EFFECTS OF OESTROGEN ON AQUATIC ECOSYSTEMS

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ABSTRACT

Some aquatic pollutants mimic the effects of oestrogen. These substances effect both plants and invertebrates. Research showed that they cause the decrease in photosynthesis rate and heart rate of *Daphina.* In the food chain, these substances can be bioaccumulated and effect fish populations and those organisms that eat them including man.

In this research, the aim was to determine the effect of ethynyloestardiol on the photosynthetic rate of *Elodea* and the heart rate of *Daphina*. Ethynyloestardiol was chosen as the oestrogenic substance because it could be easily obtained from birth control pills. Both *Elodea* and *Daphina* were chosen because they are common fresh water aquatic organisms. *Elodea* and *Daphina* were exposed to several different concentrations of oestradiol solutions. The photosynthetic rate was measured by comparing the amount of oxygen produced between control and experimental groups. The heart rate of *Daphina* was measured by counting heartbeat under the microscope and was compared to a control. The data was analyzed statistically and the results show that oestradiol decreases both the heart rate of *Daphina* and the rate of photosynthesis in *Elodea*.

INTRODUCTION

Research shows that oestrogenic substances decrease the number of sperms produced in human males, and cause testicular cancer in males and breast cancer in human females – Wakefield (2002),Vines(1993). It was also observed that oestrogenic substances affect the reproductive behaviour and physiology of fish that live in fresh water ecosystems – Pearce (1998).

Under normal conditions, a variety of oestrogenic substances are found in low concentrations in nature. Birth control pill metabolites, detergants, pesticides, DDT and natural oestrogenic substances found in soy beans, are some of the examples of oestrogenic substances which find their way into fresh water ecosystems. These substances are not broken down easily in nature and are stored in animal fat tissues. These oestrogenic substances become active during water treatment processes – Walker (1998). Oestrogenic substances have three major effects on organisms that live in fresh water ecosystem:

1. Male animals behave as females.
2. Prevents the development of testes in males.
3. Blocks testostrone with an anti-andregenic effect.

Daphnia is a crustacean that lives in fresh water ecosystems. They have an important role in this particular food chain, as they are food for young fish.

Elodea is a plant that is commonly found in fresh water ecosystems.

The effect of oestrogenic substances on crustaceans is not very well known. Research done shows that the oestrogen-like molecules decreases the male population in *Daphnia* and affect their fat metabolism.

Oestrogenic substances decrease the heart rate of *Daphnia*, allowing fish to catch them more easily. Therefore, fish biologically store oestrogenic substances in their metabolism after eating *Daphnia*. This ultimately affects human health.

There seems to be no research on the effect of oestrogenic substances on plants. However, Achlorotriozine-like substances which is found in herbicides, inhibit photosynthesis in plants. There is no research concerning it on water plants – Walker (1998).

AIM

The purpose of this project is to observe the effects of oestrogen on the heart rate of *Daphnia* and on the photosynthetic rate of *Elodea*.

MATERIALS

21 contraceptive pills (Minulet)
Distilled water
Beakers, test tubes
Depression slides
Heat filter
Light source
Elodea
Daphnia
Chronometer

PROCEDURE

In all birth control pills there are inactive ingredients such as lactose, maize starch and povidone. There is also a source of the active ingredient progesterone (in this case gestodene). The purpose of our study was educational not genuine scientific reasearch so the effects of these substances was ignored.

The technique used to count the heart rate of the *Daphnia* was stressful for the *Daphnia* but it was equal for both the control and the experimental groups.

21 tablets of Minulet birth control pills containing 0,30 mg Ethynyloestradiol/tablet were dissolved in 750 ml distilled water. According to analysis in a medical laboratory, the concentration of Ethynyloestradiol in this stock solution was found to be 840000 pg/ml. A total of four solutions of 250 ml were prepared. The prepared solutions were: Stock (840000 pg/ml), 1/10 (84000 pg/ml), 1/40 (21000 pg/ml), Control (0 pg/ml). 10 ml of each solution (control, experiment, 1/10 and 1/40) was put into beakers and 5 *Daphnia* were added to them. After 30 minutes (time given to let the *Daphnia* adapt the new environment), heart rates of *Daphnia* in all four solutions were counted using a microscope.

