

23 December 2016

Re: EMFs, the Birds and the Bees, and the Canadian Environmental Assessment Processes Review

Thank you for the opportunity to provide input on this review.

I am a retired Government of Canada research biologist with over 30 years experience in original research projects including ten years in freshwater ecosystem toxicology.

I fully support modernizing the Environmental Assessment processes to identify and include new environmental threats. A relevant example is that of anthropogenic electromagnetic fields - estimated to be millions of times above historical levels in many urban areas. Proper assessment data, including pre-project baseline data, should be conducted by an independent agency (not the proponent). Cumulative effects from multiple sources, as well as over time, should be monitored for undesirable effects e.g. the installation of wireless radiation emitting devices in close proximity (e.g. cellphone antennas, smart meters¹ and 5G microcells).

The full potential adverse effects of EMFs on wildlife, and hence ecosystems, has not been taken into account by Canadian environmental legislation. This is a largely unstudied field². Human health is covered somewhat by Health Canada's Safety Code 6 which applies to federal workplaces and has been adopted by Innovation, Environment and Economic Development Canada in the regulation of wireless radiation devices. Other jurisdictions such as the Provinces, Territories and school boards have also adopted these guidelines.

Undesirable effects below Safety Code 6 guidelines have been established in birds, insects and plants. An example is the disorientation in European robins exposed to ambient AM radiofrequency transmissions. There is also some question as to whether EMFs may be a contributing factor in the world wide phenomenon of Colony Collapse Disorder in bees. For substantiating evidence of concerns about anthropogenic EMFs, attached is my recently submitted brief regarding the review of the Canadian Environmental Protection Act (CEPA).

In summary

1. The Canadian Environmental Assessment process should allow for newly identified environmental threats to biota such as anthropogenic electromagnetic fields.
2. Proper baseline studies by an independent government body should be conducted before major installations go forward e.g. cell tower constructions, large scale roll outs of smart meters and deployment of 5G microcells.
3. Effective monitoring and reporting by an independent government agency for cumulative effects (concurrently and over time) is essential in the process to ensure minimal adverse effects.

I would be pleased to provide more information.

Respectfully submitted,
Margaret Friesen M.Sc.

¹ Also referred to as automated metering devices

² See letter by Mr. Willie Taylor of the US Department of the Interior. https://www.ntia.doc.gov/files/ntia/us_doi_comments.pdf

1 December 2016

Ms Deborah Schulte, M.P.

Chair, Standing Committee on Environment and Sustainable Development

House of Commons, Ottawa, ON K1A 0A6

By Email: ENVI@parl.gc.ca

Dear Ms Schulte,

Re: EMFs, the Bees and the Birds and the Canadian Environmental Protection Act (CEPA) Review

I am former Government of Canada research biologist having retired in 2008 with over 30 years experience involved in original research projects - primarily in freshwater ecosystem toxicology (10 years) and in DNA population genetics of Arctic marine mammals (about 10 years). My Bachelor of Science (Honours) is in zoology. My Master of Science degree is in entomology (insects) and my thesis project was a toxicological study examining the effects of a pesticide on a non-target species. I have co-authored papers in peer-reviewed journals in those fields. I have also worked in cancer research as technician and as a summer student at the University of Manitoba in parasitology.

I have no conflict of interest and have not been paid in any way for preparing this brief.

Being concerned about the collapse of bee colonies worldwide, I began taking a closer look at possible effects that electromagnetic fields (EMFs) might be having on bees. As well as finding a number of studies showing adverse effects at below current safety guidelines for humans (there don't appear to be comparable Canadian guidelines for non-humans), I also found studies on other insect and wildlife species, including birds. I compiled this into a poster presentation I made at the 70th Annual Meeting of the Entomological Society of Manitoba in October, 2014 titled: REVIEW OF THE LITERATURE ON THE BIOLOGICAL EFFECTS OF WIRELESS RADIATION ON INSECTS: A CALL FOR STUDIES ON HONEY BEES.

The abstract of that poster, as well as the list compiled of 91 references, are in Appendix 1. Studies showing effects and no effects are included. Not all studies are peer-reviewed. Some studies show no effect, some are neutral but the majority show effects. Some of these effects could have substantial impacts on survival and reproduction which in turn, if wide scale enough, would affect ecosystems. Additional studies, published after my compilation, are listed immediately below my signature. Please note the underlined parts of the abstract in the Lazaro et al. (2016) paper.

