

The Effect of Cell Phone Radiations on the Life Cycle of Honeybees

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Abstract—As many other species, honeybees are becoming extinct in the world; this phenomenon is called the Colony Collapse Disorder. Many reasons have been proven to be behind this environmental disaster like climate changes, pesticides, fungal pathogens and others, in addition to radiations generated by mobile phones, especially, since in recent years wild life has been exposed to microwaves and radio frequency's radiation signals from various sources, including wireless phones. Bees have a specific organ for sensing magnetic forces, enabling them to navigate using their own compass. The claim of the research is that radiations generated by mobile phones are disturbing the life cycle of honeybees and affecting their reproduction system and honey producing. The research involves testing the behavior of honeybees away from mobile phones, with a mobile phone in its standby mode and active communication mode. The results of the experiments verified that mobile phone affect the honeybees' life system.

Keywords: Honeybees; Mobile phone Radiation; Colony collapse Disorder; Audiogram; Spectrogram.

I. INTRODUCTION

Honey bees are sometimes called social insects; this is due to the fact that they live in colonies and they divide the jobs inside the hive between themselves, bees life cycle is a complex process in which a good communication is needed between honeybees in order to survive as a whole colony [1].

Bees have different ways to communicate, these communication ways are dances; bees dance to share information between each others, for example, they communicate the specific location of good food sources, thus, any intruder will disturb this non stopping system [2].

The claim in this research is that the radiations emitted by mobile phones are possibly the reason behind a great natural disaster: the disappearance of the honeybees all over the world. The mobile phone radiations disturb the bees' navigational system, leaving them unable to find their way back to the colony; this phenomenon will lead to problems in their reproduction system and to their death eventually.

This project has great significance because honeybees are a very important part of the ecological system since they pollinate 80% of the flowering plants, which makes up the

1/3 of what humans eat. In the same sense, Albert Einstein predicted that if something eliminates the bees from our planet, mankind would soon perish.

The effects of colony collapse disorder can be economically significant as well since the food and agriculture industry could lose billions of dollars.

II. BACKGROUND INFORMATION

A. Disappearance of honey bees

As of 1972, beekeepers started to notice that the number of honeybees is decreasing more and more; losses differ from country to country and from region to region inside the same country. In North America, the National Agriculture Statistics service reported in February 2008 that there were 2.44 million honeybees' hives in the United States, while there were 4.5 million in 1980, and 5.9 million in 1947. The NAS report evaluated winter losses during 2000-2001 to be 50%, while its normal rate of loss is 15-25%. During 2006-2007 the losses reached 45%, and during 2007-2008 the losses reached 40.8%, and in 2010 the losses were 34% [3].

According to the European Food Safety Authority (EFSA), the United Kingdom had a decrease of 30% of its honeybees' hives between 2007 & 2008, and Italy had a drop of 40-50% ; in Scotland the disappearance was catastrophic in 2009 where it reached 80%, and in Germany 40% of hives died in 2007 [3].

In Lebanon, the case is not better. A study done by Mr. Mazen Aboud, a professor at the American University of Beirut (AUB) and an FAO technician on the National Census Project, showed that the losses in honeybees in Lebanon were more than 50% in 2006. Dr. Rami Ollaik, another professor at the American University of Beirut (AUB) Faculty of Agricultural and Food Sciences, found in his study about colony collapse disorder that 30 to 35% of Lebanese hives disappeared in 2010. This study took place in South Lebanon and in Batroun region: in south Lebanon the losses reached 30-35%, and in Batroun they reached 22.2%, where 100 of the 450 hives were lost [4].

B. Existing Work

The topic discussed in this paper was researched in some other studies but from a different angle; they didn't analyze the buzzing sounds produced by bees when exposed to mobile phones' radiations.

Sharmal and Kumar studied the effect of mobile phones on honeybees by taking into consideration the following measures: brood area, queen prolificacy, foraging which includes flight activity, pollen foraging efficiency, and returning ability, and finally the colony growth which includes bees' strength, honey stores and pollen storage [5].

