology Program under the National Institutes of Health has completed the largest-ever animal study on cell phone radiation and cancer. The results confirm that cell phone radiation exposure levels within the currently allowable safety limits are the "likely cause" of..

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Comment Letter: Rebutting the validity of findings of SCENIHR's Final Opinion on Potential Health Effects of Electromagnetic Fields (EMF)

BioInitiative Working Group's members Cindy Sage, MA, Lennart Hardell, MD, PhD and David O. Carpenter, MD have published a Comment Letter in the journal Bioelectromagnetics rebutting the validity of findings of SCENIHR's Final Opinion on Potential Health Effects of Electromagnetic Fields (EMF). Sage C, Hardell L, Carpenter DO. Comment on SCENIHR: Opinion on Potential Health..

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Submission of Comments on Final SCENIHR Opinion from the BioInitiative Working Group

The BioInitiative Working Group submitted extensive comments to SCENHIR in spring of 2014 on their Draft Opinion on Potential Health Effects of Electromagnetic Fields (EMF) and provided detailed reasoning and evidence supporting the need for corrections in the Final Report. + BIWG SCENIHR Rebuttal to Opinion (DOWNLOAD PDF) In January of 2015, SCENIHR (Scientific Committee..

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The Porto Alegre Resolution

We, the undersigned scientists, were honored to participate in a workshop organized by the Universidade Federal do Rio Grande do Sul and the Public Ministry of Rio Grande do Sul and sponsored by the Brazilian Health Ministry, the International Commission for Electromagnetic Safety, the Porto Alegre Environmental Council (COMAM/PA), the Rio Grande do Sul Center for Health Vigilance (CEVS/RS) and others, entitled, "International Workshop on Non-Ionizing Radiation, Health and Environment" which took place on May 18 and 19, 2009, in Porto Alegre, Brazil.

This resolution follows several international resolutions agreed to by concerned scientists and medical doctors over the past decade, including resolutions developed by the International Commission for Electromagnetic Safety [1], based on evidence and consideration on documents such as the BioInitiative Report [2] and a special issue of the journal Pathophysiology on electrical and magnetic fields, published in August 2009 [3].

We agreed that the protection of health, well-being and the environment requires immediate adoption of the Precautionary Principle, which states, "*when there are indications of possible adverse effects, though they remain uncertain, the risks from doing nothing may be far greater than the risks of taking action to control these exposures. The Precautionary Principle shifts the burden of proof from those suspecting a risk to those who discount it*", until new scientific discoveries are recognized as the only criterion for the establishment or modification of non-ionizing radiation exposure standards;

We recognize that, in Brazil as well as all over the world, where there has been an unprecedented explosion in the availability and use of non-ionizing electromagnetic fields for electrical and wireless communications technologies (mobile and cordless phones, WiFi and WIMAX networks, RFID, etc,), as well as major electrical grid and wireless broadband infrastructure changes, this assessment should inform risk management to take proper steps to protect the public from long-term, low-level exposure to extremely-low frequency as well as radiofrequency electromagnetic fields that have substantially increased in the ambient environment in recent years.

We are concerned about the body of evidence that indicates that exposure to electromagnetic fields interferes with basic human biology and may increase the risk of cancer and other chronic diseases. The exposure levels at which these effects have been observed are many times lower than the standards promulgated by the International Commission for Non-Ionizing radiation Protection (ICNIRP) [4] and the IEEE's International Committee on Electromagnetic Safety (ICES) [5]. These standards are obsolete and were derived from biological effects of short-term high intensity exposures that cause health effects by temperature elevation and nerve excitation discovered decades ago. Recent research indicates that electromagnetic fields could cause detrimental health effects even at very low levels of exposure. The ICNIRP and IEEE/ICES standards are being supported and promoted by interested parties to avoid precautionary technical planning, precautionary laws, and precautionary advice to the public.

We are deeply concerned that current uses of non-ionizing radiation for mobile phones, wireless computers and other technologies place at risk the health of children and teens, pregnant women,

seniors and others who are most vulnerable due to age or disability, including a health condition known as electromagnetic hypersensitivity. We strongly recommend these precautionary practices:

1. Children under the age of 16 should not use mobile phones and cordless phones, except for emergency calls;

2. The licensing and/or use of Wi-Fi, WIMAX, or any other forms of wireless communications technology, indoors or outdoor, shall preferably not include siting or signal transmission in residences, schools, day-care centers, senior centers, hospitals or any other buildings where people spend considerable time;

3. The licensing for siting and installation of infrastructure related to electrical power and wireless broadband telecommunications, particularly, cellular telephony, Wi-Fi and WIMAX, should only be approved after open public hearings are held and approval granted with full consideration given to the need to apply the Precautionary Principle. Sensitive areas should be avoided to protect vulnerable populations;

4. Mankind shall be encouraged to continue to discover new means of harnessing non-ionizing electromagnetic energy, aiming at bringing benefits to society, through definition of new standards of human exposure, which are based on the biological realities of nature and not solely on the consideration of economic and technological needs.

We, therefore, urge all nations to join Switzerland, Italy, Belgium, Russia China, the U.S. (for the FCC standard for partial exposure of the head) and other countries and regions that have chosen to adopt a more precautionary strategy, aiming to assure more safety to the public while maintaining good service quality.

We make an urgent call to all nations to convene a panel of experts, selected from candidates recommended by civil society groups (not only those preferred by the affected industries) to discuss precautionary technology, laws and advice in order to develop policies that reconcile public health concerns with further development of wireless communications technology such as mobile phones as well as electric power transmission and distribution systems.

Citations:

[1] ICEM's Benevento Resolution (2006) and Venice Resolution (2008) www.icems.eu.
[2] BioInitiative Report www.bioinitiative.org
[3] A Special Issue of Pathophysiology on the science and public health/policy issues regarding Electromagnetic Fields was published March 2009, and is the only peer reviewed scientific journal referenced on this list. It is now available online at http://www.sciencedirect.com/science/journal/09284680
[4] International Commission on Non-ionizing Radiation Protection www.icnirp.de
[5] Institute of Electrical and Electronics Engineers. www.ieee.org.

For further information, please contact info@icems.eu.

Signed by:

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Additional scientists signing on to the Porto Alegre Resolution after September 15, 2009:

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Simona Carrubba, PhD, Louisiana State Univ. Health Science Center, Shreveport, La, USA.
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Karl Braun-von Gladiß. Dr. med., Arzt für Allgemeinmedizin, Deutsch Evern, Germany
Yury Grigoriev, Professor, Dr. of Medical Science, Chairman of Russian National Committee on
- Non-Ionizing Radiation Protection, Moscow (Russian Federation)
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Olle Johansson, Assoc. Prof., The Experimental. Dermatology Unit, Department of Neuroscience,
- Karolinska Institute; and Professor, The Royal Institute of Technology, Stockholm, Sweden
Lukas H. Margaritis,Professor of Cell Biology and Radiobiology, Athens University, Greece

L. Lloyd Morgan, Electronics Engineer (retired), USA.
Wilhelm Mosgoeller, MD, Prof. Medical University of Vienna, Austria
Jerry L. Phillips, PhD. Prof. Dir. Science Learning Ctr. Univ. Colorado, Colorado Springs, USA.
Nesrin Seyhan, PhD., ICEMS, Prof. Medical Faculty of Gazi University, Chair, Biophysics Dept. - Turkey Rep/WHO EMF IAC, Panel member, NATO RTO, HFM, Turkey
David Servan-Schreiber, MD, PhD. Clinical Professor, Psychiatry, Univ. Pittsburgh USA
Stanislaw Smigielski, MD, ICEMS, Military Institute of Hygiene & Epidemiology, Poland
Stelios A Zinelis MD, ICEMS, Hellenic Cancer Society, Cefallonia, Greece

Other signers who are advocates, organizations or members of the general public:
Dea Emilia Carneiro de Andrade, Sou Presidente do Comitê de Cidadania Comissão Justiça e Paz - da Arquidiocese de Juiz de Fora – MG, Brazil
Ana Maria Daitx Valls Atz, Farmacêutica,Porto Alegre/RS, Brasil
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Jose Maria Tiburcio Barroso, engineer, Niteroi, RJ, Brazil
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Sergio A. Pereira De Borja, Prof. Direito Constituciona, PUC/RS e da Instituicones de Direito, UFRGS
Elaine S. A. Cabral, M. Sc., Education, Environmental Law; member, Human Rights Commission - of Attorney Association-OAB, J. de Fora, MG, Brazil
Kerry Crofton, PhD, Health Educator, Canada
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Cristiano M. Gallep, Prof. Dr., DTT, Unicamp, Brazil
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Sandra H. Wilkinson, Hamilton Township Residents against Pennsylvania Creek Tower, PA, USA

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Please indicate your name, title, affiliation, city and country (1-2 lines at most.)

EM Watch

Electromagnetic Radiation Health and Safety

Cell Tower Health Risks

Cell Towers are the base stations which control cell (or mobile) phone communication. The term "cell site" can also be used – to include all cell phone towers, antenna masts and other base station forms.

Each cell tower serves a small area around it, known as a cell. Service providers are scrambling to improve their coverage and to service more users, so they need to keep on building more cell sites.

Increased cellphone traffic also contributes to cell tower density. When a cell becomes too busy, a frequent solution is to divide it into smaller cells, which then require more cell sites.

There are over 300,000 cell sites in the USA alone, and in the U.K. over 60,000, and these figures are more than doubling every 10 years.

Cell tower radiation from chimneys?

Cell sites may take the form of a mast or tower, but may also be disguised, in some cases so they cannot be visually discerned at all.

You might notice the camouflaged "trees", but perhaps not the cell sites on top of buildings, looking like elongated loudspeaker boxes.

You'd very likely fail to notice cell sites installed around chimneys, church steeples, even flagpoles. I have even seen a small cell site installed on the wall of a private house. No doubt the owner was collecting a useful rental, and probably had some screening from the radiation.

But his neighbours were unprotected.

Where a base station is installed on top of a building where people live or work, those people are usually quite unaware that there is a cell site close by, and of the high levels of radiation that they are subjected to every day.

Cell tower health dangers

The cellular phone industry continues to maintain that cell phone towers pose no health risk, but fewer people believe that these days. Almost all scientists in this field would disagree that cell towers are safe, except those employed by the industry, perhaps.

There is strong evidence that electromagnetic radiation from cell phone towers is damaging to human

 Example: A study into the effects of a cell tower on a herd of dairy cattle was conducted by the Bavarian state government in Germany and published in 1998.

The erection of the tower caused adverse health effects resulting in a measurable drop in milk yield.

Relocating the cattle restored the milk yield. Moving them back to the original pasture recreated the problem. DairyCowStudy.pdf.

A human study (Kempten West) in 2007 measured blood levels of seratonin and melatonin (important hormones involved in brain messaging, mood, sleep regulation and immune system function) both before, and five months after, the activation of a new cell site.

Twenty-five participants lived within 300 metres of the site. Substantial unfavourable changes occurred with respect to both hormones, in almost all participants. Kemptem West Study.

Can Cell Towers Cause Cancer?

A study performed by doctors from the German city of Naila monitored 1000 residents who had lived in an area around two cell phone towers for 10 years. During the last 5 years of the study they found that those living within 400 meters of either tower had a newly-diagnosed cancer rate three times higher than those who lived further away.

Breast cancer topped the list, but cancers of the prostate, pancreas, bowel, skin melanoma, lung and blood cancer were all increased. NailaStudy.pdf

 **Very few studies have specifically concentrated on cancer risk from cell phone towers. This lack of studies is in itself a cause for concern, especially since anecdotal evidence is plentiful.**

For example, in a case known as "Towers of Doom", two cell masts were installed (in 1994) on a five story apartment building in London. Residents complained of many health problems in the following years. Seven of them were diagnosed with cancer.

The cancer rate of the top floor residents (closest to the tower) was 10 times the national average. Further info.

Even the World Health Organisation has conceded that radio-frequency radiation may cause cancer. See this report.

If cell towers are causing cancer, you would expect it to occur after several years of exposure, because damage from radiation exposure accumulates over time. Cancer only occurs when all body defences and repair mechanisms have been exhausted and overwhelmed.

During those years, our bodies would be stressed by that radiation every day. This affects our health in other ways, too.

Individuals differ in their response to electromagnetic radiation.

For some people, short term effects from cell tower radiation exposure may include headaches, sleep disorders, poor memory, mental excitation, confusion, anxiety, depression, appetite disturbance and listlessness.

A small group of doctors from Bamberg, Germany, conducted their own study in 2005. They found increasing levels of both minor and serious health problems in patients exposed to higher radiation levels.

These health problems included tumours, diabetes, heart rhythm disturbances, inflammatory conditions, joint and limb pains, frequent infections, headaches, sleep disturbances, depression and memory problems.

Makes you wonder how much more information would be revealed by a well-designed and well-funded government study!

So don't just worry about cancer. Those doctors found that all kinds of illnesses showed a similar pattern: a higher incidence in patients with higher radiation exposure.

The American Academy of Environmental Medicine reports that studies demonstrate "significant harmful biological effects occur from non-thermal RF exposure", and these effects may include genetic damage, reproductive defects, cancer, neurological degeneration and nervous system dysfunction, immune system dysfunction, cognitive effects, protein and peptide damage, kidney damage, and developmental effects – all of which have been reported in peer-reviewed scientific literature. Further Info.

Legal Cell Tower Radiation Levels

The current legal limit for cell site radiation in the US and the UK is 1000 microwatts per square centimetre.

Other countries have set limits as low as 1 microwatt per square centimetre! Switzerland, Italy, China and others manage perfectly well with a limit of 10 microwatts per square centimetre.

Why such a huge difference? It appears that some governments are more concerned about EMF safety than others.

The truth is that no one really knows what level of cell tower radiation will prove to be safe in the long term.

But isn't that a good reason to set a low limit, not a high one?

It appears that current EMF limits in the US and UK may have been influenced more by economic and political motives than by health and safety concerns.

Cell towers safe distance

It is hard to predict how much radiation you will experience in your house or workplace.

- Radiation from a single cell tower may be different in different directions.
- Radiation is affected by the lie of the land too, and by shielding and reflections from buildings.
- And finally, the construction of your house affects its resistance to radio-frequency EMF.

It can also happen that the cell tower you are aware of in your neighbourhood is not actually the closest cell site to your house.

Cell sites are often disguised. And many units are much smaller than the old familiar towers (though not necessarily less potent), and installed in unexpected locations.

So start off by making a careful check of your area, to find all the cell sites. Then use a map to work out the distance from each cell site to your house.

If the closest cell site is more than 400 metres away, you are probably not being harmed by it – although high risk groups and electro-sensitive people may need to be more cautious.

Cell tower – Personal Protection

If you are still concerned, try to get hold of an RF (radio frequency) gauss meter designed for measuring electromagnetic radiation in the cell phone frequency (microwave) range.

Another alternative is to order an EMF survey of your property. (EM Watch conducts EMF surveys in the southern half of England.)

Be aware that in every house there are rooms (and areas within rooms) where EMF radiation is higher or lower, just as some parts of your house may be brighter or darker because of window placement.

An EMF meter, or a survey will tell you which places in your home are safe, and which are not ideal for spending lots of time in.

When you next change your job or your house, find out how far away you are going to be from the nearest cell site, and let that influence your decision. Do the same when you decide where to send your child to school.

If you are still worried about cell tower radiation – here are some things you can do

- Spend less time in rooms where you can see the tower from a window. Rooms on the far side of the house from the tower will usually have lower EMF levels.
- EMFs are cumulative. You can't control the radiation coming from the cell tower, but do what you can to reduce EMF from other sources.
- Get a radio-frequency EMF meter and measure the radiation levels in different parts of your house. (Measurement with a suitable meter is the only sure way to know how much radiation you are receiving at any particular spot.)
- Consider shielding to reduce cell tower EMF – it can be shielded with special window film, metallic mesh curtaining, EMF paint, and metal foil in the roof.

EMF Shielding Video

Shielding RF Radiation with Aluminum Screening

High EMF levels are but one source of stress to the body. If your options for reducing EMF are limited, you can help your body in other ways, for example by minimizing exposure to other kinds of pollution in your air, water and food.

Good nutrition, exercise, and plenty of quality sleep will help your body repair radiation damage.

For more suggestions see our page EMF Protection Tips.

In the long term, we need to find ways of providing cell phone services without exposing people to high levels of cell tower and cell phone radiation.

Many have Liked, Shared or Voted for this page. If you are one of them, thanks so much!

You may find these articles helpful:

- Power Lines and Sub-Stations
- EMF Protection Tips
- EMF Health Effects
- Cell Phones
- Smart Meters
- What EMF Does to You
- Measure Radio-Frequency Radiation

photos by: busyPrinting & K.Wiklund, Leszek.Leszczynski, garryknight, satguru, Ron Cogswell

Product Categories

- Cell Phone Radiation Protection
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- Radio Frequency EMF Meters
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- Microwave Oven Radiation
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- EMF Survey Services
- EMF Research Quality and Quantity
- Substation Health Risks

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GB 34,293	NG 1,521	RS 709
AU 28,937	TR 1,513	HR 660
IN 22,521	ID 1,482	NE 653
PH 14,715	FR 1,321	LT 570
MY 7,841	RU 1,305	TW 557
SG 5,989	ES 1,300	TT 529
ZA 5,551	BR 1,295	FI 527
NZ 5,273	RO 1,284	GH 518
IE 3,126	GR 1,279	OM 517
AE 3,026	TH 1,075	VN 516
IL 2,269	IT 1,065	BE 506
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HK 2,010	MX 1,017	SI 476
DE 1,827	SE 982	JM 434
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PK 1,786	BD 832	MM 401
MD 1,753	LB 793	BG 387

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BioInitiative 2012

A Rationale for Biologically-based Exposure Standards for Low-Intensity Electromagnetic Radiation

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WHAT'S NEW?

Updated Research Summaries
December 15, 2017

BioInitiative Report: Medical concerns intensify over deadly brain tumors from cell phone use/Orebro University Hospital, Sweden
November 17, 2017

Electromagnetic Fields, Pulsed Radiofrequency Radiation, and Epigenetics: How Wireless Technologies May Affect Childhood Development
May 15, 2017

Effects of Mobile Phones on Children's and Adolescents' Health: A Commentary
May 15, 2017

Comment to the FCC on Docket 16-421 on Streamlining for Small Cell (Antenna) Rollout By Relaxing the Rules for Siting
February 1, 2017

THE BIOINITIATIVE REPORT 2012

A Rationale for Biologically-based Public Exposure Standards for Electromagnetic Fields (ELF and RF)

READ THE REPORT | DOWNLOAD THE REPORT

WHO WE ARE

The BioInitiative 2012 Report has been prepared by 29 authors from ten countries, ten holding medical degrees (MDs), 21 PhDs, and three MsC, MA or MPHs. Among the authors are three former presidents of the Bioelectromagnetics Society, and five full members of BEMS.

read more →

CONCLUSIONS

Bioeffects are clearly established to occur with very low exposure levels (non-thermal levels) to electromagnetic fields and radiofrequency radiation exposures.

read more →

Reported Biological Effects

Henry Lai's Research Summaries

These are invaluable sets of abstracts (data-based to be searchable) covering the RFR scientific literature, as well as collections of scientific abstracts on oxidative effects (from both RFR and ELF), and a set specific to Electrosensitivity. New comet assay abstracts for RFR and ELF are added in 2017.

SHOW ME THE SUMMARIES

WHY WE CARE?

DO WE KNOW ENOUGH?

RF Color Charts

The RF Color Charts summarize many studies that report biological effects and adverse health effects relevant for cell towers, WI-FI, 'smart' wireless utility meters, wireless laptops, baby

COMMUNITY DEVELOPMENT SERVICES

PLANNING AND BUILDING DEPARTMENT

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NOTICE OF PUBLIC HEARING

The **County of El Dorado Planning Commission** will hold a public hearing in the Building C Hearing Room, 2850 Fairlane Court, Placerville, CA 95667 on **February 8, 2018**, at **8:30 a.m.**, to consider: **Conditional Use Permit S17-0016/AT&T CAF4** submitted by AT&T MOBILITY (Agent: Epic Wireless) to allow the construction and operation of seven separate wireless telecommunication facilities consisting of seven new monopine towers ranging in size from 120 to 160 feet, with individual ground equipment with fencing. The properties are as follows: **Site 1-Cool:** Assessor's Parcel Number 071-032-15, consisting of 25 acres, is located on the south side of Triple Seven Road, approximately 1,200 feet south of the intersection with Highway 193, in the Cool area, Supervisorial District 4; **Site 2-Newtown:** Assessor's Parcel Number 077-091-06, consisting of 4.9 acres, is located on the east side of Snows Road, approximately 365 feet east of the intersection with Clouds Rest Road, in the Newtown area, Supervisorial District 3; **Site 3-Pleasant Valley:** Assessor's Parcel Number 078-180-38, consisting of 2 acres, is located on the north side of Pleasant Valley Road, approximately 400 feet west of the intersection with Mount Aukum Road, in the Pleasant Valley Rural Center, Supervisorial District 2; **Site 4-Soapweed:** Assessor's Parcel Number 085-010-13, consisting of 10 acres, is located on the north side of Stope Road, approximately 1,200 feet north of the intersection with Dickinson Road, in the Swansboro area, Supervisorial District 4; **Site 5-Latrobe:** Assessor's Parcel Number 087-181-10, consisting of 20 acres, is located on the west side of Dragon Point Road, approximately 0.3 miles southwest of the intersection with Latrobe Road, in the Latrobe area, Supervisorial District 2; **Site 6-Zee Estates:** Assessor's Parcel Number 104-370-24, consisting of 60 acres, is located on the west side of Gate Lane, approximately 925 feet southeast of the intersection with Salmon Falls Road, in the Pilot Hill area, Supervisorial District 4; and **Site 7-Gold Hill:** Assessor's Parcel Number 105-110-81, consisting of 10 acres, is located on the south side of Gods Way, approximately 2,200 feet south of the intersection with Clark Mountain Road, in the Lotus area, Supervisorial District 4. (County Planner: Evan Mattes) (Mitigated Negative Declaration prepared)*

Staff Reports are available two weeks prior at https://eldorado.legistar.com/Calendar.aspx

All persons interested are invited to attend and be heard or to write their comments to the Planning Commission. If you challenge the application in court, you may be limited to raising only those items you or someone else raised at the public hearing described in this notice, or in written correspondence delivered to the Commission at, or prior to, the public hearing. Any written correspondence should be directed to the County of El Dorado Planning and Building Department, 2850 Fairlane Court, Placerville, CA 95667 or via e-mail: planning@edcgov.us.

*This is a notice of intent to adopt the negative declaration or mitigated negative declaration that has been prepared for this project and which may be reviewed and/or obtained in the County of El Dorado Planning and Building Department, 2850 Fairlane Court, Placerville, CA 95667, during normal business hours or online at http://edcapps.edcgov.us/Planning/ProjectInquiry.asp. A negative declaration or mitigated negative declaration is a document filed to satisfy CEQA (California Environmental Quality Act). This document states that there are no significant environmental effects resulting from the project, or that conditions have been proposed which would mitigate or reduce potential negative effects to an insignificant level. The public review period for the negative declaration or mitigated negative declaration set forth in CEQA for this project is thirty days, beginning January 6, 2018, and ending February 4, 2018 (or next business day).

To ensure delivery to the Commission prior to the hearing, written information from the public is encouraged to be submitted by Thursday the week prior to the meeting. Planning Services cannot guarantee that any FAX or mail received the day of the Commission meeting will be delivered to the Commission prior to any action.

COUNTY OF EL DORADO PLANNING COMMISSION
ROGER TROUT, Executive Secretary
January 5, 2018

Granted Patent US 5774088 A lens.org/054-672-504-803-351

Method And System For Warning Birds Of Hazards

Published: Jun 30, 1998 Family: 1 Cited: 76 Cites: 8 Non Patent Citations: 14 Info: Full text Published

US5774088A

(12) **United States Utility Patent** (10) **Patent No:** **US 5,774,088 A**

Kreithen (45) **Date of Patent:** Jun. 30, 1998

(54) **Method and system for warning birds of hazards**

(75) Inventor: **Melvin L. Kreithen, Pittsburgh, Pennsylvania (US)**

(73) Assignee: **The University of Pittsburgh,** Pittsburgh, Pennsylvania

Type: **U.S.**

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **08/852,915**

(22) Filed: **May 08, 1997**

(51) **Int. Cl.**[6] **G01S 13/93**

(52) **U.S. Cl.** **342/22**

(58) **Field of Search** 342/22; 367/139; 116/22.A

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(74) *Primary Examiner* — Ian J. Lobo
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Attorney, Agent, or Firm — Flehr Hohbach Test Albritton & Herbert LLP
Exemplary claim number — 1
Art Unit — 362

(57) **Abstract**

[00001] A hazard warning system radiates pulses of microwave energy in the frequency range of 1 GHz to about 40 GHz to alert and warn target flying birds of the presence of wind turbine electrical generators, power distribution systems, aircraft, and other protected areas from hazardous intrusion. The warning system includes a control unit governing pulse control circuitry that outputs pulses ranging from about 5 μs to about 25 μs in duration. These pulses trigger a pulsed source of microwave energy that is coupled to a microwave antenna that emanates the warning radiation. The radiation is sensed by the birds auditory system, attaining their attention to the presence of the protected area. The sensed radiation itself may cause the birds to veer from a collision course, or supplemental hazard-warning radiation including ultraviolet light and infrasound may also be employed. A proximity detector can enhance operating efficiency by steering the antenna toward a detected target. Further, the warning system can remain in a standby mode until alerted by the proximity detector to the presence of target birds, whereupon the warning system begins to output pulsed microwave energy. The pulse control circuitry may be caused to generate complex pulse trains that can preferably evoke a biologically significant response within recipient birds. The warning system operates at the speed of light, and can transmit a benign warning, transparently to humans. Not only is an area protected by the system, but the birds themselves can be protected from the area.

1 Claim, 3 Drawing Sheets, and 4 Figures

[00002] This is a continuation of application Ser. No. 08/598,093 filed Feb. 7, 1996, now abandoned which is a continuation of application Ser. No. 08/280,287 filed Jul. 26, 1994 now abandoned.

FIELD OF THE INVENTION

[00003] The present invention relates generally to systems that seek to ward off flying birds, and more specifically to systems for protecting wind turbine electrical power generators, electrical power distribution equipment., flying aircraft, and other objects from danger from flying birds.

BACKGROUND OF THE INVENTION

[00004] Flying birds can represent a safety hazard to many objects, and conversely such objects represent a hazard to the birds. Birds colliding with wind turbine electrical generators can not only damage the generators, but generally are injured or die as a result. For example, in northern California, the collision-death of eagles and other protected bird species has resulted in environmental litigation threatening to curtail operation of such generators. Further, birds colliding with high voltage power lines can break or short-circuit the lines, interrupting electrical power distribution. The resultant power outage can also cause damage to the equipment generating and distributing the high voltage. In addition, sparks from broken power lines can start fires.

[00005] Birds also present a serious danger to flying aircraft. A medium sized bird striking the windshield or engine an aircraft in flight can damage the aircraft, endangering the safety of those on board. Even modern jet aircraft are susceptible to damage from birds. Not only can they break the windshield, but birds can be sucked into the air intake of a jet engine. The resultant engine damage can require substantial maintenance to repair.

[00006] Birds that fly into skyscrapers, monuments and the like can also create serious danger. A bird flying into the window of a skyscraper may cause serious injury to persons on the ground cut by falling broken window glass. Although birds that fly into other large objects may not present as serious a hazard to humans, repairing any resultant damage can be risky and expensive.

[00007] It is known in the art to use flashing lights to try to ward birds away from an object. For example, U.S. Pat. No. 5,270,707 to Schute et al. discloses using flashing aircraft lights to ward off in-flight impact with birds. Apparently birds viewing the flashing lights may tend to change their course to avoid collision.

[00008] It is generally assumed that flying birds will not knowingly collide with an object. However, the efficiency of Schute et al.'s system is diminished unless the presence of the aircraft is indeed communicated to the birds by the lights. The birds may not be looking at the aircraft (and thus at the lights), perhaps because they are searching for food, are viewing predators including other birds. Alteratively, the lights may not be seen by the birds because visibility is diminished due to inclement weather.

[00009] It is also known to use reflector strips that are intended to deter birds in scarecrow-like fashion from a protected area such as a garden. For example, power utility companies often mount passive strips of reflecting material near high voltage towers and lines in an attempt to ward off birds. However, such passive strips are of little use during darkness or other periods of diminished visibility. Further, such passive strips do not actively communicate their presence to the birds, whose attention may in fact be directed elsewhere.

[00010] Further, because reflector strips tend to present a substantially constant stimulus pattern to the birds, whatever warning effect they initially provide soon diminishes. This effect is termed "adaptation", and is analogous to the ability of humans to disregard a continuous loud noise (or other stimulus) after hearing the noise for a few minutes.

[00011] It is also known to use audible sound waves to try to ward off impact by flying birds. However, if the environment to be protected from avian collision is noisy, the efficiency of such sound waves is diminished. Further, because acoustic waves propagate at only about 1,100 feet/second (335 m/second), any benefit they might provide can literally occur too slowly to be of use.

[00012] Unfortunately, the use of light energy or acoustic energy is conspicuous and thus not transparent to humans in the vicinity. What is meant by "not transparent" is that humans not intended to be the target of the hazard communication system can sense the object-announcing light or sound radiation, and become distracted or otherwise annoyed.

[00013] In general, active hazard warning systems, e.g., flashing lights or radiated sound waves, tend to be active at all times, even if potential danger from flying birds is not present. Such constant activation is not always desirable, especially if the lights or sound will needlessly annoy humans in the area to be protected. In addition, constant activation is undesirable because it causes adaptation, whereby the recipient birds soon pay little or no attention to the stimulus. Further, constant activation of such systems wastes operating electrical power, and shortens the working lifetime of the hazard warning system.

[00014] Thus, there is a need for a hazard communication system to alert and warn birds of the presence of an object or area with which a collision should be avoided. Such system should preferably be transparent to humans in the protected area, and should communicate its warning at the speed of light.

[00015] Further, the efficiency of the warning should not be substantially diminished by poor visibility or ambient acoustic noise, or by the target not looking at the source of the system radiation. Such system should also minimize adaption by the birds receiving the warning. Finally, such system should be capable of activation only when a target is sufficiently close to the protected region to warrant communicating the presence of the protected region to the target.

[00016] The present invention discloses such a system.

SUMMARY OF THE INVENTION

[00017] The present invention communicates the presence of a protected area to flying birds and other vertebrates by radiating pulses of microwave energy to announce the presence of such area. Applicant has discovered that 5 μs to 75 μs pulses of microwave radiation in the 1 GHz to 40 GHz range are sensed by the birds, apparently by stimulating their auditory system.

[00018] The pulsed microwave radiation attains the birds' attention in a benign manner, serving to communicate the presence of the protected area to the birds. This attention-grabbing warning is communicated to the birds at the speed of light, without regard to visibility conditions, and without regard to whether the birds happen to be looking toward the protected area.

[00019] The effect of the pulsed microwave radiation upon the birds' auditory system may itself cause the birds to veer off course, to avoid collision with the now-noticed protected area. However, collision avoidance may be further enhanced by providing supplemental hazard-warning radiation including light, ultraviolet, and/or sound, including infrasound. The efficiency of such additional warning radiation may be promoted because the birds' attention will have been attained by the present invention.

[00020] The present invention includes a control unit that governs pulse control circuitry whose output triggers a pulsed source of microwave energy in the L through K.sub.a bands. The microwave energy is coupled to a microwave antenna system that emanates the protective radiation to announce the presence of the protected area. The microwave energy preferably is radiated at average power levels in the approximate range 1 mw/cm.sup.2 to 10 mw/cm.sup.2 for considerations of environmental safety. The present invention can be used to communicate to birds the presence of diverse protected areas or objects, for example wind turbine power generators, power transmission systems, and airborne aircraft.

[00021] To minimize stimulus adaptation by the recipient birds and to promote effective communication of the warning, the pulse control circuitry preferably permits generating complex, pulse-code modulation type waveforms. Suitably complex pulse trains are believed to evoke a biologically relevant response, causing the recipient bird to be more alert to the warning.

[00022] The antenna system preferably is steerable to increase the effective range of the protected area. The present invention may include an optional proximity detector that can detect the presence of nearby targets. The output from the proximity detector may be used to steer the antenna toward the detected target, thus enhancing system operating efficiency.

[00023] Further, the proximity detector allows maintaining the present invention in a standby mode until such time as oncoming targets are detected by the proximity detector. Upon target detection, the present invention enters an active mode, and emits the microwave radiation for as long as the targets remain in proximity to the protected area. Such bimodal system operation both conserves operating power and extends the lifetime of the system. Further, such operation tends to reduce adaption by recipient birds.

[00024] Because the hazard communicating system uses microwave rather than visible light or acoustic energy, the present invention is transparent to humans not within the radiation target range of the antenna system. Further, the system remains transparent if the supplemental hazard-warning radiation is ultraviolet.

[00025] Other features and advantages of the invention will appear from the following description in which the preferred embodiments have been set forth in detail, in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[00026] FIG. 1 is a block diagram of an hazard communication system, according to the present invention;

[00027] FIG. 2 depicts protection of a wind turbine power generator with a hazard communication system, according to the present invention;

[00028] FIG. 3 depicts protection of a power transmission system with a hazard communication system, according to the present invention;

[00029] FIG. 4 depicts protection of an aircraft in flight with a hazard communication system, according to the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

[00030] FIG. 1 depicts a hazard communication system 10 as emanating a primary microwave radiation 12 that attains the attention of birds 14 (and possibly bats) within the effective range of the radiation. By thus attaining the immediate attention of the birds, the birds may be warned of the presence of a protected region, and a collision by the birds with the protected region may be avoided.

[00031] Alternatively, supplemental secondary eminators may cause the birds to veer off course, avoiding a collision. Such secondary eminators are more likely to be noticed by the birds, whose attention has been attained by the primary pulsed microwave radiation.

[00032] More specifically, the present invention 10 includes a control unit 16 that governs operation of pulse control circuitry 18, whose output triggers a pulsed source of microwave energy 20. The pulsed microwave energy is fed to a microwave antenna system 22 and radiated as primary microwave energy 12. Pulse control circuitry 18 preferably outputs fixed duration pulses having a pulse width in the range of about 5 μs to about 75 μs. For a given pulse width, the duty cycle of the pulse train is determined from the average power level of microwave energy to be provided. A narrower pulse width will have a higher duty cycle for a given level of average power than will a longer pulse width.

[00033] Optionally, a pulse modulator unit 26 is coupled to the pulse control circuitry 18. Modulator unit 26 introduces a modulated variation in the time between preferably fixed-duration pulse widths, which duration varies from about 0.001 Hz to about 10 KHz. Modulation from unit 26 can advantageously reduce adaptation in recipient birds by varying in a complex manner the patterns of output radiation 12. Further, by suitably programming unit 26, the auditory system of recipient birds 14 may be stimulated using non-thermal microwave energy 12 to evoke biologically relevant responses. For example, a complex pattern of pulsed microwave radiation 12 ideally would evoke the same response in a recipient bird 14 that the alarm call or warning shriek of another bird would evoke. However, evoking other responses could also attain the birds' attention but perhaps less effectively.

[00034] Central control unit 16 monitors and controls pulse control circuit 18, which in turn controls the pulse parameters associated with microwave energy source 20. Central control unit 16 typically will also include bi-directional communications to a remote operator site. Safety interlock 24 provides for shutdown of system 10 in case of any potential danger to service personnel or to system components.

[00035] Pulse energy source 20 preferably includes a magnetron or a cavity oscillator operating in the range of about 1.0 GHz to about 40 GHz. Applicant has found that pulsed microwave radiation the range 1.0 GHz to about 2.5 GHz is quite effective, and radiation in the approximate range 15 GHz to about 25 GHz should be similarly quite useful. This microwave energy is coupled from source 20 to antenna system 22 using coaxial cable or waveguides. Antenna system 22 includes an antenna whose direction of radiation preferably can be steered to direct the primary microwave emissions 12 toward targets 14.

[00036] Applicant has discovered that the emission of such pulsed microwave radiation is sensed by pigeons, apparently by affecting their auditory system in a non-thermal manner. Even without emitting a complex pattern of pulses, the resultant effect upon the birds is believed perhaps to be analogous to a buzzing, clicking, or popping sensation in the ears of a human.

[00037] During testing by applicant, applicant exposed pigeons to S and L band pulsed microwave radiation, using fixed pulse widths in the approximate range 5 μs to 75 μs, and more preferably approximately 5 μs to about 25 μs. In providing this microwave energy, pulse width, pulse duty cycle and repetition rate into the pulsed microwave source were controlled to limit the radiation density to less than about 1 mw/cm.sup.2 to 10 mw/cm.sup.2, an environmentally safe level.

[00038] Under laboratory conditions, the ability of such birds to sense the microwave radiation was confirmed by monitoring a standard conditioned cardiac response. Within about three seconds after exposure to this microwave radiation, pigeons having a baseline heartbeat of about 100 beats/minute were found to experience a relatively sudden increase of about 40 beats/minute, a 40% increase. The onset of the heartbeat change occurred within a second or so of the onset of exposure to the pulsed microwave radiation. In reality, the pulsed microwave radiation is sensed instantly by the pigeons, and the delay in attaining a detectable change in heart rate represents a normal response latency.

[00039] While applicant's testing was directed to pigeons, it is believed that other birds and possibly bats would also sense their exposure to the pulsed microwave radiation.

[00040] As noted, applicant's pulsed microwave energy is sensed by birds, thus attaining their attention, which may include immediate communication to the birds of the presence of the area of object to be protected. Once aware, the birds cab avoid knowingly colliding with the protected area or object. With reference to FIG. 1, after the presence an area or object protected by radiation 12 is communicated to birds 14 by the radiation, the birds should take evasive action. Such action can include veering off a collision course, preferably by flying out of the target zone that is radiated by microwave antenna system 22.

[00041] Because avian hazard communication according to the present invention uses microwave rather than visible light or acoustic energy, it is transparent to humans not within the effective radiation path of the antenna system 22. Further, microwave radiation travels at the speed of light, and thus the attention-attaining effect of radiation 12 upon targets 14 can be realized relatively instantaneously. Further, it will be appreciated that the effectiveness of the emanating microwave radiation 12 is not diminished by inclement weather, or the direction in which target 14 may be at the moment.

[00042] Optionally, system 10 includes a hazard proximity detector 28 that can include motion detectors, heat detectors, simple radar systems, and the like. The function of detector unit 28 is to detect when targets 14 have approached sufficiently close to the area protected by system 10 to constitute a potential hazard.

[00043] Until detector 28 signals a potential hazard, control unit 16 and the remainder of system 10 may remain in a standby mode. In standby mode, no radiation is emanated by antenna system 22, and system 10 consumes relatively little operating power. However, when detector 28 signals that a target 14 is nearing the protected zone, control unit 16 causes pulsed microwave source 20 to output microwave energy that is radiated by antenna system 22.

[00044] Once targets 14 have sensed pulsed microwave radiation 12, are alerted to the presence of the area protected by system 10, and have veered their course or otherwise avoided the target zone, detector 28 once again returns system 10 to the standby mode. If desired, hazard proximity detector 28 can share the microwave antenna system 22 for detecting purposes. Further, upon actually detecting a target 14, the hazard proximity detector 28 can cause antenna system 22 to be pointed more directly at target 14.

[00045] Thus, the inclusion of a hazard proximity detector 26 can enhance the operating accuracy of system 10. In addition, adaptation by target birds 14 is minimized because radiation 12 is not always present. Further, by permitting standby mode operation until the need to emanate microwave radiation is actually at hand, proximity detector 28 helps conserve system operating power, and also increases system 10 operational lifetime.

[00046] Optionally, system 10 can also emit secondary radiations. For example, secondary source unit 30 can provide control signals and voltages to secondary eminator unit 32, which may include flashing lamps used with various lenses and/or filters, acoustic loudspeakers, and the like. These secondary light and/or acoustic emanations can provide additional warning to targets 14, and are more likely to be noticed after the target birds have sensed the primary radiation 12.

