REVIEW OF THE LITERATURE ON THE BIOLOGICAL EFFECTS OF WIRELESS RADIATON ON INSECTS:

- A CALL FOR MORE STUDIES ON HONEY BEES -

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M. Friesen M.Sc.
safer.wireless@gmail.com

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.

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

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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.

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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

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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.

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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.

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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.

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