The results showed that the total bees' strength decreased due to the exposure; in addition, the brood area declined for the same reason as well as the number of eggs laid. Moreover, the number of bees leaving and returning to the hive decreased; consequently, the total number of bees holding pollen also decreased, so did the pollen area, the nectar area and the honey storing ability [5].

In a research on the impact of mobile phones on the density of honeybees, Sahib [6] related the decline in bees' population in India to mobile phones' radiations. To demonstrate his hypothesis, the author introduced the test colonies to mobile phones' radiations of 900 MHz frequency, for 10 minutes, during ten days. He studied the bees' life cycle by observing the productivity of bees in terms of laying of eggs, flight activity, and the returning ability; i.e., the number of bees leaving and returning back respectively to the hive per minute, before, during and after the exposure [6].

After ten days of mobile phone's radiation exposure, the bees did not return back to the hive, and the bees' strength of the test colonies was reduced. In addition, the productivity of queens was reduced as compared to that of the control colonies: in the test colonies bees were producing fewer eggs than those in the control colonies [6].

Mixson et al. [7] did four experiments to study the effect of mobile phones on honeybees. In the first experiment, the proboscis extension response of honeybees was studied after exposing them to mobile phone's radiations; this experiment showed that there was no effect due to GSM radiations exposure [7].

The second experiment was to study the feeding ability of bees exposed to mobile phone's radiations; the experiment showed that those radiations had no effect on the feeding ability of bees [7].

The third experiment was to study the effect of the same radiations on the flight navigation activity of forager bees. The authors say that similarly to the previous experiments, the third experiment showed that mobile phone's radiations had no effect on the bees' ability to return back to a food source that they were previously trained to visit [7].

The last experiment was to study the effect of GSM radiations on the aggression of bees. The authors said that the radiations generated by mobile phones did not increase the aggression of the bees [7].

The authors concluded that: if mobile phone's radiations

affect honeybees' behavior, it should have been apparent during the experiments; moreover, they saw that the decline in honeybees' population has other reasons than GSM radiations, like biological pathogens, agrochemicals, climate change, and genetically modified crops [7].

It is clearly noticed that the previous researchers did not take into consideration the sounds that are naturally produced by bees; as such, this study tackles the behavior of honeybees and their response to mobile phones' radiations as studied through sounds produced by bees in all modes of the mobile phone. In addition, using a jammer provides an additional analysis, especially that the jammer transmits signals similar to GSM signals, but with higher transmission power.

In short, as deduced from the aforementioned literature, two experiments support the hypothesis of the writers, while the last study rejected it; this discrepancy means that additional experiments are needed to utterly prove one of the claims.

III. PROPOSED SOLUTION

In this study, the spectrum analyzer is used as the measurement instrument that gives a representation of the signals transmitted by mobile phones, where the 2G bands available in Lebanon are GSM 900 with 890-915 MHz uplink band and 935-960 MHz downlink band, and GSM 1800 with 1710-1735 MHz uplink band and 1805-1880 MHz downlink band, while the 3G bands are UMTS900 with 880-915 MHz uplink band and 925-960 MHz downlink bands, and UMTS2100 with 1920-1980 MHz uplink band and 2110-2170 MHz downlink bands [8].

In addition, the Adobe Audition software is used to plot the audiogram, which represents the intensity of sounds produced by honeybees and the spectrogram that represents the spectrum of the signals produced.

After exposing bees to mobile phones' radiations, if these radiations disturb honeybees' navigational system, then the claim is proved. This fact leads to the need of studying the behavior of honeybees in their normal setting, which means without the presence of a mobile phone in the near vicinity, then with the presence of a mobile phone operating in its standby mode, and finally in its active communication mode. "Fig. 1" represents the basic design of the experiment.

