The Effects of Magnetic Fields on the Reproduction of Daphnia

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With little research being done, it is unknown the effects of magnetic fields on living organisms. This experiment investigated the effects of B fields on the reproduction rate of Magnum, daphnia. This was studied by quantitatively analyzing birth count, and qualitatively analyzing the conditions of the daphnia. It was first hypothesized that the magnetic fields would affect the daphnia in a negative manor but was disproven as the reproduction health of the daphnia was improved by the magnetic fields.

Introduction

This investigation will be used as a primary step to many further experiments. Initially the experiment proposed was to see the effects of magnetic fields on embryonic stem cells to understand if expectant mothers in the early stages of pregnancy needed to shield their fetuses from magnetic fields as there are times when expectant mothers need to undergo MRIs, etc. However, this project was much too costly, and ethically controversial for this project. Although on a much smaller scale, this experiment is a much-needed step to take in order to carry out the initial study. There have been studies done by MIT and presented by NCBI where researchers have analyzed how magnetic fields up to 30mT affected the mental health and physical health of rats. These studies have found that magnetic fields caused no behavioral difference, but caused some of the rats to develop tumours long term wise but the results were inconsistent. These experiments can be used as a lead to see the effects of magnetic emittance on a smaller scale by using Daphnia or commonly known as "water fleas". Daphnia were chosen as the test subject for this experiment as they are already an established model species in toxicology. In this experiment, it is assumed that the magnetic fields will affect the Daphnia in a negative manner, hence reducing birth rate. In this experiment we will be using magnetic fields, a magnetic field is a vector field created by magnetic dipoles and moving electric charges that create electric currents and exerts a force on other nearby moving charges and magnetic dipoles. The type of magnetic field used in the experiment conducted was the B-field which is a magnetic field measured in tesla compared to the irrotational H-field that is measured in amperes. The difference between the spatial dependence of the magnetic fields can be seen in figure 1.2. In this experiment we will be implementing different powers of magnetic fields on daphnia. Daphnia are a genus of small planktonic crustaceans. They are characterized by their bodies enclosed by an uncalcified shell, also known as the carapace which is primarily composed of chitin. They are also classified by their 2 antennae used to swim, and 4-6 pairs of legs. The anatomy of the Daphnia can be seen in figure 1.1.

Materials and Methods

When this experiment was conducted, one female daphnia obtained from the Carolina Biological Supply Company was grown in a petri dish with 10 ml of spring water being fed two to three drops of food pellet(algae) solution(one food pellet diluted in 50 ml of water) every one to three days. The daphnia were under light for 16 hours per day at a room temperature of 18-22degrees. Each petri dish was surrounded by a magnetic field of either 0.1T, 0.05T, 0.005T, or controlled. The magnetic fields were made by layering 150-350 0.25"X0.1" rare earth magnets from Lee Valley Tools on top of each other to make a solenoidal magnetic field as seen in figure1.6. Every day for five days the temperature was measured by a thermometer, the pH by litmus paper, and birth count was measured by counting including qualitative observations seen through a compound light microscope. Indications of stress included discolouration, presence of unhatched eggs, dead offspring, low number of offspring, and mortality among parents. In addition to these regular measurements, all offspring were removed to a separate tank of water in order to avoid competition in the tests.

Results

This experiment tested the extent of how magnetic fields affect the reproduction and growth of daphnia, it was found that under the magnetic fields, the daphnia had shown improvement in birth rate over the two trials, indicating magnetic fields to have positive effects on reproduction of daphnia. The pH and temperature although were initially intended to be used as an indicator of the toxicity of the water and the health of the daphnia but were not presented in the results as throughout the experiment the pH and temperature remained a constant of pH seven and temperature 19-21 degrees celsius which creates no important impact on the results.

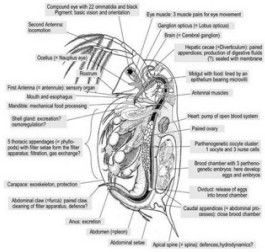

Figure 1.1 "Daphnia Anatomy." A study of the heart, http://bvsheart.weebly.com/daphnia-anatomy.html

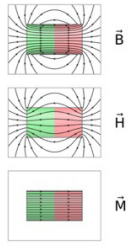

Figure 1.2 "Magnetic Field." Wikipedia, Wikimedia Foundation, 16 June 2018, https://en.m.wikipedia.org/wiki/Magnetic_field

Figure 1.1 and 1.2

The quantitative and qualitative results can be seen in figures 1.2 to 1.5. In figure 1.2 the first three trends display that the birth count is increasing while the fourth trend show that the birth count is decreasing. The fourth trend is the petri dish with no magnetic field and the other three are petri dishes with magnetic fields. The same trend was shown in figure 1.3 but to a lesser extent. It can also be seen in

qualitative observations that the daphnia under the magnetic fields get pregnant much faster than the ones that are not under the magnetic field. This was contradictory to the hypothesis that postulated that the magnetic fields would have negative effects on the reproduction of daphnia.