We know that honey bees are susceptible to certain pesticides and viruses have taken a heavy toll. Given the evidence provided in the studies listed here, the possibility exists that the effects of electromagnetic fields e.g. from satellite transmissions and cell tower antennas could be a factor in weakening the bees' ability to withstand other insults.

The search methodology I used was relatively crude and consisted mainly of entering search terms into the scientific references database EMF PORTAL³ as well as selecting relevant looking titles from

³ emf portal- RWTH Aachen University: <https://www.emf-portal.org/en/cms/page/funding>

references of various papers. A properly conducted systematic search⁴ would undoubtedly identify more studies.

The purpose of the CEPA (1999) is "An Act respecting pollution prevention and the protection of the environment and human health in order to contribute to sustainable development".

The purpose this brief is to outline only some of the evidence indicating that EMFs can be an environmental pollutant. I hope that you will make that addition to the revised Act.

If electromagnetic fields, as a potential environmental pollutant, do not belong in CEPA, then where do they belong?

I would be glad to respond to questions and provide further information.

Respectfully submitted,

Margaret Friesen

Email: friesenm.ehs@gmail.com

Some studies published after completion of the poster:

Boga, A., Emre, M., Sertdemir, Y., Akillioglu, K., Binokay, S., & Demirhan, O. (2015). The effect of 900 and 1800MHz GSM-like radiofrequency irradiation and nicotine sulfate administration on the embryonic development of *Xenopus laevis*. *Ecotoxicology and Environmental Safety*, 113, 378–390

Fedele, G., Green, E. W., Rosato, E., & Kyriacou, C. P. (2014). An electromagnetic field disrupts negative geotaxis in *Drosophila* via a CRY-dependent pathway. *Nature Communications*, 5 doi:10.1038/ncomms5391

Kirschvink, J. L. (2014). Sensory biology: Radio waves zap the biomagnetic compass. *Nature*, 509(7500), 296–297

Lázaro, A., Chroni, A., Tscheulin, T., Devalez, J., Matsoukas, C., & Petanidou, T. (2016). Electromagnetic radiation of mobile telecommunication antennas affects the abundance and composition of wild pollinators. *Journal of Insect Conservation*, 20(2), 315–324 ABSTRACT: "The exponential increase of mobile telephony has led to a pronounced increase in electromagnetic fields in the environment that may affect pollinator communities and threaten pollination as a key ecosystem service. Previous studies conducted on model species under laboratory conditions have shown negative effects of electromagnetic radiation (EMR) on reproductive success, development, and navigation of insects... Here we studied the effects of EMR from telecommunication antennas on key wild pollinator groups (wild bees, hoverflies, bee flies, remaining flies, beetles, butterflies, and wasps)...All pollinator groups except butterflies were affected by EMR. As EMR affected the abundance of several insect guilds negatively, and changed the composition of wild pollinators in natural habitats, it might also have additional ecological and economic impacts on the maintenance of wild plant diversity, crop production and human welfare."

Waldmann-Selsam, C., Balmori-de la Puente, A., Breunig, H., & Balmori, A. (2016). Radiofrequency radiation injures trees around mobile phone base stations. *The Science of the Total Environment*, 572, 554–569

Zmejkoski, D., Petković, B., Pavković-Lučić, S., Prolić, Z., Anđelković, M., & Savić, T. (2016). Different responses of *Drosophila subobscura* isofemale lines to extremely low frequency magnetic field (50 Hz, 0.5 mT): fitness components and locomotor activity. *International Journal of Radiation Biology*, 1–29

⁴ Rooney, A. A., Boyles, A. L., Wolfe, M. S., Bucher, J. R., & Thayer, K. A. (2014). Systematic Review and Evidence Integration for Literature-Based Environmental Health Science Assessments. *Environmental Health Perspectives*. doi:10.1289/ehp.1307972

Appendix 1. Poster presented at the 70th annual meeting of the Entomological Society of Manitoba, October 31st, 2014.

REVIEW OF THE LITERATURE ON THE BIOLOGICAL EFFECTS OF WIRELESS RADIATION ON INSECTS: - A CALL FOR STUDIES ON HONEY BEES -

Poster presentation, October 31st, 2014
Entomological Society of Manitoba, 70th Annual Meeting

Margaret Friesen M.Sc.