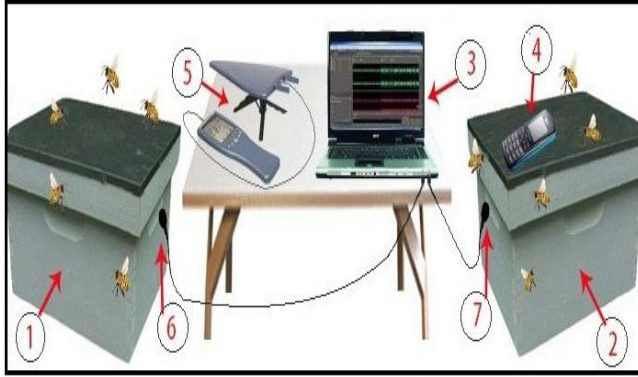


Fig. 1. The basic design of the experiments

The different parts of the design are described as follows:

- 1: Background hive.
- 2: Hive exposed to mobile phones radiations.
- 3: Portable computer.
- 4: Mobile phone.
- 5: Aaronia Spectrum Analyzer Materials.
- 6 and 7: Bidirectional compact microphones with frequency response from 70 to 14000 Hz.

MATLAB Software was used in order to plot the recordings of the spectrum analyzer, saving them in a two dimensional table where results can be either frequency versus time (plotting the activated frequencies at different times), or amplitude versus frequency (plotting the amplitudes of different frequencies at a constant time).

IV. MEASURMENTS

A. Measuring Signals Transmitted by the Honeybees

First, the honeybees' behavior was studied while in their normal setting, which means in the absence of any mobile phone operating in the near vicinity.

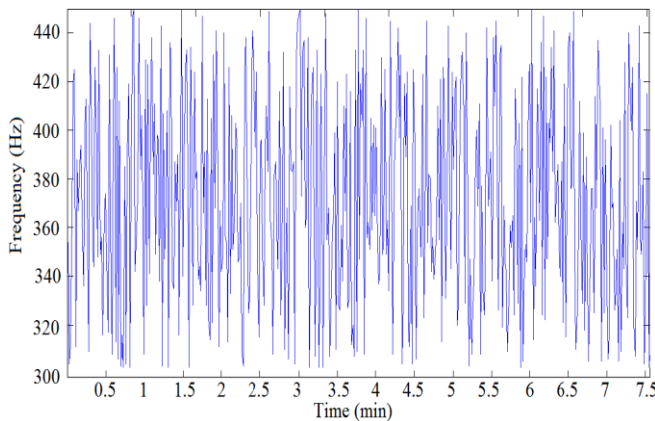


Fig. 2. Frequency versus time in normal case (plotted using MATLAB)

As "Fig. 2" shows, honeybees were transmitting signals with frequency varying between 400 Hz and 500 Hz in their normal setting. This result will be used as a reference to be compared with the results obtained when the honeybees are

disturbed. Any change in these frequencies will indicate that the honeybees are not in their normal setting anymore.

In order to get clearer results, Adobe Audition Software was used to give the audiograms and the spectrograms.

"Fig. 3" represents the audiogram of the sounds produced by honeybees in their normal setting; the figure shows that the sounds' intensity varies between 0 and 0.4 normalized amplitude.

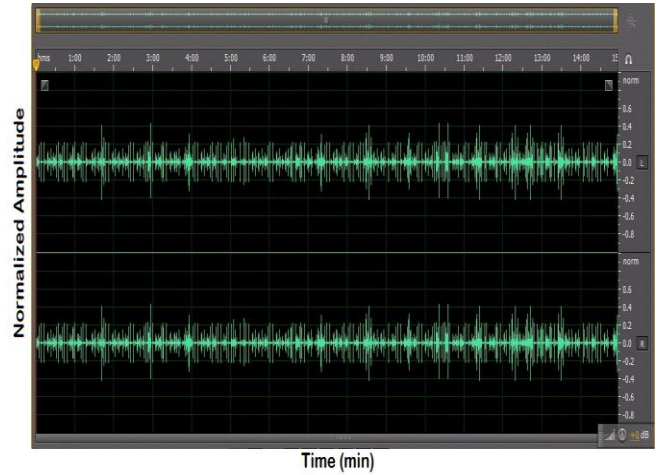


Fig. 3. Audiogram of honeybees' sounds without mobile phone (Sketched using Adobe Audition)