[00047] One useful secondary emission is acoustic energy 34, especially energy containing frequencies in the approximate range 0.001 Hz to about 10 KHz. Applicant has discovered that the auditory system of birds is quite sensitive at infrasound frequencies. Further, the emission of infrasound frequencies, e.g., 0.001 Hz to about 10 Hz advantageously is transparent to humans.

[00048] An earlier discovery of applicant is the birds recognize ultraviolet radiation 36 in the 305 nm to 400 nm range, and especially in the approximate range 325 nm to about 375 nm. Applicant has discovered that an effective way to generate such radiation transparently to humans is to filter components from the output of a strobe-type lamp 38. More specifically, the strobe-lamp output is passed through a filter sandwich comprising a type UG-1 Schott glass layer 40, one surface of which includes a preferably vacuum-deposited anti-red blocking coating 42. (While FIG. 1 shows coating 42 facing away from lamp 38, the sandwich may be reversed so coating 42 faces toward lamp 38.) The net effect is that radiation 36 is broad bandwidth ultraviolet, with no red components that would be visible to humans. Of course, if the radiation were not required to be transparent to humans, the anti-red coating layer could be omitted. The resultant radiation 36 would be broad bandwidth ultraviolet that included red components visible to humans.

[00049] In some applications, it may in fact be possible to warn birds 14 of a hazard by using a system 10 that includes secondary eminators 32, but that omits the pulsed microwave source 20 and antenna system 32.

[00050] FIG. 2 depicts the use of system 10 to warn birds 14 of the presence of a wind turbine generator system 50. Typically generator system 50 includes a tower 52 that may be perhaps 70 m or more in height, atop which is located an electrical generator 54 that is rotated by wind-blown turbine blades 56. Because the power generating efficiency of system 50 increases with the size of the blades, blades 56 may be 30 m or more in length.

[00051] Although FIG. 2 depicts system 10 as mounted at the top of tower 52, system 10 may be disposed elsewhere. It suffices if the pulsed microwave radiation 12 emanating from the microwave antenna system 22 effectively covers the region whose presence is to be communicated to birds 14 to avoid avian impact. If desired, operating voltage for system 10 may be obtained from generator 54, which typically is coupled to an electrical grid carrying electrical power. In applications where there is no coupling to an electrical grid, the generator 54 output voltage could be supplemented by a rechargeable storage battery. This would permit powering system 10, even when the absence of wind caused generator 54 to cease generating voltage.

[00052] Birds, bats or the like 14 approaching the protected area of system 10 sense the presence of the pulsating microwave energy 12, apparently by the radiation's effect upon their auditory system. The resultant auditory effect serves to attain the attention of the birds. The microwave energy 12 itself may cause the birds to avoid flying into the protected area, perhaps to minimize the auditory effect. Alternatively, the now more attentive birds may observe the protected area of system 10, and veer off course to avoid contact.

[00053] Optionally, if secondary sources and eminators (e.g., elements 28, 30 in FIG. 1) are included, such second radiation may also alert and cause the birds to change course to avoid a collision. Eventually the birds will fly out of regions of the antenna radiation path having sufficient energy density to affect their auditory system. Once the birds have so veered, they no longer endanger the portion of system 50 being protected. Conversely, the protected region would no longer threaten the birds.

[00054] The net result is that the hazard presented to system 50 and the hazard to birds 14 from an avian collision will have been avoided. Further, this hazard warning can occur at the speed of light, independently of weather conditions, and occurs transparently to humans in an area not encompassed by the antenna radiation field. In addition, it will be appreciated that the warning is benign in that the levels of emitted microwave energy preferably are sufficiently low in density to alert but not harm the recipient target birds 14.

[00055] FIG. 3 depicts the application of system 10 to warn birds 14 as to the presence of a protected area of an electric power distribution system 60. The purpose of such warning is to prevent a collision by the birds with the protected area. System 10 may (but need not) include the secondary sources and eminators 30, 32 and the hazard proximity detector 28 described earlier.

[00056] In FIG. 3, system 60 includes a utility tower 62 that carries various high voltage conductors 64, a transformer and/or other equipment 66. Of course, system 60 may include other components as well, or as alternatives to what is shown in FIG. 3. Although system 10 is depicted as mounted atop tower 62, system 10 may be disposed elsewhere providing that radiation 12 emanating from the microwave antenna system 22 covers the region whose presence is to be communicated to birds 14, to avoid avian impact. Those skilled in the relevant art will appreciate that operating voltage for system 10 may be obtained by stepping-down voltages present in lines 64.

[00057] Although FIG. 3 shows system 10 as protecting a power distribution system 60, tower 62 could in fact represent some other object whose presence is to be communicated to oncoming avians. As such, protected object 62 could represent a skyscraper, a tall monument, among other objects.

[00058] Again, flying birds or bats 14 will be warned of the presence of the protected portion of system 60 by the pulsed microwave energy 12 and/or secondary eminators 32. As was described with respect to FIG. 2, the likelihood of avian contact is reduced in a benign manner, preferably transparently to humans in the area.

[00059] FIG. 4 shows another application of the present invention 10, whose components are mounted within an aircraft 70. In flight, system 10 emanates pulsed microwave radiation 12 that is intended to attain the attention of birds and the like 14 to the aircraft, whereupon the birds will veer off course. Possibly system 10 can share existing microwave antenna and other system facilities already present in aircraft 70. Alteratively, system 10 can include its own microwave antenna system 22 as shown in FIG. 1. It is understood that FIG. 4, like FIGS. 2 and 3, is not drawn to scale.

[00060] In military aircraft applications, the use of a hazard proximity detector 28 may advantageously permit aircraft 70 to fly over terrain without needlessly emanating radiation 12 until actually required to warn and/or deter targets 14. In this fashion, the presence of aircraft 70 is less likely to be detected by hostile aircraft or ground forces monitoring for pulsed microwave radiation frequencies in the 1.0 GHz to 40 GHz range.

[00061] Normally, system 10 emits a benign density of radiation 12 that complies with environmental safety standards. In contrast to such benign use, for an aircraft protection system such as shown in FIG. 4, it may be feasible to use substantially larger magnitudes of pulsed microwave radiation that intentionally damages one or more organs in the birds. Such damage may in fact impair the birds' ability to orient themselves and to continue flying. In this fashion, the safety of aircraft 70 and all on board could be ensured.

[00062] Other features and advantages of the invention will appear from the following description in which the preferred embodiments have been set forth in detail, in conjunction with the accompanying drawings. For example, although the preferred embodiments use fixed-width pulses, those skilled in the art will recognize that pulses of variable width may be used as well. Modifications and variations may be made to the disclosed embodiments without departing from the subject and spirit of the invention as defined by the following claims.

(57) **What is claimed is:**

1. A method for benignly communicating the presence of an object to a flying vertebrate, the method comprising the following steps:

propagating a region at least partially surrounding said object with pulses of microwave energy having an average power level of about 1 mw/cm.sup.2, wherein said pulses of microwave energy are selected to elicit a warning signal within said flying vertebrate's auditory system without physically harming said flying vertebrate.

* * * * *

The Truth.

Who Protects us from these Hazards?

No one. Just like the tobacco industry of the 1950s, Big Telecom has bought the science and influenced our government. With billions of dollars at stake, the wireless industry protects their profits rather than our health. "Only 25% of studies funded by the wireless industry show some type of biological effect from microwave radiation, while among independently funded studies, 75% show a bioeffect." — *Henry Lai, PhD, Department of Bioengineering, University of Washington*

What Are The Health Risks?

In addition to cancer, RF health impacts include headaches, sleep disruption, ringing in the ears, heart rhythm disturbances, dizziness, nausea, skin rashes, loss of concentration, memory and learning problems, depression, immune system suppression, and DNA damage. "There is now sufficient scientific data about the biological effects of EMF, in particular about radiofrequency (RF) radiation to argue for precautionary measures. We can state unequivocally that EMF can cause single and double strand DNA breakage at exposure levels that are considered safe under the FCC guidelines in the USA." — *Martin Blank, PhD, Columbia University Professor of Physiology and Cellular Biophysics.*

"We have seen clinical evidence that electropollution affects the normal functioning of the electrically sensitive heart, including the rate and rhythm, and other systems of the body." — *Stephen Sinatra, MD, Cardiologist, Fellow in the American College of Cardiology and founder of Heart MD Institute.*

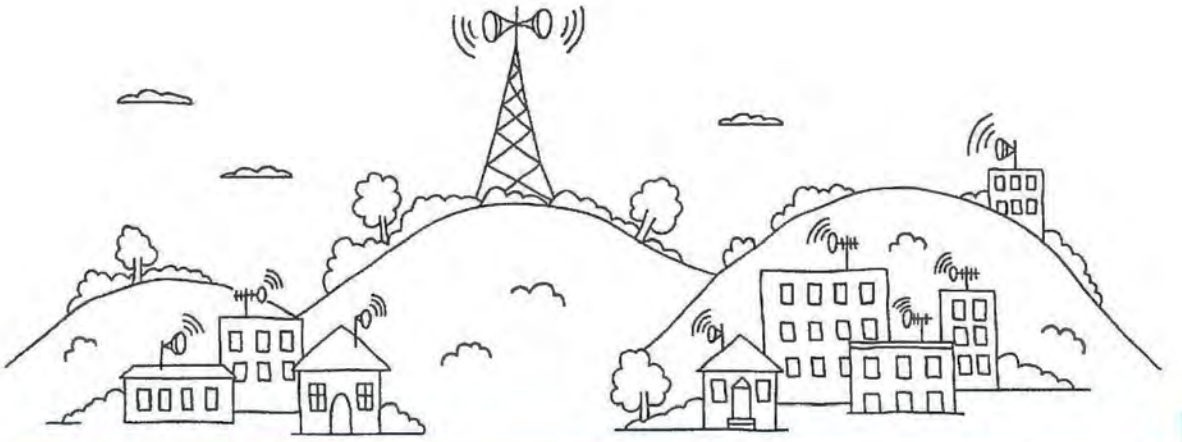
The Truth About Cell Towers

"I have no doubt in my mind that at the present time, the greatest polluting element in the earth;s environment is the proliferation of electromagnetic fields."

— Dr. Robert O. Becker, two-time nominee for the Nobel Prize and author of Cross

Should We Be Concerned?

The World Health Organization's International Association for Research on Cancer has classified radiofrequency electromagnetic fields (RF or wireless) as a carcinogen, in the same category as lead, DDT and asbestos. Studies indicate serious risk to public and environmental health within 1,000 feet of a cell tower. There are no safety studies specific to 4G antennas, but their frequencies and power levels are known to better penetrate buildings and affect biological systems more adversely than existing technology.



Outdated Radiation Standards

The Interior Department accused the Federal government of employing outdated radiation standards set by the Federal Communications Commission (FCC), a federal agency with no expertise in health. "The electromagnetic radiation standards used by the Federal Communications Commission (FCC) continue to be based on thermal heating, a criterion now nearly 30 years out of date and inapplicable today."

- "There is a growing level of anecdotal evidence linking effects of non-thermal, non-ionizing electromagnetic radiation from communication towers on nesting and roosting wild birds and other wildlife in the U.S.
- Study results have documented nest and site abandonment, plumage deterioration, locomotion problems, reduced survivorship, and death (e.g., Balmori 2005, Balmori and Hallberg 2007, and Everaert and Bauwens 2007).
- Nesting migratory birds and their offspring have apparently been affected by the radiation from cellular phone towers in the 900 and 1800 MHz frequency ranges- 915 MHz is the standard cellular phone frequency used in the United Stateshttp://www.saferemr.com/2014/03/dept-of-interior-attacks-fcc-regarding.html
- Microwave and radiofrequency pollution constitutes a potential cause for the decline of animal populations and deterioration of health of plants living near phone masts." *— Alfonso Balmori, Electromagnetic Biology and Medicine (2005; 24:109–119)*

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Expert Studies - (page 1 of 6)

There is a wealth of data and studies which evidence the adverse health impacts of prolonged exposure to RF emissions, such as those which emanate from Cell Towers. One recurring conclusion reached by the scientists who have conducted such studies, is that there is causal link between RF emissions and cancer, and more specifically, leukemia in children.

In a 2004 German study entitled "The Influence of Being Physically Near to a Cell Phone Transmission Mast on the Incidence of Cancer," the authors provided a summary of several previous, and well known studies, as follows:

"A series of studies available before this investigation provided strong evidence of health risks and increased cancer risks associated with physical proximity to radio transmission masts. . . . In many studies an increased risk of developing leukemia has been found; in children living near transmitter antennas for Radio and Television in Hawaii; increased cancer cases and general mortality in the area of Radio and Television transmitters in Australia; and in England, 9 times more leukemia cases were diagnosed in people who live in a nearby area to transmitter antennas. In a second study, concentrating on 20 transmitters in England, a significant increase in Leukemia was found. The Cherry Study indicates an association between an increase in cancer and living in proximity to a transmitter station. According to a study of the transmitter station of Radio Vatican, there were 2.2 times more leukemia cases in children within a radius of 6km, and adult mortality from leukemia also increased."

The German Study of 2004

"The Influence of Being Physically Near to a Cell Phone Transmission Mast on the Incidence of Cancer."

Ten year study conducted from 1994-2004, revealed that living within 400 meters of a Cell Tower increased the risk of developing cancer by three hundred (300%) percent.

Authors: Horst Eger, Klaus Uwe Hagen, Birgitt Lucas, Peter Vogel, Helmut Voit

The Israeli Study of 2004

"Increased Incidence of Cancer Near a a Cell-Phone Transmitter Station (a Cell Tower)."

Study indicated an association between increased incidence of cancer and living in proximity to a Cell Tower. Those living near a Cell Tower are 4.15 times more likely to develop cancer.

Authors: Ronni Wolf MD, Danny Wolf MD

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Expert Studies - (page 2 of 6)

In addition to the German and Israeli sudies of 2004, there are literally hundreds of studies and reports which evidence the adverse health impacts of RF emissions and EMFs. The following is a sampling of various reports, expert studies, abstracts, and short videos of expert presentations.

"Health Effects from Cell Phone Tower Radiation"

By Karen J. Rodgers Read Report

An excellent introduction, in plain english, to (1) the well-established health risks associated with Cell Towers, (2) how the wireless industry has manipulated the U.S. government into stripping citizens' rights to challenge the installation of Cell Towers based upon health concerns, and (3) how, to the delight of the wireless industry, the FCC has deemed "safe" levels of RF emissions to be 5,000 times higher than the levels deemed safe by other countries.

The United States Study 2010

"Biological Effects from exposure to electromagnetic radiation emitted by cell tower base stations and other antenna arrays"

Read Study

"It makes little sense to keep denying health symptoms that are being reported in good faith. Many biological effects have been documented at very low intensities comparable to what the population experiences within 200 to 500 ft of a cell tower."

"Effects reported include: genetic, growth, and reproductive; increases in permeability of the blood–brain barrier; behavioral; molecular, cellular, and metabolic; and increases in cancer risk."

B. Blake Levitt, Henry Lai, Dept of Bioengineering, University of Washington

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Expert Studies - (page 3 of 6)

With the wireless industry having spent over $400 million dollars in political contributions and lobbying in Washington, it comes as no surprise that the U.S. has done little, if anything, to research the potential adverse health impacts of RF emissions. As a result, all emerging information regarding the adverse health impacts of RF emissions is being generated through expert studies being conducted in countries other than the U.S.

The Poland Military Study 1996

"Cancer morbidity in subjects occupationally exposed to high frequency (radiofrequency and microwave) electromagnetic radiation."

The Military Center for Radiation Safety studied the cancer death rates for all career military personal (approx 128,000 persons each year), for the 14 year period of 1971-1985. The study revealed that persons occupationally exposed to RF emissions were nearly twice as likely to develop brain tumors, 13.9 times more likely to develop chronic myeocylic leukemia, 8.62 times more likely to develop acute myeoblastic leukemia and 5.82 times more likely to develop non-hodgkin lymphomas.

Department of Biological Effect of Non-Ionizing Radiations, Center for Radiobiology and Radiation Safety at the Military Institute of Hygiene and Epidemiology, Warsaw, Poland

The Australia Study 1996

Cancer inidence and mortality and proximity to RF emissions from TV Towers

18 year study of residents of 9 municipalities, from 1972-1990, revealed increased rates of childhood leukemia and death for children subjected to RF emissions from TV antennas.
Bruce Hocking, Ian Gordon, Heather L. Grain and Gifford E. Hatfield

The Australia Study 2003

"Decreased Rate of Survival for Childhood Leukemia
in Proximity to Television Towers"

Study reflected that the survival rates of children with leukemia increasingly dropped, the closer they lived to an RF emitting TV antenna.

Bruce Hocking, Ian Gordon, Archives of Environmental Health, September 2003

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Expert Studies - (page 4 of 6)

Based upon the results of expert studies worldwide, other countries have determined that the maximum safe limits for RF radiation is as much as 5,000 times lower than the level permitted by the FCC.

Report of Canadian Board of Health - outcome of The International Conference of Cell Tower Siting, Linking Science and Health

Read Report

After meeting with 300 public health officals from around the world to discuss the potential adverse impacts of RF emissions from Cell Towers, the Canadian Medical Officer of Health issued a report recommending that Canada reduce the permissable limit for Cell Tower RF emissions to 0.001 w/m2 - a level 5,800 times lower than what the FCC permits in the United States.

The Belgium Study 2008

"Genetic Damage in Subjects Exposed to Radiofrequency radiation"

Highly technical examination of 16 expert cytogenic monitoring studies performed around the world. Confirmed that 13 of the 16 independant studies performed worldwide evidence that RF exposed individuals suffered genetic damage."A significant increase in chromosome breaks . . . was reported in all individuals."

Luc Verschaeve, Scientific Institute of Public Health, Brussels, Belgium

The India Study 2009

"Biological Effects of Cell Tower Radiation on the Human Body"

Radiation from Cell Towers has been associated with an increase of brain tumors due to damage in the blood brain barrier. Where Cell Antennas are mounted on rooftops, the distance to the top floor is short so the radiation levels in the top 2 floors remains very high.

Neha Kumar, Prof. Girish Kumar, Electrical Engineering Department, ITT Bombay

News Report July 9, 2010

8 out of 10 Studies Found Cancer Risk From Cell Tower Proximity

Read News Report

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Expert Studies - (page 5 of 6)

Below is a series of highly informative short videos which address five aspects of Cell Phone Tower Radiation. Parts 2 and 3 are particularly informative.

Cell Phone Tower Radiation Pollution Part 1	Watch Video - 10:43	Section 704 of the Telecommunications Act of 1996 was written by lobbyists for the telecom industry, to strip homeowners and local zoning commissions of the ability to protect the health safety and welfare of the community. Blake Levitt
Cell Phone Tower Radiation Pollution Part 2	Watch Video - 9:19	How the FCC is Not Protecting School Children from the Constant Bombardment of RF Emissions from Cell Towers. Whitney Semour Jr.
Cell Phone Tower Radiation Pollution Part 3	Watch Video - 10:45	How the RF Emission Safety Standards in the U.S. are "Unrelated" to the Actual Dangers of RF Emissions, Especially With Regard to Causing Leukemia in Children. Martin Blank Phd
Cell Phone Tower Radiation Pollution Part 4	Watch Video - 6:14	How Countries, other than the United States, have deemed the Maximum Safe RF Emissions to be 100 times lower than the standard adpoted by the FCC. DebCarney
Cell Phone Tower Radiation Pollution Part 5	Watch Video - 2:32	The Impacts of Cell Towers on Wildlife

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Expert Studies - (page 6 of 6)

It must be noted that the expert studies described herein are nothing more than a sampling of the evidence compiled by experts around the world. For a more comprehensive listing, or to learn about specific illnesses caused by RF emissions or EMFs, See the Marin Project below, which contains a list of 600 specific studies.

The French Study 2002

"Study of the health of people living in the vicinity of mobile phone base stations" (Cell Towers)

Study examined adverse health impacts of people living in close proximity to Cell Towers and any disparity of such impact on females as compared to males. Based upon adverse affects reported, conclusion was that Cell Towers should not be constructed less than 300 meters from populations.

R. Santini, P. Santini, J.M. Danze, P. Le Ruz, M. Seige - Institute national des sciences appliquees - laboratoire de biochimie-pharmacologie

The California Study 2002

"Executive Study of The California EMF Risk Evaluation for Policymakers and The Public"

Three scientists who work for the California Department of Health Services were directed to study whether EMF's were associated with health problems. The three scientists unanimously concluded that the likelihood of a casual relationship between EMFs and childhood leukemia is ninety five (95%) percent.

The Swedish Study 2007

"Cognitive Impairment in Rats After Long Term Exposure to GSM-900 Mobile Phone Radiation"

Five scientists from the Rausing Laboratory and University Hospital conducted a study within which they determined that rats exposed to RF emissions for 55 weeks suffered "impaired memory functions." Henrietta Nittby, Gustav Grafstrom, Dong Ping Tian, Lars Malmgren, Arne Brun, Bertil R.R. Persson, Leif G. Salford, Jacob Eberhardt

"The Marin Project"

The Marin Project List of Studies

The Marin Project lists six (600) hundred studies which link low level RF/MW radiation and EMF's with cancer and other adverse health impacts.

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Electromagnetic Radiation Safety

Scientific and policy developments regarding the health effects of electromagnetic radiation exposure cell phones, cell towers, Wi-Fi, Smart Meters, and other wireless technology

Wednesday, October 25, 2017

Scientists and Doctors Demand Moratorium on 5G

The European Commission responds with denial and empty promises to scientists and doctors demanding a moratorium on 5G.

On October 12, the European Commission (EC) issued its **response** to a September 13 **declaration** that demands a moratorium on planned 5G expansion, the fifth generation of mobile communication technology. To date, the declaration has been signed by over 180 scientists and doctors from 35 nations.

The Commission's response contradicts the basic assertion of the declaration. The EC claims that current limits on electromagnetic field (EMF) exposure established by the International Commission on Non-Ionizing Radiation Protection (ICNIRP) are adequate to protect the population, and that these limits apply to the frequencies to be deployed for 5G.

Signers of the declaration argue that these limits were designed to protect the population from the effects of heating attributable to brief EMF exposures but were not intended to protect people from chronic exposure to low intensity EMF.

The declaration cites language from the 2015 **International EMF Scientist Appeal** which has now been signed by more than 230 scientists who have published peer-reviewed research on EMF and biology or health. Prior to the current controversy about 5G, these experts reported "serious concerns" regarding the ubiquitous and increasing exposure to EMF. Their appeal refers to numerous scientific publications which have shown that EMF "affects living organisms **at levels well below most international and national guidelines.**" These effects include increased cancer risk, neurological disorders, and reproductive harm. The Appeal calls for the strengthening of EMF guidelines and regulatory standards.

In addition, the September declaration cites the International Agency for Research on Cancer's classification of radio frequency radiation as "possibly carcinogenic" in 2011; recommendations of the 2015 Brussels Congress on multiple chemical sensitivity and electromagnetic hypersensitivity; results from the U.S. National Toxicology Program study in 2016 finding cell phone radiation causes DNA damage and cancer in rats; and the Europa EM-EMF 2016 Guideline that long-term EMF exposure is a risk factor for chronic disease and infertility.

The declaration for a 5G moratorium argues that ...

> "current ICNIRP 'safety guidelines' are obsolete. All proofs of harm mentioned above arise although the radiation is below the ICNIRP safety guidelines. Therefore new safety standards are necessary. The reason for the misleading guidelines is that conflict of interest of ICNIRP members due to their relationships with telecommunications or electric companies undermine the impartiality that should govern the regulation of Public Exposure Standards for non-ionizing radiation...."

The EC claims that it "is not aware of any conflicts of interests of members of international bodies such as ICNIRP...."

The EC maintains that "Digital technologies and mobile communication technologies, including high speed internet, will be the backbone of Europe's future economy."

The EC letter acknowledges that citizens deserve appropriate protection against EMF from wireless devices, and concludes with the following empty promise,

> "Please be assured that the Commission will pursue scrutiny of the independent scientific evidence available to ensure the highest health protection of our citizens."

The EC response letter was sent electronically to the authors of the declaration, Professors Rainer Nyberg and Lennart Hardell. The letter was signed by John F. Ryan, the director of public health, country knowledge, crisis management in the EC Directorate—General Health and Food Safety.

September 13, 2017

Increased radiation from cell towers poses potential risks, say scientists from around the world.

(Örebro, Sweden) Over 180 scientists and doctors from 35 countries sent a **declaration** to officials of the European Commission today demanding a moratorium on the increase of cell antennas for planned 5G expansion. Concerns over health effects from higher radiation exposure include potential neurological impacts, infertility, and cancer.

"The wireless industry is trying to deploy technology that may have some very real unintended harmful consequences," explains one of the organizers of the letter, **Lennart Hardell, MD, PhD**, Associate Professor, Department of Oncology, Faculty of Medicine and Health, Örebro University, Örebro, Sweden. "Scientific studies from years ago along with many new studies are consistently identifying harmful human health impacts when wireless products are tested properly using conditions that reflect actual exposures. With hazards at those exposures, we are very concerned that the added exposure to 5G radiation could result in tragic, irreversible harm."

Joel M. Moskowitz, Ph.D.
Director
Center for Family and Community He
School of Public Health
University of California, Berkeley

Electromagnetic Radiation Safety

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- Cell phone cancer risk: Spin vs. Fact
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5G expansion, which is designed to carry higher loads of data more rapidly through wireless transmission, will require the construction of cell towers every 10-20 houses in urban areas.

In their letter to the European Commission, the scientists write:

> "We, the undersigned, more than 180 scientists and doctors from 35 nations, recommend a moratorium on the roll-out of the fifth generation, 5G, for telecommunication until potential hazards for human health and the environment have been fully investigated by scientists independent from industry."

University of California, Berkeley public health researcher **Joel Moskowitz, PhD,** explains:

> "Peer-reviewed research has documented industry influence on studies of the health impacts of wireless radiation. We are insisting on a moratorium on 5G until non-industry research can be conducted to ensure the safety of the public."

Moskowitz is one of the advisors to an earlier effort, the **International EMF Scientist Appeal**, a petition submitted to the United Nations and World Health Organization in 2015. The Appeal has now been signed by more than 230 scientists from 41 nations—all have published peer-reviewed research on the biologic or health effects of electromagnetic fields (EMF).

Since the Appeal was published, the world's largest $25 million study, conducted by the **National Toxicology Program** in the US, shows statistically significant increases in the incidence of brain and heart cancer in animals exposed to cellphone radiation at levels below international guidelines. This supports human studies on cellphone radiation and brain tumour risk, as demonstrated in **many peer-reviewed scientific studies.**

The Appeal and this week's declaration identify health concerns from exposure to radiofrequency radiation including ...

> " ... increased cancer risk, cellular stress, increase in harmful free radicals, genetic damages, structural and functional changes of the reproductive system, learning and memory deficits, neurological disorders, and negative impacts on general well-being in humans. Damage goes well beyond the human race, as there is growing evidence of harmful effects to both plant and animal life."

Roll-out of 5G in the US

In the US, the wireless industry is promoting legislation in at least 20 states to facilitate the roll-out of 5G in addition to sponsoring legislation at the federal level.

In California, city and county governments are opposing **SB 649**,an industry-sponsored bill which overrides local control over the wireless industry's access to utility poles and public buildings for 5G deployment. Environmental health advocates fear that exposure to the added radiation from 5G infrastructure will contribute to increased health problems.

"If this bill passes, many people will suffer greatly, and needlessly, as a direct result. This sounds like hyperbole. It is not." according to **Beatrice Golomb, MD, PhD**, Professor of Medicine in the medical school at the University of California, San Diego. In her **open letter** which summarizes the research on the effects of radio frequency radiation, she concludes, "Let our focus be on safer, wired and well shielded technology – not more wireless."

The declaration and list of signatories can be found here:
http://bit.ly/5Gappeal170913a

Media Inquiries:

Finland: Rainer Nyberg, EdD
Sweden: Lennart Hardell, MD, PhD
UK: Alasdair Philips, BSc, DAgE, MIEEE
USA: Joel Moskowitz, PhD
USA: Beatrice Golomb, MD, PhD

Related Posts:

International EMF Scientist Appeal - also see https://emfscientist.org/
5G Wireless Technology: Is 5G Harmful to Our Health?
5G Wireless Technology: Millimeter Wave Health Effects
Cell Tower Health Effects
Electromagnetic Hypersensitivity (EHS)
5G Wireless Technology: Major newspaper editorials oppose "small cell" antenna bills

Industry-funded Scientists Undermine Cell Phone Radiation Science
Government Failure to Address Wireless Radiation Risks
FCC Open Letter: Moratorium on New Commercial Applications of RF Radiation
An Exposé of the FCC: An Agency Captured by the Industries it Regulates
WHO Radiofrequency Radiation Policy

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Labels: 5G, 5G moratorium, 5th generation, appeal, declaration, EU, Golomb, Hardell, Orebro, roll-out, SB 649, scientist declaration, small cell

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TABLE 3.

Results of bibliographical revision

COUNTY	YEAR	NUMBER OF COUPLES	TOTAL PRODUCTIVITY	PARTIAL PRODUCTIVITY	NUMBER OF UNSUCCESSFUL COUPLES (%)	REFERENCES
Palencia	1984	110	1,51	2,26	24,5	Lázaro *et al.*, 1986
Soria	1984	61	1,6	2	1,6	Lázaro *et al.*, 1987
Segovia	1984	246	1,01	2,06	45,9	Lázaro *et al.*, 1988
Ávila	1984	188	0,97	1,81	42	Lázaro *et al.*, 1989
Burgos	1984	77	1,39	2,04	27,2	Lázaro *et al.*, 1990
León	1984	397	1,44	1,99	23,9	Lázaro *et al.*, 1991
Salamanca	1984	591	1,68	2,03	11,1	Lázaro *et al.*, 1992
Zamora	1984	260	0,96	2,14	16,5	Lázaro *et al.*, 1993
Ávila (Valle del Tietar)	1985	78	2,69	3,04	8,97	Muñoz *et al.* 1988
Ávila (Valle del Tietar)	1986	71	2,17	2,62	14,08	Muñoz *et al.* 1988
Ávila	1986	151	2,22		18,5	Hernández, 1987
Zamora	1986	201		2,32		Ocellum durii, 1986
Ávila	1989	150	1,77	2,46		Hernández, 1989
León	1990	509	2,56	2,75	6	Urz, 1990
Palencia	1991	205	1,85	2,5		Gepopn, 1991
SPAIN	1984	6753	1,39	2,12	16,6	Lázaro *et al.*, 1986
SPAIN	1994	16643	1,6	2,5	7,9	Martí *et al.*, 1999
Valladolid (provincial)	1984	113	1,69	2,13	7	Lázaro *et al.*, 1986
Valladolid (provincial)	1992	115		1,93	5,2	Alauda, 1992
Valladolid (capital)	1994	24	1,84		7,6	Alauda, 1994
Valladolid (capital)	2001	35		2,43		García, 2001
VALLADOLID	2003 (<200 m.)	30	0,83	1,44	40	THIS STUDY
VALLADOLID	2003 (>300 m.)	30	1,6	1,65	3,3	THIS STUDY

TABLE 2.- *Results of monitoring of breeding white stork (Ciconia ciconia) at four building/ monuments in Valladolid. Spring of 2003. (See also Fig. 1)*

MONUMENT	NEST	FINISH NEST: NOT FINISH NEST	FINISH NEST: COUPLES WITHOUT CHICKS	FINISH NEST: COUPLES WITH CHICKS	NUMBER OF CHICKS	PHONE MASTS NEAR
SAN PABLO	A	0	4	3	1, 3, 1, 0, 0, 0, 0	1,2,4,5
	B	3	0	0	_	1,2,4,5
SAN MARTÍN	C	0	4	0	0,0,0,0	1,2,4,5,6
ANGUSTIAS	D	0	0	1	2	2,3,6
	E	0	1	0	0	2,3,6
CATEDRAL	F	1	1	2	1,1,0	3,6
	G	1	1	3	1,1,1, 0	3,6
TOTAL		**5 (20%)**	**11 (44%)**	**9 (36%)**	**12 (0,6 chicks/nest)**	

Table 1: Municipalities studied and number of white stork nests in each one

Distance to the more next phone masts			
< 200 meters		> 300 meters	
Boecillo	7	Tordesillas	6
Laguna de Duero	1	Serrada	4
Pesquera de Duero	1	Villanueva de Duero	1
Villanubla	1	Viana de Cega	1
San Pablo (VA)	7	San Bernardo	1
San Martín (VA)	4	Esguevillas de Esgueva	1
Angustias (VA)	2	Villanueva de los Infantes	1
Catedral (VA)	7	Pozaldez	1
		Iscar	1
		Megeces	1
		Dueñas	2
		Cigales	1
		Mucientes	1
		Fuensaldaña	1
		Puenteduero	1
		Simancas	1
		Geria	1
		Villavieja del Cerro	1
		Mota del Marqués	1
		San Cebrián de Mazote	1
		Torrelobatón	1

FIG.2

Comparison of the total productivity (breeding success or nº of chickens for nest) of white stork (Ciconia ciconia) in 30 nests located nearer than 200 meters and 30 located far away than 300 meters of the phone masts.

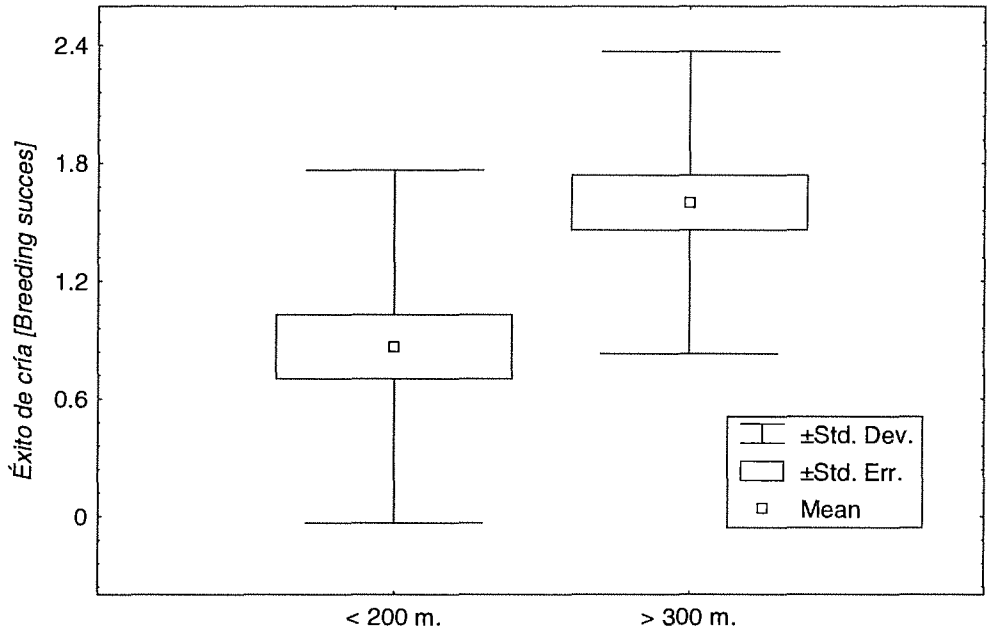
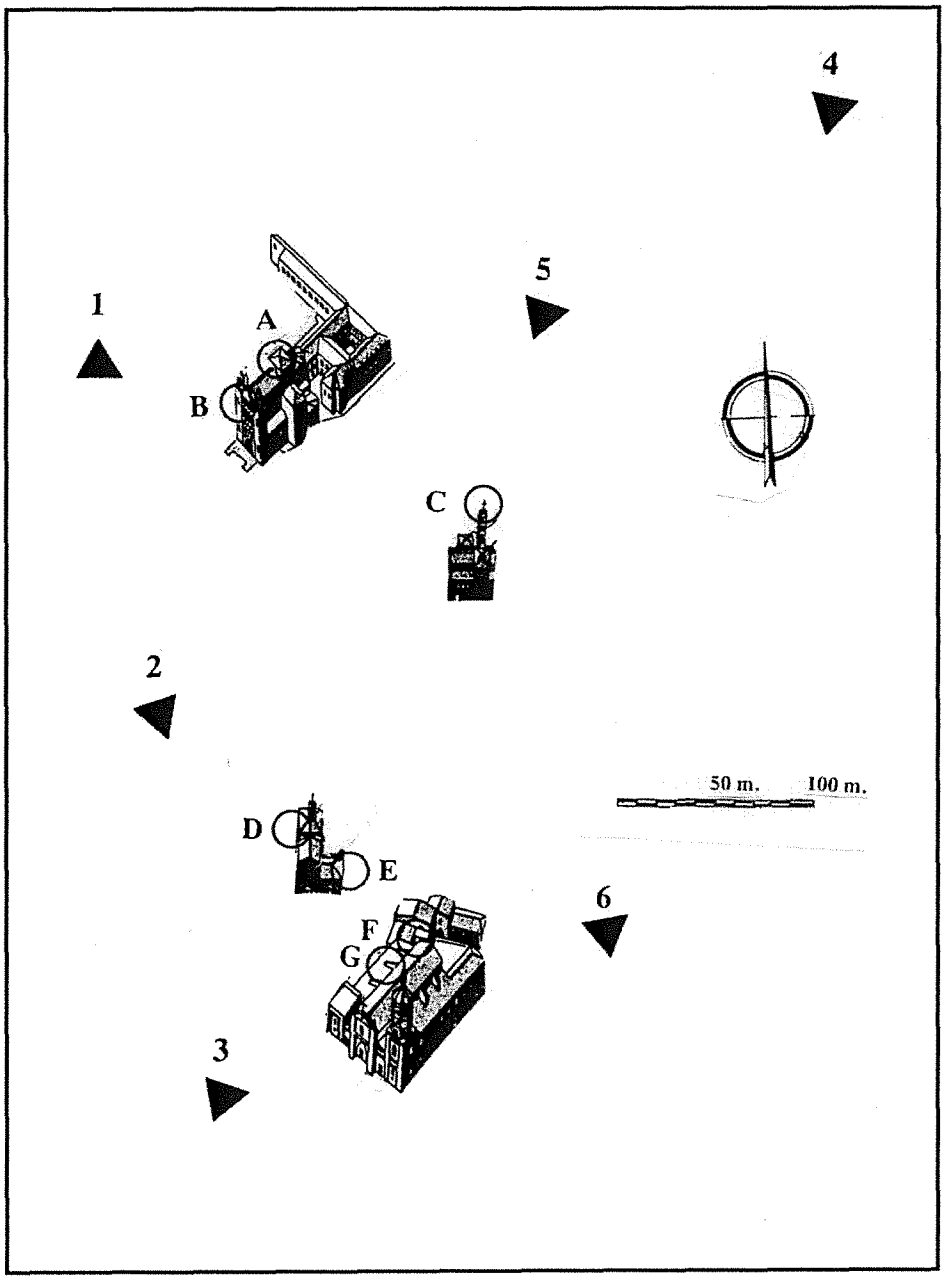


FIG. 1

Sketch with the situation of the building monuments that have been studied.It is also represented the nests or colonies of White Storks (with capital letters) and the phone masts (black triangles with numbers) nearers to the same ones. The vertexes of the triangles point out the approximate direction of main lobe (beam)



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SANTINI, R., SANTINI, P., LE RUZ, P., DANZE, J.M., SEIGNE, M. 2003. Survey Study of People Living in the Vicinity of Cellular Phone Base. *Electromagnetic Biology and Medicine*, 22: 41-49.

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YOUBICIER-SIMO, BJ.,BASTIDE, M. 1999. Pathological effects induced by embryonic and postnatal exposure to EMFs radiation by cellular mobile phones. *Radiat Protect*, 1: 218-223.

PubMed ▼ 2879671[uid]

Format: Abstract

Comp Biochem Physiol A Comp Physiol. 1986;85(4):679-87.

Response of Japanese quail to hemorrhagic stress after exposure to microwave radiation during embryogeny.