ABSTRACT: World-wide reports of declining bee colonies are of great concern. Among the suspected agents which could be responsible, or be a contributing factor, is non-ionizing, electromagnetic wireless radiation e.g. radiofrequency/microwave emissions from cell tower antennae and other devices. Behavioural effects documented for bees include induction of abnormal worker piping signalling and foraging flight. Decline in colony strength, reduced egg laying ability of the queen and loss of ability to store honey also have been reported. I review the literature on behavioural and other effects documented for insects and include some well designed studies on non-insect species, including birds and mammals.

The US Department of the Interior recently called for field studies in North America "to validate potential impacts of communication tower radiation - both direct and indirect- to migratory and other trust species". It seems appropriate that ecologically and economically important pollinators such as bees should rank high for concerted, systematic studies. With our well developed network of honey bee operators, and layperson and academic expertise, Manitoba is a prime location for such work.

REFERENCES: includes low frequency and grey literature.

Particularly relevant studies at radiofrequency/microwave (e.g. cell phone frequency) radiation appear in borders with extracts from the abstracts:

- A. Honey bees (*Apis mellifera*) : # 26, 34, 40, 46, 51, 64
- B. Ants (*Myrmica*): # 16, 17, 18
- C: Fruit fly (*Drosophila*): # 3, 53
- D. Birds/European robin (*Erithacus rubecula*) : # 24
- E. Mammals: contact M. Friesen (email listed above) for the 1,000+ reference list.

1. Altmann, G., & Warnke, U. (1976). [Metabolism of bees (*Apis mellifera* L.) in 90Hz high-tension field] Der Stoffwechsel von Bienen (*Apis mellifica* L.) im 50-Hz-Hochspannungsfeld. *Zeitschrift Für Angewandte Entomologie*, 80(1-4), 267–271.

2. Altmann, G., & Warnke, U. (1987). [Thermography of honeybee colonies in winter influenced by high-voltage electric fields] Thermographie der Honigbienen-Wintertraube unter Einfluß von Hochspannungswechselfeldern. *Journal of Applied Entomology*, 104(1-5), 69–73. doi:10.1111/j.1439-0418.1987.tb00498.x

3. Atli, E., & Unlü, H.. (2006). The effects of microwave frequency electromagnetic fields on the development of *Drosophila melanogaster*. *International Journal of Radiation Biology*, 82(6), 435–441.

Extract: 10 GHz EMF can cause developmental delay and decrease the number of offspring in *D. melanogaster*.

4. Balmori, A.. (2005). Possible Effects of Electromagnetic Fields from Phone Masts on a Population of White Stork (*Ciconia ciconia*). *Electromagnetic Biology and Medicine*, 24(2), 109–119.

5. Balmori, A.. (2009). Electromagnetic pollution from phone masts. Effects on wildlife. *Pathophysiology: The Official Journal of the International Society for Pathophysiology / ISP*, 16(2-3), 191–199. doi:10.1016/j.pathophys.2009.01.007

6. Balmori, A.. (2010). Mobile phone mast effects on common frog (*Rana temporaria*) tadpoles: the city turned into a laboratory. *Electromagnetic Biology and Medicine*, 29(1-2), 31–35.

7. Balmori, A., & Hallberg, Ö.. (2007). The Urban Decline of the House Sparrow (*Passer domesticus*): A Possible Link with Electromagnetic Radiation. *Electromagnetic Biology and Medicine*, 26(2), 141–151.

8. Becker, G.. (1963). Ruheinstellung nach der Himmelsrichtung, eine Magnetfeldorientierung bei Termiten. *Naturwissenschaften*, 50(12), 455–455.

9. Becker, G.. (1964). Reaktion von Insekten auf Magnetfelder, elektrische Felder und atmosphärische. *Zeitschrift Für Angewandte Entomologie*, 54(1-4), 75–88.

10. Becker, G.. (1971). Magnetfeld-Einflüsse auf die Galeriebau-Richtung bei Termiten. *Naturwissenschaften*, 58(1), 60–60.

11. Becker, G.. (1972). Aktivitätsschwankungen bei Termiten, ein Phänomen von grundsätzlicher biologischer Bedeutung. *Zeitschrift Für Angewandte Entomologie*, 72(1-4), 273–290.