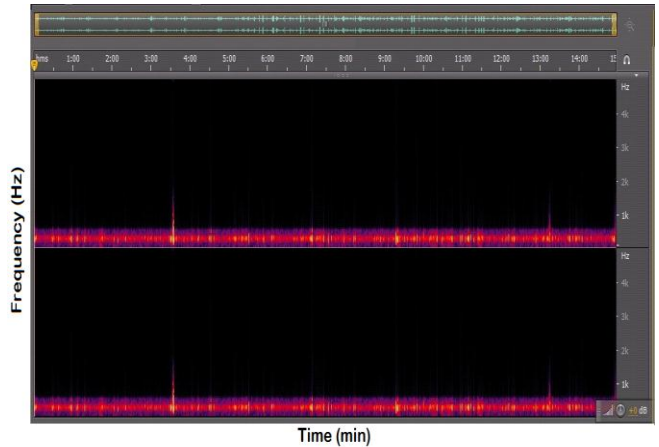


Fig. 4. Spectrogram of honeybees' sounds without mobile phone (Sketched using Adobe Audition)

"Fig. 4" represents the spectrogram of the honeybees' sounds in normal setting. Honeybees use a constant range of frequencies between 300 Hz and 500 Hz.

Second, the behavior of honeybees with the presence of a mobile phone operating in its standby mode was studied.

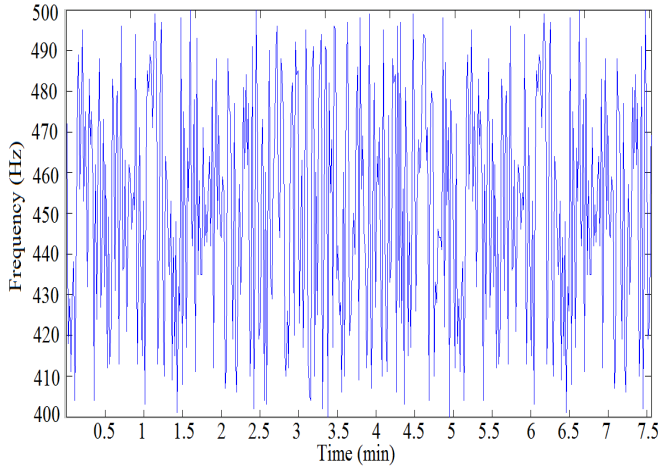


Fig. 5. Frequency versus time with mobile phone in standby mode (plotted using MATLAB)

B. The Effect of a Mobile Phone in Standby Mode

"Fig. 5" shows that a mobile phone in its standby mode does not affect honeybees since the signals transmitted by honeybees are identical to those transmitted in the normal case, which is between 400 Hz and 500 Hz. This means that honeybees behave in the presence of a mobile phone in its standby mode as if there is no mobile phone nearby.

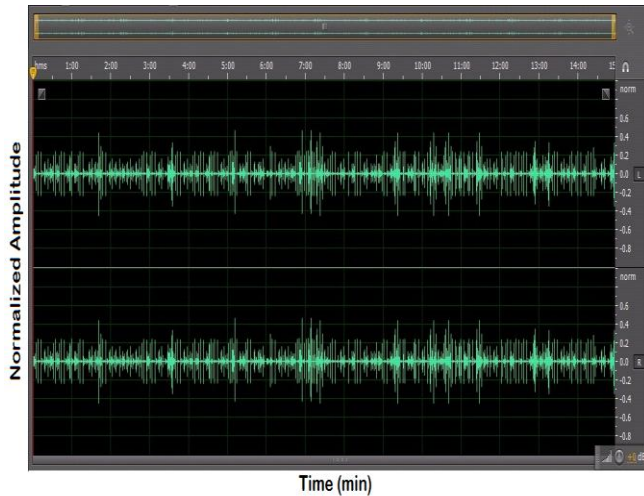


Fig. 6. Audiogram of bees' sounds with mobile phone in standby mode (Sketched using Adobe Audition).