Gildersleeve RP, Galvin MJ, McRee DI, Thaxton JP.

Abstract

Coturnix coturnix japonica eggs were exposed to 2.45 GHz continuous wave microwave radiation at an incident power density of 5 mW/cm2 (SAR = 4 mW/g) during the first 12 days of embryogeny. After hatching, hematologic changes in response to an acute hemorrhage were measured in exposed and nonexposed (control) juveniles and adults of both sexes. Reticulocyte numbers and percentages were depressed below control numbers at 24 hr postphlebotomy in exposed adult females. Lymphocyte numbers were depressed below control levels at 24 hr postphlebotomy in exposed juvenile and adult males. At 72 hr heterophil numbers were depressed in exposed juvenile and adult males. These data suggest that microwave irradiation during embryogeny affects the ability of Japanese quail to recover from an acute and voluminous hemorrhage and that these radiation effects are small.

PMID: 2879671

[Indexed for MEDLINE]

Publication type, MeSH terms, Grant support

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Format: Abstract

Comp Biochem Physiol A Comp Physiol. 1988;89(4):531-4.

Serum enzymes in hemorrhaged Japanese quail after microwave irradiation during embryogeny.

Gildersleeve RP[1], Bryan TE, Galvin MJ, McRee DI, Thaxton JP.

Author information

Abstract

1. Japanese quail eggs were exposed to 2.45 GHz continuous wave microwave radiation at an incident power density of 5 mW/cm2 and a specific absorption rate of 4.03 mW/g during the first 12 days of embryogeny. 2. After hatching, serum biochemical changes in response to hemorrhagic stress were measured following a hemorrhage of 30% of the calculated total blood volume. 3. Lactate dehydrogenase, beta-glucuronidase, acid phosphatase, glucose and protein were not affected by microwave irradiation during embryogeny either before or after hemorrhage. 4. Microwave irradiation in ovo affected the response of serum glutamic oxaloacetic transaminase activity to hemorrhagic stress in Japanese quail.

PMID: 2899471

[Indexed for MEDLINE]

Publication type, MeSH terms, Substances, Grant support

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Format: Abstract

Bioelectromagnetics. 1981;2(3):269-78.

Humoral and cell-mediated immune function in adult Japanese Quail following exposure to 2.45-GHz microwave radiation during embryogeny.

Galvin MJ, McRee DI, Hall CA, Thaxton JP, Parkhurst CR.

Abstract

Japanese quail, Coturnix coturnix japonica, eggs were subjected to 2.45-GHz CW microwave radiation at 5 mW/cm2 (SAR = 4.03 mW/g) during the first 12 days of embryogeny. Following hatching the exposed embryos, as well as nonexposed controls, were reared to 22 weeks of age. Humoral immune potential, as indicated by comparable anti-CRBC antibody, IgM and IgG, levels at 0, 4, and 7 days postimmunization in both exposed and control quail was not affected significantly. However, cell-mediated immune potential, measured by the reaction to intradermal injection of phytohemagglutinin-P in the wing web, was reduced in the exposed females, but not in the exposed males. Additionally, total leukocyte numbers and absolute circulating numbers of lymphocytes, monocytes, and heterophils were increased significantly only in the exposed females. These data show that exposure of Japanese quail during embryogenesis reduced cell mediated immune potential and induced a general leukocytosis in females.

PMID: 7306223

[Indexed for MEDLINE]

MeSH terms, Substances

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Format: Abstract

J Toxicol Environ Health A. 2000 Apr 28;59(8):597-603.

Behavior of free-ranging and captive American kestrels under electromagnetic fields.

Fernie KJ[1], Leonard NJ, Bird DM.

Author information

Abstract

Wild birds, particularly raptors, commonly use electrical transmission structures for nesting, perching, hunting, and roosting. Consequently, birds are exposed to electromagnetic fields (EMFs). The amount of time that wild reproducing American kestrels (Falco sparverius) were exposed to EMFs was determined, and the effects of EMFs on the behavior of captive reproducing kestrels were examined. Wild kestrels were exposed to EMFs for 25% to 75% of the observed time. On a 24-h basis, estimated EMF exposure of wild kestrels ranged from 71% during courtship, to 90% during incubation, similar to that experienced by captive kestrels (88% of a 24-h period). Additionally, captive kestrels were exposed to EMF levels experienced by wild kestrels nesting under 735-kV power lines. Captive EMF females were more active, more alert, and perched on the pen roof more frequently than control females during courtship. EMF females preened and rested less often during brood rearing. EMF male kestrels were more active than control males during courtship, and more alert during incubation. Increased activity of kestrels during courtship may be linked to changes in corticosterone, but likely not melatonin. Observed behavioral changes were unlikely to directly result in the better growth of nestlings and fledging success, or poorer hatching success, of the EMF group, as previously reported. Behavioral changes of captive EMF kestrels may be observed in wild kestrels.

PMID: 10839495

[Indexed for MEDLINE]

Publication type, MeSH terms

LinkOut - more resources

Environ Health Perspect. 1999 Nov; 107(11): 901–904. PMCID: PMC1566687
Research Article

Effects of electromagnetic fields on photophasic circulating melatonin levels in American kestrels.

K J Fernie, D M Bird, and D Petitclerc

Natural Resource Sciences, McGill University, Quebec, Canada; Toxicology Centre and Biology, University of Saskatchewan, Saskatoon, Saskatchewan, Canada. kfernie@yahoo.com

Abstract

Birds reproduce within electromagnetic fields (EMFs) from transmission lines. Melatonin influences physiologic and behavioral processes that are critical to survival, and melatonin has been equivocally suppressed by EMFs in mammalian species. We examined whether EMFs affect photophasic plasma melatonin in reproducing adult and fledgling American kestrels (Falco sparverius), and whether melatonin was correlated with body mass to explain previously reported results. Captive kestrel pairs were bred under control or EMF conditions for one (short-term) or two (long-term) breeding seasons. EMF exposure had an overall effect on plasma melatonin in male kestrels, with plasma levels suppressed at 42 days and elevated at 70 days of EMF exposure. The similarity in melatonin levels between EMF males at 42 days and controls at 70 days suggests a seasonal phase-shift of the melatonin profile caused by EMF exposure. Melatonin was also suppressed in long-term fledglings, but not in short-term fledglings or adult females. Melatonin levels in adult males were higher than in adult females, possibly explaining the sexually dimorphic response to EMFs. Melatonin and body mass were not associated in American kestrels. It is likely that the results are relevant to wild raptors nesting within EMFs.

Full text

Full text is available as a scanned copy of the original print version. Get a printable copy (PDF file) of the **complete article** (1.5M), or click on a page image below to browse page by page. Links to PubMed are also available for **Selected References**.


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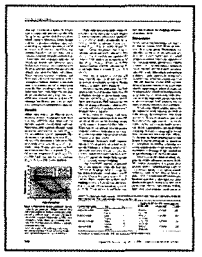
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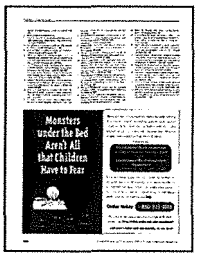

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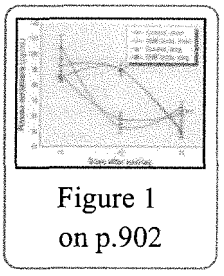
Figure 1
on p.902

Click on the image to see a larger version.

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Evidence of oxidative stress in American kestrels exposed to electromagnetic fields.

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Author information

Abstract

Exposure to electromagnetic fields (EMFs) alters melatonin, behavior, growth, and reproduction of captive American kestrels (Falco sparverius), particularly of males. EMF exposure is a "possible" human carcinogen and associated with some neurodegenerative diseases. Oxidative stress contributes to cancer, neurodegenerative diseases, and immune disorders. We tested whether EMF exposure elicits an avian immune response and alters oxidative stress levels. Captive male kestrels were bred under control or EMF conditions equivalent to those experienced by wild kestrels. Short-term EMF exposure (one breeding season) suppressed plasma total proteins, hematocrits, and carotenoids in the first half of the breeding season. It also suppressed erythrocyte cells and lymphocyte proportions, but elevated granulosa proportions at the end of the breeding season. Long-term EMF exposure (two breeding seasons) suppressed hematocrits in the first half of the reproductive period too. Results indicate that only short-term EMF birds experience an immune response, particularly during the early half of the breeding season. The elevation of granulocytes, and the suppression of carotenoids, total proteins, and previously melatonin in the same kestrels, signifies that the short-term EMF male kestrels had higher levels of oxidative stress, due to an immune response and/or EMF exposure. Long-term EMF exposure may be linked to higher levels of oxidative stress through EMF exposure only.

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The Condor 101:616–621

EFFECTS OF ELECTROMAGNETIC FIELDS ON BODY MASS AND FOOD-INTAKE OF AMERICAN KESTRELS[1]

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Abstract. Raptors commonly nest and roost on transmission towers and hydroelectric poles which exposes them to electromagnetic fields (EMFs) from power lines. Our objective was to determine whether EMF exposure affected the body mass of reproducing adult American Kestrels (*Falco sparverius*), and consequently, whether increased body mass was a function of increased dry matter intake related to EMF exposure. Captive kestrels were paired for one (short-term) or two (long-term) breeding seasons to determine EMF effects on body mass of adults. Short- and long-term EMF exposure of males affected overall mean body mass during the reproductive season, with EMF males heavier than controls when molting began. In contrast, the body mass and pectoral muscle scores of females were unaffected by EMF exposure during egg laying, 20 days post-laying, and after 70 days of EMF exposure. There were no significant effects on body mass or food-intake of wintering kestrels related to 10 days of EMF exposure. Our results can be explained by EMFs affecting the birds' response to the photoperiod as indicated by altered melatonin levels in these male kestrels. The onset of molt was advanced in EMF male kestrels.

Key words: American Kestrels, electromagnetic fields, Falco sparverius, *food-intake, mass, molt.*

INTRODUCTION

Transmission towers have proved beneficial to birds, providing alternative sites for perching, nesting, roosting, and hunting (Steenhof et al. 1993). Nest platforms and boxes have been erected on transmission towers and hydroelectric poles for use by raptors (Olendorff et al. 1981). Over 10 years, 133 pairs of raptors and Ravens (*Corvus corax*) established new nests along a 500-kV transmission line in southern Idaho–Oregon, and 82% of pairs repeatedly nested on this line (Steenhof et al. 1993). Overall nest success rates were similar to or higher than pairs nesting on surrounding substrates.

Power lines and structures also have electrocuted many birds, particularly birds of prey (Olendorff et al. 1981). However, it was unknown whether birds spending considerable time in the vicinity of power lines were affected by electromagnetic fields (EMFs). EMF exposure adversely affected hatching success of American Kestrels (*Falco sparverius,* Fernie 1998), and possibly reproductive success of free-ranging Tree Swallows (*Tachycineta bicolor*) although these results could not be directly attributed to EMF exposure (Doherty and Grubb 1996).

Physiological changes from EMF exposure may, or may not, have adverse biological effects on exposed animals. Plasma melatonin was suppressed then elevated in male kestrels exposed to EMFs (Fernie 1998). Kestrel embryos exposed to EMFs were structurally larger than control embryos (Fernie 1998), and female nestlings were larger in terms of bone and body mass development (K. Fernie, unpubl. data). Dry matter intake and body mass of Holstein cows increased under EMF conditions (Burchard et al. 1996; M. Rodriguez, pers. comm.).

EMF exposure affected the kestrels' response to the photoperiod, i.e., they responded as if the photoperiod was longer under EMF conditions than control conditions (Fernie 1998). Manipulations of photoperiods advance the onset or rate of molt in several bird species (Dawson 1991, 1998), and molt is associated with changes in body mass in American Kestrels (Fernie 1998). Here, our objective was to determine whether EMF exposure affected body mass of adult kestrels during reproduction, and consequently, body mass and dry matter intake of nonbreeding adult kestrels during the winter.

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METHODS

REPRODUCTIVE CONDITION

We used 56 pairs of captive American Kestrels from the Avian Science and Conservation Centre of McGill University. In 1995, 28 pairs were randomly assigned to the control room, and 28 pairs to the EMF room. In 1996, new birds were randomly assigned as 13 control pairs and 15 EMF pairs. Another 13 control and 15 EMF pairs, randomly selected from 1995, were assigned for a second season to the control and EMF room, respectively. Kestrels used in the experiment for one breeding season identified effects of "short-term" EMF exposure, whereas those used for two seasons identified "long-term" EMF effects.

Pairs were genetically unrelated within the past seven generations. Each bird had previous breeding experience. Within each sex, adults were similar in age (2–5 years), size (wing chord), body mass, and condition (body mass: wing chord index) at pairing (1-way ANOVAs, all Ps ≥ 0.45).

In the control and EMF rooms, humidity, temperature, and photoperiod followed natural conditions (45°30′N, 73°26′W) and were similar (t-tests, all Ps ≥ 0.34). Air exchange between the two rooms was similar. Noise levels with EMFs on or off, and average light intensity at birds' head level, were similar between rooms (t-tests, all Ps ≥ 0.24). Noise levels are indicative of mechanical vibrations from the EMF equipment (D. Nguyen, pers. comm.).

A 60 Hz electrical current in the EMF room created a magnetic field of 30 microtesla (μT) and an electric field of 10 kV m^{-1}. EMFs were equivalent to those to which wild kestrels are exposed when nesting under a 735-kV transmission line running at peak capacity. The EMFs were controlled by a computer to provide consistent and uniform fields (Nguyen et al. 1991). The magnetic field of the control room was 2 μT, and the electric field was 0.03 kV m^{-1}.

Kestrels were paired on 11 May 1995 and 13 May 1996. EMF exposure to pairs began immediately and lasted for 95 days in 1995, and 91 days in 1996. Kestrels were exposed to EMFs for approximately 21 hr day^{-1} in 1995 and 23.5 hr day^{-1} in 1996. These exposure periods are comparable to those potentially experienced by free-ranging kestrels which are incubating eggs and young nestlings, and perch-hunting from distribution lines (Fernie 1998).

Each pair was housed in a visually-isolated breeding pen of the same size (0.7 × 0.7 × 1.2 m) and made of reinforced corrugated cardboard and roofed with nylon netting. A standard wooden nest box and rope perch were provided. Wood shavings served for bedding and nesting material. Metal materials were minimized to reduce disturbance of the electric field and possible electric shock to the birds (F. Renaud, pers. comm.). Magnetic fields penetrated all housing materials (D. Nguyen, pers. comm.).

Male kestrels were weighed (nearest 0.1 g) every 14 days, between 08:00 and 11:00 prior to morning feeding. Female kestrels were weighed and measured three times, between laying of the third and fourth egg (mid-clutch), 20 days post-laying, and at 70 days after pairing. Females were weighed at 13:00 to avoid disturbing egg laying which generally occurs in the early morning (Liou et al. 1987; I. Ritchie, pers. comm.). Pectoral muscles of the females were scored from 1 (poor) to 4 (excellent; Gosler 1991) to monitor protein reserves throughout the experiment. Initiation or occurrence of molt was recorded at sampling periods. Kestrel pairs were provided daily with ad libitum day-old cockerels and water, and leftover food was removed.

For the reproductive condition study, repeated measures ANOVAs (Sokal and Rohlf 1995) were used to analyze EMF effects on body mass using SAS (1985) software. Analyses were conducted separately by sex within short- and long-term groups. When necessary, data were transformed using the Box-Cox transformation (Sokal and Rolf 1995). Friedman's repeated measures ANOVA on ranks was used to analyze female pectoral muscle scores. Statistical significance was considered at the $P < 0.05$ level, and means ± SE are reported.

WINTER FOOD TRIAL

The food trial was conducted during the winter to eliminate complications from chicks and/or mates consuming food. A 10-day period of EMF exposure was selected as EMF females laid larger eggs after 11 days of EMF exposure (Fernie 1998). Furthermore, the availability of the EMF room was restricted by other experiments.

A cross-over experimental design using 32 captive kestrels was used for the winter food trial study (4 December 1996 to 11 January 1997).

Sixteen kestrels were housed in each of the control and EMF rooms for trial one, then switched to the opposite room for trial two. In each room, eight males and eight females were housed individually in the breeding pens without nest boxes. Before beginning the EMF trial, the kestrels went through a 6-day acclimation period in the heated rooms (EMF 20 ± 0.5°C, control 21 ± 1°C) because they were previously housed at ambient temperatures (0 ± 5°C). Once food intake was stabilized, EMF exposure began for 10 days, followed by a 4-day elimination period without EMFs to remove any residual effects. Kestrels were then switched from EMF to control rooms, and vice versa, followed by another 4-day acclimation period without measurements taken. Another 10-day trial and 4-day elimination period followed.

The kestrels in which food intake was monitored were exposed to EMFs for 23 hr day^{-1}. EMF levels and daily exposure periods were comparable to the reproductive condition study. In both rooms, photoperiod was natural, and humidity, temperature, noise, and vibration conditions were similar (1-way ANOVA, all Ps ≥ 0.38).

Kestrels in the winter food trial study were similar in age (3–4 years) to each other and to the reproductive birds. They had been previously exposed to EMFs for one season in the reproductive condition study.

As in the reproductive condition study, kestrels were provided with ad libitum day-old whole cockerel and water between 08:00 and 11:00 each day. Kestrels were weighed daily at this time. To facilitate leftover food collection, pens were lined with wax paper which was changed at each feeding. Leftover food from each bird was immediately frozen at −20°C until thawing for 24 hr prior to drying. Food samples were dried to a constant weight at 177°C for 24 hr, and weighed to the nearest 0.01 g. The average dried mass of a cockerel (n = 20) was used to determine the dry mass of provided food. Dry matter intake was calculated as dry mass fed minus dry mass of leftover food.

Statistical analyses for the winter food trial study were based on dry matter intake, and involved repeated measures ANOVA. The statistical model controlled for residual effects from the initial acclimation period or the two EMF trials. Data were transformed by standardized transformation prior to analysis due to the large variation within the raw data (Sokal and Rohlf 1995). Means ± SE are presented.

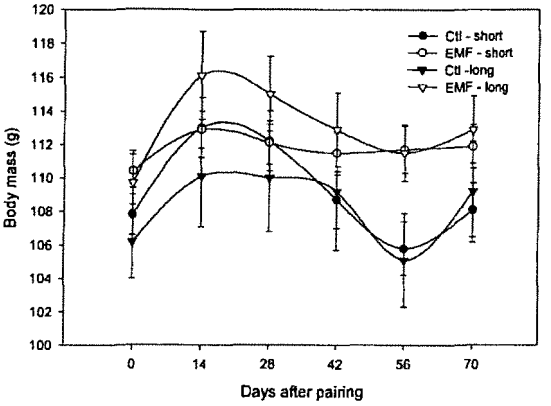

FIGURE 1. Effects of electromagnetic fields on body mass of adult male American Kestrels (*Falco sparverius*) exposed to short-term or long-term EMFs. Ctl = Control; EMF = Electromagnetic fields; short = short-term exposure for one breeding season; long = long-term exposure for two breeding seasons.

RESULTS

REPRODUCTIVE CONDITION

There were no significant differences in body mass of short-term males between years within control or EMF groups, either overall or at specific sampling periods (all Ps ≥ 0.32). Consequently, data were pooled. Short-term EMF exposure of male kestrels affected body mass ($F_{6,68}$ = 4.8 P < 0.001; Fig. 1). EMF males were heavier than controls at 56 days ($F_{1,76}$ = 8.8, P < 0.01) and at 70 days ($F_{1,76}$ = 5.7, P < 0.05). Time ($F_{5,69}$ = 10.5 P < 0.001) and treatment × time interactions were significant ($F_{5,69}$ = 5.4 P < 0.001).

Long-term EMF males also were heavier than control males ($F_{6,20}$ = 5.4, P < 0.01; Fig. 1). A trend was evident at 56 days, i.e., long-term EMF males were heavier than controls ($F_{1,25}$ = 3.8, P = 0.06). Time ($F_{5,21}$ = 140.3 P < 0.001) and treatment × time interactions ($F_{5,21}$ = 4.3 P < 0.01) were significant for this group.

Body mass data for short-term females were pooled because there were no differences between years for each treatment, either overall or at individual sampling periods (all Ps ≥ 0.31). Short- and long-term EMF exposure of female kestrels had no effect on body mass (ANOVA, all Ps ≥ 0.59). Time effects were significant for short-term females in 1996 only ($F_{3,15}$ = 70.0 P < 0.001) and for long-term females ($F_{3,18}$ = 57.0

$P < 0.001$). There were no significant treatment × time interactions (all $Ps \geq 0.35$). Pectoral protein reserves of females were unaffected by EMF exposure or time (Friedman's ANOVA, all $Ps \geq 0.47$).

WINTER FOOD TRIAL

Initially, control and EMF kestrels within each sex were similar in body mass (1-way ANOVAs, all $Ps \geq 0.24$), with males weighing 129.9 ± 4.5 g, and females weighing 142.8 ± 5.5 g. No significant differences were observed in body mass of birds between EMF and control groups throughout any trial period (ANOVAs, all $Ps \geq 0.18$).

There were no differences in dry matter intake for either sex during the winter food trial (ANOVAs, all $Ps \geq 0.17$). Average daily dry matter intake of wintering adult males was 11.8 ± 1.0 g, and for wintering adult females, 13.3 ± 1.1 g. These measurements are equivalent to each bird consuming 43.0 to 48.6 g (wet mass) daily.

DISCUSSION

This study showed that EMF exposure had an overall effect on body mass of reproducing male kestrels, particularly at molting, and effects increased as the season progressed. Molting had begun in the EMF males (93%), but was very limited in the control males (5%), at 56 days of the trial (Fernie 1998). Molting is accompanied by an increase in body mass in kestrels (Dietz et al. 1992, Fernie 1998).

The advance in molt of EMF kestrels in this study can be explained by EMFs affecting the birds' response to the photoperiod. Suppressed melatonin in EMF reproducing males at 42 days (Fernie 1998), the same birds used in this study, indicated the EMF birds were responding as if the photoperiod was longer than in the control room. Longer photoperiods, or decreases in daylength prior to gonadal regression, advance the onset of molt in many bird species (Meijer 1989, Dawson 1991, 1998). In this study, the photoperiod began to decrease at 39 days. Molt and (likely) gonadal regression began in the EMF males by 56 days of the trial, after the decrease in photoperiod. The birds' perception of a longer photoperiod in the EMF room, and the timing of the decrease in photoperiod, would have advanced the onset of molt in EMF males compared to control males.

The mass of growing new feathers explains why short-term EMF males were heavier at 70 days. In kestrels, feather loss occurs at molt onset with a two-week delay until initial feather regrowth (Fernie 1998). We calculated the potential feather mass of short-term males at 70 days using Turček's (1966) formula, $Fw = 0.09W^{0.95}$, where W is mass in grams. Estimated plumages of EMF males (8.1 ± 0.2 g) were heavier than those of controls (7.5 ± 0.2 g; $F_{1,75} = 7.1$, $P < 0.05$).

EMFs did not affect body mass of females. We offer several explanations for the lack of EMF effects, which are not necessarily mutually exclusive. First, female kestrels begin to molt earlier than males during mid-incubation or in this study after approximately 28 days of EMF exposure. This exposure period is shorter than when EMF effects appeared in males (i.e., ≥42 days). The results indicate EMF effects on adult birds may only occur after continuous, extended exposure. Second, females reabsorb the oviduct when molting, which occurred prior to the decline in daylength in our study. If females are similar to males, the decrease in daylength after the onset of gonadal regression increases the rate of molt, but not its onset (Dawson 1998). Consequently, we would not expect to see an advance in molt onset with associated differences in mass in EMF females. Finally, if female body mass was indeed affected by EMF exposure during molt, any effects may have been masked by the significant weight loss (~40 g) experienced during incubation. This seasonal decline in body mass after clutch production is typical of female kestrels (Bird 1988).

The lack of EMF effects on body mass of captive wintering kestrels is related to their winter body mass being 20–30 g more than their post-clutch reproductive mass. Wintering kestrels experienced consistent warm temperatures, approximately 20°C above ambient temperatures, which would not induce excess eating or fattening for overnight winter survival (Dawson and Marsh 1986). Photoperiod inducement of seasonal fattening was unlikely given that there were no photoperiod differences between groups, and melatonin concentrations were similar between reproducing EMF and control males at 14 days of the trial (Fernie 1998). European Kestrels (*F. tinnunculus*), and likely American Kestrels, experience their lowest periods of daily energy expenditure (DEE) during winter (Masman et al. 1988; I. Ritchie, pers.

comm.). Body mass or food intake was unlikely to increase regardless of EMF exposure as wintering kestrels in our study had reached their maximum seasonal weight gain and were experiencing a relatively low DEE period.

To our knowledge, this study is the first investigation of food intake by birds under EMF conditions. EMF exposure had no effect on food intake of kestrels. Dry matter intake of kestrels is unlikely to be affected by photoperiod (Fernie 1998). Total daily food intake of molting White-crowned Sparrows (*Zonotrichia leucophrys gambelii*) was unaffected by photoperiod length (Murphy and King 1990). Furthermore, an increase in dry matter intake by the kestrels due to increased activity is not expected. The EMF and control reproducing males were similarly active during the nestling phase (Fernie 1998) which was when EMF males were heavier. Consequently, a longer photoperiod experienced by the kestrels would not necessarily increase dry matter intake regardless of reproductive, molting, or overwintering demands.

In summary, short-term and long-term EMF exposure affected body mass of reproducing male but not reproducing female American Kestrels. EMFs affected the birds' response to the photoperiod. EMF birds responded as if the photoperiod was longer in the EMF room than the control room. This perceived longer photoperiod, and its decline prior to molt onset, advanced the onset of molt in EMF males. EMF exposure for 10 days had no effect on body mass or food intake of wintering male and female kestrels. EMF effects on adult birds may only occur after continuous, extended EMF exposure.

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Effects of electromagnetic fields on the reproductive success of American kestrels.

Fernie KJ[1], Bird DM, Dawson RD, Laguë PC.

Author information

Abstract

Reduced reproductive success of birds nesting near power lines has been documented but never directly attributed to electromagnetic fields (EMFs). Laboratory studies have identified EMF effects on embryonic development, but reproductive success of wild birds is dependent on additional factors, including fertility, egg size, hatching, and fledging success. We tested whether EMFs affect reproductive success of birds. Captive American kestrels (Falco sparverius) were bred for one season per year for 2 yr under either controlled or EMF conditions. EMF exposure was equivalent to that experienced by wild reproducing kestrels and was weakly associated with reduced egg laying in 1 yr only. In both years fertility was higher, but hatching success was lower in EMF pairs than control pairs. Fledging success was higher in EMF pairs than control pairs in 1995 only. Egg composition and embryonic development were examined in 1 yr only, but hatchlings were measured in both years. EMF eggs were larger, with more yolk, albumen, and water, but had thinner egg shells than control eggs. Late-term EMF embryos were larger and longer than control embryos, although hatchlings were similar in body mass and size. EMF exposure affected reproductive success of kestrels, increasing fertility, egg size, embryonic development, and fledging success but reducing hatching success.

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Format: Abstract

J Toxicol Environ Health B Crit Rev. 2005 Mar-Apr;8(2):127-40.

The effects of electromagnetic fields from power lines on avian reproductive biology and physiology: a review.

Fernie KJ[1], Reynolds SJ.

Author information

Abstract

Electrical power lines are ubiquitous in the developed world and in urban areas of the developing world. All electrical currents, including those running through power lines, generate electric and magnetic fields (EMFs). Electrical power lines, towers,and distribution poles are used by birds for perching, hunting, and nesting. Therefore, many bird species, like humans, are exposed to EMFs throughout their lives. EMFs have been implicated in adversely affecting multiple facets of human health,including increasing the risks of life-threatening illnesses such as leukemia, brain cancer, amyotrophic lateral sclerosis, clinical depression, suicide, and Alzheimer's disease. A great deal of research and controversy exists as to whether or not exposure to EMFs affects the cellular, endocrine, immune, and reproductive systems of vertebrates. Laboratory work has used mice, rats, and chickens as models for this EMF research in an effort to understand better the possible implications of EMF exposure for humans. However, EMF exposure of wild birds may also provide insight into the impacts of EMFs on human health. This review focuses on research examining the effects of EMFs on birds; most studies indicate that EMF exposure of birds generally changes, but not always consistently in effect or in direction, their behavior, reproductive success, growth and development, physiology and endocrinology, and oxidative stress under EMF conditions. Some of this work has involved birds under aviary conditions, while other research has focused on free-ranging birds exposed to EMFs. Finally, a number of future research directions are discussed that may help to provide a better understanding of EMF effects on vertebrate health and conservation.

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[Indexed for MEDLINE]

Publication types, MeSH terms

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Bioelectromagnetics. 1997;18(6):431-8.

The effect of pulsed and sinusoidal magnetic fields on the morphology of developing chick embryos.

Farrell JM[1], Litovitz TL, Penafiel M, Montrose CJ, Doinov P, Barber M, Brown KM, Litovitz TA.

Author information

Abstract

Several investigators have reported robust, statistically significant results that indicate that weak (approximately 1 microT) magnetic fields (MFs) increase the rate of morphological abnormalities in chick embryos. However, other investigators have reported that weak MFs do not appear to affect embryo morphology at all. We present the results of experiments conducted over five years in five distinct campaigns spanning several months each. In four of the campaigns, exposure was to a pulsed magnetic field (PMF); and in the final campaign, exposure was to a 60 Hz sinusoidal magnetic field (MF). A total of over 2500 White Leghorn chick embryos were examined. When the results of the campaigns were analyzed separately, a range of responses was observed. Four campaigns (three PMF campaigns and one 60 Hz campaign) exhibited statistically significant increases ($P > or = 0.01$), ranging from 2-fold to 7-fold, in the abnormality rate in MF-exposed embryos. In the remaining PMF campaign, there was only a slight (roughly 50%), statistically insignificant ($P = 0.2$) increase in the abnormality rate due to MF exposure. When the morphological abnormality rate of all of the PMF-exposed embryos was compared to that of all of the corresponding control embryos, a statistically significant ($P > or = .001$) result was obtained, indicating that PMF exposure approximately doubled the abnormality rate. Like-wise, when the abnormality rate of the sinusoid-exposed embryos was compared to the corresponding control embryos, the abnormality rate was increased (approximately tripled). This robust result indicates that weak EMFs can induce morphological abnormalities in developing chick embryos. We have attempted to analyze some of the confounding factors that may have contributed to the lack of response in one of the campaigns. The genetic composition of the breeding stock was altered by the breeder before the start of the nonresponding campaign. We hypothesize that the genetic composition of the breeding stock determines the susceptibility of any given flock to EMF-induced abnormalities and therefore could represent a confounding factor in studies of EMF-induced bioeffects in chick embryos.

PMID: 9261540

[Indexed for MEDLINE]

Publication types, MeSH terms, Grant support

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Format: Abstract

Schweiz Arch Tierheilkd. 2012 Feb;154(2):82-6. doi: 10.1024/0036-7281/a000300.

[Increased occurrence of nuclear cataract in the calf after erection of a mobile phone base station].

[Article in German]

Hässig M[1], Jud F, Spiess B.

Author information

Abstract

We examined and monitored a dairy farm in which a large number of calves were born with nuclear cataracts after a mobile phone base station had been erected in the vicinity of the barn. Calves showed a 3.5 times higher risk for heavy cataract if born there compared to Swiss average. All usual causes such as infection or poisoning, common in Switzerland, could be excluded. The real cause of the increased incidence of cataracts remains unknown.

PMID: 22287140 DOI: 10.1024/0036-7281/a000300

[Indexed for MEDLINE] Free full text

Publication type, MeSH terms

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Format: Abstract

Electromagn Biol Med. 2007;26(1):63-72.

A possible effect of electromagnetic radiation from mobile phone base stations on the number of breeding house sparrows (Passer domesticus).

Everaert J[1], Bauwens D.

Author information

Abstract

A possible effect of long-term exposure to low-intensity electromagnetic radiation from mobile phone (GSM) base stations on the number of House Sparrows during the breeding season was studied in six residential districts in Belgium. We sampled 150 point locations within the 6 areas to examine small-scale geographic variation in the number of House Sparrow males and the strength of electromagnetic radiation from base stations. Spatial variation in the number of House Sparrow males was negatively and highly significantly related to the strength of electric fields from both the 900 and 1800 MHz downlink frequency bands and from the sum of these bands (Chi(2)-tests and AIC-criteria, $P<0.001$). This negative relationship was highly similar within each of the six study areas, despite differences among areas in both the number of birds and radiation levels. Thus, our data show that fewer House Sparrow males were seen at locations with relatively high electric field strength values of GSM base stations and therefore support the notion that long-term exposure to higher levels of radiation negatively affects the abundance or behavior of House Sparrows in the wild.

PMID: 17454083 DOI: 10.1080/15368370701205693

[Indexed for MEDLINE]

0 comments

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Format: Abstract

Biofizika. 1976 Nov;21(6):1097-102.

[Mechanism of generation and perception of electric fields by honey bees].

[Article in Russian]

Es'kov EK, Sapozhnikov AM.

Abstract

Generation and reception mechanisms of electrostatic and alternating, currents by bees are studied. It is shown that generation of electric fields is concerned with the properties of body integuments to carry a comparative large electrostatic charge. Transport of charged bodies is percieted by bees with the help of antennae subjected to the action of coulon powers. Perception of a alternating artificially generated electric fields is mainly concerned with physiological influence of induced currents flowing in the site of contact of bees to one another or to current-conducting bodies. The studies performed did not show the existence of specialized organs for the generation and perception of electric fields.

PMID: 1009204

[Indexed for MEDLINE]

Publication type, MeSH terms

PubMed Commons

PubMed Commons home

0 comments

How to join PubMed Commons

PubMed

Format: Abstract

Biofizika. 2006 Jan-Feb;51(1):153-5.

[Destabilization of the cardiac function of an insect by a low-frequency electric field].

[Article in Russian]

Es'kov EK.

Abstract

The effect of high-intensity low-frequency electric field on the functioning of the heart of an insect was estimated from electrocardiogram. It was found that electric field causes a disturbance of the cardiac function. Its stressing activity is mainly related to the excitation of the insect by induced currents whose exciting action is enhanced by vibration in trichoid sensillas and antennas.

PMID: 16521566

[Indexed for MEDLINE]

Publication type, MeSH terms

LinkOut - more resources

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PLoS One. 2009; 4(7): e6246. PMCID: PMC2705803
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The Aversive Effect of Electromagnetic Radiation on Foraging Bats—A Possible Means of Discouraging Bats from Approaching Wind Turbines

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Conceived and designed the experiments: PAR. Performed the experiments: BN. Analyzed the data: BN. Wrote the paper: BN.

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Abstract

Go to:

Large numbers of bats are killed by collisions with wind turbines and there is at present no accepted method of reducing or preventing this mortality. Following our demonstration that bat activity is reduced in the vicinity of large air traffic control and weather radars, we tested the hypothesis that an electromagnetic signal from a small portable radar can act as a deterrent to foraging bats. From June to September 2007 bat activity was compared at 20 foraging sites in northeast Scotland during experimental trials (radar switched on) and control trials (no radar signal). Starting 45 minutes after sunset, bat activity was recorded for a period of 30 minutes during each trial and the order of trials were alternated between nights. From July to September 2008 aerial insects at 16 of these sites were sampled using two miniature light-suction traps. At each site one of the traps was exposed to a radar signal and the other functioned as a control. Bat activity and foraging effort per unit time were significantly reduced during experimental trials when the radar antenna was fixed to produce a unidirectional signal therefore maximising exposure of foraging bats to the radar beam. However, although bat activity was significantly reduced during such trials, the radar had no significant effect on the abundance of insects captured by the traps.

Introduction

Go to:

The UK government is committed to ensure that 10% of the country's electricity will be generated from renewable sources by 2010 with an aspiration to double this figure by 2020. Unfortunately the drive to ameliorate the indirect impact of energy production on the environment has led to a more immediate impact on local fauna. The exploitation of wind as a renewable and pollution-free source of energy has led to the proliferation of wind farms across the UK where 206 are currently operational, comprising 2381 turbines and with an estimated 444 sites proposed for future development [1]. Several studies

have highlighted the problem of birds colliding with turbines placed along traditional migratory routes [2]–[6] but until recently the impact of wind turbines on bats has received little attention.

The scale of the problem became apparent in 2004 when, during a six-week period, an estimated 1,764 and 2,900 bat fatalities were recorded at two wind farms in Pennsylvania and West Virginia respectively [7]. The number of collision mortalities reported in America are greater than in Europe, where surveys have begun more recently. However, 15 of the 35 species of European bat have been recorded as regular victims of turbine collisions, and an Intersessional Working Group of Eurobats listed 20 species thought to be at risk of collision due to their foraging and commuting behaviour [8]. Currently, research in Europe is concentrated on arriving at scientifically credible mortality estimates to assess the extent of the problem. Although this is clearly important, the rapid proliferation of wind turbines requires a more urgent response. Research has to be focussed on the underlying reasons behind these collisions and potential methods of mitigation to prevent what is undoubtedly an increasing threat to bat populations.

Attempts at mitigating bird collisions with wind turbines have typically involved the application of visual stimuli to increase the conspicuousness of the turbine blades [9], [10], but for bats, where audition is the primary sensory modality, this is clearly not appropriate. The design of an acoustic deterrent for bats, as used to mitigate cetacean entanglement in drift nets [11]–[13], is complicated by the intrinsic properties of ultrasound, which attenuates rapidly in air [14]. Despite this inherent problem, a recent study [15] revealed a significant aversive response by big brown bats (*Eptesicus fuscus*) following exposure to broadband white noise in a laboratory. However, when an acoustic deterrent was deployed at a wind farm in New York State, USA, results were more equivocal, and researchers concluded that the acoustic envelope of the deterrent system was probably not large enough to consistently deter the activity of bats within the large volume of the rotor-swept zone [16].

A more promising solution is offered by curtailing the operations of wind turbines during high-risk periods. A substantial portion of bat fatalities at operating wind farms occurs during relatively low-wind conditions during the bat migration period [17]. Some curtailment of turbine operations during these conditions, and during this period, has been proposed as a possible means of reducing impacts to bats [17], [18]. Recent results from studies in Canada [19] and North America [20] indicate that changing turbine "cut-in speed" (i.e., the wind speed at which wind generated electricity enters the power grid) from the customary 3.5–4.0 m/s, on modern turbines, to 5.5 m/s, resulted in at least a 50% reduction in bat fatalities. This requires considerable cooperation on behalf of the project operators as curtailing turbine operations, even on a limited basis, clearly poses operational and economic restrictions resulting in some loss of revenue. This method does however offer a promising solution, particularly in areas where it has been proven that bat mortalities occur over a clearly defined and restricted time period. It is not yet clear whether this method of mitigation will prove sufficiently feasible and effective at reducing impacts to bats at costs that are acceptable to companies that operate wind energy facilities. Therefore, given the problems associated with the existing proposed methods of mitigation it is essential to investigate all other alternatives.

It has been suggested that the radio frequency (RF) radiation associated with radar installations could potentially exert an aversive behavioural response in foraging bats [21]. In 2006 Nicholls and Racey recorded bat activity along an electromagnetic gradient at ten radar installations throughout Scotland. Their results revealed that bat activity and foraging effort per unit time were significantly reduced in habitats exposed to an electromagnetic field (EMF) strength of greater than 2v/m when compared to matched sites registering EMF levels of zero. Even at sites with lower levels of EMF exposure (<2v/m), bat activity and foraging effort was significantly reduced in comparison to control sites.

Ahlén *et al.* [22] also reported anecdotal evidence that bats foraging offshore in Sweden avoided an area around Utgrunden lighthouse where a powerful radar was in permanent operation. However,

although it has been demonstrated that large air traffic control and weather radars appear to exert an aversive response on foraging bats [21], this has little practical application in preventing bats from colliding with turbine blades. It is therefore necessary to establish whether a deterrent effect can be replicated with a small, portable radar system. It is also possible that the electromagnetic radiation from the radar may not be affecting bats directly but rather the insects upon which they feed. Bat activity within an area is strongly correlated with insect density [23], [24] therefore any reduction in insect density would result in a concurrent reduction in bat activity. In order to provide an efficient deterrent it is necessary to determine whether any observed reduction in bat activity is a direct result of exposure to electromagnetic radiation or an indirect result of a localised reduction in insect density.