12. Becker, G., & Kerner-Gang, W.. (1963). Schädigung und Förderung von Termiten durch Schimmelpilze. *Zeitschrift Für Angewandte Entomologie*, 53(1-4), 429–448.

13. Becker, G., Petrowitz, H.-J., & Lenz, M.. (1971). Über die Ursache der abschreckenden Wirkung von Kiefernholz auf Termiten. *Zeitschrift Für Angewandte Entomologie*, 68(1-4), 180–186.

14. Becker, G., & Speck, U.. (1964). Untersuchungen über die Magnetfeld-Orientierung von Dipteren. *Zeitschrift für vergleichende Physiologie*, 49(4), 301–340. 15. Becker, G.. (1963). Magnetfeld-Orientierung von dipteren. *Naturwissenschaften*, 50(21), 664–664.

16. Cammaerts, M.-C., De Doncker, P., Patris, X., Bellens, F., Rachidi, Z., & Cammaerts, D. (2012). GSM 900 MHz radiation inhibits ants' association between food sites and encountered cues. *Electromagnetic Biology and Medicine*, 31(2), 151–165.

Extract: ... experiments were conducted on six other naive identical colonies of *M. sabuleti*, under electromagnetic radiation similar to those surrounding GSM and communication masts. In this situation, no association between food and either olfactory or visual cues occurred. After a recovery period, the ants were able to make such an association but never reached the expected score. Such ants having acquired a weaker olfactory or visual score and still undergoing olfactory or visual training were again submitted to electromagnetic waves. Not only did they lose all that they had memorized, but also they lost it in a few hours instead of in a few days (as under normal conditions when no longer trained). They kept no visual memory at all (instead of keeping 10% of it as they normally do). The impact of GSM 900 MHz radiation was greater on the visual memory than on the olfactory one. These communication waves may have such a disastrous impact on a wide range of insects using olfactory and/or visual memory, i.e., on bees.

17. Cammaerts, M.-C., & Johansson, O.. (2013). Ants can be used as bio-indicators to reveal biological effects of electromagnetic waves from some wireless apparatus. *Electromagnetic Biology and Medicine*, 1–7.

Extract: ...we designed and validated a fast and easy test on ants – these insects being used as a biological model – for revealing the effect of wireless equipments like mobile phones, smartphones, digital enhanced cordless telephone (DECT) phones, WiFi routers and so on. This test includes quantification of ants' locomotion under natural conditions, then in the vicinity of such wireless equipments. Observations, numerical results and statistical results allow detecting any effect of a radiating source on these living organisms.

18. Cammaerts, M.-C., Rachidi, Z., Bellens, F., & De Doncker, P.. (2013). Food collection and response to pheromones in an ant species exposed to electromagnetic radiation. *Electromagnetic Biology and Medicine*, 32(3), 315–332.

Extract: [Exposed] ants followed trails for only short distances, no longer arrived at marked areas and no longer orientated themselves to a source of alarm pheromone. Also when exposed to electromagnetic waves, ants became unable to return to their nest and recruit congeners; therefore, the number of ants collecting food increases only slightly and slowly. After 180 h of exposure, their colonies deteriorated. Electromagnetic radiation obviously affects social insects' behavior and physiology

19. Capaldi, E. A., Smith, A. D., Osborne, J. L., Fahrbach, S. E., Farris, S. M., Reynolds, D. R., ... Riley, J. R.. (2000). Ontogeny of orientation flight in the honeybee revealed by harmonic radar. *Nature*, 403(6769), 537–540. doi:10.1038/35000564

20. Clarke, D., Whitney, H., Sutton, G., & Robert, D.. (2013). Detection and Learning of Floral Electric Fields by Bumblebees. *Science*. doi:10.1126/science.1230883

21. Cucurachi, S., Tamis, W. L. M., Vijver, M. G., Peijnenburg, W. J. G. M., Bolte, J. F. B., & de Snoo, G. R.. (2013). A review of the ecological effects of radiofrequency electromagnetic fields (RF-EMF). *Environment International*, 51, 116–140.

22. El Kholly, S. E., & El Husseiny, E. M.. (2012). Effect of 60 minutes exposure to electromagnetic field on fecundity, learning and memory, speed of movement and whole body protein of the fruit fly *Drosophila melanogaster*. *Journal of the Egyptian Society of Parasitology*, 42(3), 639–648.