"Fig. 6" represents the audiogram of the honeybees' sound in the presence of a mobile phone in its standby mode; the normalized output varies between 0 and 0.45 as a maximum; hence, no effect was introduced.

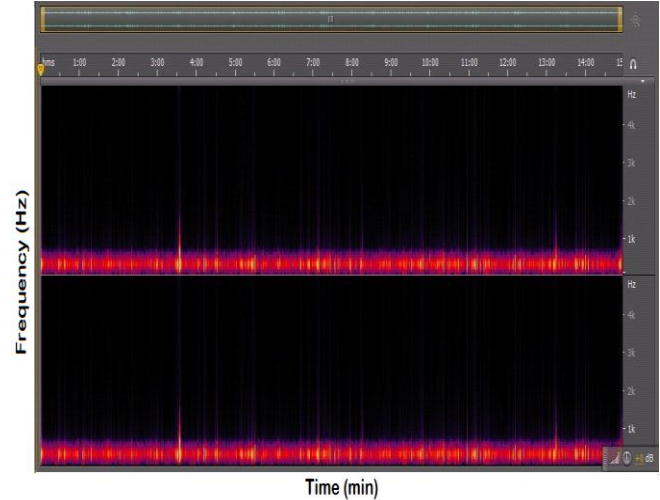


Fig. 7. Spectrogram of bees' sounds with mobile phone in standby mode (Sketched using Adobe Audition)

The spectrogram shown in "Fig. 7" is not far from what was obtained in the previous figure. The frequency response of the honeybees was not affected by the presence of the mobile phone in its standby mode; it is approximately the same compared to the frequency response obtained in the absence of mobile phone, and the frequencies used by the bees vary between 300 Hz and 500 Hz.

C. The Effect of a Mobile Phone in Active Mode

The third step was to test the behavior of honeybees in the presence of a mobile phone operating in its ON mode. First, the mobile phone was set in standby mode for approximately five minutes, after that a call was made. The results of this test are shown in "Fig. 8".

The mobile phone was set in standby mode until marker 1; at marker 1, a call was made to the mobile phone. The bees stayed relaxed for approximately ten minutes, producing sounds at normal frequencies: between 400 Hz and 500 Hz. At marker 2, the honeybees started producing sounds at increasingly higher frequencies. The frequencies kept increasing until they reached the maximum frequency of 1520 Hz, after 1150 seconds (19.16 minutes). At marker 3, the call was interrupted, but the honeybees did not return to a relaxing state until approximately 3.3 minutes after interrupting the call. At marker 4, the frequencies used by honeybees started decreasing; at marker 5, the honeybees returned totally to their relax mode and their frequencies returned to varying between 400 Hz and 500 Hz.

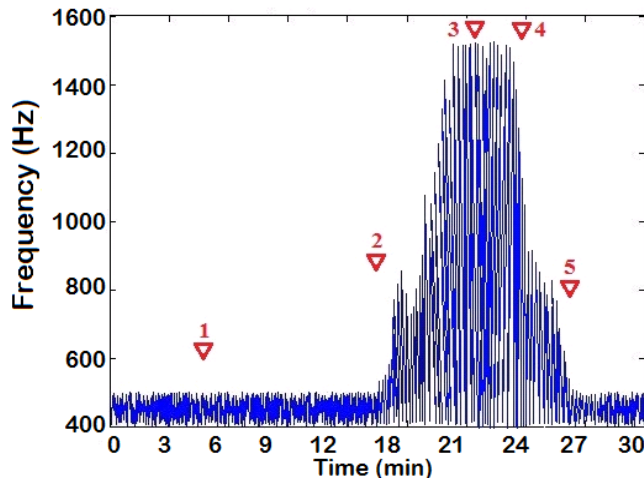


Fig. 8. Frequency versus time with mobile phone in active mode (plotted using MATLAB)

The results given by the Adobe Audition Software were very close to those obtained using the Spectrum Analyzer. "Fig. 9" clearly shows how the mobile phone in its active communication mode affected the behavior of honeybees: at marker 1, on the onset of the experiment, the intensity of the sounds produced by honeybees had normalized amplitude between 0 and 0.3, even if at some very short periods the normalized amplitude reached 0.5.