Therefore the aims of the present study were to test the following hypotheses:

1. Bat activity will be reduced following exposure to a pulsed electromagnetic signal from a small portable radar unit.
2. The abundance of aerial insects will be reduced following exposure to a pulsed electromagnetic signal from a small portable radar unit.

Materials and Methods

Go to:

Study sites and sampling protocol

In Britain, foraging bats are predominantly associated with areas where insect density is high: broadleaved woodland, particularly woodland edge, linear vegetation (tree lines and hedgerows) and riparian habitat. More open and intensively managed areas are avoided. In order to assess the impact of radar on foraging bats it was important to locate foraging sites with a high level of bat activity. Using existing knowledge obtained from detailed radio telemetry projects [25] in conjunction with extensive acoustic surveys, 20 foraging sites, with a high and consistent level of bat activity, were selected. All foraging sites were located within a 100 km radius of Aberdeen in northeast Scotland (latitude 57°23' N, longitude 02°45' W) and were separated by a minimum straight-line distance of >1 km to ensure independence. Twelve of these sites were located within riparian habitats (small ponds, rivers and streams) and the remainder along the edge of woodland where the radar signal would not be attenuated by any obstruction.

The radar used throughout the study was a Furuno FR - 7062 X-band marine radar (peak power 6 kW, beamwidth: horizontal −1.9°, vertical −22°, rotation 24 rpm or 48 rpm) with a slotted waveguide array antenna (1.2 m) capable of transmitting at pulse lengths of 0.08 μs–0.8 μs depending on the range selected. At each site the radar antenna was placed on a platform 2 m above ground level, such that the core area of bat activity was directly in line with the radar beam. At each foraging site a control (no radar signal) and experimental trial (radar switched on) were carried out. Starting 45 minutes after sunset, bat activity was recorded for a period of 30 minutes during each trial and the order of trials were alternated between nights. To avoid pseudoreplication, recordings were carried out only once at each of the 20 sites.

As in most radar systems, the antenna of the radar usually swept through 360 degrees. For the current experiment this would reduce the extent of exposure along any radius. Therefore the experiment was repeated with the antenna of the radar fixed such that the radar signal was orientated directly towards the area of highest bat activity. Similarly the duration of exposure to the radar signal is dependent on the duty cycle of the radar transmitter (pulse length×pulse repetition frequency). Therefore the experiment was repeated at each site using two different pulse length/pulse repetition rates (0.08 μs/2100 Hz, 0.3 μs/1200 Hz,) with the radar antenna fixed to maximise exposure. A portable electromagnetic field meter (PMM 8053-Accelonix Ltd.) and isotropic field probe (EP-330 Isotropic E-Field probe-Accelonix Ltd.) were used to measure the maximum value (peak hold) of the

electromagnetic field strength (EMF) of the radar in volts per metre (v/m) at three distances from the radar antenna (10, 20, 30 m) for each of the two radar settings implemented throughout the study.

Bat activity recording

At each foraging site bat activity was recorded at three distances from the radar antenna (10, 20, 30 m) using automatic bat-recording stations [26]. Each automatic station consisted of a Batbox III heterodyne bat detector (Stag Electronics, Sussex, UK) linked to a count data logger (Gemini Data Loggers, UK Ltd, Chichester, UK) via an analogue to digital signal converter (Skye instruments, Ltd). The signal converter converts analogue signals from the bat detector into digital signals that can be recorded by the data logger. Every 0.5 seconds a positive or negative signal is sent to the data logger indicating the presence or absence of ultrasound respectively. Therefore the recorded number of bat active half seconds referred to as 'bat counts' over a thirty-minute trial provides a quantitative index of bat activity during that period. Most narrowband detectors will detect a range of frequencies centred on the value shown on the tuning dial. For the Batbox III this window is±8 kHz of the tuned frequency, therefore the frequency was set to 50 khz in order to effectively detect each of the 5 breeding species of bat in Scotland (*Pipistrellus pipistrellus*, *Pipistrellus pygmaeus*, *Myotis daubentonii*, *Myotis nattereri* and *Plecotus auritus*). The component parts of the system were housed in large plastic boxes with a hole cut for the bat detector microphones. Automatic recording stations were positioned on platforms 1.5 m above the ground and orientated perpendicular to the radar signal (Fig. 1).

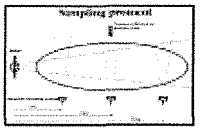


Figure 1

Sampling protocol of experimental trials carried out at 20 independent sites from July to September 2007.

In conjunction with the automatic recording stations bat activity was recorded continuously during each trial using a frequency division bat detector (S-25, Ultrasound Advice, London). This method of ultrasound transformation allows calls to be recorded in real time on audiocassettes and the number of recorded passes provides a quantitative assessment of bat activity Bat detectors were linked to a tape recorder (Sony Professional Walkman, Tokyo, WMD6C) containing metal-tape cassettes. At each site the bat detector was placed at a distance of 20 m from the radar antenna and the height and direction remained constant at 70 cm. The 60 minutes recording at each site were analysed using BatSound software (BatSound Pro, Pettersson Elektronic AB, Uppsala Sweden). In addition to the total number of bat passes, terminal feeding buzzes at each site were counted. These characteristic sounds are produced by aerial hunting and trawling vespertilionid bats when prey capture is attempted [27] and can be used to quantify foraging activity within a site. Foraging rate is expressed as the ratio of terminal buzzes to bat passes; this feeding buzz ratio (FBR) provides a measure of foraging intensity per unit of flight activity [28]. The use of frequency division detectors also allowed accurate species identification at each site.

Insect Abundance

From July to September 2008 aerial insects were sampled using two identical Pirbright-Miniature light-suction traps (PMLT) [29] equipped with 8 W UV light bulbs. Each trap operated at 220 V transformed to 12 V to run from a car battery. At the base of each trap was a water-filled collecting vessel containing 2–3 drops of detergent. Most large insects were excluded by a large-mesh screen immediately above the fan and below the light bulb. The traps were deployed at 16 of the 20 foraging sites described above and were switched on for one hour prior to sunset. At each site the traps were positioned approximately 40 m apart with their trap inlets 2 m above ground level. On each sampling night the radar antenna was positioned on a platform 2 m above ground level and 10 m from one of the

traps such that the antenna was orientated directly towards the trap inlet and fixed to produce a unidirectional signal. The second trap was positioned perpendicular to the radar beam to prevent any potential exposure to electromagnetic radiation and left to function as a control. To avoid any potential bias the selection of traps used as the control was alternated each night. The parameters of the radar tested were identical to those described above (Pulse length/pulse repetition rate: 0.08 μs/2100 Hz; 0.3 μs/1200 Hz,) no test was carried out with the antenna rotating.

Immediately following sampling, the insect catch was transferred from the collecting column into a 70% ethanol in water solution using a fine brush. Insects were then counted using a dissecting microscope (×30). Any insects with wingspans exceeding 20 mm were removed from the catch, as they would exceed the range of insect sizes captured by the species recorded throughout the study [30]. Following counting and sorting, the dry mass of insects was recorded by drying the samples in an oven until a constant mass was achieved (21 h).

Statistical analysis

Differences in bat activity (bat counts and bat passes), bat foraging activity (feeding buzz ratios) and insect abundance between experimental and control trials were analysed using paired t tests. To account for multiple comparisons in paired t tests, we applied a manual Bonferroni correction (*P*-values×number of comparisons). However since the application of the Bonferroni correction increases the risk of making more type II errors, i.e. not recognising a true effect as significant [31] we report both corrected $P_{\text{Bonferroni}}$ and uncorrected *P*-values. The effect of distance from the radar antenna was analysed using one-way ANOVA. Analyses were carried out using Minitab version 14 [32].

Ethics statement

The authors' work on bats is licensed by the statutory nature conservation organisation in Scotland (Scottish Natural Heritage).

Results

Go to:

Bat activity

Experimental trials were carried out during 58 nights from July 2007 till September 2007 representing a total of 58 hours of recording data within the following parameters:

1. Rotating antenna – pulse length/pulse repetition rate (0.08 μs/2100 Hz) – 20 h
2. Fixed antenna – pulse length/pulse repetition rate (0.08 μs/2100 Hz) – 20 h
3. Fixed antenna – pulse length/pulse repetition rate (0.3 μs/1200 Hz) – 18 h

The maximum value (peak hold) of the electromagnetic field strength within these parameters is shown in Table 1. Field strength diminished slightly with increasing distance from the antenna under all radar parameters. However when the radar antenna was fixed to emit a unidirectional signal a fourfold increase in field strength was observed at all distances (Table 1).

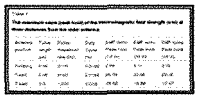


Table 1

The maximum value (peak hold) of the electromagnetic field strength (v/m) at three distances from the radar antenna.

The three automatic stations recorded a total of 102,810 bat counts during 58 h of recording (Table 2). No significant difference was observed in the number of bat counts recorded between automatic stations positioned at 10, 20 and 30 m from the radar antenna (ANOVA, rotating antenna with pulse

length 0.08 μs: P=0.57; fixed antenna with pulse length 0.08 μs: P=0.64; fixed antenna with pulse length 0.3 μs P=0.68) therefore all further tests were carried out on the average of these three values. A further 53,731 bat passes were recorded with the frequency division detector (Table 2). As expected, the majority of passes (84%) were attributed to the two cryptic pipistrelle species: *Pipistrellus pygmaeus* and *P. pipistrellus* (51% and 33% respectively) which are the most common and abundant bats in Scotland. A further 16% of bat passes were attributed to *Myotis daubentonii*.

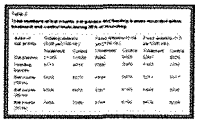


Table 2

Total numbers of bat counts, bat passes and feeding buzzes recorded within treatment and control trials during 58 h of recording.

Total bat activity was invariably higher during the control trials when compared to experimental trials (Table 2). However paired t tests carried out on all indices of bat activity (bat counts, bat passes, feeding buzz ratios) revealed no significant difference in bat activity between control and experimental trials when exposed to a short pulse length (0.08 μs) radar signal from a rotating antenna (bat counts: t=1.50; P=0.151; $P_{Bonferroni}$=0.453; Fig. 2a. Bat passes: t=1.89; P=0.074; $P_{Bonferroni}$=0.222; Fig. 3a. FBR: t=1.80; P=0.088; $P_{Bonferroni}$=0.264; Fig. 4a). Paired t tests carried out on all indices of bat activity (bat counts, bat passes, feeding buzz ratios) showed that bats were significantly less active during experimental trials than during control trials when exposed to a short pulse length (0.08 μs) radar signal from a fixed antenna (bat counts: t=2.87; P=0.010; $P_{Bonferroni}$=0.030; Fig. 2b. Bat passes: t=2.54; P =0.020; $P_{Bonferroni}$=0.060; Fig. 3b. FBR: t=3.82; P=0.001; $P_{Bonferroni}$ =0.003; Fig. 4b). However, following Bonferroni correction the difference in the number of bat passes between experimental and control trials was no longer significant. Bats were also significantly less active during experimental trials than during control trials when exposed to a medium pulse length (0.3 μs) radar signal from a fixed antenna (bat counts: t=3.95; P=0.001; $P_{Bonferroni}$=0.003; Fig. 2c. Bat passes: t=3.69; P=0.002; $P_{Bonferroni}$ =0.006; Fig. 3c. FBR: t=6.78; P<0.001; $P_{Bonferroni}$ =0.003; Fig. 4c). A summary of these results is presented in Table 3.

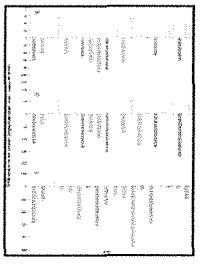


Figure 2

The response of bats to:

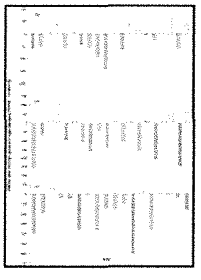
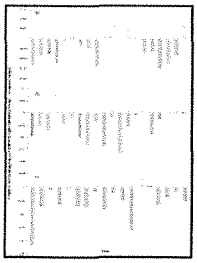


Figure 3

The response of bats to:

Figure 4

The response of bats to:



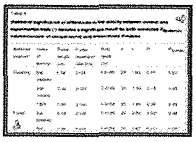


Table 3

Statistical significance of differences in bat activity between control and experimental trials (*) denotes a significant result for both corrected $P_{Bonferroni}$ (P values×number of comparisons) and uncorrected P-values.

Insect Abundance

Experimental trials were carried out during 32 nights from July 2008 till September 2008 representing a total of 32 hours of recording data within the following parameters:

1. Fixed antenna – pulse length/pulse repetition rate (0.08 μs/2100 Hz) – 16 h
2. Fixed antenna – pulse length/pulse repetition rate (0.3 μs/1200 Hz) – 16 h

A total of 10 430 insects were caught during 32 hours of sampling per trap. Ninety five percent of the insects caught had wingspans <20 mm and were dried and included in further analyses. Paired t tests revealed no significant difference in insect abundance between control and experimental traps when exposed to either a short (0.08 μs) or medium pulse length (0.3 μs) radar signal (short pulse: n=16, t= 1.50; P=0.151; $P_{Bonferroni}$=0.453; long pulse: n=16, t=1.89; P=0.074; $P_{Bonferroni}$=0.222).

Discussion

Go to:

Currently there is no accepted method of successfully mitigating bat collisions with wind turbines and attempts at deterring bats by the use of ultrasound have, as yet, been unsuccessful. Therefore the identification of alternative methods capable of inducing an aversive response in bats approaching turbine blades is of paramount importance. Very few field experiments have been carried out to ascertain the possible effects of high frequency electromagnetic radiation on populations of wild animals. However studies have shown that electromagnetic radiation can influence the development, reproduction, and physiology of insects [33], mammals [34], and birds [35]. Our results demonstrate that an electromagnetic signal from a small radar unit with a fixed antenna invariably reduced the foraging activity of bats within 30 m of the unit. However no significant decrease in activity was observed when the radar antenna was rotating. This is not surprising; the length of time a bat would be exposed to the radar signal is a function of the duty cycle of the radar signal (pulse length×pulse repetition rate) and the dwell time (the duration of time that a target remains in the radar beam during each rotation). The rotation of the radar antenna would reduce the time that bats were exposed to pulse-modulated microwave radiation and would therefore attenuate any potential deterrent effect. When the radar antenna was fixed to emit a unidirectional signal a fourfold increase in field strength was observed at all distances.

When foraging sites were exposed to a short pulse length signal from a fixed antenna there was a significant reduction in bat activity during experimental trials (bat counts and bat passes dropped by 15.5% and 13.3% respectively). Although once the Bonferroni correction had been applied, the difference in bat passes between control and experimental trials was no longer significant. An even greater level of significance was however observed when foraging sites were exposed to a medium

pulse length signal from a fixed antenna (bat counts and bat passes dropped by 38.6% and 30.8% respectively). Clearly this represents a substantial reduction in bat activity. However, bats continued to forage at each site during experimental trials, and on no occasion were bats observed behaving abnormally or actively avoiding the beam of the radar. However, temporal and spatial fluctuations in bat foraging behaviour are common [23.24] and therefore results have to be treated with caution. Despite this caveat the significant reduction in bat activity during all experimental trials with a fixed antenna supports our hypothesis that electromagnetic radiation exerts a deterrent effect on foraging bats. This raises questions regarding the mechanisms through which bats could perceive electromagnetic fields and why they would seek to avoid them.

Nicholls and Racey [21] suggest that the aversive behavioural response of foraging bats to electromagnetic radiation may be a result of thermal induction. Studies investigating the behavioural response of laboratory animals to the presence of electromagnetic fields have shown that even short-term exposure can produce a thermal burden in an organism that can result in significant behavioural and physiological changes, some of which may be harmful [36]. Behavioural effects of such exposure include perception, aversion, work perturbation, work stoppage and convulsions [37]. The wing membranes of bats present a large surface area over which radiation might be absorbed, increasing heat load on the animal. This, combined with the heat energy produced during flight, makes bats particularly susceptible to overheating [38], [39]. Furthermore, observations of captive bats have noted their aversion to even a moderate infra-red heat source [40].

However the pulsed microwave radiation characteristic of radars is a rather inefficient source of energy. The energy produced by a radar signal can reach very high values of peak power density, at relatively low levels of power density averaged over time. This is because the pulse length of the radar signal is hundreds of times shorter than the pulse repetition rate, therefore the average value of power density is hundreds of times lower than the peak value of the radiation. Therefore it would seem unlikely that the energy in the radar signal would be sufficient to induce a thermal burden in bats foraging within the beam. However several studies have reported significant behavioural and physiological effects resulting from exposure to pulsed microwave radiation even when the average power density of the signal was relatively low [41]–[43]. The mechanism through which pulsed microwave radiation could affect behaviour in this manner is unclear although one possibility is an auditory response commonly referred to as the auditory microwave hypothesis.

The auditory perception of pulsed microwaves is now widely accepted. The effect is generally attributed to the thermoelastic expansion of brain tissue following the small but rapid increase in temperature due to the absorption of the incident energy. This generates a sound wave in the head that subsequently stimulates the cochlea. Repeated or prolonged exposure to these auditory effects is considered stressful [44].

Laboratory experiments have shown that the frequency of the induced sound is a function of head size and of the acoustic properties of the brain tissue. The estimated fundamental frequency of vibration in guinea pigs, cats and adult humans are 45, 38, and 13 kHz respectively [45], [46]. It is therefore not only plausible but probable that bats exposed to an RF pulse of sufficient power would effectively hear this pulse and the frequency detected would lie within the range of frequencies used for orientation, prey detection and capture for the majority of bat species. It is possible that, as reported in other studies, exposure to these auditory effects may be stressful for bats or indeed it may interfere with their echolocation, inhibiting prey detection or capture. During the present study, foraging rate per unit time was significantly reduced during experimental trials indicating that bats foraging within the exposed area were feeding at a reduced rate in comparison to those foraging during the control trials. This is particularly surprising given that exposure to the radar had no significant impact on the abundance of aerial insects, and the observed reduction in foraging rate is therefore unlikely to be linked to a decline

in insect abundance. It is therefore possible that the auditory perception of the radar signal during experimental trials could have interfered with the bats ability to detect or capture prey. However further experimentation would be required to accurately identify the causal relationship between exposure to electromagnetic radiation and the observed reduction in both bat activity and foraging rate.

Although we have demonstrated a clear biological effect, one of the limitations of the present study was the use of a commercial marine radar that was not specifically designed for the task. With only a limited control over the parameters of the radar signal, it is difficult to determine which parameters are most effective in deterring bats. To better understand the response of bats to electromagnetic radiation, and to identify an optimum signal capable of deterring bats, will require radar engineers to work with bat biologists to develop a portable radar which can be manipulated to produce a wider range of electromagnetic outputs. The parameters most likely to be important are the frequency, pulse length/pulse repetition rate and power output of the signal. Similarly, the radar used in the present study was only effective when the antenna was fixed to produce a unidirectional signal with a horizontal beamwidth of 1.9°. A narrow unidirectional signal is clearly not appropriate to deter bats from approaching wind turbines. In order to provide an effective deterrent it would be necessary to emit a multidirectional electromagnetic signal capable of encapsulating the large volume of the rotor-swept zone.

Conclusion

We have demonstrated that pulsed electromagnetic radiation from a small, affordable and portable radar system can reduce bat activity within a given area. Results were most effective when the radar antenna was fixed to produce a unidirectional signal therefore maximising dwell time within the beam of the radar. However although bat activity was significantly reduced during experimental trials substantial numbers of bats continued to forage within the beam. It is possible that only a particular combination of wavelength, pulse repetition rate, power output and target size or orientation may provoke a reaction and further work is necessary to elucidate this relationship further.

Acknowledgments

Go to:

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Stray voltage and developmental, reproductive and other toxicology problems in dogs, cats and cows: a discussion.

Marks TA[1], Ratke CC, English WO.

Author information

Abstract

Ten years ago, after 3 y of investigations, attempts to determine the cause(s) of reproductive and developmental problems at a dog kennel in Allegan County, MI were suspended. This kennel had lost more than 120 litters of Shetland Sheepdogs (Shelties) over the preceding 12 y; many of the puppies that died were deformed as were several that survived. Similar effects occurred in Persian cats, although on a smaller scale, and later in German Shepherds and Golden Retrievers. Such problems began after drilling a deeper water well and the building of a new kennel of concrete and metal fencing in 1969. Prior to that time the kennel owner had successfully bred and raised at least 15 litters/y of mostly Shelties in an old wooden chicken coop. Health problems in the kennel owner prevented her from breeding dogs in the late 1980's. She gradually resumed a more regular breeding schedule in 1989, initially with some success. However, in 1992 reproductive problems returned. Female dogs ceased cycling or had abnormal "unbreedable" seasons. Sperm checks revealed a lack of sperm in four males. Concurrently, neither the Persian nor mongrel female cats in the kennel showed signs of cycling. Two dairy farmers in Allegan County, who reportedly had similar health, reproductive and management concerns in cows, were contacted. Tests performed at these dairy farms had revealed the presence of what has commonly been called stray voltage. Equipment brought by the farmers to the kennel revealed the presence of AC and DC currents on the premises, which was later confirmed by a Staff Engineer of the Michigan Public Service Commission (PSC). Such current was detected even when the electrical power to the premises was shut off. For example, 2.45 volts AC and -0.150 volts DC were detected at the well head, with variable amounts detected at various locations in the kennel. The current was not constant, with transients (spikes) frequently detected. Similar problems were evident in Van Buren County at a recently constructed kennel about 15 miles south of the kennel in Allegan County. Shortly after moving to the property, health problems not previously experienced by the breeder began cropping up in the dogs. Experts from the power company, the PSC, and 2 independent consultants have taken a variety of measurements on the property. The tests confirmed the presence of stray voltage (AC and DC) with periodic voltage spikes, as well as electromagnetic fields and electric fields. None of the extensive tests have proven the property owner to be at fault.(ABSTRACT TRUNCATED AT 400 WORDS).

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Exposure to cell phone radiations produces biochemical changes in worker honey bees

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Abstract

Go to:

The present study was carried out to find the effect of cell phone radiations on various biomolecules in the adult workers of *Apis mellifera* L. The results of the treated adults were analyzed and compared with the control. Radiation from the cell phone influences honey bees' behavior and physiology. There was reduced motor activity of the worker bees on the comb initially, followed by en masse migration and movement toward "talk mode" cell phone. The initial quiet period was characterized by rise in concentration of biomolecules including proteins, carbohydrates and lipids, perhaps due to stimulation of body mechanism to fight the stressful condition created by the radiations. At later stages of exposure, there was a slight decline in the concentration of biomolecules probably because the body had adapted to the stimulus.

Keywords: *Apis mellifera*, biomolecules, cell phone radiations, hemolymph

INTRODUCTION

Go to:

Cell phone usage is a major public health concern because of potential risk of chronic exposure to low level of radiofrequency and microwave radiation that pulse off the phone antennae in close proximity to the head.[1] These concerns have induced a large body of research, both epidemiological and experimental, in humans and animals. Honeybees are reliable indicators of environmental status and possess several important ecological, ethological, and morphological characteristics. They are the best experimental animals to study the effect of electromagnetic waves because they possess in their abdomen magnetite granules which help the bees in their orientation flight. Moreover, the integument of bees has semiconductor functions. It is in the light of these characteristics of honey bees that the present investigation was planned to study the metabolic changes with respect to proteins, carbohydrates, and lipids in hemolymph of worker honeybee of *Apis mellifera* L. exposed to cell phone radiation.

MATERIALS AND METHODS

Go to:

Study area

The samples of *A. mellifera* adult worker bees were drawn from the colonies maintained by Department of Zoology, Punjab University, Chandigarh.

Experimental design

A specially designed wooden box called the observation hive was used for the experiment. Front and back of the box were made up of glass while the two sides had wire gauze to ensure proper ventilation. Two such boxes, one experimental and the other control, were taken for the present study. The phones used were of the same make and model and had the same network. Phones were kept in listen-talk mode for 40 min using a tape recorder. Ten honeybees were collected from the exposed frame at intervals of 10, 20 and 40 min. Ten honeybees were collected from the control at the same time intervals.

Sample preparation

Hemolymph of the worker bees was extracted with the help of the micropipette inserted into the inter-segmental region of the bee's abdomen. Equal volume of hemolymph from all bees was dissolved in 1 ml of normal saline.

Biochemical estimation

Estimation of total carbohydrates The quantitative estimation of total carbohydrates in the test and control samples of *A. mellifera* was carried out by following the method of Sawhney and Singh.[2]

Estimation of glycogen Seifter's method[3] was followed for the estimation of glycogen in treated and non-treated hemolymph of *A. mellifera*.

Glucose estimation For the estimation of glucose in the hemolymph of *A. mellifera*, the method of Somogyi and Nelson[4] was employed.

Estimation of total lipids The quantitative estimation of total lipids in the treated and non-treated hemolymph extract of *A. mellifera* was carried out by following the procedure of Fringes and Dunn.[5]

Cholesterol estimation Method of Zlatki's *et al.*[6] was employed for the estimation of cholesterol in treated and non-treated sample.

Estimation of protein The total quantity of protein in the test and control sample of *A. mellifera* was determined by following the standard procedure of Lowry.[7]

RESULTS AND DISCUSSION

Go to:

Total carbohydrates

Control In the non-treated or control sample, the concentration of total carbohydrates in the hemolymph was found to be 1.29±0.02 mg/ml.

Test In the hemolymph of treated bees, the concentration was 1.5±0.04 mg/ml in 10 min, 1.73±0.01 mg/ml in 20 min and 1.61±0.02 mg/ml in 40 min exposure samples.

Glycogen In the treated sample, the glycogen content (mg/ml) was found to be 0.019 0.001 as compared to 0.047 0.001, 0.076±0.001 and 0.028±0.002 in 10, 20 and 40 min exposure samples, respectively.

Glucose

The glucose content (mg/ml) in control sample was 0.218±0.0005, while in the various treated samples the concentration was 0.231±0.002, 0.277±0.001 and 0.246±0.002 in 10, 20 and 40 min exposure samples, respectively.

Total lipids The concentration of total lipids (mg/ml) in the hemolymph of control worker bee was found to be 2.06±0.02. For the treated sample, the concentration of total lipids was 3.03±0.02, 4.50±0.035 and 3.10±0.02 in 10, 20 and 40 min exposure samples, respectively.

Cholesterol The cholesterol concentration (mg/ml) in the non-treated sample was 0.230 0.001. In the treated sample, the concentration was 1.381±0.002, 2.565±0.002 and 1.578±0.002 in 10, 20 and 40 min exposure samples, respectively.

Total protein content In the hemolymph of control sample, the protein concentration (mg/ml) was 0.475±0.002. In the treated sample, the protein concentration was 0.525±0.003, 0.825±0.0001 and 0.650±0.0003 in 10, 20 and 40 min exposed samples, respectively.

Very little work has been done on biochemical, metabolic and physiological influences of cell phone radiations pertaining to health risk in man.[8] Therefore, the present investigations on the influence of cell phone radiations on some biochemical and physiological aspects of honeybee biology were undertaken. That the behavior of honeybee is altered to some extent by high or low energy fields or electromagnetic radiations has been known for quite some time.[9]

During the present investigation, it was observed that there was an increase in concentration of total carbohydrates in the bees exposed to cell phone radiation for 10 min as compared to unexposed or control bees. Increasing the exposure time to 20 min resulted in further increase in the concentration, while an exposure of 40 min had a reverse effect and there was a decline in carbohydrate concentration, though it was still higher as compared to control. Hemolymph glycogen and glucose content also showed the same trend, i.e., there was increase in content up to 20 min exposure after which there was a slight decline in the concentration which remained more than the control. Sharma[10] had also reported increase in glycogen and glucose levels in the exposed pupa of *A. mellifera*.

Lipids are the major energy reserves of insects. Certain lipid classes are structure components of membranes while others are raw materials for a variety of hormones and pheromones. Estimation of total lipids and cholesterol during the present study showed that the trend was similar to that of carbohydrates. After an initial increase in concentration at the 10 and 20 min exposure period, a decline was observed in the concentration of total lipids and cholesterol at 40 min exposure.

It was interesting to note that during the present study as the exposure time increased, it appeared that the bees having assessed the source of the disturbance decided to move and a large scale movement of the workers toward the talk-mode (not toward the listening mobile) was observed. Also, the bees became slightly aggressive and started beating their wings in agitation. This mobility of the bees could be responsible for increase utilization of energy sources and consequent decrease in concentration of carbohydrates and lipids in the 40 min exposed sample.

Acknowledgments

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Footnotes

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10. Sharma A. M Phil. Thesis, Department of Zoology. Chnadigarh India : Punjab University Chnadigarh ; 2008. Biochemical changes in *Apis mellifera* L. Worker Brood Induced by Cell Phone Radiation.

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Biomedical Research

Exposure to radio frequency radiation emitted by cell phone and mortality in chick embryos (Gallus domesticus)

Author(s): I. V. Ingole, S. K. Ghosh

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Key words: Cell phone, EMR, radio frequency, radiation, mortality, chick embryo

Accepted September 24, 2006

Abstract

The rapidly increasing use of cell phones since late 1990s has caused a general concern on the possible hazardous health effects of exposure to radio frequency electro-magnetic radiation (EMR) emitted by them. While considering the bio-logical effects of EMR on the human body, its intensity, frequency of radiation and duration of exposure are important determinants. Many researchers have reported several harmful effects associated with exposure to radio frequency EMR while some of the studies could not show any effect at all. The present study addresses the effect of cell phone emanating EMR in 900 MHz radio fre-quency (widely used) range in determining the health of developing chick em-bryos. A standard cell phone hand set working at a radio frequency band of 900 MHz, power of 2 W and Specific Absorption Ratio (SAR) 0.37W/Kg was used. Sets of fertile hen eggs (Gallus domesticus) in batches were incubated in a spe-cially designed incubator (radio transparent) at a constant temperature, humidity. During incubation one set of eggs was exposed for a short period and the other set was exposed for a longer duration to radiation of the cell phone while the remaining set of eggs was not exposed to any radiation. It was observed that exposure to radiation increased the mortality in chick embryos. It was further observed that the rate of mortality is the function of EMR energy comprising power density at the egg location and duration of exposure.

Introduction

With the proliferation of personal wireless telecommunication instruments like cordless phones the cell phone has taken over the society by storm. Its compact size, low weight and ease of use have found millions of users. Though introduced only in 1990 the user base of cell phone has crossed 40 million marks within a decade espe-cially in a country like India. Unlike other electronic equipments the transmitter in the cell phones which radi-ates EMR happens to be close to human body hence it calls for an attention for its effects on human. Scientific researches have highlighted some extremely hazardous effects of exposure to radiation emitted by the cell phones on the human body like disruption of learned behavior, headache, fatigue, dysaesthesia etc [1,2,3]. Significant increases in single and double strand DNA breakages in rat's brain cells have been reported [4] after exposure to radio frequency radiation. These changes at molecular level are potentially dangerous to the animal and may prove lethal. Radio frequency radiation exposure has been reported to induce changes in the prenatal development [5]. Effect of role of frequency modulation of microwaves on ornithine decarboxylase activity has been reported [6]. Use of cell phones has been incriminated as a risk for brain tumours [7]. Lethal effects leading to high rate of mortality were reported in chick embryos following exposure of eggs to cell phone radiation in the radio frequency bandwidth and 2W power [8]. Six times the mortality in the exposed chick embryos than that of the control group was reported by the above investigators. In another study, during the embryonic development chick embryo mortality was reported to have increased to 75% as a result of exposure to EMF from GSM mobile phone as compared to 16% in the control group [9]. Conversely some of the investigations have reported no adverse biological effects of exposure to radio frequency radiation emitted by the cell phone. The studies aimed to investigate the effects of microwaves emitted by cell phones on peripheral blood parameters of rats did not reveal any difference in the experimental group from sham-exposed group. But the birth weight of offspring in the experimental group was signifi-cantly lower than in the sham-exposed group [10]. Cyto-genetic investigations on microwaves emitted by a 455.7MHz car phone have failed to show any significant difference in chromosomal aberration or sister chromatid exchanges between microwave exposed human lymphocytes and unexposed control samples[11].

In considering the biological effects of exposure to radiation, the frequency, its power density and duration of ex-posure are the important determinants [12]. Regulatory organizations in different countries have established norms for human radio wave exposure and Specific Ab-sorption Ratio (SAR). Considering the controversial reports of the effects of exposure to RF radiation and the varying situations of exposure duration, frequency and intensity of radiation, the present article addresses the concern regarding the safety of exposure to radio frequency radiation emitted by handheld communication devices commonly known as cell phone handset on grow-ing embryos particularly of chick as a first pointer.

Materials and Methods

Fertile hen eggs were acquired from State Government Poultry Farm, Camp, Amravati 444602, India.

A popular brand cell phone hand set and service provider were selected with a frequency in the bandwidth of 900 MHz, power of 2 Watt and Specific Absorption Rate (SAR) of 0.37 W/Kg.

An egg incubator cubicle (W-35 cm, H-30 cm, and D-30 cm) made from specific heat resistant non-metallic material to avoid any internal reflection of the cell phone radiation within the enclosure was used. It had temperature and humidity controller with forced air ventilation. Fur-thermore it had an arrangement for automatic rotation of eggs twice a day. It had an arrangement for mounting the cell phone at on the top of the eggs. A radiation exposure duration meter (EDM) was used to measure the cumula tive time of cell phone radiation having an inbuilt control-ler to initiate the cumulative recording of time whenever the cell phone started radiating outgoing signal.

Positioning the eggs and cell phone

Eggs were arranged in 3X3 array and numbered as shown in Diagram 1. The cell phone antenna was kept at a distance of five cm above egg no.5. Calculated radiation power intensity for particular numbered egg is as shown in the Table 1.

1	2	3
4	5 Antenna	6
7	8	9

Diagram 1: Relative position of numbered eggs and cell phone antenna

Table 1: Table showing power intensity received by eggs at different positions

Egg Number	Distance between egg & cell phone antenna in cms	Power intensity W/sq.cm
1,3,7,9	9.25	1.9
5	5	6.4
2, 8	7	3.2
4,6	7.8	2.6

The experiment was divided in the following sets:

First set (Short duration of exposure)

In the first set of experiment eggs were incubated in five batches of eighteen eggs each. Nine eggs from each batch were incubated in a standard egg incubator at 37± 0·5° C and 50-55% humidity without any exposure. Remaining nine eggs in each batch were incubated giving radiation in sessions of half an hour each and sessions spaced evenly at twelve hours interval. For exposure, the cell phone was placed in the incubator after dialing a particular number. The cell phone started emitting signal and the duration was recorded by the exposure duration meter (EDM). This was followed by a silent interval during which there was an automatic redialing but there was no emission of signal. After the redialing was complete, cell phone again started emitting signal and it's duration was detected and recorded by EDM. Thus the total duration of exposure of half an hour in each session was not continuous but interrupted by short exposure-free periods. The exposed groups of all the five batches were exposed for four sessions, thus giving two hours of total exposure in the first

forty eight hours of incubation. The eggs from these five batches were sacrificed at the completion of 4th, 5th, 10th, 12th and 14th day respectively (Table 2)..

Table 2: Observations of First Set (Short duration of exposure)

Age	Control				Exposed			
ED (Days)	Live	Dead	Infertile	% Mortality	Live	Dead	Infertile	% Mortality
ED4	8	Nil	1	0.00	8	1	Nil	11.11
ED5	8	NI	1	0.00	8	Nil	1	0.00
ED10	8	Nil	1	0.00	8	1	Nil	11.11
ED12	7	1	1	11.11	7	2	Nil	22.22
ED14	7	1	1	11.11	7	2	Nil	22.22

Table 3: Observations of Second set (long duration of exposure)

Age	Control				Exposed			
ED (Days)	Live	Dead	Infertile	% Mortality	/Live	Dead	Infertile	% Mortality
ED4	9	Nil	Nil	0.00	8	1	Nil	11.11
ED9	7	1	1	11.11	7	2	Nil	22.22
ED10	9	Nil	Nil	0.00	6	3	Nil	33.33
ED12	7	1	1	11.11	5	4	Nil	44.44
ED14	8	Nil	1	0.00	2 .	7	Nil	77.78

Second set (long duration of exposure)

Eggs were incubated in five batches of 18 eggs each similar to that of the 1st set.

Nine eggs in each batch were incubated as control in an incubator at 37±0.5°C and 50-55% humidity. Remaining nine eggs in each batch were incubated in the special in-cubator (as mentioned for the first set). Eggs were placed on the numbered slots and were incubated at 37±0.5 ° C and 50-55% humidity (as in the first set). The cell phone was placed in the same position as for exposed groups of first set. Exposures were given in sessions of half an hour each, spaced at 12 hrs intervals. Duration of exposure was recorded by EDM. The five batches were exposed to radiation exposure schedules of four h, four h, six h, nine h and tens h respectively. These five batches were sacrificed at the completion of 4th, 9th, 10th, 12th and 14th day of incubation respectively (Table 3). The embryos were taken out and observed for viability and gross morphology.

Observations and Discussion:

First Set: (short duration of exposure)

At the completion of 4th, 5th, 10th, 12th and 14th day of in-cubation, the condition of the embryos in the control group receiving no radiation and the condition of the embryos in the exposed group receiving exposure to radia-tion during the first 48 h of incubation is tabulated in Ta-ble 2.

Second Set: (long duration of exposure):

In the control groups where no exposure was given, at the completion of 4th, 9th, 10th , 12th and 14th day of incubation, the condition of the eggs was as shown in Table 3.

In the exposed groups from this long exposure set, where total exposures were four hours, four hours, six hours, nine hours and ten hours respectively, at the completion of 4th, 9th, 10th, 12th, and 14th day of incubation, the condition of eggs is shown in Table 3. Status including the mortality of embryos in all above experiments is shown in Table 4. The embryo [5] underlying the antenna having an exposure of 6.4 mW/sq.cm was consistently found dead in all the batches of exposed groups of second set (Table 4).