23. Engelmann, J. C., Deeken, R., Müller, T., Nimtz, G., Roelfsema, M. R. G., & Hedrich, R.. (2008). Is gene activity in plant cells affected by UMTS-irradiation? A whole genome approach. *Advances and Applications in Bioinformatics and Chemistry: AABC*, 1, 71–83.

24. Engels, S., Schneider, N.-L., Lefeldt, N., Hein, C. M., Zapka, M., Michalik, A., ... Mouritsen, H.. (2014). Anthropogenic electromagnetic noise disrupts magnetic compass orientation in a migratory bird. *Nature*, 509(7500), 353–356.

Extract: ...we show that migratory birds are unable to use their magnetic compass in the presence of urban electromagnetic noise... These fully double-blinded tests document a reproducible effect of anthropogenic electromagnetic noise on the behaviour of an intact vertebrate.

25. Everaert, J., & Bauwens, D.. (2007). A possible effect of electromagnetic radiation from mobile phone base stations on the number of breeding house sparrows (*Passer domesticus*). *Electromagnetic Biology and Medicine*, 26(1), 63–72.

26. Favre, D.. (2011). Mobile phone-induced honeybee worker piping. *Apidologie*, 42(3), 270–279.

Extract: 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.

27. Frier, H., Edwards, E., Smith, C., Neale, S., & Collett, T.. (1996). Magnetic compass cues and visual pattern learning in honeybees. *The Journal of Experimental Biology*, 199(6), 1353–1361.

28. Gary, N. E., & Westerdahl, B. B.. (1981). [No effect during transient passage] Flight, orientation, and homing abilities of honeybees following exposure to 2.45-GHz CW microwaves. *Bioelectromagnetics*, 2(1), 71–75.

29. Gould, J. L., Kirschvink, J. L., & Deffeyes, K. S.. (1978). Bees Have Magnetic Remanence. *Science*, 201(4360), 1026–1028. doi:10.1126/science.201.4360.1026

30. Gould, J. L., Kirschvink, J. L., Deffeyes, K. S., & Brines, M. L.. (1980). Orientation of demagnetized bees. *The Journal of Experimental Biology*, 86(1), 1–8.

31. Government of India - Ministry of Environment and forests (Wildlife Division). (2012). Subject: Advisory on the use of mobile towers to minimize their impact on wildlife including birds and bees -conveyed. *Office Memorandum. No.15-11/2010/WL-1*, 3.

32. Grefner, N. M., Yakovleva, T. L., & Boreisha, I. K.. (1998). Effects of electromagnetic radiation on tadpole development in the common frog (*Rana temporaria* L.). *Russian Journal of Ecology*, 29(2), 133–134.

33. Greggers, U., Koch, G., Schmidt, V., Durr, A., Floriou-Servou, A., Piepenbrock, D., ... Menzel, R.. (2013). Reception and learning of electric fields in bees. *Proceedings of the Royal Society B: Biological Sciences*, 280(1759), 20130528–20130528. doi:10.1098/rspb.2013.0528

34. Harst, W., Kuhn, J., & Stever, H.. (2006). Can electromagnetic exposure cause a change in behaviour? Studying possible non-thermal influences on honeybees. An approach within the framework of educational informatics.. *ACTA SYSTEMATICA - International Journal*, vi(1), 1–6.

Extract: ... honey bees are suitable biomarkers to serve as a model of a living being to study learning processes in this aspect [non-thermal high-frequency electromagnetic fields] ...

35. Herriman, S.. (2010). Study links bee decline to cell phones - CNN.com. *CNN World*. Retrieved from zotero://attachment/6725/

36. Holland, R. A., & Helm, B.. (2013). A strong magnetic pulse affects the precision of departure direction of naturally migrating adult but not juvenile birds. *Journal of the Royal Society, Interface / the Royal Society*, 10(81), 20121047. doi:10.1098/rsif.2012.1047

37. Hsu, C.-Y., Ko, F.-Y., Li, C.-W., Fann, K., & Lue, J.-T.. (2007). Magnetoreception System in Honeybees (*Apis mellifera*). *PLoS ONE*, 2(4), e395. doi:10.1371/journal.pone.0000395

38. Kavaliers, M., Choleris, E., Prato, F. S., & Ossenkopp, K.. (1998). Evidence for the involvement of nitric oxide and nitric oxide synthase in the modulation of opioid-induced antinociception and the inhibitory effects of exposure to 60-Hz magnetic fields in the land snail. *Brain Research*, 809(1), 50–57.