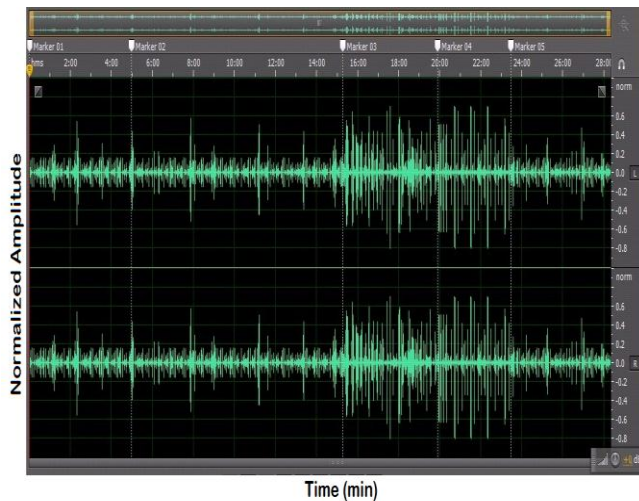


Fig. 9. Audiogram of honeybees' sounds with mobile phone in active mode (Sketched using Adobe Audition)

At marker 2, the bees remained relaxed until approximately ten minutes into the experiment; at marker 3, the bees started producing sounds with higher intensity, where the normalized amplitude reached 0.7 as a maximum. At marker 4, the call was ended and the bees remained disturbed for three to four more minutes; while, at marker 5, they started returning to their normal case with normal sounds.

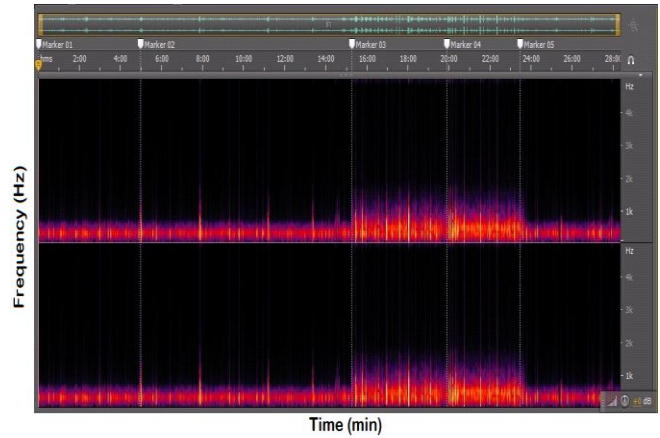


Fig. 10. Spectrogram of honeybees' sounds with mobile phone in active mode (Sketched using Adobe Audition)

The result obtained by the spectrogram shown in "Fig. 10" is complementary to that shown by the audiogram. The intensity of the sounds produced by the honeybees is not the only evidence that the phone in active mode has disturbed the bees; the frequency response of the honeybees is also evidence.

The 10 minutes delay is due to the time needed for the bees to realize the presence of an intruder: the electromagnetic waves; the intense buzzing sounds are considered as an alarm to inform the colony that something abnormal is present. Moreover, the delay after interrupting the call is due to the time needed for the bees to notice that the intruder is not present anymore.

D. The Effect of a Jammer

Another experiment was performed in order to see the effect of mobile phones' radiations on the bees' life system. After keeping a mobile for a period of one month next to the hive, and by making a fifteen-minute call each day, it was realized that the number of bees inside the hive decreased; the bee keeper estimated that 80% of the bees were lost. The eggs were also not transformed into larva, "Fig. 11". These results verify that mobile phones' radiations affect the honeybees' life's system.

In order to study the effect of the same signals transmitted by mobile phones, but with higher amplitude or higher transmission power, a jammer was used and the behavior of the bees was recorded.