Table 4: Mortality of embryos with respective position of eggs

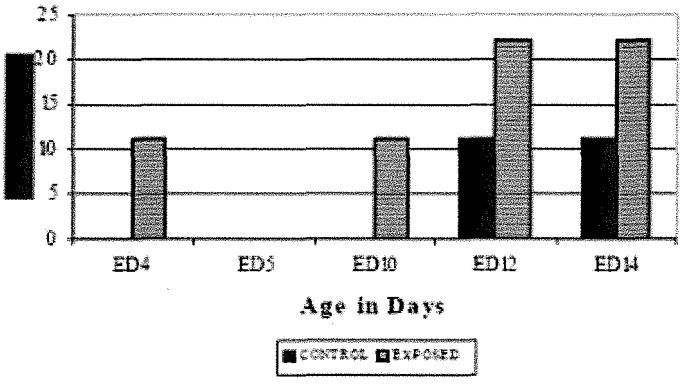
SET 1						SET 2					
CONTROL			EXPOSURE FIRST 48 H			CONTROL			EXPOSURE THRU'OUT INCUBATION		
CONTROL ED4			EXPOSED ED4 2H 4 Sessions			CONTROL ED4			EXPOSED ED4 4H 8 Sessions		
1	2*	3	1	2	3	1	2	3	1	2	3
4	5	6	4	5	6	4	5	6	4	5	6
7	8	9	7	8	9	7	8	9	7	8	9
CONTROL ED 5			EXPOSED ED5 2H 4 Sessions			CONTROL ED9			EXPOSED ED 9 4H 8 Sessions		
1	2	3*	1	2*	3	1*	2	3	1	2	3
4	5	6	4	5	6	4	5	6	4	5	6
7	8	9	7	8	9	7	8	9	7	8	9
CONTROL ED10			EXPOSED ED10 2H 4 Sessions			CONTROL ED10			EXPOSED ED10 6H 12 Sessions		
1	2*	3	1	2	3	1	2	3	1	2	3
4	5	6	4	5	6	4	5	6	4	5	6
7	8	9	7	8	9	7	8	9	7	8	9
CONTROL ED12			EXPOSED ED12 2H 4 Sessions			CONTROL ED12			EXPOSED ED12 9H 18 Sessions		
1*	2	3	1	2	3	1	2*	3	1	2	3
4	5	6	4	5	6	4	5	6	4	5	6
7	8	9	7	8	9	7	8	9	7	8	9
CONTROL ED14			EXPOSED ED14 2H 4 Sessions			CONTROL ED14			EXPOSED ED14 10H 20 Sessions		
1	2	3*	1	2	3	1	2	3	1	2	3
4	5	6	4	5	6	4	5	6	4	5	6
7	8	9	7	8	9	7	8	9*	7	8	9

(For larger image, click here)

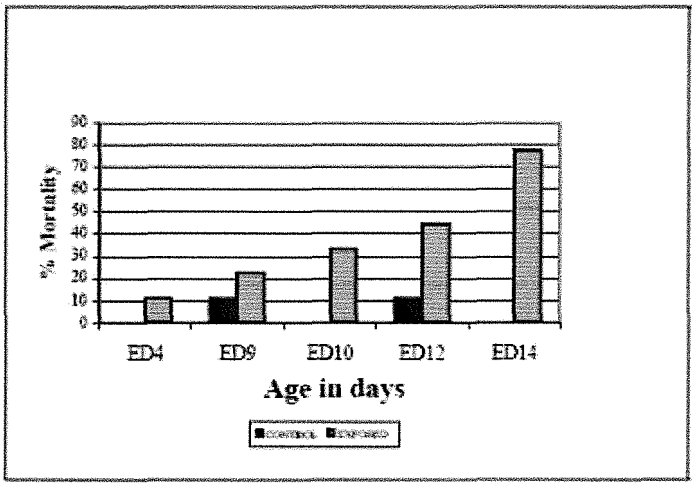
In the present work, the mortality of chick embryos with a short exposure (2 h) to cell phone EMF did not show significant difference between the exposed group and that of the control group in the initial period of incubation. While with the same dose of radiation exposure, as the incuba-tion was allowed to progress, mortality was found to be higher than that of control group in the later days of incubation (Graph1). Since in the short exposure schedule, no significant difference in the mortality between 4th and 5th day was noted, the 5th day schedule was omitted in the second set of experiment and the incubation was allowed to progress up to the completion of 9th day with the same dose of exposure as for 4th day schedule i.e. 4 h. In this batch 2 embryos were found dead (Table 3). Both these findings may be attributed to some delayed effect of ex-posure to radiation.

In our experiment with longer duration of exposure (second set), the exposed groups had a higher mortality rate compared to their control counter parts in all the batches (Graph 2). Also the mortality of embryos exposed to radiation for a longer duration was significantly higher than those exposed for a shorter period (Graph 3). It was observed that in the batches incubated for a longer period, there was a significant increase in the mortality rate of embryos as the duration of exposure increased. These results are much in conformity with the reports of the work of Saito et al [13], who reported lethal and terato-genic effects in chick embryos following exposure to 428 MHz frequency radiation at a power density of 5.5 mW/cm2 where low level radiation was applied throghout the incubation period over 20 days. Lethality amounted to 60% in the exposed group (against 16% in the control group) where SAR ranged from 3.1 to 47.1 mW/kg. varying with the position of the egg in the field. In our work the radiation was at higher frequency (900MHz) and SAR also higher (0.37 W/Kg.), which possibly accounted for the higher mortality (77.78) in the exposed group (long exposure). Similarly Youbicier et al [8]) also reported six fold increase in the mortality of chick embryos as a result of exposure to cell phone radiation with a frequency of 900 MHz compared to control group. In the work of above researchers the exposure was given continuously throughout the incubation period whereas the significance of the finding of the present work lies in the fact that the duration of exposure is intermittent similar to day-to-day use. In another study, Gregor'ev lug reported 75 mortality of chick embryos during embryonic development as a result of exposure to EMF from GSM mobile phone as against 16% in control group [9]. Details like frequency and SAR could not be ascertained in this case.

Graph 1: Mortality of embryos in control and exposed groups after short duration of exposure



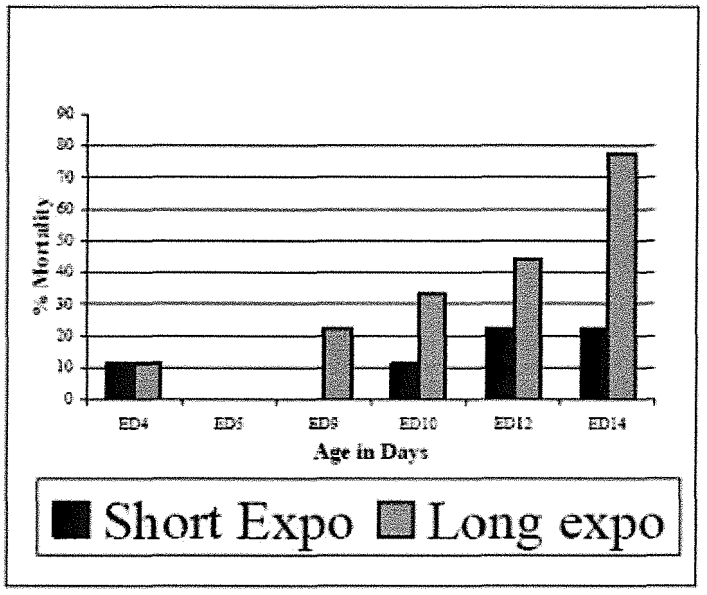
Graph 2: Mortality of embryos in control and exposed groups after long duration of exposure



On the longer duration exposure experiment, the embryo no. 5 lying right under the antenna having been exposed to power intensity of 6.4 mW/sq.cm was found dead in all the five batches. Embryo no. 2 and no. 8 exposed to the 3.2 mW/sq.cm power intensity survived in the initial batches but were found dead in the batches receiving an exposure of six hours and more. The embryo no. 4 & 6 exposed to 2.6 mW/sq.cm power intensity radiation were found dead in the last two batches receiving an

exposure of 9 h and 10 h respectively. Embryos no 3 and 9 exposed to 1.9 mW/sq.cm power intensity were found to be alive in all the batches except one embryo in the batch sacrificed on the completion of 9th day. Similarly embryos no. 1 and no.7 exposed to 1.9 mW/sq.cm power intensity sur-vived in all the batches except the last one receiving long-est exposure. (Dia.2 & Table1). It shows that the power intensity plays a significant role in causing the mortality of chick embryos.

Graph 3: Mortality in embryos after short and long exposure



Conclusion

The present work shows that radiation emitted from cell phone causes an increase in the mortality of chick embryos which depends on the increase in energy of dose comprising the exposure in the form of increased duration and power intensity of cell phone operating in the frequency range of 900 MHz and 2 watt power. High rate of mortality in the exposed groups is indicative of tissue damage, which is being investigated.

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Small electric currents affecting farm animals and man: A review with special reference to stray voltage

I. Electric properties of the body and the problem of stray voltage

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Abstract

The literature on the electrical properties of the body and sensitivity to steady electric current in humans and farm animals is reviewed and the problem of stray voltage is examined. Stray voltage poses a problem to animal health and protection in cattle and pigs and possibly also in other animals. Dairy cattle can perceive alternating currents exceeding 1 mA between the mouth and all four hooves. Behavioural effects in cows usually occur above 3 mA. In practice, the major influence on dairy cows appears to be behavioural. In experimental research on sensitivity to electric current, the effects studied should be related primarily to the actual current densities or electric fields in the affected tissues rather than to the total voltages applied. Under normal conditions, herdsmen are less likely to be affected by stray voltage than their animals.

Keywords

behaviour cows electricity perception pigs stray voltage

Preview

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Schweiz Arch Tierheilkd. 2009 Oct;151(10):471-8. doi: 10.1024/0036-7281.151.10.471.

Prevalence of nuclear cataract in Swiss veal calves and its possible association with mobile telephone antenna base stations.

Hässig M[1], Jud F, Naegeli H, Kupper J, Spiess BM.

Author information

Abstract

The purpose of this study was to valuate the prevalence of nuclear cataract in veal calves and to elucidate a possible impact by mobile phone base stations (MPBS). For this experiment a cohort study was conducted. A follow-up of the geographical location of each dam and its calf from conception through the fetal period up to slaughter was performed. The first trimester of gestation (organogenesis) was particularly emphasized. The activities of selected protective antioxidants (superoxide dismutase, catalase, glutathione peroxidase [GPx]) were assessed in aqueous humor of the eye to evaluate the redox status. Of 253 calves, 79 (32 %) had various degrees of nuclear cataract, but only 9 (3.6 %) calves had severe nuclear cataract. Results demonstrate a relation between the location of veals calves with nuclear cataracts in the first trimester of gestation and the strength of antennas. The number of antennas within 100 to 199 meters was associated with oxidative stress and there was an association between oxidative stress and the distance to the nearest MPBS. Oxidative stress was increased in eyes with cataract (OR per kilometer: 0.80, confidence interval 95 % 0.62,0.93). It has not been shown that the antennas actually affected stress. Hosmer-Lemeshow statistics showed an accuracy of 100 % in negative cases with low radiation, and only 11.11 % accuracy in positive cases with high radiation. This reflects, that there are a lot of other possibilities for nuclear cataract beside MPBS. Further studies on the influence of electromagnetic fields during embryonic development animal or person at risk are indicated.

PMID: 19780007 DOI: 10.1024/0036-7281.151.10.471

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Hamrick PE, McRee DI, Thaxton P, Parkhurst CR.

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Radiats Biol Radioecol. 2003 Sep-Oct;43(5):541-3.

[Biological effects of mobile phone electromagnetic field on chick embryo (risk assessment using the mortality rate)].

[Article in Russian]

Grigor'ev IuG[1].

Author information

Abstract

Chicken embryos were exposed to EMF from GSM mobile phone during the embryonic development (21 days). As a result the embryo mortality rate in the incubation period increased to 75% (versus 16% in control group).

PMID: 14658287

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Article

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Bernard Greenberg , Vytautas P. Bindokas, James R. Gauger

First published:
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Funding Information

Abstract

Honeybee colonies exposed under a 765-kV, 60-Hz transmission line at 7 kV/m show the following sequence of effects: 1) increased motor activity with transient increase in hive temperature; 2) abnormal propolization; 3) impaired hive weight gain; 4) queen loss and abnormal production of queen cells; 5) decreased sealed brood; and 6) poor winter survival. When colonies were exposed at 5 different E fields (7, 5.5, 4.1, 1.8, and 0.65–0.85 kV/m) at incremental distances from the line, different thresholds for biologic effects were obtained. Hive net weights showed significant dose-related lags at the following exposures: 7 kV/m, one week; 5.5 kV/m, 2 weeks; and 4.1 kV/m, 11 weeks. The two lowest exposure groups had normal weight after 25 weeks. Abnormal propolization of hive entrances did not occur below 4.1 kV/m. Queen loss occurred in 6 of 7 colonies at 7 kV/m and 1 of 7 at 5.5 kV/m, but not below. Foraging rates were significantly lower only at 7 and 5.5 kV/m. Hive weight impairment and abnormal propolization occur at lower E-field intensity than other effects and limit the "biological effects corridor" of the transmission line to approximately 23 m beyond a

ground line projection of each outer phase wire. Intrahive E fields of 15–100 kV/m were measured with a displacement current sensor. Step-potential-induced currents up to 0.5 μA were measured in an electrically equivalent bee model placed on the honeycomb in a hive exposed at 7 kV/m. At 1.8 kV/m body currents were a few nanoamperes, or two orders of magnitude lower, and these colonies showed no effects. E-field versus electric shock mechanisms are discussed.

Assessing the health status of managed honeybee colonies (HEALTHY-B): a toolbox to facilitate harmonised data collection

EFSA Panel on Animal Health and Welfare (AHAW)

25 October 2016

Citing Literature

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Comp Biochem Physiol A Comp Physiol. 1988;89(3):415-24.

Plasma corticosterone in hemorrhaged Japanese quail after microwave irradiation in ovo.

Gildersleeve RP[1], Satterlee DG, McRee DI, Bryan TE, Parkhurst CR.

Author information

Abstract

1. Sexually immature male and female Japanese quail were divided within each sex into three treatment groups: hemorrhaged by jugular puncture; immobilized for 2 min, but not hemorrhaged (shams); and neither immobilized nor hemorrhaged (controls). 2. Hemorrhage resulted in increased plasma corticosterone levels in both sexes. Corticosterone levels in shams were higher than in controls. 3. In another experiment, Japanese quail eggs were irradiated during incubation with 2.45 GHz CW microwave radiation. Nonirradiated eggs were incubated under identical conditions without irradiation. After hatching, juvenile males and females were hemorrhaged. 4. After hemorrhage, irradiated males had higher plasma corticosterone levels than nonirradiated males. No effect of irradiation on females was found. 5. The results of these two experiments indicate that male quail respond to blood loss with increased adrenocortical activity and that this response is modified in male quail after irradiation with microwaves during embryogeny.

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EFFECTS OF THE ELECTROMAGNETIC FIELDS OF PHONE MASTS ON A POPULATION OF WHITE STORK (*Ciconia ciconia*)

©Alfonso Balmori Martínez. Biologue.
Valladolid. Spain. March, 2004

SUMMARY.– *effects of the electromagnetic fields of phone masts on a population of White Stork (Ciconia ciconia).* Monitoring of a population of White Stork in the vicinity of Cellular Phone Base Stations was carried out in Valladolid (Spain) with the objective to detect possible effects. **Very significant differences among the total productivity of the nests located within 200 meters and those located further than 300 meters of phone masts were found (U=240; p=0,001, test of Mann-Whitney)**. In another intensive monitoring carried out around four monuments, **failures in the breeding of this species in the nests near to antennae were observed. The productivity** obtained in this study **shows very low levels** regarding the censuses previously realized. **The most affected couples could not build the nest**, had disputes for the placement of the sticks and the sticks dropped to the ground. These results are compatible with the possibility that **the microwaves are interfering especially with the reproduction of the white storks** in the inhabited nuclei and would corroborate the results of laboratory research by other authors.

Key words: *Ciconia ciconia*, electromagnetic fields, microwaves, non thermal effects, phone masts, White stork

INTRODUCTION

The objective of this study was to investigate if the cellsites cause effects in wild birds effects similar to the laboratory studies, and to those recorded in studies carried out on people exposed to this radiation (Lilienfeld, 1978; Hyland, 2000, Hutter *et al.*, 2002; Santini *et al.*, 2003; Navarro *et al.*, 2003) that could cause the abandonment of the area, the failure of the breeding, the decrease of the brood or other anomalies.

The white stork (*Ciconia ciconia*) was chosen to study because it is one of the most vulnerable species. The couple builds their nests on pinnacles and other very high places exposed to the microwaves. Also, they usually live inside urban environment, where the electromagnetic contamination is higher.

MATERIALS AND METHOD

During the 2002, 2003 and 2004 springs we carried out a monitoring of the reproduction of White Stork (*Ciconia ciconia*) in several nests of Valladolid (Spain).

The spring 2002 we take contact with the problem of the effects of phone masts on the species. That year we began to observe problems in the white storks breeeding nearer phone masts. Historical nests disappeared and we began to observe a reduction on the productivity (chicks/nest) and a high mortality of the youngs.

During the spring of 2003 we carried out a more exhaustive monitoring on the breeding success of white stork population. 30 nests were selected located within 200 meters of one or several cellsite antennae and another 30 nests located further than 300 meters of any cellsites, in Valladolid (Spain) (Table 1). The nests were visited in May and June of 2003. To compare the breeding success of both groups of nests a non parametric test was applied (U of Mann - Whitney).

We also carried out 15 visits between the months of February and June 2003 to four historical building (monuments) of Valladolid, with more than 20 nests of the species. The visits embraced all the phases of breeding, from the construction of the nest, until the appearance of youngs exercising the wings and practising flight. The monuments studied were San Pablo (A, B), San Martin (C), Las Angustias (D, E) and La Catedral (F, G) (Fig. 1). We made mensurements of the of Electric Field Intensity (radiofrequencies) in the proximity of the monuments.

The results of the previous censuses of white stork carried out in Valladolid and in other Spanish counties were consulted for comparison as a reference for the results obtained in this study.

During the spring of 2004 we are studying by means of observations, the behavior of the most affected white storks.

RESULTS

The total productivity (number of young flown by couple, including the nests with 0 chicks), in the nests located within 200 meters of antennae, was 0,86±0,16. For those located further than 300 meters, the result was practically duplicated, with

an average of 1,6±0,14 (Fig. 2). Both groups showed very significant differences in the breeding success (U=240; P=0,001, Test U of Mann-Whitney) (Fig. 2).

In partial productivity (number of young flown by number of couples with some chicks, excluding the nests with 0 chicks), an average of 1,44±0,16 was obtained for the first group (within 200 m. of antennae.) and of 1,65±0,13 for the second (further than 300 m. of antennae) respectively. The difference between both groups of nests in this case were not statistically significant (U=216; P=0,26, Test U of Mann-Whitney).

Twelve nests (40%) located within 200 meters of antennae didn't have any chicks, while only one (3,3%) of those located further than 300 meters didn't have chicks.

The results of the monitoring realized during the spring of 2003 near the four monuments studied in Valladolid are presented (Fig. 1 and Table 2). The white storks had a total productivity of 0.6±0,18 chicks per nest, while the partial productivity was 1,33±0,23. The nests that didn't have chicks generally presented a very scruffy and compressed aspect, as if the couple had not placed sticks in the last months. This happened especially in those located within 200 meters of antennae and on those that the main beam impacted directly. In the nests from San Martin (Fig. 1-C) and San Pablo (Fig. 1-A and B) at least one or two young **died from unknown causes**. Five nesting sites located within 200 meters from antennae, that received the direct beam of waves, **were never built in spite of the couple's repeated attempts** (Fig. 1 and Table 2). In their vicinity high Intensity levels of Electric Field (higher than 2 V/m) were measured.

The results of the bibliographical revision are presented. The results of productivity of this study are generally less than those obtained in previous studies, especially for the nests located within 200 meters of the cellsite antennae (Table 3).

From the behavior of most affected white storks, the most interesting observations include:

- The couple frequently dispute for the sticks

- Fall of the sticks to the ground while the copuple try to build the nest.

- The couple don't advance in the construction of the nest.

- The most affected nests don't end up being built.

- Increases the number of nests without chicks.

- Frequent death of young in their first stages.

- The storks remain passively in front of phone masts.

DISCUSSION

The results of the difference of total productivity between the near nests and those far from the antennae indicate the existence of nests without chicks, or the death of young in their first stages in the nests most affected by the microwaves. In the monitoring (more exhaustive) of the monuments near to cellsite antennae, dead young were observed (Fig. 1 and Table 2). Also, several couples (adults) never built the nest. The results of productivity of this study are generally less than those obtained in previous studies, especially for the nests located within 200 meters of the cellsite antennae (Table 3).

Keeping in mind these results, the microwaves could be affecting one or several reproductive stages: the construction of the nest, the number of eggs, the embryonic development, the hatching or to the mortality of chicks and young in their first stages.

Other authors have obtained similar results in studies with birds carried out in laboratories (Farrel *et al.*, 1997; Youbicier - Simo *et al.*, 1998; Grigoriew, 2003). Our observations indicate that the most affected nests would be those that are within 200 meters of the cellsite antennae (exposed to the incident beams of one or several antennae focused directly).

A Greek study (Magras & Xenos, 1997) relates to a progressive drop in the number of births of rodents. The mice exposed to 0.168 μW/cm2 become sterile after five generations, while those exposed to 1.053 μW/cm2 became sterile after only three generations. The interaction seems to take place through the central nervous system more than on the reproductive gland directly. In the areas of breeding of white storks in this study intensity of electric field levels are overcome (Pers. Obs.).

Other studies find a decrease of fertility, increase of deaths after the birth in rats and dystrophyc changes in their reproductive organs (Nikolaevich *et al.*, 2001). An increase in the mortality (Youbicier-Simo *et al.*, 1999) and the appearance of morphological abnormalities, especially of the neural tube (Farrel *et al.*, 1997) has been notified in chicken embryos exposed to pulsed magnetic fields, with different susceptibility among individuals probably for genetic reasons. A recent study shows a statistically significant high mortality of chicken embryos subjected to the radiation from a cellphone, compared to the control group (Grigoriew, 2003). These waves can be affecting the wild birds in the polluted areas in the same way (Balmori, 2003).

The radiofrequency electromagnetic contamination from antennae in cities is much higher than in the rural environment (Pers. Obs.). For this reason urban birds especially can suffer the effects of this radiation. One of the effects that can take place is reduction of the population (specially urban), in places with high electromagnetic contamination. The birds are specially sensitive to the magnetic fields (Liboff & Jenrow, 2000) For this reason they abandon the electromagnetic polluted areas (Balmori, 2003). It is probable that each species, even each individual, show different susceptibility to the radiation, since the susceptibility depends on the genetic bias (Fedrowitz *et al.*, 2004), and of the irradiated living organisms physiologic and neurological state (Hyland, 2001).

In the electromagnetic polluted areas (within an approximate radius of 300-500 meters of an antenna, in the direct emission of the main beam), a deterioration of the good habitat, for the permanency of the birds, takes place. That can cause the abandonment of the breeding areas, sleeping places etc. (Balmori, 2003). In far away areas, where the radiation decreases progressively, the chronic exposure can also have long term effects (Adey, 1996; Magras & Xenos, 1997). The effects from phone masts on the habitat of birds are difficult to quantify, but they can cause a serious deterioration, generating silent areas without male singers nor reproductive couples. The deterioration of the ecosystem can also take place from the impact of the radiation on the populations of invertebrate prey and on the plants (Balmori, 2003).

Microwaves have the potential to induce adverse reactions in the health of people (Hyland, 2000 and 2001, Santini *et al.*, 2002 and 2003; Navarro *et al.*, 2003) and on the fauna that lives in the vicinity of the antennae (Balmori, 2003). The freedom of movement of the birds and their habit of settling in the proximity and even on the cellsites makes them potentially susceptible to the effects. The small organisms (children, birds, small mammals, etc...) are specially vulnerable, so much to approach their size to the frequency of resonance, like for the smallest thickness from their skull that facilitates a higher penetration of the radiation in the brain (Magras & Xenos, 1997; Santini, 2000; Hyland, 2001; Maisch, 2003; Balmori, 2003).

When the experimental conditions (power density, frequency, duration, composition of the tissue irradiated etc.) change, their biological effects also change (Kemerov *et al.*, 1999; Dasdag *et al.*, 1999). Below the levels (0,1 $\mu W/cm.^2$) recommended in the Salzburg conference adverse effects on health have never notified. At the same time when going away to more than 300 meters distance from the antennas, most of the symptoms notified in people diminish or disappear (Santini, 2003).

Recently it has also been demonstrated that the microwaves used in cellphones produce a non thermal response in several types of neurons of the Nervous System in the birds (Beason & Semm, 2002) and they can affect the blood brain barrier like it has been observed in rats (Salford *et al.*, 2003).

It is recommended to consider the electromagnetic contamination in the microwave range a risk factor in the decline of some populations, especially the urban birds, subjected to higher radiation levels.

We consider that the birds most affected from the microwave electromagnetic contamination could be: 1) The ones bound to urban environments with more sedentary customs. In general those that pass a lot of time in the vicinity of the base stations. 2) Those that live or breed in high places, more exposed to the radiations and at higher power density levels. 3) Those that breed on open structures where the radiation impacts directly on adults and chickens in the nest. 4) those that spend the night outside of holes or structures that attenuate the radiation.

Future investigation should be carried out with long term monitoring of the breeding succes, of the sleeping places and of the uses of the habitat for species more vulnerable to the waves for its behaviour. Of special interest should be the investigations that try to correlate the numeric evolution with the results of the radiofrequency electromagnetic field mensurements. Field studies investigating populations of urban parks and territories surrounding cellsites should be hight-priority.

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Possible Effects of Electromagnetic Fields from Phone Masts on a Population of White Stork (*Ciconia ciconia*)

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Monitoring of a white stork population in Valladolid (Spain) in the vicinity of Cellular Phone Base Stations was carried out, with the objective of detecting possible effects. The total productivity, in the nests located within 200 meters of antennae, was 0.86 ± 0.16. *For those located further than 300 m, the result was practically doubled, with an average of* 1.6 ± 0.14. *Very significant differences among the total productivity were found* ($U = 240$; $p = 0.001$, *Mann-Whitney test). In partial productivity, an average of* 1.44 ± 0.16 *was obtained for the first group (within 200 m of antennae) and of* 1.65 ± 0.13 *for the second (further than 300 m of antennae), respectively. The difference between both groups of nests in this case were not statistically significant* ($U = 216$; $P = 0.26$, *Mann-Whitney Test U). Twelve nests (40%) located within than 200 m of antennae never had chicks, while only one (3.3%) located further than 300 m had no chicks. The electric field intensity was higher on nests within 200 m* (2.36 ± 0.82 *V/m) than on nests further than 300 m* (0.53 ± 0.82 *V/m). Interesting behavioral observations of the white stork nesting sites located within 100 m of one or several cellsite antennae 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.*

Keywords Cellsites; Cellular phone masts; *Ciconia ciconia*; Electromagnetic fields; Microwaves; Nonthermal effects; Reproduction; White stork.

Introduction

Most of the attention on the possible biological effects of electromagnetic fields (EMF) has been focused on human health. People frequently use wildlife as biological indicators to detect the alterations in the ecosystems and in an urban

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habitat. The numeric tendency of the populations of birds is of particular interest in the conservation of nature [1].

The cellsite antennae emit a frequency of 900 or 1800 MHz, pulsed in very low frequencies, generally known as microwaves (300 MHz–300 GHz), similar to the radar spectrum. The cellsite ordinarily have 3 sectors, with 3 antennae that cover an angle of 120 degrees each [2–5]. Though they have many and varied outputs, at a distance of 50 m, the power density is about 10 $\mu W/cm^2$ [2], while at distances of 100 m at ground level it measures above 1 $\mu W/cm^2$ (personal observation). Between 150 and 200 m, the power density of the main lobe near the ground is typically of some tenth of 1 $\mu W/cm^2$ [3].

In real life, living organisms are exposed to variable levels of electromagnetic fields (radiofrequencies), according to the distance from the cellular bases stations, the presence of passive structures to either amplify the waves (e.g., the metallic structures) or to shield them (buildings or other obstacles), the number of transmission calls within the transmitters and their position with relationship to the orientation of the antenna [2].

Animals are very sensitive electrochemical complexes that communicate with their environment through electrical impulses. Ionic currents and electric potential differences exist through the cellular membranes and corporal fluids [6]. The intrinsic electromagnetic fields from the biological structures are characterized by certain specific frequencies that can be interfered with by the electromagnetic radiation, through induction and causing modification in their biological responses [3]. Animals exposed to the EMF can suffer a deterioration of health, changes in behavior [7, 8], and changes in reproductive success [9, 10].

The low intensity pulsed microwave radiation from cellsites produces subtle athermal influences in the living organisms, because this radiation is able to produce biological responses by the microwave carrier and by the low frequency of pulses from GSM system. "Windows" exist in whereby EMFs produce biological effects at specific frequencies (window effect) [11]. Some effects are manifested exclusively with a certain power density [12], while others are manifested after a certain duration of the irradiation, which indicates long-term cumulative effects [13]. During lingering exposure, the effects can change from stimulant to inhibition, depending on the pulse shape [14, 15], the duration, development, and differentiation and the physiologic condition or health of the receiving organism [16], and their genetic predisposition [17]. These waves seem to cause different, and even contrary effects, depending on their frequency, intensity, modulation, pulses or time of exposure [12, 16, 18]. The pulsed waves (in bursts) and certain low frequency modulations, produce great biological activity [14, 15, 18]. The dose-response relationships (athermal) are nonlinear [19].

Research has shown such effects on the living organisms at molecular [12] and cellular levels [20] on immune processes [21], in DNA [22], on the nervous, cardiac, endocrine, immune, and reproductive systems [16, 23–28], modification of sleep and alteration of the cerebral electric response (EEG) [29], increase of the arterial pressure and changes in the heart rhythm [30], and an increase in the permeability of the blood brain barrier [31].

The objective of this study was to investigate if the phone mast cellsites caused effects in wild birds similar to the laboratory studies, and studies carried out on people exposed to this radiation [3, 5, 32–35].

Materials and Methods

For monitoring the breeding success of the white stork population, nests ($n = 60$) were selected and visited from May to June of 2003. The difficulty of the investigation in the field, (and when studying wild species) does not allow one to control all variables as in the laboratory; however, the selected nests had similar characteristics. They were located in the roof of churches and buildings inside urban nuclei in Valladolid (Spain). (The nests on trees and other natural supports or outside the urban nuclei were never studied.) Since the cellsite radiations are omnipresent, very few places exist with an intensity of 0 V/m near inhabited nuclei. For that reason, nests were chosen that were exposed at very high or very low levels of electromagnetic radiation, depending on the distance from the nests to the antennas.

The nests were selected and separated in two categories:

a) Nests ($n = 30$) located within 200 m of one or several cellsite antennae (GSM-900 MHz and DCS-1800 MHz), placed in masts and in the roof of the buildings at 15–30 m high.
b) Nests ($n = 30$) located further than 300 m of any cellsites.

The nest were observed using a prismatic Zeiss 8 x 30 and a "Leika" 20-60 X telescope. The number of young were counted.

For the analysis of the results of the reproduction, two indexes were used:

1) the total productivity (number of young flown by each couple, including nests with zero chicks).
2) the partial productivity (number of young flown by couples with some chicks, excluding nests with zero chicks).

To compare the breeding success of both groups of nests a nonparametric test was applied (Mann-Whitney test U).

Also, we measured the electric field intensity (radiofrequencies and microwaves) in V/m, using a "Nuova Elettronica" device Model LX 1435 with 10% sensitivity, from a unidirectional antenna (range: 1 MHz–3 GHz). Keeping in mind the inaccessibility of the nests, the measurements were made in their vacinity under similar conditions, recording the reproducible values obtained when directing the antenna of the device toward the cellsite antenna in line of sight.

Between February 2003 and June 2004, we carried out 15 and 10 visits, respectively, to 20 nests located within 100 m of one or several cellsite antennae to observe the behavior of the species. The visits covered all the phases of breeding, from construction of the nest, until the appearance of young storks exercising their wings and practicing flight.

Results

Table 1 presents the number of young and electric field intensity (V/m) of each studied nest.

The total productivity, in the nests located within 200 m of antennae was 0.86 ± 0.16. For those located further than 300 m, the result was practically doubled, with an average of 1.6 ± 0.14 (Table 1). Both groups showed very significant differences in the breeding success ($U = 240$; $P = 0.001$, Mann-Whitney Test U).

Table 1
Intensity of electric field, total and partial productivity in the nests within 200 m and further than 300 m to the phone mast

Nests within 200 m			Nests further than 300 m		
Nest	Number of young	EMF (V/m)	Nest	Number of young	EMF (V/m)
1	2	0.8	1	1	0.4
2	2	0.6	2	2	0.7
3	0	0.8	3	1	1.3
4	3	1.5	4	1	1.1
5	1	1.7	5	1	0.6
6	2	2.9	6	3	0.4
7	1	3.1	7	2	0.6
8	1	1.3	8	2	0.7
9	1	1.3	9	3	0.6
10	1	2.8	10	1	0.7
11	1	1.8	11	2	0.8
12	3	3.2	12	2	0.3
13	1	1.6	13	3	0.1
14	0	2.7	14	1	0.6
15	0	2.3	15	2	0.5
16	0	2.7	16	3	0
17	0	2.5	17	2	0.3
18	0	3.5	18	1	0.8
19	0	3.5	19	2	0.2
20	0	2.7	20	0	0.8
21	0	2.9	21	2	0.2
22	2	3.2	22	1	0.6
23	0	2.5	23	1	0.5
24	1	2.6	24	1	0.7
25	1	2.4	25	1	1.4
26	0	2.2	26	2	0.1
27	1	2.6	27	1	0.1
28	1	3.1	28	2	0.2
29	1	3.1	29	1	0
30	0	3.0	30	1	0.6
Mean EMF		2.36			0.53
Total productivity		0.86		1.6	
Partial productivity		1.44		1.65	
Nests without young		12 (40%)		1 (3.3%)	

In partial productivity in average of 1.44 ± 0.16 was obtained for the first group (within 200 m of antennae) and 1.65 ± 0.13 for the second (further than 300 m of antennae) respectively. The difference between both groups of nests in this case was not statistically significant ($U = 216$; $P = 0.26$, Mann-Whitney Test U).

Twelve nests (40%) located within 200 m of the antennae never had any chicks, while only one (3.3%), located further than 300 m, never had chicks.

The electric field intensity was higher on nests within 200 m (2.36 ± 0.82 V/m) that on nests further 300 m (0.53 ± 0.82 V/m) (Table 1).

The results of the findings and interesting behavioral observations of the white stork nesting sites located within 100 m of one or several cellsite antennae and on those that the main beam impacted directly (EFI > 2 V/m) included young that died from unknown causes. Also, within this distance, couples frequently fought over the nest construction sticks and failed to advance the construction of the nests. (Sticks fell to the ground while the couple tried to build the nest.) Some nests were never completed and the storks remained passively in front of cellsite antennae.

Discussion

The effects of athermal microwaves on birds have been well known for more than 35 years [36, 37]. Some authors obtained beneficial effects in the production of insect eggs and exposed birds, but found that the mortality was doubled [38]. In hen experiments, problems of health and a deterioration of the plumage arose, while in the autopsies, leucosis and tumors of the central nervous system appears [39]. Giarola and Krueger [40] obtained a large reduction of the rate of growth and also a reduction of the adrenal glands, in exposed chickens. Kondra et al. [41] obtained an increase in the frequency of ovulation of exposed birds, and a bigger production of eggs but with less weight, proposing that the pituitary gland was stimulated. Other authors also have obtained effects reducing the rate of growth in chickens and rats, reduction in the production of eggs in hens exposed to microwaves of different frequencies and intensities, increase of fertility, and a deterioration of the quality of the eggshell at certain frequencies [42]. An increase in the embryonic mortality of chickens also has been found [15, 17, 43, 44]. These microwave effects are athermal [45]. Recently, it also has been demonstrated that the microwaves used in cellphones produce an athermal response in several types of neurons of the nervous system in birds [46] and that they can affect the blood brain barrier as has been observed in rats [47].

Birds are especially sensitive to the magnetic fields [48]. The white stork (*Ciconia ciconia*) build their nests on pinnacles and other very high places with high electromagnetic contamination (exposed to the microwaves). Also, they usually live inside the urban environment, where the electromagnetic contamination is higher, and remain in the nest a lot of the time, for this reason the decrease on the brood can be a good biological indicator to detect the effects of these radiations.

The results indicate a difference in total productivity but not in partial productivity between the near nests and those far from the antennae. This indicate the existence of nests without chicks, or the death of young in their first stages in the nests near cellsites (40% of nest without young, compared to 3.3% in nests further 300 m). Also, in the monitoring of the nests near to cellsite antennae, some dead young were observed and several couples never built the nest.

In previous studies in Valladolid, the results of productivity were generally higher than those obtained in this study and less nests appeared without young (Table 2).

Consistent with these results, the microwaves could be affecting one or several reproductive stages: the construction of the nest, the number of eggs, the embryonic

Table 2
Results of censuses carried out in Valladolid (Spain).

Year	Number of visited nests	Total productivity	Partial productivity	Couples without young(%)	References
1984	113	1.69	2.13	7	[65]
1992	115		1.93	5.2	[62]
1994	24	1.84		7.6	[63]
2001	35		2.43		[64]
2003 (<200 m)	30	0.83	1.44	40	This study
2003 (>300 m)	30	1.6	1.65	3.3	This study

development, the hatching or the mortality of chicks in their first stages. The faithfulness of the white stork to nest sites can increase the effects of the microwaves. A Greek study [49] relates to a progressive drop in the number of births of rodents. The mice exposed to 0.168 $\mu W/cm^2$ become sterile after 5 generations, while those exposed to 1.053 $\mu W/cm^2$ became sterile after only 3 generations. The interaction seems to take place through the central nervous system more than on the reproductive gland directly. Other studies find a decrease of fertility, increase of deaths after the birth in rats and dystrophic changes in their reproductive organs [16]. A recent study shows a statistically significant high mortality rate of chicken embryos subjected to the radiation from a cellphone, compared to the control group [43]. EMF exposure affected the reproductive success of kestrels (*Falco sparverius*), increasing fertility, egg size, embryonic development and fledging success but reduced hatching success [10]. An increase in the mortality [50] and the appearance of morphological abnormalities, especially of the neural tube [14, 15, 17] has been recorded in chicken embryos exposed to pulsed magnetic fields, with different susceptibility among individuals probably for genetic reasons. It is probable that each species, even each individual, shows different susceptibility to the radiation, since the susceptibility depends on the genetic bias, and of the irradiated living organisms physiologic and neurological state [4, 51]. Different susceptibility of each species also has been proven in wild birds exposed to CEM from high-voltage powerlines [9]. When the experimental conditions (power density, frequency, duration, composition of the tissue irradiated, etc.) change, their biological effects also change [25, 52]. Microwaves have the potential to induce adverse reactions in the health of people [2–5, 34, 35, 47]. Although the power output differs per site and type of transmitter, at more than 300 m distance from the antennas, most of the symptoms recorded in people diminish or disappear [34, 35]. It also has been pointed out that below 0.6 V/m the effects on the people disappear (Salzburg resolution).

Since, we cannot see symptoms for white storks, it is necessary to use objective variables such as the Total and Partial Productivity, and other characteristics of behavior (nonconstruction of nest, sticks fall, etc.). We recommend electromagnetic contamination in the microwave range be considered a risk factor in the decline of some populations, especially urban birds, especially when exposed to higher radiation levels. Because of their thinner skull, their great mobility and the fact that they use areas with high levels of microwave electromagnetic radiation, birds

are very good biological indicators. The freedom of movement of birds and their habit of settling in the proximity and even on the cellsites, makes them potentially susceptible to such effects. Small organisms (children, birds, small mammals, etc.) are especially vulnerable, as absorption of microwaves of the frequency used in mobile telephones is greater as a consequence of the thinner skull of a bird, the penetration of the radiation into the brain is greater [2, 49, 53, 54].

Several million birds of 230 species die annually from collisions with the masts of telecommunication facilities in United States during migration [55]. The cause of the accidents has yet to be proven, although one knows that they mainly take place during the night, in fog, or bad weather. The birds use several orientation systems: the stars, the sun, the site-specific recognition and the geomagnetic field [48]. The illumination of the towers probably attracts the birds in the darkness, but it is possible that the accidents take place in circumstances of little visibility, because at the time, other navigational tools are not available. The perception to the terrestrial magnetic field can be altered by the electromagnetic radiation from the antennae. The reports of carrier pigeons losing direction in the vicinity of cellsites are numerous, and more investigation is necessary.

In the United Kingdom, where the allowed radiation levels are 20 times higher than those of Spain, a decline of several species of urban birds has recently taken place [56], coinciding with the increasing installations of cellsites. Although this type of contamination is considered at the present time by some experts as the most serious [4], inspection systems and controls have never been developed to avoid their pernicious effects on living organisms. Some of the biological mechanisms of the effects of these waves are still ignored [12], although the athermal effects on organisms have been sufficiently documented. The telephone industry could be taking advantage of the complexity of the biological and physical processes implied, to create an innocuous atmosphere, repeatedly denying the existence of harmful effects in living organisms. For this reason the reports related to animals are of special value, since in this case it can never be alleged that the effects are psychosomatic [3].