39. Keim, C. N., Cruz-Landim, C., Carneiro, F. G., & Farina, M.. (2002). Ferritin in iron containing granules from the fat body of the honeybees *Apis mellifera* and *Scaptotrigona postica*. *Micron (Oxford, England: 1993)*, 33(1), 53–59.

40. Kimmel, S., Kuhn, J., Harst, W., & Stever, H.. (2007a). Electromagnetic radiation: influences on honeybees (*Apis mellifera*). In *Preprint (IIAS-InterSymp Conference, Baden-Baden 2007)* http://agbi.uni-landau.de/material_download/preprint_IAAS_2007.pdf. Retrieved from http://www.hese-project.org/hese-uk/en/papers/kimmel_iaas_2007.pdf

Extract: The presented data set of [partially significant results] is based on earlier studies in 2005, which showed significant differences in returning, 39.7% of the non-irradiated bees came back compared to 7.3% of the irradiated ones. Standard commercial DECT phones were used as exposition source.

41. Kirschvink, J. L.. (1981). The horizontal magnetic dance of the honeybee is compatible with a single-domain ferromagnetic magnetoreceptor. *Bio Systems*, 14(2), 193–203.

42. Kirschvink, J. L.. (1996). Microwave absorption by magnetite. *Bioelectromagnetics*, 17, 187–194.

43. Kirschvink, J. L.. (2014). Sensory biology: Radio waves zap the biomagnetic compass. *Nature*, 509(7500), 296–297. doi:10.1038/nature13334

44. Kirschvink, J. L., & Kirschvink, A. K.. (1991). Is Geomagnetic Sensitivity Real? Replication of the Walker-Bitterman Magnetic Conditioning Experiment in Honey Bees. *American Zoologist*, 31(1), 169–186. doi:10.1093/icb/31.1.169

45. Kirschvink, J., Padmanabha, S., Boyce, C., & Oglesby, J.. (1997). Measurement of the threshold sensitivity of honeybees to weak, extremely low-frequency magnetic fields. *Journal of Experimental Biology*, 200(9), 1363–1368.

46. Kumar, N. R., Sangwan, S., & Badotra, P.. (2011). Exposure to cell phone radiations produces biochemical changes in worker honey bees. *Toxicology International*, 18(1), 70–72.

Extract: 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...

47. Lean, G., & Shawcross, H.. (2007). Are mobile phones wiping out our bees?. *The Independent*. Retrieved from <http://www.independent.co.uk/environment/nature/are-mobile-phones-wiping-out-our-bees-444768.html>

48. Levitina, N. A.. (1966). [Non-thermal effect of microwaves on the rhythm of cardiac contractions in the frog]. *Biulleten' Eksperimental'noi Biologii I Meditsiny*, 62(12), 64–66.

49. Li, S.-S., Zhang, Z.-Y., Yang, C.-J., Lian, H.-Y., & Cai, P.. (2013). Gene expression and reproductive abilities of male *Drosophila melanogaster* subjected to ELF-EMF exposure. *Mutation Research*, 758(1-2), 95–103. doi:10.1016/j.mrgentox.2013.10.004

50. Mall, P., & Kumar, Y.. (2014). [No effect] Effect of electromagnetic radiations on brooding, honey production and foraging behavior of European honeybees (*Apis mellifera* L.) article1396540463_Mall and Kumar.pdf. Retrieved from http://www.academicjournals.org/article/article1396540463_Mall%20and%20Kumar.pdf

51. Margaritis, L. H., Manta, A. K., Kokkaliaris, K. D., Kokkaliaris, C. D., Schiza, D., Alimisis, K., ... Ziomas, K.. (2013). *Drosophila* oogenesis as a bio-marker responding to EMF sources. *Electromagnetic Biology and Medicine*.

Extract: A total of 280 different experiments were performed... All EMF sources used created statistically significant effects regarding fecundity and cell death-apoptosis induction, even at very low intensity levels (0.3 V/m blue tooth radiation), well below ICNIRP's guidelines, suggesting that *Drosophila* oogenesis system is suitable to be used as a biomarker for exploring potential EMF bioactivity.