A jammer was turned ON and placed near the hive in order to study the behavior of the honeybees that are subjected to such high powered signals.



Fig. 11. Comparison between the healthy hive (a) and the hive exposed to mobile phone radiations (b)



Fig. 12. Audiogram of honeybees' sounds with a jammer nearby (Sketched using Adobe Audition)

The audiogram in "Fig. 12" shows how the honeybees were extremely disturbed by the jammer. At marker 1, the sounds produced by honeybees had normalized amplitudes that were between 0 and 0.3 approximately. At marker 2, the jammer was turned ON, the bees remained relaxed until three minutes and a half, where at marker 3, the bees started producing sounds with higher intensity and the normalized amplitudes exceeded 0.6. At marker 4, the jammer was turned OFF, but it is clear that the bees did not return to the relaxed mode even after thirteen minutes from turning the jammer off. The spectrogram shown in "Fig. 13" represents similar results.

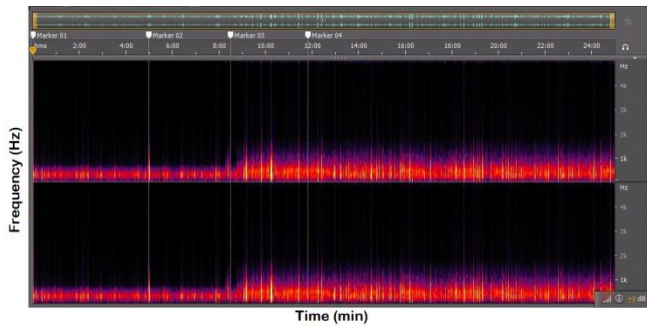


Fig. 13. Spectrogram of honeybees' sounds with a jammer nearby (Sketched using Adobe Audition).

V. DISCUSSION

The experiments performed showed that honeybees in their normal case produced sounds at lower frequencies around 450 Hz, and with lower intensity 0.3 normalized amplitude. But, when they were disturbed by the presence of a mobile phone, they produced sounds with higher frequencies that reached 1.5 KHz, and with higher intensity that reached 0.7 normalized amplitude. The same experiments were done in Talya- Bekaa-Lebanon; the same results were obtained.

All experiments were executed under the same conditions, no intruders or abnormal circumstances were added; this means that the disturbance couldn't have been for another reason than the mobile phone's radiations.

The time needed for bees to start being affected depends essentially on the transmission power of waves' source; this is observed after using the jammer which transmits signals similar to those of the mobile phone but with higher transmission power, for that reason, in the case of using a jammer bees started producing sounds with higher intensity and at higher frequencies after a shorter time than the case of using a mobile phone. Moreover, bees did not return back to their normal case after turning the jammer off because they need more than thirteen minutes to realize that the waves are not existing anymore, and because the effect of the jammer is more harmful than that of the mobile phone.

VI. CONCLUSION

In this paper, the behavior of honeybees was studied in different cases, including the absence of mobile phone, the presence of a mobile phone in standby mode, the presence of a mobile phone in active communication mode and in the presence of a jammer.

The placing of mobile phones or jammers very close to the honeybees does not reflect the case in real life. Finding the minimum space required for mobile phones to start affecting honeybees' life system will be the next step. In this paper, honeybees were exposed to an average of 25 nT of electromagnetic waves strength. The effect of mobile phone towers on honeybees will be also important since these towers create much higher electromagnetic waves than those emitted by mobile phones.

This research could be extended into several branches: the effects of the mobile radiations could be studied on different animals like birds, ants, bats and other animals, since bees are not the only animals which are becoming extinct; the electromagnetic fields may be the reason behind this decline. Also the effects of the electromagnetic fields on the human beings could be analyzed, because in the last few years the rate of people affected with brain cancer has been increasing and the electromagnetic fields may be the reason. In addition, a research may be done on the ways to protect both the animals and the humans from these harmful radiations; the specific waves that may affect the human species and animals in a negative way may be measured.

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