Future investigation should be carried out with long-term monitoring of the breeding success, of the sleeping places and of the uses of the habitat for species more vulnerable to the microwaves. Of special interest should be investigations that try to make correlations with the radiofrequency electromagnetic field measurements. Field studies investigating populations of urban parks and territories surrounding cellsites should be a high-priority. A radius of 1 sq K and the layout of concentric lines at intermediate distances can be useful to investigate differential results among areas depending on their vicinity and the radiation levels. We consider that the birds most affected from the microwave electromagnetic contamination could be:

1) those bound to urban environments with more sedentary customs, in general those that spend more time in the vicinity of the base stations;
2) those that live or breed in high places, more exposed to the radiation and at higher power density levels;
3) those that breed on open structures where the radiation impacts directly on adults and chicks in the nest;
4) those that spend the night outside of holes or structures that attenuate the radiation.

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. The deterioration of the ecosystem can also take place from the impact of the radiation on the populations of invertebrate prey [54, 57, 58] and on the plants [59].

Bioelectromagnetics is historically a frontier discipline. Controversy is frequent when the scientists recognize serious effects on health and on the environment that cause high economic losses. Independent investigators state the necessity of a drastic reduction of the emmitted power levels on people and the ecosystems and that it is technically viable although more expensive for the industry [4, 22, 60]. Our opinion is that areas of continuous use should never exist at the height of the antennas either inside the beam or within a radius of several hundreds meters. The restriction to exposure to fauna presents special complexity; the main reason for the drastic reduction in the emission power of the antennae is presented as the only viable and effective solution to prevent these effects. Some authors have already propose that we are withessing a paradigm change in biology [61].

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Electromagnetic pollution from phone masts. Effects on wildlife

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Abstract

A review on the impact of radiofrequency radiation from wireless telecommunications on wildlife is presented. Electromagnetic radiation is a form of environmental pollution which may hurt wildlife. Phone masts located in their living areas are irradiating continuously some species that could suffer long-term effects, like reduction of their natural defenses, deterioration of their health, problems in reproduction and reduction of their useful territory through habitat deterioration. Electromagnetic radiation can exert an aversive behavioral response in rats, bats and birds such as sparrows. Therefore microwave and radiofrequency pollution constitutes a potential cause for the decline of animal populations and deterioration of health of plants living near phone masts. To measure these effects urgent specific studies are necessary.

Keywords: Effects on wildlife; Effects on birds; Electromagnetic radiation; Mammals; Microwaves; Mobile telecommunications; Non-thermal effects; Phone masts; Radiofrequencies

1. Introduction

Life has evolved under the influence of two omnipresent forces: gravity and electromagnetism. It should be expected that both play important roles in the functional activities of organisms [1]. Before the 1990's radiofrequencies were mainly from a few radio and television transmitters, located in remote areas and/or very high places. Since the introduction of wireless telecommunication in the 1990's the rollout of phone networks has caused a massive increase in electromagnetic pollution in cities and the countryside [2,3].

Multiple sources of mobile communication result in chronic exposure of a significant part of the wildlife (and man) to microwaves at non-thermal levels [4]. In recent years, wildlife has been chronically exposed to microwaves and RFR (Radiofrequency radiation) signals from various sources, including GSM and UMTS/3G wireless phones and base stations, WLAN (Wireless Local Area Networks), WPAN (Wireless Personal Area Networks such as Bluetooth), and DECT (Digital Enhanced (former European) Cordless Telecommunications) that are erected indiscriminately without studies of environmental impact measuring long-term effects. These exposures are characterized by low intensities, varieties of signals, and long-term durations. The greater portion of this exposure is from mobile telecommunications (geometric mean in Vienna: 73% [5]). In Germany the GSM cellular phone tower radiation is the dominating high frequency source in residential areas [6]. Also GSM is the dominating high frequency source in the wilderness of Spain (personal observation).

Numerous experimental data have provided strong evidence of athermal microwave effects and have also indicated several regularities in these effects: dependence of frequency within specific frequency windows of "resonance-type"; dependence on modulation and polarization; dependence on intensity within specific intensity windows, including super-low power density comparable with intensities from base stations/masts [4,7–9]. Some studies have demonstrated different microwave effects depending on wavelength in the range of mm, cm or m [10,11]. Duration of exposure may be as important as power density. Biological effects resulting from electromagnetic field radiation might depend on dose, which indicates long-term accumulative effects [3,9,12]. Modulated and pulsed radiofrequencies seem to be more effective in producing effects [4,9]. Pulsed waves (in blasts), as well as certain low frequency modulations exert greater

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biological activity [11,13–15]. This observation is important because cell phone radiation is pulsed microwave radiation modulated at low frequencies [8,9].

Most of the attention on possible biological effects of electromagnetic radiation from phone masts has been focused on human health [5,16–21]. The effects of electromagnetic pollution on wildlife, have scarcely been studied [22–25].

The objective of this review is to detail advances in knowledge of radiofrequencies and microwave effects on wildlife. Future research may help provide a better understanding of electromagnetic field (EMF) effects on wildlife and plants and their conservation.

2. Effects on exposed wildlife

2.1. Effects on birds

2.1.1. Effects of phone mast microwaves on white stork

In monitoring a white stork (*Ciconia ciconia*) population in Valladolid (Spain) in vicinity of Cellular Phone Base Stations, the total productivity in nests located within 200 m of antennae, was 0.86 ± 0.16. For those located further than 300 m, the result was practically doubled, with an average of 1.6 ± 0.14. Very significant differences among total productivity were found ($U = 240$; $P = 0.001$, Mann–Whitney test). Twelve nests (40%) located within 200 m of antennae never had chicks, while only one (3.3%) located further than 300 m had no chicks. The electric field intensity was higher on nests within 200 m (2.36 ± 0.82 V/m) than nests further than 300 m (0.53 ± 0.82 V/m). In nesting sites located within 100 m of one or several cellsite antennae with the main beam of radiation impacting directly (Electric field intensity >2 V/m) many young died from unknown causes. Couples frequently fought over nest construction sticks and failed to advance the construction of the nests. Some nests were never completed and the storks remained passively in front of cellsite antennae. These results indicate the possibility that microwaves are interfering with the reproduction of white stork [23]. (Fig. 1)

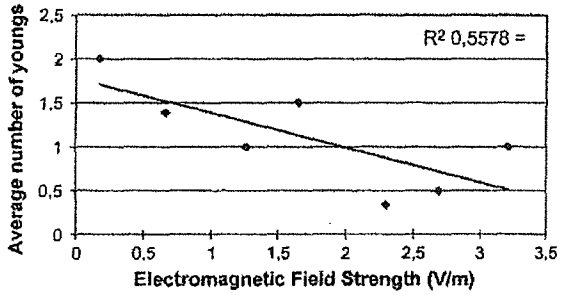

Fig. 1. Average number of youngs and electric field intensity (V/m) in 60 nests of white storks (*Ciconia ciconia*) (Hallberg, Ö with data of Balmori, 2005 [23]).

2.1.2. Effects of phone mast microwaves on house sparrows

A possible effect of long-term exposure to low-intensity electromagnetic radiation from mobile phone (GSM) base stations on the number of house sparrows during the breeding season was studied in Belgium. The study was carried out sampling 150 point locations within six areas to examine small-scale geographic variation in the number of house sparrow males and the strength of electromagnetic radiation from base stations. Spatial variation in the number of house sparrow males was negative and highly significantly related to the strength of electric fields from both the 900 and 1800 MHz downlink frequency bands and from the sum of these bands (Chi-square-tests and AIC-criteria, $P < 0.001$). This negative relationship was highly similar within each of the six study areas, despite differences among areas in both the number of birds and radiation levels. Fewer house sparrow males were seen at locations with relatively high electric field strength values of GSM base stations and therefore support the notion that long-term exposure to higher levels of radiation negatively affects the abundance or behavior of house sparrows in the wild [24].

In another study with point transect sampling performed at 30 points visited 40 times in Valladolid (Spain) between 2002 and 2006, counting the sparrows and measuring the mean electric field strength (radiofrequencies and microwaves: 1 MHz to 3 GHz range). Significant declines ($P = 0.0037$) were observed in mean bird density over time, and significantly low bird density was observed in areas with high electric field strength. The logarithmic regression of the mean bird density vs. field strength groups (considering field strength in 0.1 V/m increments) was $R = -0.87$; $P = 0.0001$ According to this calculation, no sparrows would be expected to be found in an area with field strength >4 V/m [25]. (Fig. 2)

In the United Kingdom a decline of several species of urban birds, especially sparrows, has recently happened [26]. The sparrow population in England has decreased in the last 30 years from 24 million to less than 14. The more abrupt decline, with 75% descent has taken place from 1994 to 2002. In 2002, the house sparrow was added to the Red List of U.K. endangered species [27]. This coincides with the rollout of mobile telephony and the

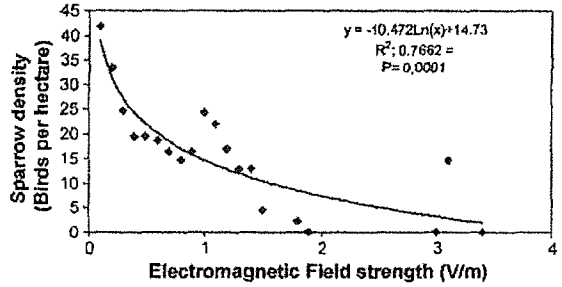

Fig. 2. Mean sparrow density as a function of electric field strength grouped in 0.1 V/m. (Balmori and Hallberg, 2007 [25]).

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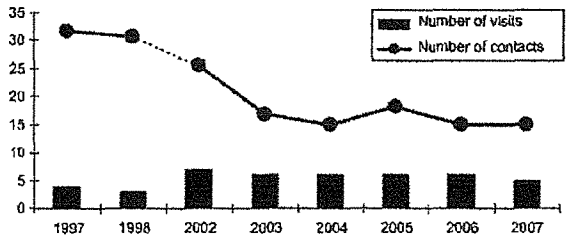

Fig. 3. Annual number of contacts (Mean) for 14 species studied in "Campo Grande" urban park (lack the information of the years 1999–2001).

possible relationship of both circumstances should be investigated.

In Brussels, many sparrows have disappeared recently [28]; similar declines have been reported in Dublin [29]. Van der Poel (cited in Ref. [27]) suggested that sparrows might be declining in Dutch urban centres also.

2.1.3. Effects on the bird community at an urban park

Microwaves may be affecting bird populations in places with high electromagnetic pollution. Since several antennas were installed in proximities of "Campo Grande" urban park (Valladolid, Spain) the bird population has decreased and a reduction of the species and breeding couples has occurred. Between 1997 and 2007, of 14 species, 3 species have disappeared, 4 are in decline and 7 stay stable (Balmori, unpublished data) (Fig. 3). In this time the air pollution (SO2, NO2, CO and Benzene) has diminished.

During the research some areas called "silence areas" contaminated with high microwave radiation (>2 V/m), where previously different couples usually bred and later disappeared, have been found. Several anomalies in magpies (*Pica pica*) were detected: plumage deterioration, locomotive problems (limps and deformations in the paws), partial albinism and melanism, especially in flanks [30]. Recently cities have increased cases of partial albinism and melanism in birds (*Passer domesticus*, *Turdus merula* and *P. pica*) (personal observation).

2.1.4. Possible physiological mechanisms of the effects found in birds

Current scientific evidence indicates that prolonged exposure to EMFs, at levels that can be encountered in the environment, may affect immune system function by affecting biological processes [3,31,32]. A stressed immune system may increase the susceptibility of a bird to infectious diseases, bacteria, viruses, and parasites [33].

The plumage of the birds exposed to microwaves looked, in general, discolorated and lack of shine. This not only occurred in ornamental birds; such as peacocks, but also in wild birds; such as, tits, great tits, house sparrows, etc (personal observation). We must mention that plumage deterioration is the first sign of weakening or illnesses in birds since damaged feathers are a sure sign of stress.

Physiological conditions during exposure minimize microwave effects. Radical scavengers/antioxidants might be involved in effects of microwaves [4].

Microwaves used in cellphones produce an athermal response in several types of neurons of the birds nervous system [34]. Several studies addressed behavior and teratology in young birds exposed to electromagnetic fields [23,25,35–37]. Most studies indicate that electromagnetic field exposure of birds generally changes, but not always consistently in effect or in direction, their behavior, reproductive success, growth and development, physiology and endocrinology, and oxidative stress [37]. These results can be explained by electromagnetic fields affecting the birds' response to the photoperiod as indicated by altered melatonin levels [38].

Prolonged mobile phone exposure may have negative effects on sperm motility characteristics and male fertility as has been demonstrated in many studies made in man and rats [39–46]. EMF and microwaves can affect reproductive success in birds [23,25,35,36,47]. EMF exposure affected reproductive success of kestrels (*Falco sparverius*), increasing fertility, egg size, embryonic development and fledging success but reducing hatching success [35,36].

The radiofrequency and microwaves from mobile telephony can cause genotoxic effects [48–55]. Increases in cytological abnormalities imply long-term detrimental effects since chromosomal damage is a mechanism relevant to causation of birth defects and cancer [55].

Long-term continuous, or daily repeated EMF exposure can induce cellular stress responses at non-thermal power levels that lead to an accumulation of DNA errors and to inhibition of cell apoptosis and cause increased permeability of blood–brain barrier due to stabilization of endothelial cell stress fibers. Repeated occurrence of these events over a long period of time (years) could become a health hazard due to a possible accumulation of brain tissue damage. These findings have important implications with regards to potential dangers from prolonged and repeated exposure to non-ionizing radiation [56,57].

Pulsed magnetic fields can have a significant influence on the development and incidence of abnormalities in chicken embryos. In five of six laboratories, exposed embryos exhibited more structural anomalies than controls. If the data from all six laboratories are pooled, the difference for the incidence of abnormalities in exposed embryos and controls is highly significant [58]. Malformations in the nervous system and heart, and delayed embryo growth are observed. The embryo is most sensitive to exposure in the first 24 h of incubation [58]. An increase in the mortality [59] and appearance of morphological abnormalities, especially of the neural tube [13,60,61] has been recorded in chicken embryos exposed to pulsed magnetic fields, with different susceptibility among individuals probably for genetic reasons. A statistically significant high mortality rate of chicken embryos subjected to radiation from a cellphone, compared to the control group exists [62,63]. In another study eggs exposed to a magnetic

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field intensity of 0.07 T showed embryonic mortality during their incubation was higher. The negative effect of the magnetic field was manifested also by a lower weight of the hatched chicken [64]. Bioelectric fields have long been suspected to play a causal role in embryonic development. Alteration of the electrical field may disrupt the chemical gradient and signals received by embryo cells. It appears that in some manner, cells sense their position in an electrical field and respond appropriately. The disruption of this field alters their response. Endogenous current patterns are often correlated with specific morphogenetic events [65].

Available data suggests dependencies of genotype, gender, physiological and individual factors on athermal microwave effects [4,9]. Genomic differences can influence cellular responses to GSM Microwaves. Data analysis has highlighted a wide inter-individual variability in response, which was replicated in further experiments [4]. It is possible that each species and each individual, show different susceptibility to radiation, since vulnerability depends on genetic tendency, and physiologic and neurological state of the irradiated organism [15,35–37,61,66–68]. Different susceptibility of each species has also been proven in wild birds exposed to electromagnetic fields from high-voltage power lines [47].

2.2. *Effects on mammals*

2.2.1. *Alarm and aversion behavior*

Rats spent more time in the halves of shuttle boxes that were shielded from 1.2 GHz. Microwaves irradiation. The average power density was about 0.6 mW/cm^2. Data revealed that rats avoided the pulsed energy, but not the continuous energy, and less than 0.4 mW/cm^2 average power density was needed to produce aversion [69]. Navakatikian & Tomashevskaya [70] described a complex series of experiments in which they observed disruption of rat behavior (active avoidance) from radiofrequency radiation. Behavioral disruption was observed at a power density as low as 0.1 mW/cm^2 (0.027 W/kg). Mice in an experimental group exposed to microwave radiation expressed visible individual panic reaction, disorientation and a greater degree of anxiety. In the sham exposed group these deviations of behavior were not seen and all animals show collective defense reaction [71]. Microwave radiation at 1.5 GHz pulsing 16 ms. At 0.3 mW/cm^2 power density, in sessions of 30 min/day over one month produced anxiety and alarm in rabbits [72].

Electromagnetic radiation can exert an aversive behavioral response in bats. Bat activity is significantly reduced in habitats exposed to an electromagnetic field strength greater than 2 V/m [73]. During a study in a free-tailed bat colony (*Tadarida teniotis*) the number of bats decreased when several phone masts were placed 80 m from the colony [74].

2.2.2. *Deterioration of health*

Animals exposed to electromagnetic fields can suffer a deterioration of health and changes in behavior [75,76].

There was proof of frequent death in domestic animals; such as, hamsters and guinea pigs, living near mobile telecommunication base stations (personal observation).

The mice in an experimental group exposed to microwave radiation showed less weight gain compared to control, after two months. The amount of food used was similar in both groups [71]. A link between electromagnetic field exposure and higher levels of oxidative stress appears to be a major contributor to aging, neurodegenerative diseases, immune system disorders, and cancer in mammals [33].

The effects from GSM base transceiver station (BTS) frequency of 945 MHz on oxidative stress in rats were investigated. When EMF at a power density of 3.67 W/m^2, below current exposure limits, were applied, MDA (malondialdehyde) level was found to increase and GSH (reduced glutathione) concentration was found to decrease significantly ($P < 0.0001$). Additionally, there was a less significant ($P = 0.0190$) increase in SOD (superoxide dismutase) activity under EM exposure [77].

2.2.3. *Problems in reproduction*

In the town of Casavieja (Ávila, Spain) a telephony antenna was installed that had been in operation for about 5 years. Then some farmers began blaming the antenna for miscarriages in many pigs, 50–100 m from the antenna (on the outskirts of the town). Finally the topic became so bad that the town council decided to disassemble the antenna. It was removed in the spring 2005. From this moment onwards the problems stopped (C. Lumbreras personal communication).

A Greek study reports a progressive drop in the number of rodent births exposed to radiofrequencies. The mice exposed to 0.168 μW/cm^2 become sterile after five generations, while those exposed to 1.053 μW/cm^2 became sterile after only three generations [22].

In pregnant rats exposed to 27.12 MHz continuous waves at 100 μW/cm^2 during different periods of pregnancy, half the pregnancies miscarried before the twentieth day of gestation, compared to only a 6% miscarriage rate in unexposed controls, and 38% of the viable foetuses had incomplete cranial ossification, compared to less than 6% of the controls. Findings included a considerable increase in the percentage of total reabsorptions (post-implantation losses consequent to RF radiation exposure in the first post-implantation stage). Reduced body weight in the exposed dams reflected a negative influence on their health. It seems that the irradiation time plays an important role in inducing specific effects consequent to radiofrequency radiation exposure [78]. There was also a change in the sex ratio, with more males born to rats that had been irradiated from the time of conception [2]. Moorhouse and Macdonald [79] find a substantial decline in female Water Vole numbers in the radio-collared population, apparently resulting from a male skew in the sex ratios of offspring born to this population. Recruits to the *radio-tracked* population were skewed heavily in favour of males (43:13). This suggests that radio-collaring of females caused male-skewed sex ratios.

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Mobile phone exposure may have negative effects on sperm motility characteristics and male fertility in rats [46]. Other studies find a decrease of fertility, increase of deaths after birth and dystrophic changes in their reproductive organs [11]. Intermittent exposure showed a stronger effect than continuous exposure [4]. Brief, intermittent exposure to low-frequency EM fields during the critical prenatal period for neurobehavioral sex differentiation can demasculinize male scent marking behavior and increase accessory sex organ weights in adulthood [80].

In humans, magnetic field exposures above 2.0 mG were positively associated with miscarriage risk [81]. Exposure of pregnant women to mobile phone significantly increased foetal and neonatal heart rate, and significantly decreased the cardiac output [82].

2.2.4. Nervous system

Microwaves may affect the blood brain barrier which lets toxic substances pass through from the blood to the brain [83]. Adang et al. [84] examined the effect of microwave exposure to a GSM-like frequency of 970 MHz pulsed waves on the memory in rats by means of an object recognition task. The rats that have been exposed for 2 months show normal exploratory behavior. The animals that have been exposed for 15 months show derogatory behavior. They do not make the distinction between a familiar and an unfamiliar object. In the area that received radiation directly from "Location Skrunda Radio Station" (Latvia), exposed children had less developed memory and attention, their reaction time was slower and neuromuscular apparatus endurance was decreased [85]. Exposure to cell phones prenatally and, to a lesser degree, postnatally was associated with behavioral difficulties such as emotional and hyperactivity problems around 7 years of age [86]. Electromagnetic radiation caused modification of sleep and alteration of cerebral electric response (EEG) [87–89]. Microwave radiation from phone masts may cause aggressiveness in people and animals (personal observation).

2.3. Effects on amphibians

Disappearance of amphibians and other organisms is part of the global biodiversity crisis. An associated phenomenon is the appearance of large numbers of deformed amphibians. The problem has become more prevalent, with deformity rates up to 25% in some populations, which is significantly higher than previous decades [90]. Balmori [91] proposed that electromagnetic pollution (in the microwave and radiofrequency range) is a possible cause for deformations and decline of some wild amphibian populations.

Two species of amphibians were exposed to magnetic fields at various stages of development. A brief treatment of early amphibian embryos produced several types of abnormalities [92]. Exposure to a pulsed electromagnetic field produced abnormal limb regeneration in adult Newts [93]. Frog tadpoles (*Rana temporaria*) developed under electromagnetic field (50 Hz, 260 A/m) have increased mortality. Exposed tadpoles developed more slowly and less synchronously than control tadpoles and remain at the early stages for longer. Tadpoles developed allergies and EMF caused changes in blood counts [94].

In a current study exposing eggs and tadpoles ($n = 70$) of common frog (*R. temporaria*) for two months, from the phase of eggs until an advanced phase of tadpole, to four telephone base stations located 140 m away: with GSM system 948.0–959.8 MHz; DCS system: 1830.2–1854.8; 1855.2–1879.8 MHz. and UMTS system: 1905–1910; 1950–1965; 2140–2155 MHz. (electric field intensity: 1.847–2.254 V/m). A low coordination of movements, an asynchronous growth, with big and small tadpoles, and a high mortality (90%) was observed. The control group ($n = 70$), under the same conditions but inside a Faraday cage (metallic shielding component: EMC-reinforcement fabrics 97442 Marburg Technic), the coordination of movements was normal, the development was synchronously and the mortality rate was only 4.2% [95].

2.4. Effects on insects

The microwaves may affect the insects. Insects are the basis and key species of ecosystems and they are especially sensitive to electromagnetic radiation that poses a threat to nature [96].

Carpenter and Livstone [97] irradiated pupae of Tenebrio molitor with 10 GHz microwaves at 80 mW for 20–30 min and 20 mW for 120 min obtained a rise in the proportion of insects with abnormalities or dead. In another study exposing fruit flies (*Drosophila melanogaster*) to mobile phone radiation, elevated stress protein levels (Hsp70) was obtained, which usually means that cells are exposed to adverse environmental conditions ('non-thermal shock') [98]. Panagopoulos et al. [99] exposed fruit flies (*D. melanogaster*) to radiation from a mobile phone (900 MHz) during the 2–5 first days of adulthood. The reproductive capacity of the species reduced by 50–60% in modulated radiation conditions (emission while talking on the phone) and 15–20% with radiation nomodulated (with the phone silent). The results of this study indicate that this radiation affects the gonadal development of insects in an athermal way. The authors concluded that radio frequencies, specifically GSM, are highly bioactive and provoke significant changes in physiological functions of living organisms. Panagopoulos et al. [100] compare the biological activity between the two systems GSM 900 MHz and DCS 1800 MHz in the reproductive capacity of fruit flies. Both types of radiation were found to decrease significantly and non-thermally the insect's reproductive capacity, but GSM 900 MHz seems to be even more bioactive than DCS 1800 MHz. The difference seems to be dependent mostly on field intensity and less on carrier frequency.

A study in South Africa finds a strong correlation between decrease in ant and beetle diversity with the

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electromagnetic radiation exposure (D. MacFadyen, personal communication.). A decrease of insects and arachnids near base stations was detected and corroborated by engineers and antenna's maintenance staff [101]. In houses near antennas an absence of flies, even in summer, was found.

In a recent study carried out with bees in Germany, only a few bees irradiated with DECT radiation returned to the beehive and they needed more time. The honeycomb weight was lower in irradiated bees [102]. In recent years a "colony collapse disorder" is occurring that some authors relate with pesticides and with increasing electromagnetic pollution [96].

The disappearance of insects could have an influence on bird's weakening caused by a lack of food, especially at the first stages in a young bird's life.

2.5. *Effects on trees and plants*

The microwaves may affect vegetables. In the area that received radiation directly from "Location Skrunda Radio Station" (Latvia), pines (*Pinus sylvestris*) experienced a lower growth radio. This did not occur beyond the area of impact of electromagnetic waves. A statistically significant negative correlation between increase tree growth and intensity of electromagnetic field was found, and was confirmed that the beginning of this growth decline coincided in time with the start of radar emissions. Authors evaluated other possible environmental factors which might have intervened, but none had noticeable effects [103]. In another study investigating cell ultrastructure of pine needles irradiated by the same radar, there was an increase of resin production, and was interpreted as an effect of stress caused by radiation, which would explain the aging and declining growth and viability of trees subjected to pulsed microwaves. They also found a low germination of seeds of pine trees more exposed [104]. The effects of Latvian radar was also felt by aquatic plants. *Spirodela polyrrhiza* exposed to a power density between 0.1 and 1.8 $\mu W/cm^2$ had lower longevity, problems in reproduction and morphological and developmental abnormalities compared with a control group who grew up far from the radar [105].

Chlorophylls were quantitatively studied in leaves of black locust (*Robinia pseudoacacia* L.) seedlings exposed to high frequency electromagnetic fields of 400 MHz. It was revealed that the ratio of the two main types of chlorophyll was decreasing logarithmically to the increase of daily exposure time [106].

Exposed tomato plants (*Lycopersicon esculentum*) to low level (900 MHz, 5 V/m) electromagnetic fields for a short period (10 min) measured changes in abundance of three specific mRNA after exposure, strongly suggesting that they are the direct consequence of application of radio-frequency fields and their similarities to wound responses suggests that this radiation is perceived by plants as an injurious stimulus [107]. Non-thermal exposure to radiofrequency fields induced oxidative stress in duckweed (*Lemna minor*) as well as unespecific stress responses, especially of antioxidative enzymes [108].

For some years progressive deterioration of trees near phone masts have been observed in Valladolid (Spain). Trees located inside the main lobe (beam), look sad and feeble, possibly slow growth and a high susceptibility to illnesses and plagues. In places we have measured higher electric field intensity levels of radiation (>2 V/m) the trees show a more notable deterioration [109]. The tops of trees are dried up where the main beams are directed to, and they seem to be most vulnerable if they have their roots close to water. The trees don't grow above the height of the other ones and, those that stand out far above, have dried tops (Hargreaves, personal communication and personal observation). White and black poplars (*Populus sp.*) and willows (*Salix sp.*) are more sensitive. There may be a special sensitivity of this family exists or it could be due to their ecological characteristics forcing them to live near water, and thus electric conductivity. Other species as *Platanus sp.* and *Lygustrum japonicum*, are more resistant (personal observation). Schorpp [110] presents abundant pictures and explanations of what happens to irradiated trees.

3. Conclusions

This literature review shows that pulsed telephony microwave radiation can produce effects especially on nervous, cardiovascular, immune and reproductive systems [111]:

- Damage to the nervous system by altering electroencephalogram, changes in neural response or changes of the blood–brain barrier.
- Disruption of circadian rhythms (sleep–wake) by interfering with the pineal gland and hormonal imbalances.
- Changes in heart rate and blood pressure.
- Impairment of health and immunity towards pathogens, weakness, exhaustion, deterioration of plumage and growth problems.
- Problems in building the nest or impaired fertility, number of eggs, embryonic development, hatching percentage and survival of chickens.
- Genetic and developmental problems: problems of locomotion, partial albinism and melanism or promotion of tumors.

In the light of current knowledge there is enough evidence of serious effects from this technology to wildlife. For this reason precautionary measures should be developed, alongside environmental impact assessments prior to installation, and a ban on installation of phone masts in protected natural areas and in places where endangered species are present. Surveys should take place to objectively assess the severity of effects.

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A possible effect of electromagnetic radiation from mobile phone base stations on the number of breeding house sparrows (Passer domesticus).

Everaert J[1], Bauwens D.

Author information

Abstract

A possible effect of long-term exposure to low-intensity electromagnetic radiation from mobile phone (GSM) base stations on the number of House Sparrows during the breeding season was studied in six residential districts in Belgium. We sampled 150 point locations within the 6 areas to examine small-scale geographic variation in the number of House Sparrow males and the strength of electromagnetic radiation from base stations. Spatial variation in the number of House Sparrow males was negatively and highly significantly related to the strength of electric fields from both the 900 and 1800 MHz downlink frequency bands and from the sum of these bands (Chi(2)-tests and AIC-criteria, $P<0.001$). This negative relationship was highly similar within each of the six study areas, despite differences among areas in both the number of birds and radiation levels. Thus, our data show that fewer House Sparrow males were seen at locations with relatively high electric field strength values of GSM base stations and therefore support the notion that long-term exposure to higher levels of radiation negatively affects the abundance or behavior of House Sparrows in the wild.

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[Indexed for MEDLINE]

MeSH terms

LinkOut - more resources

HOUSATONIC RIVER COMMISSION

IW69

"to coordinate on a regional basis the local management and protection of the Housatonic River Valley in northwestern Connecticut"

(860) 868-7341 17 SACKETT HILL ROAD • WARREN, CONNECTICUT 06754

January 13, 2011

Hon. Daniel F. Caruso, Chairman
Ct. Siting Council
10 Franklin Square
New Britain, CT 0651

Re: AT&T Application for Certificate of Environment Compatibility and Public Need
8 Barnes Road, Canaan

Dear Chairman Caruso:

I am writing on behalf of the Housatonic River Commission, which was created by the Towns of Canaan, Cornwall, Kent, New Milford, North Canaan, Salisbury and Sharon to advise the towns on issues affecting the Housatonic River. The Commission's prime objective is to protect the free flowing and scenic character of the River.

The River Commission has two major concerns with the proposed telecommunications tower proposed by AT&T for 8 Barnes Road in Canaan. First, the access road, which is to be widened and graveled, has slopes of 20% or more. The steepness of the proposed access road will make it difficult to control stormwater runoff and the resultant erosion. Any erosion will have an immediate and detrimental impact on the adjacent wetlands, and subsequently, on the Housatonic River itself.

Second, the proposed telecommunications tower would result in a serious degradation of the entire area's scenic quality – a quality that the River Commission and numerous other organizations and individuals have worked long and hard to protect. The proposed tower would, for example, be visible for long stretches of Route 7, a section of highway that the Connecticut Department of Transportation has designated as a scenic highway.

We are, therefore, requesting that the Siting Council deny the applicant's request for a tower at this location. I am available to answer questions at any time.

Sincerely,

William Tingley

William Tingley, Chairman
Housatonic River Commission

cc: file, HRC, P. Mechare, Area Legislators, Canaan Inland Wetlands Commission

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Mobile Phone Mast Effects on Common Frog (*Rana temporaria*) Tadpoles: The City Turned into a Laboratory

ALFONSO BALMORI

C/Navarra, Valladolid, Spain

*An experiment has been made exposing eggs and tadpoles of the common frog (*Rana temporaria*) to electromagnetic radiation from several mobile (cell) phone antennae located at a distance of 140 meters. The experiment lasted two months, from the egg phase until an advanced phase of tadpole prior to metamorphosis. Measurements of electric field intensity (radiofrequencies and microwaves) in V/m obtained with three different devices were 1.8 to 3.5 V/m. In the exposed group (n = 70), low coordination of movements, an asynchronous growth, resulting in both big and small tadpoles, and a high mortality (90%) was observed. Regarding the control group (n = 70) under the same conditions but inside a Faraday cage, the coordination of movements was normal, the development was synchronous, and a mortality of 4.2% was obtained. These results indicate that radiation emitted by phone masts in a real situation may affect the 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.*

Keywords Electromagnetic pollution; Microwaves; Phone masts; *Rana temporaria*; Tadpoles.

Introduction

In recent years, a large number of mobile phone antennae have been installed, especially in urban areas. The scientific literature review shows that pulsed telephony microwave radiation may produce effects, especially on nervous, cardiovascular, immune, and reproductive systems (Balmori, 2009), but few studies on effects from phone masts on wildlife in the cities have been conducted (Balmori, 2005; Balmori and Hallberg, 2007; Everaert and Bauwens, 2007).

Concerning the effects of electromagnetic radiation on amphibians, several investigations in the laboratory have been conducted (Levengood, 1969; Landesman and Douglas, 1990; Grefner et al., 1998), but as far as we know there have not been any published studies on effects from phone antennae on amphibian populations in their natural habitat.

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Balmori (2006) suggested that microwaves from phone masts might be responsible along with other factors in the decline of some populations of amphibians.

The objective of this research was to investigate the possible effects of phone mast radiation on exposed tadpoles (*Rana temporaria*) in a real situation.

Materials and Methods

The experiment has been made in Valladolid (Spain) exposing eggs and tadpoles of the common frog (*Rana temporaria*) obtained from an anonymous supplier to several mobile (cell) phone antennae.

The tadpoles were placed in two tanks with oxygen and food every day, which were set out in the fifth floor terrace at a distance of 140 meters from four base stations located opposite. The base stations are on the roof of an eight story high building (see the picture at http://www.hese-project.org/hese-uk/en/issues/nature.php?id = frogs).

In both experimental and control groups ($n = 70$ in each) the experiment lasted two months, from the egg phase until an advanced phase of tadpole prior to metamorphosis. The control group was inside a Faraday cage (metallic shielding component: EMC-reinforcement fabrics 97442 Marburg Technic).

According to official database (Ministerio de Industria Turismo y Comercio, 2009), the type and frequency range of emissions was:

- Vodafone: GSM 948.0–959.8 MHz.
- Vodafone: DCS 1,830.2–1,854.8 MHz.
- Vodafone: UMTS 1,905–1,910; 1,950–1,965; 2,140–2,155 MHz.
- Amena (Orange): DCS 1,855.2–1,879.8 MHz.

However, as we shall see later, in reality there exist more frequencies than this, which do not correspond with the frequencies contained in the database official.

The measurements of electric field intensity (radiofrequencies and microwaves in V/m) in the two tanks containing the tadpoles were made with the following meters:

- Nuova Elettronica device Model LX 1435 with 10% sensitivity, with unidirectional probe (range: 1 MHz–3 GHz).
- PCE–EM 29 device with an isotropic probe and calibration certificate (range: 50 MHz–3.5 GHz). Resolution: 0.1 mV/m. Absolute error: ± 1.0 dB.
- Spectrum analyzer Advantest R-3272 (range: 9 KHz–26 GHz), probe Rhode & Schwarz HE-200 (Official measurements of the Ministry of Science and Technology from Spain).

Results

The results of electric field intensity to which the tadpoles were exposed with the different devices were:

- LX 1435: Electromagnetic field intensity 2.5–3.5 V/m.
- PCE–EM 29: Electromagnetic field intensity 1,847–2,254 V/m.
- Advantest R-3272: Results in decibels (Table 1).

Table 1
Results of spectrum analyzer advantest R-3272 (official measurements of the ministry of science and technology from Spain)

VODAFONE		VODAFONE		AMENA	
Frequency (MHz)	Decibels	Frequency (MHz)	Decibels	Frequency (MHz)	Decibels
88,5	69	93,1	67	98,1	67
104,5	64	487,25	43	671,25	43,9
727,25	37	751,25	37	949,2	81
953,8	77	957,2	76	958,8	57
935	57	1875,4	63	1875,6	61
1873,6	60	1871,2	62	1869	61

Note: The frequencies that exist in reality are several more and do not correspond with the frequencies contained in the database official.

Some observations on the tadpoles were as follows (Balmori, 2008; see the video clips at http://www.hese-project.org/hese-uk/en/issues/nature.php?id):

- Experimental group ($n = 70$).

Low coordination of movements, an asynchronous growth, resulting in both big and small tadpoles, and a high mortality (90%) was observed. Most of the deaths occurred after six weeks of continuous exposure.

The tadpoles' tails waved only slowly. Only about half of them reacted to a sudden stimulus in the form of a stroke on the wall of the aquarium. Some remained sideways or tilted and swam describing closed circles (Balmori, 2008; http://www.hese-project.org/hese-uk/en/issues/nature.php?id). Generally, their movements were uncoordinated. They showed low interest and few tadpoles reacted to the food. For lack of resources, we could not investigate the anatomical or physiological reasons for the problems observed.

- Control group ($n = 70$, under the same conditions but inside a Faraday cage).

The coordination of movements was normal, the development was synchronous, and a mortality of 4.2% was obtained. No deaths occurred at a particular time.

The tail moved fast and they reacted quickly to a sudden stimulus (a stroke on the wall of the aquarium). No tadpoles remained sideways or tilted and the direction of swimming was correct. Their movements were coordinated. When food was supplied most of them reacted quickly.

Discussion

The literature contains much data hinting at an important role for bioelectromagnetic phenomena as a mediator of morphogenetic information in many contexts relevant to embryonic development (Levin, 2003). The underlying mechanism by which an

endogenous electrical field may exert an influence on development remains to be discovered. Most prevailing hypotheses suggest that a field acts to directionally guide the growth and migration of some embryonic cells (Hotary and Robinson, 1992).

Strong magnetic fields (1.74–16.7 T) disrupt cell division of exposed frog eggs (*Xenopus laevis*) (Denegre et al., 1998). Valles (2002) proposed a model to explain their influence.

Several studies on effects of electromagnetic fields on amphibians have been conducted in laboratories. When amphibian eggs and embryos of *Ambystoma maculatum* and *Rana sylvatica* were exposed to high magnetic fields (6.3×10^3 G), a brief treatment of early embryos produced several types of abnormalities, incuding microcephaly, retarded (abnormal) growth, edema, and scoliosis (Levengood, 1969).

Adult newts (*Notophthalmus viridescens*) exposed to a pulsed electromagnetic field (1 T and 0.15 V/m, approx.) for the first 30 days post forelimbs were amputated and produced more abnormalities in their skeletal patterns than the native limbs or the normal regenerates. Twelve percent exhibited unique abnormalities not observed in either the native or regenerate limb population. These forelimbs demonstrated one or more of the following gross defects: acheiria (lack of carpus and digits), aphalangia, or oligodactylia (loss of digits) as well as carpal bone and long bone (radius and ulna) abnormalities (Landesman and Douglas, 1990).

Exposed frog tadpoles (*Rana temporaria*) developed under electromagnetic field (50 Hz, 260 A/m) show an increase in mortality. Exposed tadpoles developed more slowly and less synchronously than control tadpoles and remained at the early stages for longer. Tadpoles developed allergies and EMF caused changes in their blood counts (Grefner et al., 1998). These results are consistent with the observations of this work.

Deformities and disappearance of amphibians and other organisms is part of the global biodiversity crisis (Blaustein and Johnson, 2003). Some authors consider that the electromagnetic pollution is destroying nature (Warnke, 2007; Firstenberg, 1997). Balmori (2006) proposed that electromagnetic pollution (in the microwave and radiofrequency range) along with other environmental factors is a possible cause for decline and deformations of some wild amphibian populations exposed. The results of this experiment conducted in a real situation in the city of Valladolid (Spain) indicate that the tadpoles that live near such facilities, exposed to relatively low levels of environmental electromagnetic fields (1.8–3.5 V/m) may suffer adverse effects (low coordination of movements, asynchronous growth, and high mortality), and this may be a cause (together with other environmental factors) of decline of amphibian populations.