Figure 1.3 Test One

Test 1

Day	Birth Count(Series 1)	Birth Count(Series 2)	Birth Count(Series 3)	Birth Count(Series 4)
1	0	0	0	7
2	9	4	0	4
3	0	10	12	0
4	15	0	0	7
5	0	12	12	0

Series 1 = 0.1T
Series 2 = 0.05T
Series 3 = 0.005T
Series 4 = Controlled

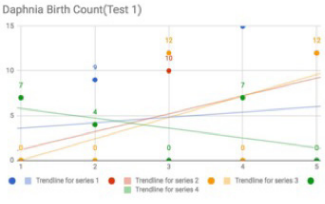

Figure 1.3

Figure 1.4 Test Two

Test 2

Day	Birth Count(Series 1)	Birth Count(Series 2)	Birth Count(Series 3)	Birth Count(Series 4)
1	0	0	0	2
2	5	6	10	13
3	11	0	0	0
4	0	13	14	15
5	4	0	0	1

Series 1 = 0.1T
Series 2 = 0.05T
Series 3 = 0.005T
Series 4 = Controlled

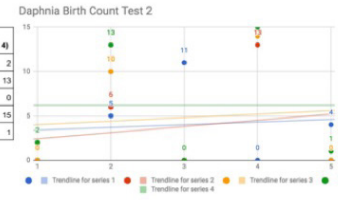

Figure 1.4

Figure 1.5 Qualitative abnormal or significant observations Test 1

Day	Series 1	Series 2	Series 3	Series 4
1	Not pregnant, difficulty moving	Not pregnant, difficulty moving	Not pregnant	Not pregnant, moved really fast
2	Pregnant, has difficulty moving	Pregnant, moves a lot	Pregnant with only a few eggs	Pregnant, doesn't move a lot
3	Pregnant, and moving quite quickly	Pregnant and moving slowly	Pregnant	Pregnant with fewer eggs than the others.
4	Pregnant with very few eggs	Not pregnant	Not pregnant	Not pregnant
5	Dead	Pregnant with 3 eggs which is a very few compared to normal	Dead	Dead

Figure 1.5

Figure 1.6 Qualitative abnormal or significant observations Test 2

Day	Series 1	Series 2	Series 3	Series 4
1	Not pregnant, difficulty moving	Not pregnant	Not pregnant	Not pregnant, moved really fast
2	Pregnant, has trouble swimming, but moves quick	Pregnant with only a few eggs	Pregnant moves quite slowly	Pregnant
3	Pregnant but eggs are unevenly distributed on its back, moves quite slowly	Pregnant, quite twitchy	Pregnant	Pregnant, moves slowly and a lot of difficulty swimming
4	Not pregnant	Pregnant	Pregnant	Amniotic sac is broken, organs are fully exposed, not pregnant it seems
5	Not pregnant, difficulty swimming	Not pregnant	Pregnant with 1 egg which is very few compared to normal	Not pregnant

Figure 1.6

Figure 1.7

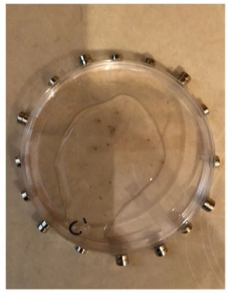

Figure 1.7

Discussion

After the experiment and the results were collected, the data was found to not support the original hypothesis. One factor that could have influenced the results was that the petri dishes were not in a controlled area. The petri dishes although were in a controlled area considerably, wireless internet still has a great affect no matter where one is which the radiation could have a great effect on the results. During the experiment each of the daphnia were affected by an unknown phenomenon, a majority of the daphnia died after five days of conducting the experiment. One of them clearly damaged their body cavity after birthing at least 15 children which could have caused that certain death but there were many anomalies which had no conclusion to what caused their death. In future tests of this experiment, a greater distance would be needed between the petri dishes as they were each approximately three to four inches apart meaning that the magnetic field of one experiment could have tampered with another. Additionally, being able to repeat the experiment one to three more times would have verified the experiment.

In future there are many experiments that can be conducted. Initially it was planned to do an experiment on the effects of magnetic emittance on a cellular level, by understanding the effects of magnetic emittance on embryonic stem cells. This experiment will be done to test how magnetic field radiation affects cell growth and intracellular ATP and NAD+ levels. This will be done by culturing and growing approximately 5-10 moles of embryonic stem cells from umbilical cords, or placenta, by coating the bottom of petri dishes with an animal protein matrix (matrigel) and regularly replacing the 2 mm of growth medium to grow the cells in 2D.Then it is planned to split the cells into 5 different groups(A-E). Which one will then use a super electromagnet (most likely made of copper wire connected to a nine-volt battery) to enforce different levels of magnetic radiation on the stem cells in group A-E up to 3T to mimic the magnetic field produced by MRIs. A Transmission Electron Microscope (TEM) to regularly qualitatively check the conditions of the growth of the cells, and quantitatively measure the number of dead and living cells. The significance of this experiment will be to see if expectant mothers in the early stages of pregnancy will need to be cautious around MRIs.

References

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Figure 1.1 taken from "Daphnia Anatomy." A STUDY OF THE HEART,bvsheart.weebly.com/daphnia-anatomy.html.