52. Mobile phone towers a threat to honey bees: study. (n.d.). Retrieved from <http://phys.org/news170920128.html>

53. Panagopoulos, D. J.. (2012). Effect of microwave exposure on the ovarian development of *Drosophila melanogaster*. *Cell Biochemistry and Biophysics*, 63(2), 121–132.

Extract: The study showed that the ovarian size of the exposed insects is significantly smaller than that of the corresponding sham-exposed insects, due to destruction of egg chambers by the GSM radiation, after DNA damage and consequent cell death induction in the egg chamber cells of the virgin females as shown in previous experiments on inseminated females.

54. Panagopoulos, D. J., Chavdoula, E. D., & Margaritis, L. H.. (2010). Bioeffects of mobile telephony radiation in relation to its intensity or distance from the antenna. *International Journal of Radiation Biology*, 86(5), 345–357.

55. Panagopoulos, D. J., Karabarounis, A., & Lioliousis, C.. (2013). ELF alternating magnetic field decreases reproduction by DNA damage induction. *Cell Biochemistry and Biophysics*, 67(2), 703–716. doi:10.1007/s12013-013-9560-5

56. Panagopoulos, D. J., Karabarounis, A., & Margaritis, L. H.. (2004). Effect of GSM 900-MHz Mobile Phone Radiation on the Reproductive Capacity of *Drosophila melanogaster*. *Electromagnetic Biology and Medicine*, 23(1), 29–43. doi:10.1081/JBC-120039350

57. Panagopoulos, D. J., & Margaritis, L. H.. (2010). The effect of exposure duration on the biological activity of mobile telephony radiation. *Mutation Research*, 699(1-2), 17–22.

58. Ratnieks, F. L. W., & Carreck, N. L.. (2010). Clarity on Honey Bee Collapse?. *Science*, 327(5962), 152–153. doi:10.1126/science.1185563

59. Ritz, T., Wiltshko, R., Hore, P. J., Rodgers, C. T., Stapput, K., Thalau, P., ... Wiltshko, W.. (2009). Magnetic Compass of Birds Is Based on a Molecule with Optimal Directional Sensitivity. *Biophysical Journal*, 96(8), 3451–3457. doi:10.1016/j.bpj.2008.11.072

60. Rosenberg, G., & Pall, M. L.. (1978). Cyclic AMP and cyclic GMP in germinating conidia of *Neurospora crassa*. *Archives of Microbiology*, 118(1), 87–90.

61. Sarkar, J.. (2011). Wildlife around communication towers. *CURRENT SCIENCE*, 101(11), 1403.

62. Schneider, F.. (1963). Systematische Variationen in der elektrischen, magnetischen und geographisch-ultraoptischen Orientierung des Maikäfers. *Vjschr. Naturforsch. Ges*, 108, 373–416.

63. Senavirathna, M. D. H. J., Takashi, A., & Kimura, Y.. (2013). Short-duration exposure to radiofrequency electromagnetic radiation alters the chlorophyll fluorescence of duckweeds (*Lemna minor*). *Electromagnetic Biology and Medicine*, 1–8. doi:10.3109/15368378.2013.844705

64. Sharma, V. P., & Kumar, N. R.. (2010). Changes in honeybee behaviour and biology under the influence of cellphone radiations. *Current Science(Bangalore)*, 98(10), 1376–1378.

Extract: A significant ($p < 0.05$) decline in colony strength and in the egg laying rate of the queen was observed. The behaviour of exposed foragers was negatively influenced by the exposure, there was neither honey nor pollen in the colony at the end of the experiment

65. Sharma, V. P., Singh, H. P., Batish, D. R., & Kohli, R. K.. (2010). Cell phone radiations affect early growth of *Vigna radiata* (mung bean) through biochemical alterations. *Zeitschrift Für Naturforschung. C, Journal of Biosciences*, 65(1-2), 66–72.

66. Sharma, V. P., Singh, H. P., Kohli, R. K., & Batish, D. R.. (2009). Mobile phone radiation inhibits *Vigna radiata* (mung bean) root growth by inducing oxidative stress. *The Science of the Total Environment*, 407(21), 5543–5547. doi:10.1016/j.scitotenv.2009.07.006

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