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Journal
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Review Article

Biological Effects of Extremely Low Frequency Electromagnetic Fields

J. M. R. Delgado

Pages 75-92 | Published online: 07 Jul 2009
Download citation https://doi.org/10.3109/15368378509040362

Abstract

Bacterial growth of Lactobacillus acidophilus was inhibited by pulsed magnetic fields of 40 gauss, 26 Hz. Exposure of male Drosophila for 70 hours to 16-Hz pulsed magnetic fields of 35 gauss produced a significant sex-linked recessive lethal mutation. This irreversible process which persisted for many generations, was transmitted by the females which carried but did not suffer the consequences of the lethal agent. The unitary discharge of the crayfish stretch receptor was influenced by application of pulsed magnetic fields. Teratogenic effects were

produced by exposing developing chick embryos to pulsed magnetic fields with intensities as low as 0.01 gauss. Pulse shape and time of development were critical for the observed effects.

The mitotic index was also influenced. In monkeys, central nervous system excitability was influenced by applying fields focussed on the cerebellum.

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V. N. Binghy

Electro- and Magnetobiology
Volume 16, 1997 - Issue 3

Published online: 7 Jul 2009

Format: Abstract

Mutat Res. 1998 Mar 13;399(1):55-64.

Transgenic nematodes as biomonitors of microwave-induced stress.

Daniells C[1], Duce I, Thomas D, Sewell P, Tattersall J, de Pomerai D.

Author information

Abstract

Transgenic nematodes (Caenorhabditis elegans strain PC72), carrying a stress-inducible reporter gene (Escherichia coli beta-galactosidase) under the control of a C. elegans hsp16 heat-shock promoter, have been used to monitor toxicant responses both in water and soil. Because these transgenic nematodes respond both to heat and toxic chemicals by synthesising an easily detectable reporter product, they afford a useful preliminary screen for stress responses (whether thermal or non-thermal) induced by microwave radiation or other electromagnetic fields. We have used a transverse electromagnetic (TEM) cell fed from one end by a source and terminated at the other end by a matched load. Most studies were conducted using a frequency of 750 MHz, at a nominal power setting of 27 dBm. The TEM cell was held in an incubator at 25 degrees C inside a shielded room; corresponding controls were shielded and placed in the same 25 degrees C incubator; additional baseline controls were held at 15 degrees C (worm growth temperature). Stress responses were measured in terms of beta-galactosidase (reporter) induction above control levels. The time-course of response to continuous microwave radiation showed significant differences from 25 degrees C controls both at 2 and 16 h, but not at 4 or 8 h. Using a 5 x 5 multiwell plate array exposed for 2 h, the 25 microwaved samples showed highly significant responses compared with a similar control array. The wells most strongly affected were those in the rows closest to the source, whereas the most distant row did not rise above control levels, suggesting a shadow effect. These differential responses are difficult to reconcile with general heating effects, although localised power absorption affords a possible explanation. Experiments in which the frequency and/or power settings were varied suggested a greater response at 21 than at 27 dBm, both at 750 and 300 MHz, although extremely variable responses were observed at 24 dBm and 750 MHz. Thus, lower power levels tended, if anything, to induce larger responses (with the above-mentioned exception), which is opposite to the trend anticipated for any simple heating effect. These results are reproducible and data acquisition is both rapid and simple. The evidence accrued to date suggests that microwave radiation causes measurable stress to transgenic nematodes, presumably reflecting increased levels of protein damage within cells (the common signal thought to trigger hsp gene induction). The response levels observed are comparable to those observed with moderate concentrations (ppm) of metal ions such as Zn2+ and Cu2+. We conclude that this approach deserves further and more

detailed investigation, but that it has already demonstrated clear biological effects of microwave radiation in terms of the activation of cellular stress responses (hsp gene induction).

PMID: 9635489

[Indexed for MEDLINE]

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IW77

STATE OF CONNECTICUT
DEPARTMENT OF ENVIRONMENTAL PROTECTION

Bureau of Natural Resources/Wildlife Division
79 Elm Street, Sixth Floor
Hartford, CT 06106
Natural Diversity Data Base

February 8, 2011

Mr. Ellery W. Sinclair
Canaan Inland Wetland/Conservation Commission
201 Under Mountain Road
Falls Village, CT 06031

Re: State Listed Species Records within an approximately Two Mile Radius Circle centering on Proposed Cobble Hill Telecommunications Tower located at 8 Barnes Hill Road in Canaan, Connecticut

Dear Mr. Sinclair:

I have reviewed Natural Diversity Data Base maps and files regarding the area delineated on the map you provided for all state-listed species records and significant natural community records within an approximately two mile radius circle that centered on the proposed Cobble Hill Telecommunications Facility to be located at 8 Barnes Hill Road in Canaan, Connecticut. As we discussed on the phone, our program had reviewed this telecommunications facility in the fall of 2010 and determined that there were no Federal or State Listed species that occurred within the project boundaries as presented by Mr. Dean Gustafson of Vanasse Hangen Brustlin Inc. I have attached that letter for your records.

Your recent request to our program provided a map with a much wider radius around the Cobble Hill Telecommunications Facility and you asked us to provide the Canaan Inland Wetlands Conservation Commission with a list of species and significant natural communities in this larger radius. I have attached a list of these records for your Commission. Please be aware, however, that this list is just that, a list. We have made no assessment on impacts or effects that this facility may or may not have on these species. This list is for informational purposes only.

Natural Diversity Data Base information includes all information regarding critical biological resources available to us at the time of the request. This information is a compilation of data collected over the years by the Department of Environmental Protection's Natural History Survey and cooperating units of DEP, private conservation

STATE OF CONNECTICUT
DEPARTMENT OF ENVIRONMENTAL PROTECTION

Bureau of Natural Resources/Wildlife Division
79 Elm Street, Sixth Floor
Hartford, CT 06106
Natural Diversity Data Base

groups and the scientific community. This information is not necessarily the result of comprehensive or site-specific field investigations. Consultations with the Data Base should not be substitutes for on-site surveys required for environmental assessments. Current research projects and new contributors continue to identify additional populations of species and locations of habitats of concern, as well as, enhance existing data. Such new information is incorporated into the Data Base as it becomes available.

Please contact me if you have further questions at 860-424-3592 or dawn.mckay@ct.gov. Thank you for consulting the Natural Diversity Data Base. Also be advised that this is a preliminary review and not a final determination. A more detailed review may be conducted as part of any subsequent environmental permit applications submitted to DEP for the proposed site.

Sincerely,

Dawn M. McKay

Dawn M. McKay
Biologist/Environmental Analyst 3

Cc: SIMS NDDB #201100523

Species List for Request Number R201100523

2/4/2011

Scientific Name	Common Name	State Protection Status
Animals		
Aegolius acadicus	Northern saw-whet owl	SC
Agrotis stigmosa	Spotted dart moth	SC
Ambystoma jeffersonianum	Jefferson salamander "complex"	SC
Ambystoma laterale	Blue-spotted salamander	E/SC
Apodrepanulatrix liberaria	New Jersey tea inchworm	T
Atylotus ohioensis	Tabanid fly	SC
Botaurus lentiginosus	American bittern	E
Calephelis borealis	Northern metalmark	E
Catocala herodias gerhardi	Herodias underwing	E
Crotalus horridus	Timber rattlesnake	E
Empidonax alnorum	Alder flycatcher	SC
Erynnis lucilius	Columbine duskywing	E
Euphyes bimacula	Two-spotted skipper	T
Euphyes dion	Sedge skipper	SC
Glyptemys insculpta	Wood turtle	SC
Gomphus ventricosus	Skillet clubtail	SC
Hemaris gracilis	Slender clearwing	T
Hybomitra luridus	Horse fly	SC
Lota lota	Burbot	E
Lycaena hyllus	Bronze copper	SC
Notropis bifrenatus	Bridle shiner	SC
Papaipema leucostigma	Columbine borer	T
Passerculus sandwichensis	Savannah sparrow	SC
Rana pipiens	Northern leopard frog	SC
Sargus fasciatus	Soldier fly	SC
Satyrodes eurydice	Eyed brown	SC
Speranza exornata	Barrens itame	T
Sturnella magna	Eastern meadowlark	SC
Natural Communities		
Acidic rocky summit/outcrop		
Circumneutral maple/ash basin swamp		
Circumneutral northern white cedar basin swamp		
Circumneutral rocky summit/outcrop		
Circumneutral seepage swamp		
Dry circumneutral forest		
Dry subacidic forest		
Floodplain forest		
Rich fen		
Subacidic rocky summit/outcrop		
Plants		
Agastache nepetoides	Yellow giant hyssop	E

E = Endangered, T = Threatened, SC = Special Concern, SC* = Special Concern, Presumed Extirpated

Species List for Request Number R201100523

2/4/2011

Scientific Name	Common Name	State Protection Status
Alopecurus aequalis	Orange foxtail	T
Anemone canadensis	Canada anemone	T
Asplenium ruta-muraria	Wallrue spleenwort	T
Calamagrostis stricta ssp. inexpansa	Reed bentgrass	SC
Cardamine douglassii	Purple cress	SC
Carex alopecoidea	Foxtail sedge	T
Carex aquatilis var. aquatilis	Sedge	SC
Carex castanea	Chestnut-colored sedge	E
Carex cumulata	Clustered sedge	T
Carex formosa	Handsome sedge	SC
Carex hitchcockiana	Hitchcock's sedge	SC
Carex oligocarpa	Eastern few-fruit sedge	SC
Carex prairea	Prairie sedge	SC
Carex sterilis	Dioecious sedge	SC
Carex trichocarpa	Sedge	SC
Carex tuckermanii	Tuckerman's sedge	SC
Cryptogramma stelleri	Slender cliff-brake	E
Cypripedium parviflorum	Yellow lady's-slipper	SC
Cypripedium reginae	Showy lady's-slipper	E
Draba reptans	Whitlow-grass	SC
Dryopteris goldiana	Goldie's fern	SC
Equisetum scirpoides	Dwarf scouring rush	E
Gentianella quinquefolia	Stiff gentian	E
Hepatica nobilis var. acuta	Sharp-lobed hepatica	SC
Linnaea borealis ssp. americana	Twinflower	E
Lythrum alatum	Winged loosestrife	E
Malaxis brachypoda	White adder's-mouth	E
Mitella nuda	Naked miterwort	SC
Petasites frigidus var. palmatus	Sweet coltsfoot	T
Pinus resinosa	Red pine	E
Plantago virginica	Hoary plantain	SC
Platanthera orbiculata	Large round-leaf orchid	SC*
Potamogeton hillii	Hill's pondweed	E
Quercus macrocarpa	Bur oak	SC
Ribes triste	Swamp red currant	E
Salix serissima	Autumn willow	SC
Schizachne purpurascens	Purple oat	SC
Schoenoplectus acutus	Hard-stemmed bulrush	T
Sibbaldiopsis tridentata	Three-toothed cinquefoil	T
Thuja occidentalis	Northern white cedar	T
Trisetum spicatum	Narrow false oats	SC
Trollius laxus	Spreading globe flower	T
Uvularia grandiflora	Large-flowered bellwort	E
Viola nephrophylla	Northern bog violet	SC

E = Endangered, T = Threatened, SC = Special Concern, SC* = Special Concern, Presumed Extirpated

17984

STATE OF CONNECTICUT
DEPARTMENT OF ENVIRONMENTAL PROTECTION

Inland Fisheries Division-Natural History Survey
Natural Diversity Data Base
79 Elm Street, 6th floor
Hartford, CT 06106-5127

September 2, 2010

Mr. Dean Gustafson
Vanasse Hangen Brustlin, Inc.
54 Tuttle Place
Middletown, CT 06457-1847

Subject: Proposed AT&T Cingular Wireless Telecommunications Facility, Canaan, CT
State/Federal Listed Species

Dear Mr. Gustafson:

I have reviewed Natural Diversity Data Base maps and files regarding the area delineated on the map you provided and listed above. According to our information, there are no known extant populations of Federal or State Endangered, Threatened or Special Concern Species that occur at the site in question.

Natural Diversity Data Base information includes all information regarding critical biological resources available to us at the time of the request. This information is a compilation of data collected over the years by the Geological and Natural History Survey and cooperating units of the DEP, private conservation groups and the scientific community. This information is not necessarily the result of comprehensive or site-specific field investigations. Consultations with the Data Base should not be substituted for on-site surveys required for environmental assessments. Current research projects and new contributors continue to identify additional populations of species and locations of habitats of concern, as well as, enhance existing data. Such new information is incorporated into the Data Base as it becomes available.

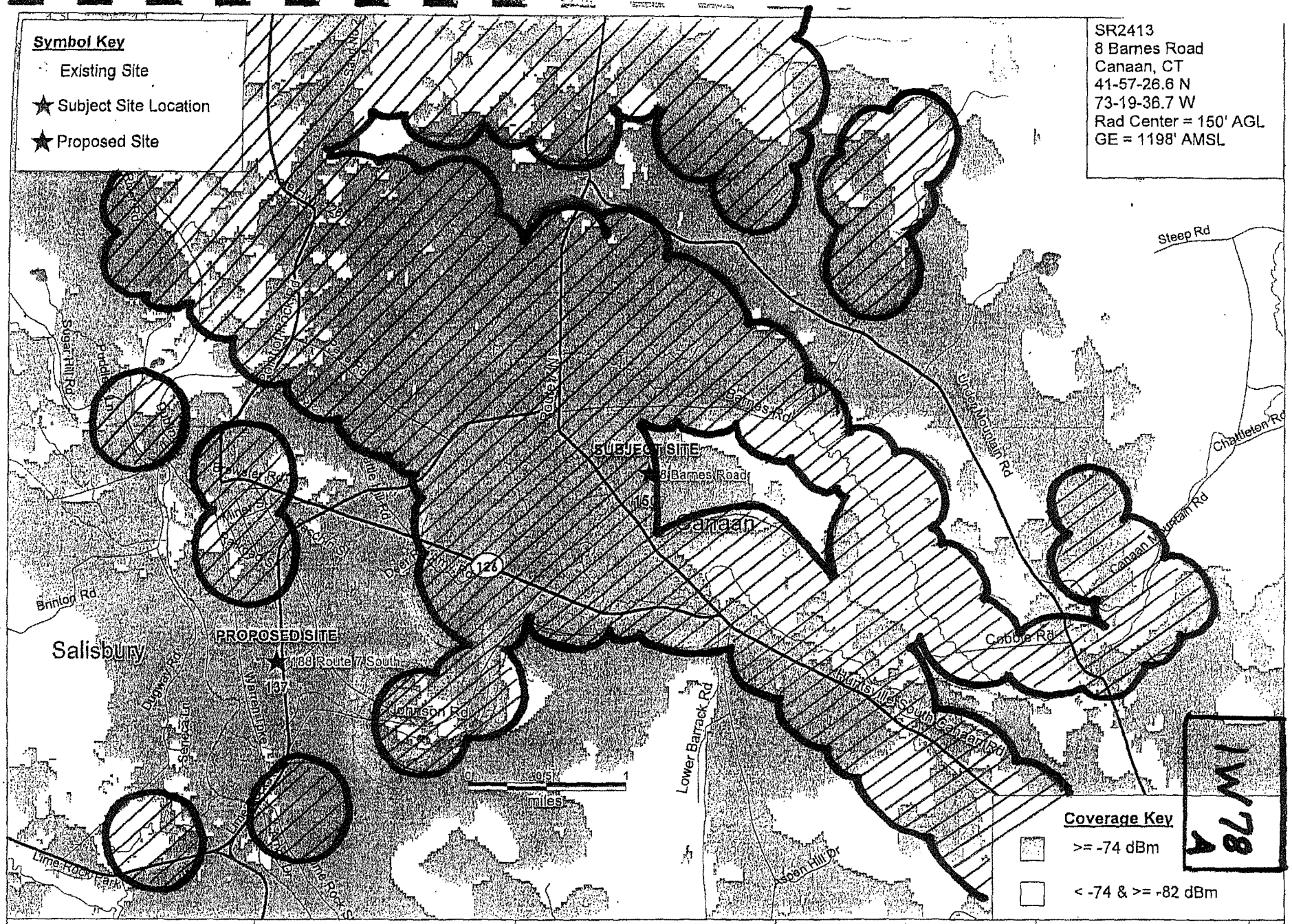
Please contact me if you have further questions (nancy.murray@ct.gov; 860-424-3589). Thank you for consulting the Natural Diversity Data Base and continuing to work with us to protect State listed species.

Sincerely,

Nancy M. Murray
Biologist/Senior Environmental Analyst
NDDB Program Coordinator

cc: NDDB File # 17984

NM:hw



Existing & Proposed Site & Subject Site Coverage	Falls Village	Canaan, CT	at&t	PREPARED ON DATE: 08/23/2010 REV 9

1W 79

Bioelectromagnetics 18:455–461 (1997)

IW76

RF Radiation–Induced Changes in the Prenatal Development of Mice

Ioannis N. Magras[1]* and Thomas D. Xenos[2]

[1]Department of Anatomy, Histology, and Embryology, School of Veterinary Medicine, Aristotle University of Thessaloniki, Thessalonike, Greece
[2]Department of Telecommunications, School of Electrical Engineering and Computer Engineering, Aristotle University of Thessaloniki, Thessaloniki, Greece

The possible effects of radiofrequency (RF) radiation on prenatal development has been investigated in mice. This study consisted of RF level measurements and in vivo experiments at several places around an "antenna park." At these locations RF power densities between 168 nW/cm^2 and 1053 nW/cm^2 were measured. Twelve pairs of mice, divided in two groups, were placed in locations of different power densities and were repeatedly mated five times. One hundred eighteen newborns were collected. They were measured, weighed, and examined macro- and microscopically. A progressive decrease in the number of newborns per dam was observed, which ended in irreversible infertility. The prenatal development of the newborns, however, evaluated by the crown-rump length, the body weight, and the number of the lumbar, sacral, and coccygeal vertebrae, was improved. *Bioelectromagnetics 18:455–461, 1997.* © 1997 Wiley-Liss, Inc.

Key words: RF radiation effects; prenatal development; mice development

Five years ago the "antenna-park of Thessaloniki" progressively developed on the top of the nearby mountain Chortiatis, 1.5 km away from a small village of the same name. Today, almost 100 commercial TV and FM-radio broadcasting transmitters in the VHF and the UHF bands are situated there. The antennas are installed on towers well visible from a large part of the village. Living so close to the antennae and the vast amount of RF power they transmit, which is of the order of 300 kW, the people of the village Chortiatis, anxious for their health, encouraged the author to undertake a research program.

The hypothesis that RF radiation may adversely affect the health of the animal organism is still under consideration in public and scientific forums. One of the critical issues seems to be the RF effects on the reproductive process [Chernoff et al., 1992]. Numerous studies dealing with this subject ended up with seemingly contradictory results. Therefore, an "in vivo" study on experimental animals sensitive to RF radiation, was chosen. Based on the relevant literature, this research investigated RF radiation effects on the reproductive system, particularly on prenatal development. The mouse was selected as the experimental animal, because it is easily manipulated in the environment in which the experiments had to take place. Of course, experimenting at the mountain sites, far from the easily controlled laboratory conditions, might add a certain amount of uncertainty; therefore, these experiments should be considered preliminary.

MATERIALS AND METHODS

We used a total of 36 mice (18 females and 18 males), 2 months old and sexually mature (BALB/c/f breed colony). Breeding colony virgin males and females were obtained from the "Theageneion Anticancer Institute of Thessaloniki." The use of these experimental animals was approved by the Veterinary Service of the Municipality of Thessaloniki, according to the provisions of the laws 1197/81 and 2015/92 and the Presidential Decree 160/91 of the Greek Democracy. Upon arrival, all experimental animals were quarantined for 2 weeks to discover and to allow them to acclimatise the mountain environment, an altitude ranging between 570 (position h) and 730 m (position d) above sea level. All the mice were healthy at the end of this period and showed no signs of illness during

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TABLE 1. Light–Dark Cycle during the Experimental Matings

		Day		Night	
Gestation	Date	Min	Max	Min	Max
1st	25.5–16.6	14.28	14.47	09.13	09.32
2nd	21.6–12.7	14.37	14.48	09.12	09.23
3rd	6.9–29.9	11.54	12.45	11.15	12.06
4th	7.10–28.10	10.45	11.35	12.25	13.15
5th	23.11–13.12	09.34	09.55	14.05	14.26

the course of the study. Tap water and certified feed (Greek Sugar Factory) were freely available.

The mice were maintained under natural lighting, both during the daytime and at the night (Table 1). Twelve Plexiglas cages transparent to RF radiation, were placed at several locations with one female in each cage. Each female was caged with one male for 12 h. Vaginal smears were taken the next morning and successful mating was identified by the presence of sperm. The day on which evidence of mating was observed was considered to be the first day of gestation. The litters were collected in the first 2 h after delivery and were moved to the laboratory for examination. After a period of recovery, the same mating procedure was repeated for each dam. Five experimental pregnancies were carried out in a period of almost 6 months.

The first pregnancy of the experimental animals took place in eight selected positions (a–h, Fig. 1), some close to the "antenna-park" and some near the village of Chortiatis. Then the experimental animals were moved to two positions, because these positions presented almost the same RF radiation levels with those initially selected and the experiment could be managed more effectively. Six dams (labelled as group A), initially placed at positions a, b, c, and d, with their males, were moved to the position d (Refuge of Hypaithrios Life). The other six dams (labelled group B), with their males, initially placed at positions e, f, g, and h were moved to position h (Public Primary School of Chortiatis). These two positions were selected because the most important living conditions, i.e., light, temperature, ventilation, food, etc., were the same.

Finally, all the experimental animals were moved to position i (Laboratory of Anatomy, School of Veterinary Medicine, University of Thessaloniki) about 10 km away from the Mountain Chortiatis, in the city of Thessaloniki, for the fifth pregnancy. This relocation was done to seek an indication of a possible reversibility of the observed phenomena. In fact, we wanted to repeat the experiment in an environment almost free of RF. An extra group of six couples of mice were mated once and used as controls in the laboratory (posi-

Fig. 1. Wide area of Chortiatis, where the fist four matings took place.

tion i), far from the "antenna park" in a more or less free-of-RF radiation environment.

It was extremely difficult to use RF-free controls at the mountain sites, because it was almost impossible to make "electromagnetically screened cages." Such a cage should ideally provide high (of the order of 30 dB) screening at the frequency range between 88.5 and 950 MHz (Commercial Radio FM band, UHF TV band, and Mobile Communication band), and therefore would require a very dense and well-grounded, highly conductive external metal grid. Obviously, mice could hardly survive in such cages for about 5 months.

The litter was considered to be the experimental unit for the analysis of data. We measured the crown-rump length, the body weight, the number of the posterior (lumbar, sacral, and coccygeal) vertebrae, the congenital malformations, and the ossification of the skeleton.

The RF power was measured in each position, using an electric field meter and a low gain (4 dB) wide-band (80–900 MHz) log-periodic antenna and spectrum analyser. To obtain comparable results the "*IEEE std. C95.3.1991*" was used. On the third floor of the public school, where the mice were situated, a 360 degree integration was also performed, due to the directivity of the measuring antenna together with the close proximity of the walls and metal furniture. Wherever iron bars or metal screens existed in front of the windows, two series of measurements were carried out; one on each side of the screen.

The collected newborns were killed for examination. Their crown-rump length was measured, and they were weighed and inspected under the dissecting microscope for external congenital malformations. Then they were fixed and subsequently cleared and stained in toto by a double staining of their skeleton [Peters, 1977]. The procedure was lightly modified as follows:

The newborns were fixed with alcohol 86% for 3 days; their skin, eyes, and viscera were removed; then they were immersed for 3 days in alcohol 100% and for 4 days in a mixture of alcohol 100% and ether 1:1. They were stained for 1–2 days with blue alcyan coloration [alcohol 86% 80 ml, acetic acid 20 ml, alcyan blue 20 mg] until the nonmineralised cartilagenous parts of the bones became blue. They were immersed in alcohol 100% for 4 days. Then they were stained for 12–24 days with red alizarin coloration [KOH 1 g, H_2O 100 ml, alizarin solution (alcohol 86% saturated with alizarin red S) 0.1 ml] until the ossified parts of the bones became red. They were immersed in solution Mall I (KOH 1 g, distilled water 80 ml, glycerine 20 ml) until the transparency of their body was completed. Finally, they were stored in a conservation solution (distilled water and glycerine 1:1, with some thymol crystals as contamination prevention). The stained newborns were inspected for skeletal defects as well as for the degree of ossification of their bones. The ossification of the skeleton and particularly of the vertebrae is an excellent and creditable indicator of the prenatal exposure to noxious agents and can be a measure of development delay.

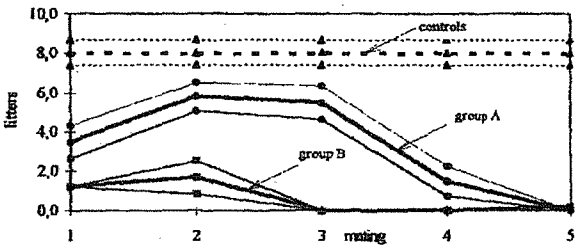

Fig. 2. Comparison of the mean values ± standard deviation of number of newborns per dam and mating from all experimental groups.

RESULTS

The RF power levels measured, although below the limits proposed by the "ENV50166-2" and the "IEEE C95.1.1991" standards, are high and well above the power levels that are likely to be measured in other European or U.S. residential areas. In fact, on the third floor of the public primary school (position h), an average power density of 1.053 $\mu W/cm^2$ was found, equivalent to a specific absorption rate of 1.935 mW/kg. In the Hypaithrios Life Refuge (position d) the average power density in which the mice were located was of the order of 168 nW/cm^2. This reduced level was due to the screening effect of the iron bars in front of the windows, which gave an 8–10 dB RF-power decrease. The average power density levels in position i (Laboratory of Anatomy, School of Veterinary Medicine, University of Thessaloniki), where the controls were placed and the fifth experimental matings were performed, was 40 dB weaker.

The number of the littered newborns by the experimental dams of groups A and B were, compared with those littered by the controls, progressively reduced from the first to the fifth pregnancy. This reduction is more evident in group B and is clearly shown in Table 2 and in Figure 2.

On the other hand, the rest of the four measured parameters, i.e., the crown rump length and the weight and the number of the lumbar, sacral, and coccygeal vertebrae increased in the newborns from groups A and B compared with the controls. This was more evident in group A than in group B (Table 2 and Fig. 3). A

TABLE 2. Statistical Characteristics of All Four Measurable Parameters per Dam, per Group, and per Gestation

Mating	Litters per dam mean ± s.d. median	Length (cm)	Weight (gr)	Vertebrae
Group A (6 dams)				
1st (25.05.1995)	3.5 ± 0.9	1.47 ± 0.13	2.71 ± 0.09	31.48 ± 1.43
	4.0	1.44	2.69	32.07
2nd (21.06.1995)	5.8 ± 0.7	1.25 ± 0.06	2.55 ± 0.05	24.28 ± 0.97
	7.0	1.22	2.50	24.29
3rd (08.09.1995)	5.5 ± 0.9	1.72 ± 0.25	2.71 ± 0.13	28.72 ± 1.92
	6.5	1.72	2.60	28.71
4th (07.10.1995)*	1.5	1.10	2.47	23.22
	0.0	1.10	2.47	23.22
5th (23.11.1995)*	0.0			
	0.0			
Mean value	3.3	1.39	2.61	26.93
Group B (6 dams)				
1st (25.05.1995)*	1.2	1.19	2.53	28.57
	0.0	1.19	2.53	28.57
2nd (21.06.1995)	1.7 ± 0.9	1.25 ± 0.04	2.60 ± 0.06	28.55 ± 1.14
	1.5	1.26	2.58	27.26
3rd (08.09.1995)*	0.0			
	0.0			
4th (07.10.1995)*	0.0			
	0.0			
5th (23.11.1995)	0.2	1.05	2.50	30.00
	0.0	1.05	2.50	30.00
Mean value	0.6	1.16	2.54	29.04
Controls (6 dams)				
1st (23.11.1995)	8.0 ± 0.07	0.96 ± 0.15	2.38 ± 0.02	19.59 ± 0.47
	7.5	0.97	2.37	19.52
Mean value	8.0	0.96	2.38	19.59

*Single or no gestation.

thorough external and internal examination under the dissecting microscope revealed only one case of extensive and two cases of limited malformation. No retardation of skeletal ossification worth mentioning was observed; only five cases out of 116 showed limited retardation. It has to be noted here, that the evaluation of the skeleton ossification was focused in the bones of the forelimbs and hindlimbs and in the lumbar, sacral, and coccygeal vertebrae.

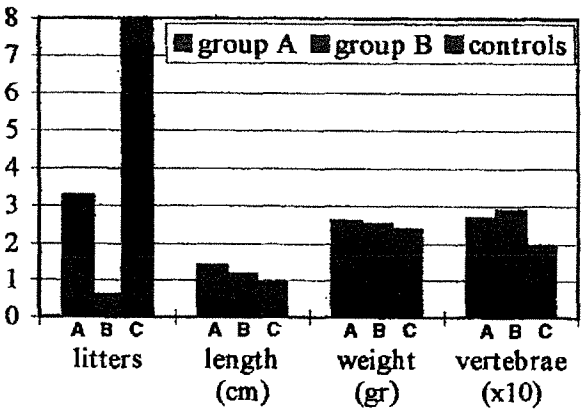

Fig. 3. Comparison of the mean values of all four measurable parameters for all gestations. Controls (C).

DISCUSSION

To study effects of a possibly noxious agent on a mammalian embryo, three groups should be considered: the embryos, the dams, and the males. In this work, all three have been studied: the infertility for dams and males, the lethality for embryos, the teratogenicity or the reduction in deformity for foetuses, or any combinations of them. They all have been considered by exposing male and female mice (before and during pregnancy) to an RF-radiation environment close to the "antenna park."

Infertility and lethality were assessed by counting the number of their newborns, whereas the possible

teratogenicity and the reduction deformity by autopsy was considered by the study of the embryonic skeletons. An important stage in this study was the examination of the skeletons, since the ossification of the bones is considered an excellent and creditable indicator of the prenatal exposure to noxious agents and can be a measure of development delay. In the beginning of organogenesis, the neural tube functions as a precursor of the cartilages and bones of the developing skeleton [Noden and Delahunta, 1985]. Teratogenic factors of any kind, that affect the embryonic nervous system, result in structural defects of the skeletal components. Therefore, to detect the teratogenic action of a factor on the embryonic nervous system, it is technically convenient to study the foetal skeleton rather than the embryonic nervous system itself.

A very important result of this experimental study (Table 2 and Fig. 2) is a progressive decrease of the number of the size of the litters of the dams of group A (position d) and group B (position h), compared with the controls (position i) and with the breeding history of these mice. Mice from the BALB/c/f breeding colony obtained from the "Theageneion Anticancer Institute of Thessaloniki" have been used for years in our laboratory for reproduction. Repeated pregnancies with a recovery period of 1–4 weeks for over a year, had never affected the fertility of the dams or any morphological parameters of the offspring, a fact that to our knowledge has not been questioned in the available literature.

It is worth noting that the RF power density levels, although very different from place to place, were very low and well below the CENELEC and IEEE relevant standards. Yet, it should be pointed out that:

(a) the experimental animals lived in this environment for 6 months, which is a long period of time,

(b) there was a considerable difference in power density levels of the order of 10 dB between the two main positions d and h and almost of 40 dB between d and i,

(c) there is a considerable difference between the volumes and consequently the body mass of the adult mouse and other experimental animals used as models in the international standards applied to humans.

The interpretation of our observations could follow various directions. The most popular view in numerous studies of the relevant literature, that this is a consequence of the overheating of the irradiated testis [Lary et al., 1986, 1987; O'Connor, 1980)] could be considered. On the other hand, the assumption that RF and microwave radiation effects are limited to heating has been questioned in a series of studies [Cleary, 1988, 1990]. The exposure conditions in these "in vivo" studies may suggest a thermal component of RF-induced testicular damage. However, interpretation of these data with respect to damage thresholds or interaction mechanisms is difficult. This difficulty is due to a number of factors, including the time, intensity, or both, the variations in species sensitivities, and the frequency-dependent non-uniform microwave energy absorption in tissue. Consequently, although these findings seem to be consistent with a hypothesis that the RF-induced heating is associated with testicular damages, the borderline between the "direct" effects of radiation and the effects that are indirectly associated with the tissue heating is not very clear.

Our observations could also be attributed to an intra-uterus death of the irradiated embryos in the early stages of the prenatal development, a speculation that could not be investigated in our experimental design because it required a postmortem autopsy of the dam. On the other hand, the prerequisite to these scenarios is a large RF power density, whereas the power densities we measured were of the order of $\mu W/cm^2$ or nW/cm^2, rather than mW/cm^2, or in terms of specific absorption rate (SAR), mW/kg rather than W/kg. Therefore, we cannot exclude the possibility of an indirect nonthermal mechanism focused on the endocrinological axon hypophysis-gonads that causes infertility to the males or the females [Thuery, 1991].

It should be noted here that the male experimental animals progressively developed a very bad physiological condition (rough hair, emaciation, etc.), not correlated to any other sickness symptoms, during their stay at the experimental positions a–g. Therefore, despite of the limited amount of data, the duration of the exposure to low intensity RF electromagnetic fields seems to be a repression parameter. In fact, chronic or long-term exposure to low intensity electromagnetic fields is generally associated with adverse results [Lary et al., 1983]. The most peculiar findings of this study were the increases in the crown-rump length, the body weight, and the number of the posterior vertebrae (lumbar, sacral, and coccygeal) of the experimental offsprings compared with the controls (Table 2, Fig. 3).

It must be noted that a study of mice [Jensh et al., 1977; 1978a; 1978b] under low levels of irradiation during the whole period of a single gestation (10 and 20 mW/cm^2) had no effect on maternal, foetal, or placental masses and no effect on the frequency of resorption, foetal death rate, size of litter, sex of the newly born, and their ability to perform. Other studies [Michaelson et al., 1976] reported a faster development of rat foetuses. This finding agrees with another report [Johnson et al., 1977] that noted an increase in the weight of newly born rats and a premature opening of the eyes after prenatal irradiation (5 mW/cm^2 at 918 MHz, for 380 h), as well as an impaired ability to learn. On the

other hand, other studies found lower average weight at birth. At medium power density levels (10, 20, and 50 mW/cm^2, at 2375 MHz), which are above the limits imposed by CENELEC and the relevant IEEE standard, the reproductive capacity of mice was somewhat impaired, with smaller litter size and a rise in neonatal mortality, which is a direct function of the power flux density [Il'Cevic and Gordodeckaja, 1976; McRee, 1980].

Although it is difficult to explain this foetal development increase, we believe that it could be due to a favourable placental nourishment of the foetuses during the pregnancy. In fact, this finding could be associated with:

(a) reproductive causes, i.e., blood-flow to a smaller number of foetuses, because of the reduction of the fertility of the irradiated males or females,

(b) thermal causes, i.e., possible increase of the blood flow of the dams, directly due to the RF irradiation,

(c) endocrinological causes, i.e., increase of the somatotrophic hormone because of the RF irradiation and

(d) environmental causes, i.e., the vasodilatation and partial increase of the blood pressure of the experimental dams because of the mountain altitude.

Of course combinations of these possibilities cannot be excluded.

According to various references [Tell and Harlen, 1979; Lu et al., 1980; Deschaux et al., 1983] discrepancies between the results of experiments may be due to different experimental conditions, random formation of hot spots in the glands and the hypothalamus, or a variety of other factors, as the cicardian rhythm and differences between species. With the exception of the high power effects on testicles, that do not belong to the endocrine ensemble, the interaction seems to involve the pituitary gland or even the central nervous system rather than the terminal glands.

We would close this discussion with what Jacques Thuery wrote (1991), that the true state of affairs is probably far more complex, but the available data are not sufficient to allow us to outline it more clearly, and that all attempts to extrapolate these results to humans lead to very high power densities, partly because geometric resonance effects are very significant in small animals. Consequently, taking into account the constant exposure of the human population living close to the "antenna park" to low intensity RF radiation, these adverse health effects in mice resulting from chronic or prolonged exposure may prove of importance in the near future. Indeed, there is evidence that chronic exposure to low-intensity RF radiation may be associated with health effects different to embryo-toxicity [Salford et al., 1992; Cleary, in press].

The findings of this preliminary experimental study have led to several conclusions. Of course, the final word to the problem in question has not been said as yet. Therefore, more work is called for; laboratory-based simulation might provide valuable information.

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A Possible Effect of Electromagnetic Radiation from Mobile Phone Base Stations on the Number of Breeding House Sparrows (Passer domesticus)

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A possible effect of long-term exposure to low-intensity electromagnetic radiation from mobile phone (GSM) base stations on the number of House Sparrows during the breeding season was studied in six residential districts in Belgium. We sampled 150 point locations within the 6 areas to examine small-scale geographic variation in the number of House Sparrow males and the strength of electromagnetic radiation from base stations. Spatial variation in the number of House Sparrow males was negatively and highly significantly related to the strength of electric fields from both the 900 and 1800MHz downlink frequency bands and from the sum of these bands (Chi^2-tests and AIC-criteria, $P < 0.001$). This negative relationship was highly similar within each of the six study areas, despite differences among areas in both the number of birds and radiation levels. Thus, our data show that fewer House Sparrow males were seen at locations with relatively high electric field strength values of GSM base stations and therefore support the notion that long-term exposure to higher levels of radiation negatively affects the abundance or behavior of House Sparrows in the wild.

Keywords Antenna; Bird; Electromagnetic radiation; GSM base station; Non thermal effect.

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Introduction

Mobile phones, also called cellular phones or handies, are now an integral part of modern life. The widespread use of mobile phones has been accompanied by the installation of an increasing number of base station antennas on masts and buildings. GSM base stations emit electromagnetic fields at high frequencies in the 900 and 1800 MHz range (= downlink frequency bands), pulse modulated in low frequencies (Hyland, 2000). In recent years, increased public awareness and scientific research have questioned to what extent the non thermal exposure to low-intensity electromagnetic fields may affect the health, reproduction, well-being and behaviour of humans and other organisms. There is an active and, as yet, unsettled controversy about current safety standards. Some researchers and national committees advised more stringent safety standards, based on experimental data with reported biological effects from (chronic) non thermal exposures (Hyland, 2000; Belyaev, 2005a, b).

There are studies showing frequency-specific biological effects, and studies demonstrating that a high frequency signal modulated at certain low frequencies, or a signal that is pulsed, has more harmful effects than an unmodulated, steady carrier. These so-called 'window effects' greatly complicate any attempt to understand the relationship between electromagnetic radiation and health (Adey, 1981; Hyland, 2000; Lai, 2005; Belyaev, 2005a).

Public and scientific concern were also raised by results of some epidemiologic studies that examined the effects of long-term exposure on humans living near mobile phone base stations. A growing number of studies point to the existence of effects, ranging from changes in cognitive performance and sleep disturbances to serious illness and disablement, with even higher cancer rates (Santini et al., 2002; Navarro et al., 2003; Bortkiewicz et al., 2004; Eger et al., 2004; Wolf and Wolf, 2004; Hutter et al., 2006; Abdel-Rassoul et al., 2006).

Short-term laboratory experiments used mice, rats, chickens and other birds as study models to better understand the possible implications of electromagnetic fields on organismal functioning. In many studies however, 'mobile communication-like' signals were investigated that in fact were different from the real exposures in such aspects as intensity, carrier frequency, modulation, polarisation, duration and intermittence (Belyaev, 2005a, b; Lai, 2005).

Studies of the effects of exposure to electromagnetic fields on populations of wild birds can provide further insights into the potential impacts on animal and human health (Fernie and Reynolds, 2005). Birds are candidates for being good biological indicators for low-intensity electromagnetic radiation: they have thin skulls, their feathers can act as dielectric receptors of microwave radiation, many species use magnetic navigation, they are very mobile and possible psychosomatic effects are absent (Bigu-del-Blanco and Romero-Sierra, 1975; Balmori, 2005). Field studies of wild populations can also reveal possible effects of long-term exposure to radiation from GSM base stations. In addition, species like the House Sparrow (*Passer domesticus*) are especially of interest because a large proportion of the birds use higher breeding height locations like roof spaces (Wotton et al., 2002) where potentially higher levels of base station radiation are present.

Here we report results of a preliminary study that explored putative effects of electromagnetic radiation emitted by mobile phone base stations on the number of House Sparrows during the breeding season. Specifically, we examined small-scale geographic variation within each of six study areas in both the number of birds and the strength of electromagnetic radiation. If electromagnetic fields from GSM base stations have adverse effects on bird populations, this should result in a decreasing number of House Sparrows with increasing levels of radiation.

Materials and Methods

Data collection

We determined, during the spring of 2006, the number of House Sparrow males and the strength of electromagnetic radiation from mobile phone (GSM) base stations at 150 locations that were distributed over six residential areas in the region of Gent – Sint-Niklaas (province of East Flanders, Belgium). The study areas were similar in overall appearance, with abundant hedges, bushes and other vegetation between the houses, and with one or more GSM base stations nearby.

The 150 study locations were selected in advance as points on a map (ArcGIS). All locations were situated along small roads within the residential areas and were at variable distances from the nearest GSM base station (mean = 352 m, range = 91 - 903 m, about 90% at 100 - 600 m). The number of locations, and study dates, within each area were: Lokeren - Eksaarde (N = 19; April 9), Lokeren - Spoele (N = 27, April 15), Lokeren - Bergendries (N = 17, April 17), Sint Niklaas - Clementwijk (N = 25, April 20), Gent- Wondelgem (N = 38, April 25) and Gent - Mariakerke (N = 24, April 26).

At each location, a point count of five minutes (see 'point transect count' in Bibby et al., 2000; Hustings et al., 1985) was made of the number House Sparrow males that were singing or otherwise visible within a distance of ca. 30 m. Sightings of birds were done with binoculars (Swarovski EL 10x42). Counts were restricted to the morning hours (7-11h), when male House Sparrows are most active (Hustings et al., 1985; Van Dijk, 2004), on days with favourable weather conditions (no rain, little wind, sunny, normal temperatures).

Simultaneously, we measured the maximum value (peak hold) of the electric field strength (in V/m) from the downlink frequencies of GSM 900 MHz (925-960 MHz) and GSM 1800 MHz (1805-1880 MHz) base station antennas. Measurements at each location were made during two minutes for each frequency band. The electric field strength was measured using a portable calibrated high-frequency spectrum analyser (Aaronia Spectran HF-6080; typ. accuracy ± 3 dB) with calibrated EMC directional antenna (HyperLOG 6080; logarithmic-periodic). To measure the maximum radiation values, the EMC antenna was turned around in all directions.

Additional antennas for the new UMTS-system are now being installed on several existing base stations in Belgium. Therefore, at several locations within each study area, the electric field strength from the downlink frequencies of UMTS antennas (2110-2170 MHz) was also checked, but no significant signals were found. Consequently, the UMTS variable was not taken into account for further analysis.

Data analyses

The sum (Egsm) of the measured GSM 900 MHz (Egsm900) and 1800 MHz (Egsm1800) electric field strength values was calculated using the formula: $Egsm = \sqrt{Egsm900^2 + Egsm1800^2}$ (Electronic Communications Committee, 2003). Prior to all analyses, the electric field strength variables were logarithmically transformed to achieve normality of their frequency distributions.

We explored relations between the number of House Sparrow males (dependent variable) and each of the three electric field strength variables. As the dependent variable consists of count data and is hence discontinuous, standard regression (or correlation) techniques are inappropriate. Instead, we used Poisson regressions (i.e., generalized linear models) with a log link function to examine putative relationships. Preliminary analyses indicated that significant variation among the six study areas was present for all variables (ANOVA, $P < 0.001$). Therefore we included "area" as a categorical factor in all models and considered it to be a proxy for all unknown, and

hence unmeasured variables causing among area variation in the number of House Sparrows (e.g., habitat characteristics, food availability, temporal differences among censuses). Statistical analyses were done with S-PLUS v. 6.2.

Results

The number of House Sparrow males varied between zero and four at the different locations. The measured electric field strengths were seldom higher than 1 V/m, and most often well below that value (Table 1).

To explore the putative effects of area, electric field strength and their interaction on the number of House Sparrows, we performed separate analyses for each of the three radiation variables. As no significant interaction effect between area and electric field strength was detected in any of the three analyses (Chi^2-tests and AIC-criteria, $P > 0.20$), we excluded the interaction term from further treatments. The final regression models were highly similar for the three electric strength variables. They revealed significant variation among study areas (Chi^2-tests, $P < 0.001$), and a highly significant negative effect of electric field strength on the number of House Sparrow males (Chi^2-tests and AIC-criteria, $P < 0.001$; Figure 1). Estimates of the scaled deviance (1.06 – 1.14) were very close to 1, and examination of the regression residuals revealed no clear patterns or deviations from normality. These observations indicate an adequate fit of the models to the data.

Table 1

Summary statistics (mean, 95% confidence interval, range) of the number of House Sparrow males and electric field strength variables in the six study areas. Means and confidence limits of the radiation variables were calculated after back-transformation of the logarithmically transformed data; the confidence intervals are therefore asymmetrical around the mean

Study area		Number of House Sparrow males	E_{gsm900} (V/m)	$E_{gsm1800}$ (V/m)	E_{gsm} (V/m)
1: Lokeren - Eksaarde	mean	1.5	0.153	0.075	0.193
	95% CI	0.8 – 2.2	0.108 - 0.216	0.046 - 0.123	0.139 - 0.270
	Min - Max	0 – 4	0.036 - 0.494	0.015 - 0.333	0.052 - 0.505
2: Lokeren - Spoele	mean	1.9	0.084	0.083	0.130
	95% CI	1.5 – 2.3	0.059 - 0.120	0.058 - 0.120	0.091 - 0.183
	Min - Max	0 – 4	0.008 - 0.327	0.013 - 0.394	0.016 - 0.412
3: Lokeren - Bergendries	mean	0.8	0.245	0.017	0.247
	95% CI	0.3 - 1.3	0.186 - 0.323	0.009 - 0.031	0.187 - 0.327
	Min - Max	0 - 3	0.052 - 0.537	0.004 - 0.125	0.052 - 0.551
4: Sint Niklaas - Clementwijk	mean	1.0	0.130	0.056	0.148
	95% CI	0.6 - 1.4	0.098 - 0.173	0.039 - 0.082	0.111 - 0.197
	Min - Max	0 - 3	0.019 - 0.412	0.009 - 0.231	0.021 - 0.469
5: Gent - Wondelgem	mean	1.3	0.109	0.040	0.121
	95% CI	0.9 - 1.6	0.079 - 0.151	0.030 - 0.054	0.089 - 0.165
	Min - Max	0 - 4	0.016 - 1.006	0.009 - 0.321	0.022 - 1.056
6: Gent - Mariakerke	mean	0.8	0.043	0.080	0.160
	95% CI	0.3 - 1.2	0.024 - 0.078	0.049 - 0.130	0.107 - 0.240
	Min - Max	0 - 4	0.006 - 1.022	0.017 - 0.824	0.040 - 1.023

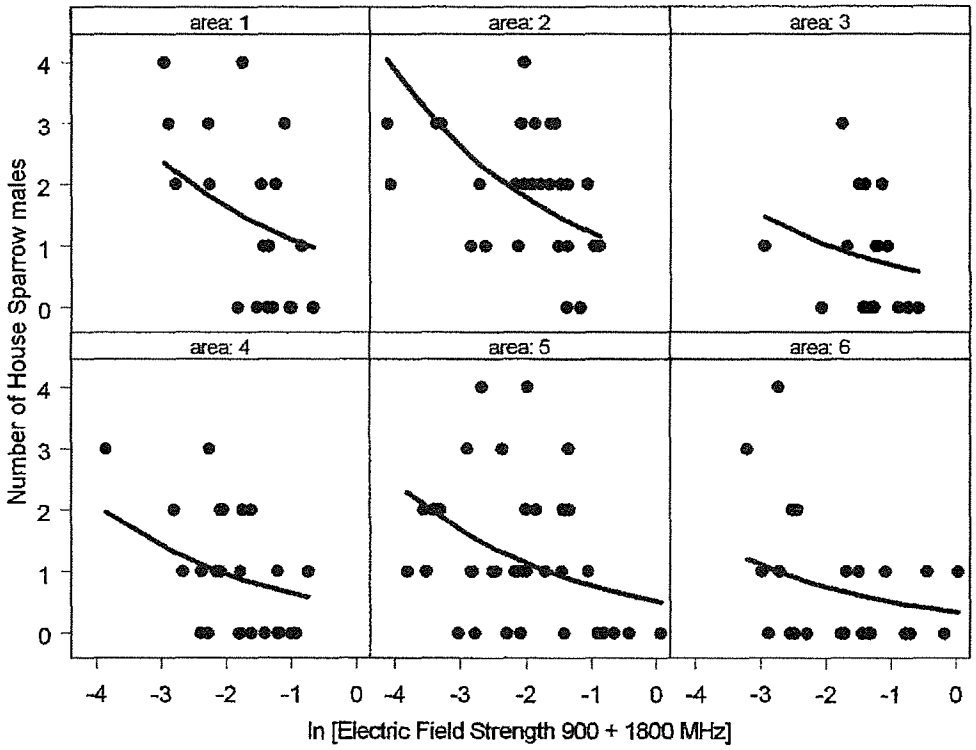

Figure 1. Scatterplots of the observed number of House Sparrow males as a function of the sum (Egsm) of GSM 900 MHz and GSM 1800 MHz electric field strength values (logarithmic scale) at the different locations within each of the six study areas. Regression lines were obtained by Poisson regressions and incorporated the effects of area and radiation intensity (see text).

We further explored the separate effects of electromagnetic radiation at the two frequencies by modelling the number of House Sparrow males as a function of area, electric field strength at 900 MHz, electric field strength at 1800 MHz, and their interactions. The final model retained included highly significant effects of area and the two electric field strengths (Chi^2-tests and AIC-criteria, $P < 0.001$) and a marginally significant interaction effect between both field strengths (Chi^2-test, $P = 0.02$). This strongly suggests that the electromagnetic radiations at both frequencies have complex additive effects on the number of House Sparrow males.

Overall, analyses indicated that the strength of all three radiation variables decreased with increasing distance to the nearest base station (F-tests, $P < 0.001$). We therefore examined whether the negative relation between the number of birds and strength of radiation was induced by variation among sampling locations in the distance to GSM base stations. Upon adding distance to the nearest base station as an additional factor to the regression models that included area and electric field strength, distance did not account for a significant portion of the residual variation (Chi^2-tests and AIC-criteria, $P > 0.50$). Conversely, when we forced distance as the first factor into the regression equations, both area and radiation strength were subsequently selected as highly significant factors (Chi^2-tests and AIC-criteria, $P < 0.001$).

Discussion

Our results indicate that spatial variation among sampling locations in the number of House Sparrow males was negatively related to the strength of electric fields emitted by GSM base stations. Importantly, this relation was highly similar among the six study areas, as evidenced by the non-significant interaction effects between area and electric field strength, despite differences among areas in both the number of birds and radiation levels. Moreover, the negative association was detected for electric field strengths from both the 900 and 1800 MHz frequency bands and from the sum of these frequency bands. Our analyses also revealed that the negative relation between the number of birds and strength of radiation was not a simple consequence of differences among sampling locations in distances to the nearest GSM base station. This can probably be attributed to variations in the orientation, position and number of antennas and to the shielding effects and multiple reflections from structures like buildings and trees, which affect local levels of exposure to electromagnetic radiation. Thus, our data show that fewer House Sparrow males were seen at locations with relatively high electric field strength values of GSM base stations and therefore support the notion that long-term exposure to higher levels of radiation negatively affects the abundance or behaviour of House Sparrows in the wild.

Nevertheless, our study should be considered as preliminary for several reasons. First, sampling locations were each visited only once, such that counts of the number of House Sparrow males and measurements of electric field strength are subject to some variation and estimation error. However, it is most likely that these errors are randomly distributed among locations. We also note that a single visit during the peak of the breeding season (April – May) is considered to be adequate to locate House Sparrow breeding territories (Hustings et al., 1985; Van Dijk, 2004). Second, because of the short study period, we ignore whether differences in bird counts reflect variation in abundance of breeding birds or in short-term behavioural responses like the tendency to sing. However, a decrease in singing intensity will result in a decrease of reproductive success and ultimately a decline of population size. Third, only the radiation from GSM base station antennas was measured. Probably, the distribution of possible other significant electromagnetic signals will be random, but due to the lack of measurements in other frequency bands (except for UMTS), this remains an object of further study. Fourth, as with all descriptive field studies, we cannot provide evidence for a causal relationship between radiation levels and the number of birds. Nevertheless, the fact that we found a highly similar pattern in each of the six study areas strengthens the possibility that the relationship is not a spurious one.

There are several unpublished and anecdotal reports about birds and mobile phone base stations, but we know of only one other published study that examined the effects of electromagnetic radiation from mobile phone base stations on wild bird populations. Balmori (2005) found a significantly lower number of White Stork (*Ciconia ciconia*) fledglings in nests exposed to relatively high electromagnetic radiation (2.36 ± 0.82 V/m) than in nests receiving lower levels of radiation (0.53 ± 0.82 V/m). Together with observations on aberrant behaviours of the adult birds, these results suggest that electromagnetic radiation interferes with reproduction in this wild population.

What could be the underlying mechanisms of the (putative) negative effects of radiation from GSM base stations on wild bird populations? Because all measured electric field strength values were far below what is required to produce heating as low as 0.5 °C (i.e., 10 mW/cm² or ca. 194 V/m; Bernhardt, 1992), the effects should be considered as non thermal at very low intensities.

Non thermal effects of microwaves on birds were reported already 40 years ago (Tanner, 1966; Tanner et al., 1967). Most studies indicate that exposure of birds to electromagnetic fields

generally changes, but not always consistently in effect or in direction, their behaviour, reproductive success, growth, development, physiology, endocrinology, and oxidative stress (Wasserman et al., 1984; Grigor'ev et al., 2003; Fernie and Reynolds, 2005). Of special relevance within the context of our research are laboratory studies that demonstrate negative effects of electromagnetic radiation from mobile phones on the development and survival of bird embryo's (Farrel et al., 1997; Youbicier-Simo and Bastide, 1999; Grigoriew, 2003).

Bird feathers are known to act as dielectric receptors of high frequency electromagnetic fields and some experiments indicate that audiofrequency pulse-modulated high frequency fields may induce piezoelectric effects in the feathers (Bigu-del-Blanco and Romero-Sierra, 1975a, b). These results are important in view of the fundamental role that feathers play in the life of birds and in the influence of environmental factors on bird behaviour. Experiments also indicated that microwave radiation can have the same averse effects on birds in flight as those observed in caged birds (Romero-Sierra et al., 1969).

Several bird species also use magnetic navigation (Liboff and Jenrow, 2000; Muheim et al., 2006) and can become disorientated when exposed to weak (< 1/50 of geomagnetic field strength) high frequency magnetic fields (Ritz et al., 2004; Thalau et al., 2005). The available evidence concerning magnetoreception suggests that birds use a radical pair mechanism for a chemical compass, and a mechanism based on magnetite particles (Wiltschko and Wiltschko, 2005; Mouritsen and Ritz, 2005). Magnetite is an excellent absorber of microwave radiation at frequencies between 0.5 and 10.0 GHz through the process of ferromagnetic resonance (Kirschvink, 1996), so that interaction with electromagnetic fields from mobile phone base stations might be possible.

In an experiment with Zebra Finches (*Taenopygia guttata*) that were temporary (10 minutes) stimulated with a pulsed electromagnetic field similar to the signal produced by mobile phones with carrier frequency 900 MHz, significant non thermal changes in the amount of neural activity by more than half of the brain cells were detected (Beason and Semm, 2002). The effect did not appear tot be limited to magnetic sensory cells, but occurred in any part of the brain. The authors postulate that similar neural responses to different frequencies point toward a common mechanism of low frequency modulation, perhaps at the cell membrane. Such a stimulus might mimic a natural mechanism involved in cell communication. Although the peak electric field strength used in that experiment (0.1 mW/cm^2 = approx. 19 V/m; Beason and Semm, 2002) was higher than the values measured in our study, results from other studies indicate that a long-term exposure at low intensities can produce the same effects as a short-term exposure at higher intensity (D'Andrea et al., 1986a, b; Lai, 2005; Belyaev, 2005a). This suggests that the non thermal effects of relatively weak electromagnetic radiation from mobile phone base stations can accumulate over time and have significant implications, as detected by several pilot epidemiological studies on humans (see Introduction).

Radiation from GSM base stations may also affect the local abundance of insects or other invertebrates and thereby indirectly influence the number of House Sparrows. Although adult House Sparrows are mainly seed-eaters, they need insects and other invertebrates to feed their young, such that it is likely that they will prefer areas with high abundance of invertebrates at the beginning of the breeding period. Several researchers have postulated that the lack of invertebrates might be an important factor in the reported decline of House Sparrow populations in urban areas (Wotton et al., 2002; Summers-Smith, 2003). Short-term exposure of pulsed mobile phone radiation with carrier frequency 900 MHz resulted in a 50-60 % decrease of the reproductive capacity of insects (Panagopoulos et al., 2004). Similar results were also found with microwave radiation at other frequencies (Bol'shakov et al., 2001; Atli and Unlu, 2006).

The results of our study suggest that long-term exposure to low-intensity (pulsed) electromagnetic radiation from GSM base stations may have significant effects on populations of wild birds. The exact mechanisms of these effects are as yet poorly understood. Given the potential importance that such effects may have on aspects of biodiversity and human health, more detailed studies in both the laboratory and the field are urgently needed to corroborate our results and to uncover the underpinning mechanistic relationships.

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The incidence of electromagnetic pollution on the amphibian decline: Is this an important piece of the puzzle?

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Abstract
A bibliographical review on the possible effects of radiofrequency radiation (RFR) from wireless telecommunications on living organisms and its impact on amphibians is presented. The technical characteristics of this new technology and the scientific discoveries that are of interest in the study of their effects on wild fauna and amphibians are described. Electromagnetic pollution (in the microwave and in the radiofrequency range) is a possible cause for deformations and decline of some amphibian populations. Keeping in mind that amphibians are reliable bio-indicators, it is of great importance to carry out studies on the effects of this new type of contamination. Finally, some methodologies that could be useful to determine the adverse health effects are proposed.

Keywords: *Athermal effects, electromagnetic pollution, effects on amphibians, microwaves, phone masts*

Introduction

Amphibians are important components of the ecosystem and reliable bio-indicators; their moist skin, free of flakes, hair or feathers, is highly permeable to water chemicals (particularly larvae) and air pollutants (especially adults). Amphibian eggs are also directly exposed to chemicals and radiation. These characteristics make amphibians especially sensitive to environmental conditions, changes of temperature, precipitation or ultraviolet (UV) radiation and reliable monitors of local conditions [1].

A recent report from the International Union for Conservation of Nature (IUCN), prepared by 500 scientists from 60 countries, analyzed populations of 5743 amphibian

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species in the world and concluded that 1856 (32%) of them were considered threatened of extinction. Nine species have become extinct since 1980 and another 113 have not been observed in the recent years, and probably are also extinct [2]. The results demonstrate that amphibians are far more threatened than either birds or mammals, and the factors causing 'enigmatic' declines are driving the species toward extinction particularly rapidly. Unless these declines are quickly understood and reversed, hundreds of amphibian species can be expected to become extinct over the next few decades [3]. The disappearance of amphibians together with other organisms is a part of the global biodiversity crisis [4,5].

An associated phenomenon is the appearance of large numbers of deformed amphibians, with absent or extra limbs [5]. From 1995, at least 60 different species were affected with a high incidence of deformities, with several species affected in one place, in 46 states of United States and in regions of Japan, Canada, and several European countries [5,6]. The problem seems to have become more prevalent, with deformity rates of up to 25% in some populations, which is significantly higher than in previous decades [6].

The problem of deformities is complex because it is related to water quality, physiology, development, anatomy, and ecology [5]. The reduction in populations and the increase in deformities are a warning of serious environmental degradation [5].

Evidence exists that several populational declines are probably the result of complex interactions among several biotic and abiotic factors [1,4,7,8]. The proposed explanations are an increase of ultraviolet radiation (UV-B)[1,5,9–14]; chemical pollutants (pesticides, herbicides, fungicides, fertilizers, etc.) [5,15]; pathogen and parasites [1,6,16], destruction and alteration of habitat, changes in meteorological patterns (climatic change) [4,17], and introduced species [1,5].

The amphibian population declines are also occurring in relatively pristine places such as National Parks, or rural areas far from urban centers [3,14]. Humans and other animals can also be affected by the same environmental factors that damage amphibians [6].

A type of contamination whose effects on amphibians have not been studied up to now, is the electromagnetic pollution, especially microwaves and radiofrequencies from mobile telecommunications and radio station transmitters that will be discussed in this review. Before the 1990s, radiofrequencies were mainly from a few radio and television transmitters, located in remote areas and/or very high places. Since the introduction of wireless telecommunication in the 1990s, the rollout of phone networks has seen a massive increase in the electromagnetic contamination in cities and in the wilderness [18,19]. At the moment, new types of antennas are being investigated to reduce the power needed to establish communication [20,21]. Recently, there has also been an increase of other wireless transmitters (radio or television stations).

The objective of this review is to detail advances in the knowledge of biological mechanisms and effects from radiofrequencies and microwaves on animals, and some considerations are made on its possible relationship with deformations and the population decline of amphibians.

Main causes of populational decline and appearance of deformations in amphibian populations

Ultraviolet radiation

UV-B radiation (1) induces mutations and cellular death, (2) weakens the immune system, (3) reduces growth, and (4) induces several types of damage, like malformations

of the limbs, body, and eyes [1,5,12,14]. Not all the species respond in the same way [14]. Embryos with higher photolyase levels (DNA photorepair enzyme) are more resistant to UV-B radiation [11,12].

The eggs of some of the amphibian species experienced high mortality that may contribute to the populational declines [9]. UV acts in conjunction with other agents like pesticides to induce defects in the development [10]. UV also decreases defense mechanisms against illnesses making individuals more susceptible to pathogen and parasites, affecting normal development and increasing mortality that consequently impacts on the decline of some populations [10]. The egg mass protected from UV-B radiation have significantly more hatching, less deformities, and develop more quickly [10].

Synergy between a pathogenic fungus and UV-B radiation increased mortality among amphibian embryos [12]. The synergy may occur when developing amphibians have reduced ability to respond to a stressor in the presence of another stressor. For example, contamination exerts more deleterious effects with UV-B [1]. Animals use molecular and physiologic mechanisms and certain behaviors [22] to limit their exposure to UV-B and repair from UV-B damage [14].

Although cellular repair mechanisms of several species are not effective in the presence of persistent increase in UV-B radiation levels [14], amphibians are relatively resistant to this radiation if they can repair the damage effectively [14]. In some species, photoreactivation is the most important repair mechanism of UV-damaged DNA [9]. Heat shock proteins may also play a role in protecting cells from UV-B damage, since they prevent the denaturation of proteins during exposure to environmental stress [14].

Chemical pollutants

Chemical pollutants appear in areas where pesticides and fertilizers are applied extensively and produce mortality and deformities in amphibians. Although on a broad scale, no correlation between pesticide contamination and amphibian deformities was found, pesticides cannot be completely ruled out as causal agents [5].

Pathogens and parasites

Three pathogens received attention recently for having produced an amphibian populational decline in some areas: *Batrachochytrium denderobatidis, Saprolegnia ferax,* and an iridovirus (*Ambystoma tigrinum virus*) [1]. The parasite *Ribeiroia ondatrae* is an important source of malformations of amphibian extremities in western USA [16]. Larvae with malformations experience higher mortality before and during metamorphosis than the normal ones. The relevance of infection by *Ribeiroia* and the influence of habitat alteration on the pathology and biological cycle of this trematode, requires further investigation [16]. In relative pristine environments, the incidence of snails infected with *Ribeiroia* is low, but the habitat alteration can increase the rate of infestation [16]. Infection of amphibian larvae by the trematode *R. ondatrae* may represent a threat to amphibians or species in decline. Although deformities can be the cause of declines in some places, numerous populations of amphibians have greatly declined in the absence of any deformity, for which there must be other factors [6].

Climatic change

Climatic change influences breeding patterns of certain organisms which affect their populational structure and may be reflected in the populational declines of very sensitive

species such as amphibians. The pattern found up to now in the published studies is that some anurans of temperate areas show an early reproduction tendency [17]. Climate-induced reductions in water depth at egg-laying sites produced high embryo mortality by increasing their exposure to UV-B radiation which is more worrying than the reduction in ozone layer. Climate also increases their vulnerability to *S. ferax* [4].

Physical and technological characteristics of mobile telephone

Electromagnetic radiation (EMR) transmits small packages of energy denominated photons [23]. The radiofrequencies occupy the range from 10 MHz to 300 GHz. Cellsite antennae emit a frequency of 900 or 1800 MHz, pulsed at low frequencies, generally known as microwaves (300 MHz–300 GHz). Microwaves carry sound information by blasts or pulses of short duration, with small modulations of their frequency, that are transferred between wireless phones and base stations over dozens of kilometres.

The main variable that measures these radiations is 'power density' (measured in $W\,m^{-2}$, or $\mu W\,cm^{-2}$) expressing radiant power that impacts perpendicularly to a surface, divided by the surface area; and 'electric field intensity' (measured in $V\,m^{-1}$), a vectorial magnitude to the force exercised on a electric loaded particle, independent of their position in space.

For a concrete address with relationship to an antenna, the power density at a point varies inversely proportional to the square of the distance to the source. Though EMR have many and varied outputs, at a distance of 50 m the power density is about $10\,\mu W\,cm^{-2}$ [24], while at distances of 100 m at ground level it measures above $1\,\mu W\,cm^{-2}$ (pers. obs.). Between 150 and 200 m, the power density of the main lobe near the ground is typically some tenth of $1\,\mu W\,cm^{-2}$ [25].

Experimental difficulties

Experiments that study the effects of EMR on living organisms are complex, since a high number of variables exist that need to be controlled. Microwave radiation produces different effects depending on certain methodological positions such as frequency, power, modulation, pulses, time of exposure, etc. [26–28]. Some studies demonstrated different microwave effects depending on the wavelength in the range of mm, cm or m [28,29]. The dose–response relationships (of non-thermal effects), are not simple to establish since they present a non-linear relationship [30–32].

Pulsed waves (in blasts), as well as certain low frequency modulations exert greater biological activity [26,28,31,33]. These radiations also have accumulative effects that depend on the duration of exposure [19,34,35]. It is possible that each species and each individual, show different susceptibility to radiations, since the vulnerability depends on the genetic tendency, and the physiologic and the neurological state of the irradiated organism [31,36–41].

Effects and action mechanisms on biological systems

One of the well known effects of microwaves is their capacity to excite water molecules and other components in food, elevating their temperature. The resulting heating level depends on the radiation intensity and the exposure time. At a power density above $500\,\mu W\,cm^{-2}$

(microwave ovens) heating effects take place, below that level the effects are 'athermal non-heating'.

Animals are sensitive complex electrochemical systems that communicate with their environment through electrical impulses. In cellular membranes and body fluids, ionic currents and electrical potential exist [42]. Electromagnetic fields (EMFs) generated in biological structures, are characterized by certain specific frequencies. It is possible a frequency-specific, non-thermal electromagnetic influence, of an informational nature exists [25,31,43]. Some organs or systems like the brain, heart, and nervous system are especially vulnerable.

The wave systems have properties such as the frequency, which affect resonance capacity of living organisms to absorb the energy of an electromagnetic field [25]. Electromagnetic fields induce biological effects at "windows of frequency" (window effect) [44]. Living organisms are exposed to variable levels of radiofrequency electromagnetic fields, according to (1) distance to phone masts, (2) presence of metallic structures which are able to reflect or obstruct the waves (buildings or other obstacles), (3) number of phone masts, and (4) orientation and position [24].

Microwaves emitted by phone antennae affect organisms living in their vicinities, like vertebrate [45–47], insects [48–55], vegetables [56–58], and humans [25,31,59–63]. Small organisms are especially vulnerable: size approach to resonance frequency and thinner skull, facilitates an elevated penetration of radiation into the brain [24,31,64]. In a recent study carried out with bees in Germany, only few irradiated bees returned to the beehive and required more time to reach the hive. The weight of honeycombs is also smaller in the bees that were irradiated [54].

The microwave effects were investigated in a variety of living organisms, but the results found in vertebrates have special interest to amphibians. For more than 30 years, there is growing evidence on the existence of athermal effects on birds [65,66]. The exposed animals suffer a deterioration of health in the vicinity of phone masts [67,68]. Rats spent more time in the halves of shuttle boxes that were shielded from illumination by 1.2 GHz microwaves. The average power density was about 0.6 $mW\,cm^{-2}$. Data revealed that rats avoided the pulsed energy, but not the continuous energy, and less than 0.4 $mW\,cm^{-2}$ average power density was needed to produce aversion [69]. Navakatikian and Tomashevskaya [70] described a complex series of experiments in which they observed disruption of a rat behavior (active avoidance) by radiofrequency radiation (RFR). Behavioral disruption was observed at 0.1 $mW\,cm^{-2}$ (0.027 $W\,kg^{-1}$) power density.

It has been documented that the radiofrequencies induce biological effects on biomolecules [27,51,71] that include changes in intracellular ionic concentration [72,73], cellular proliferation [74], interferences with immune system [19,75,76], effects on animals reproductive capacity [77,78], effects on stress hormones [79], in intrauterine development [80], genotoxic effects [81–87], effects on the nervous system [32,88–92], the circulatory system [93,94], and a decline in the number of births [47,95]. Firstenberg [18] proposed a connection between EMR, deformations, and the worldwide decline and extinction of amphibians.

Evidence that electromagnetic contamination may be responsible for the appearance of deformities and decline of amphibians

Some athermal effects of EMR on amphibians have been well known for more than 35 years [96,97]. The radiation of frogs with 30–60 $\mu W\,cm^{-2}$ produced a change in the heart

rhythm, probably due to the nervous system activation (Levitina, 1966 cited in [96]). When toad hearts were irradiated with pulses of 1425 MHz at a power density of $0.6\,\mu W\,cm^{-2}$, an increase in the heart rate and arrhythmia were observed [96]. Radiofrequency burst-type dilated arterioles were observed on the web of the anaesthetized frog (*Xenopus laevis*) by a athermal non-heating mechanism [93].

The exposure to magnetic fields on two species of amphibians induced deformities [48].

Frog tadpoles (*Rana temporaria*) developed under electromagnetic field (50 Hz, $260\,A\,m^{-1}$) have increased mortality. Experimental tadpoles developed more slowly and less synchronously than control tadpoles, remain at the early stages for a longer time. Tadpoles developed allergies and EMF causes changes in the blood counts [98].

Amphibians can be specially sensitive: thresholds of an overt avoidance response to weak electrical field stimuli down to $0.01\,V\,m^{-1}$ were found in *Proteus anguinus* and $0.2\,V\,m^{-1}$ in *Euproctus asper* at 20–30 Hz, but sensitivity covered a total frequency range of below 0.1 Hz to 1–2 kHz [99].

Deformities in nature

Ultraviolet radiation, UV-B. UV-B radiations produce deformities in amphibian embryos that go from lateral flexure of the tail to abnormal skin, eye damage, and lower survival rate [6,10]. However, numerous experiments carried out did not provide evidence that this exposure induces all types of deformities observed in nature, nor the appearance of extra limbs, one of the most frequent deformities noted [5,6]. On the other hand, most of the deformations for UV-B radiation occur in the legs or in reduction of the number of bilateral fingers. However, in the wild, amphibians exhibit a wide diversity of aberrations that are limited to only one side of the body, including problems in the skin, loss of legs, and twisted internal organs, reasons for which it was considered that this radiation is not the only source [5]. Similar abnormalities found in the wild and not induced by UV-B radiation have been obtained in laboratory studies, by exposing amphibian larvae to magnetic fields [48]. A similarity exists in the deformations of amphibians observed by Levengood [48] and Blaustein and Johnson [5]. Several studies addressed behavior and teratology in young birds exposed to electromagnetic fields [39,41]. Typical abnormalities include malformation of the neural tube and abnormal twisting of the chicken embryo. The electric currents are believed to have a significant role in the control of development and it is also possible that external EMR could influence these control systems [100]. The appearance of morphological abnormalities influenced by pulsed electromagnetic fields during embryogenesis in chickens [33,101] are similar to those produced by ultraviolet radiation [36]. The pulses are in fact a characteristic of mobile telephone radiations that have increased from 1995, when a marked rise in deformations started. Several experimental studies point out that the exposure to UV-B produced deferred effects (early exposure causes delayed effects in later stages) [1]. The exposure to electromagnetic fields also induces delayed effects and the tadpoles are the same as the control until the beginning of metamorphosis. The extra limbs and blistering were induced during the gastrula stage of the development which appeared to be the most sensitive stage [48]. The early *Rana pipiens* embryonic development was also inhibited by magnetic fields [97]. In rats, brief intermittent exposure to low-frequency EMFs during the critical prenatal period for neurobehavioral sex differentiation can demasculinize male scent marking behavior and increase accessory sex organ weights in adulthood [102]. Biological effects resulting from EMR field exposures might depend on the dose (e.g. duration of exposure). Short-term exposures up-regulate cell repair

mechanisms, whereas long-term exposures appear to down-regulate protective responses to UV radiation [103].

Parasites. The parasite *R. ondatrae* is an important and extensive cause of malformations in amphibian extremities in western USA [16]. Tadpoles with malformations experience higher mortality than the normal ones before and during metamorphosis. The *Ribeiroia* infection represents a threat for amphibian populations that are in decline. However, with a growing volume of data based on the experimental evidence, the infection from parasites does not seem to be the cause of all the malformations on limbs, since in some places with the presence of deformations, the parasite *R. ondatrae* was absent [5]. Further certain deformities like the absence of eyes, limbs, and twisted internal organs was not induced by the parasite [5].

In a laboratory study, eggs and embryos of *Rana sylvatica* and *Ambystoma maculatum* were exposed to magnetic fields at several development stages. A brief treatment of the early embryo produced several types of abnormalities: microcephalia, scoliosis, edema, and retarded growth [48]. Several of the treated tadpoles developed severe leg malformations and extra legs, as well as a pronounced alteration of histogenesis which took the form of subepidermal blistering and edema [48]. In chick embryos exposed to pulsed EMR a potent teratogenic effect was observed: microphthalmia, abnormal trunkal torsion, and malformations on the neural tube [33,36,101,104]. One of the possible reasons for these deformities appearing more often [5], may be due to wireless telecommunications and exponential increase of electromagnetic contamination.

Bioelectric fields have long been suspected to play a causal role in embryonic development. The electrical field may directly affect the differentiation of some tail structures, in particular those derived from the tail bud. Alteration of the electrical field may disrupt the chemical gradient and signals received by embryo cells. It appears that in some manner, cells sense their position in an electrical field and respond appropriately. The disruption of this field alters their response. Endogenous current patterns are often correlated with a specific morphogenetic events such a limb bud formation. The most common defect in chick embryos experimental group was in tail development. Internally, tail structures (neural tube, notochord, and somites) were frequently absent or malformed. Defects in limb bud and head development were also found in experimentally treated chick embryos, but less often than the tail defects [105]. Amphibians can be especially sensitive because their skin is always moist, and they live close to, or in water, which conducts electricity easily.

Populations' decline

Deformities found in nature can directly affect embryonic mortality and survival after hatching [10]. It seems interactions that exist among UV-B radiation and additional factors contribute to embryo mortality [9]. Water pollution and excessive ultraviolet radiation act jointly, producing specific problems and alter the immune system, making amphibians more vulnerable to parasitic invasions and pathogen infections [6,8,12,14]. It is proposed that there exists a possible relationship between the decline of amphibians and exponential increase of electromagnetic pollution. Several experiments with bird eggs showed a high mortality of embryos exposed to EMR from mobile phones [36,106,107]. EMFs increases mortality of tadpoles [98]. The EMR alters the immune, nervous, and endocrine systems, and operates independent or together with other factors like UV-B radiation or chemical pollutants. Death of embryos in nature is not due to UV radiation

as the capacity of DNA repair mechanisms like photolyase (photoreactivating enzyme) is effective [9]. EMR produces stress on the immune system [76,98] that obstructs DNA repair [42,108,109]. Heat shock proteins may play a role in protecting amphibians from UV-B damage [14] and animals exposed to EMR [27,51,71,110,111]. Different susceptibility to UV among species and even among populations exists [112], as seen with EMR [31,40].

Hallberg and Johansson [108,109] proposed that radiofrequencies increase the effects of UV radiation. A study on the causes of melanoma in humans conclude that the incidence increases and the mortality associated with this skin tumor cannot only be explained by the elevation in UV sun radiation, but rather by the continuous alterations on mechanisms of cellular repair, produced by EMR (radiofrequencies) resonant with the body, that amplify the carcinogenic effects of the cellular damage induced by the UV-B radiation. The cases of melanoma experienced a significant increase from the 1960–70s [108] that continues today, and also asthma and several types of cancer associated with deterioration of immune system. Data suggest there is an increase of electromagnetic pollution [108,113]. The public health situation in Sweden has become worse since the autumn of 1997. There is a correlation between the massive roll-out of GSM mobile phone antennae and adverse health effects [109].

Enigmatic decline of amphibian species are positively associated with streams at high elevations in the tropics and negatively associated with still water and low elevations [3]. In high places, the electromagnetic contamination is usually higher [47]. Microwave measurements of power density as low as $0.0006\,\mu W\,cm^{-2}$ show strong correlation with symptoms like depressive tendency, fatigue, and insomnia in humans [63].

Proposed research

To demonstrate the conclusive effect of microwave radiation on amphibians it is necessary to approach research with a control (non-exposed) and an experimental group. This methodological position is complicated at present due to the ubiquity of these radiations [98]. Studies that try to correlate populational evolution, appearance of deformities, or the presence or absence of amphibians with measurements of electromagnetic fields from radiofrequencies will be of great interest. Field investigations of urban park populations and phone masts surrounding territories need to be high-priority. A radius of $1\,km^2$ laid out in concentric circumferences at intermediate distances may be useful to investigate the differential results among areas, depending on their vicinity and corresponding levels of EMR. Laboratory studies on amphibians exposed to pulsated and modulated microwaves would also be of great interest.

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Seymour Jr., Whitney N.

From: crgr@aol.com
Sent: Saturday, February 05, 2011 1:44 AM
To: Seymour Jr., Whitney N.
Subject: Confidential - ?? from Camilla Rees

Hello Mr. Seymour!
I am helping someone in NYC in a 5th Avenue building where the building has given an option to T-Mobile to put a
tower on the rooftop (just above this woman's penthouse) in exchange for $35,000 a year.

The points T-Mobile has made that most of the Board believes are:
1. They can precisely beam the radiation so that it is not directed into the apartment below.
and
2. It is better to be under the antenna with it beaming outwards (i.e. placed on their building) than have
T-Mobile put it on a neighboring building where it would be beaming at them.

In my limited experience with buildings with antennas on the roof, the people below were very sick despite the antennas beaming outward.
Do you have any idea if perhaps if they placed metal under the antenna on the roof could
that *totally* shield the radiation?
Any experience with this??

Have you ever come upon the argument that it is better to be under the antenna than have the antennas on the building next door?

There is some possibility the roof may not hold the intended structure, and that they would use the side of the
building in the center courtyard instead to which to attach antennas. In that case, where antennas are attached to
the side of the building, I wonder if it is it realistic that a metal plate of some sort could shield.

Any thoughts on this would be gratefully appreciated! **Do you know of any research negating these T-Mobile
arguments? Have you ever encountered this sort of situation before and addressed it from a legal
perspective?**

She is a very high potential donor to this cause so I want to help her marshall the forces fast to show her
board these 2 points are invalid if possible! If you have any thoughts on this I would love to hear them!!

Many thanks!!

Camilla
415-992-5093