For the *Elodea* two different methods were used to measure the rate of photosynthesis:

Method 1:

Four groups were formed consisting of the four concentrations of oestrogen solutions. One piece of *Elodea* was placed in each of them. The pieces were about the same length with the same number of leaves. Glass funnels leading to glass test tubes filled with water were used to collect the gas produced. At the end of the third week, the volumes of O_2 produced were measured and compared.

Method 2:

The number of bubbles produced by *Elodea* of the same size and having the same number of leaves placed in the stock solution and the control were counted. Heat was filtered using a large clear container of water placed between the light and the *Elodea*. The results of both groups were compared.

DATA:

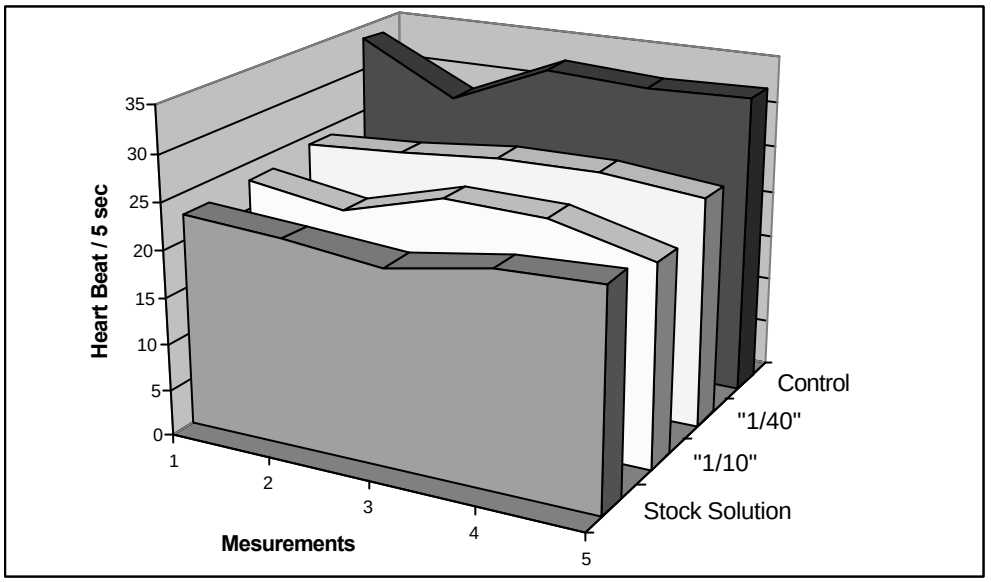

Chart 1 - The effect of Changing Concentrations of Oestrogen on *Daphnia*s' Heart Rate. (Data from Table 1 – Average of 5 measurements for each group)

Table 1 – Data collected from 20 groups of *Daphnia*. Each 4 main groups (stock, 1/10, 1/40, control) consists of 5 different samples. For each sample 5 measurements are made.

Stock (1)	**Stock (2)**	**Stock (3)**	**Stock (4)**	**Stock (5)**	**Control (1)**	**Control (2)**	**Control (3)**	**Control (4)**	**Control (5)**
23	23	20	22	23	31	27	32	31	32
20	22	20	23	24	34	27	32	33	33
22	22	22	22	24	34	28	32	32	32
25	23	21	22	23	33	29	33	32	33
24	20	22	25	23	35	29	34	32	32
1/10 (1)	**1/10 (2)**	**1/10 (3)**	**1/10 (4)**	**1/10 (5)**	**1/40 (1)**	**1/40 (2)**	**1/40 (3)**	**1/40 (4)**	**1/40 (5)**
24	22	24	24	21	23	24	25	25	26
24	21	24	24	21	25	25	25	25	25
24	21	25	24	22	24	24	26	26	24
22	22	25	25	22	25	26	26	26	26
22	22	25	25	23	23	25	27	27	23

Table 2 – Average heart beats/min of 4 groups of *Daphnia*.
(Data from Table 1)

Group	Average
Stock S.	22,4
Control	31,68
"1/10"	23,12
"1/40"	25,04

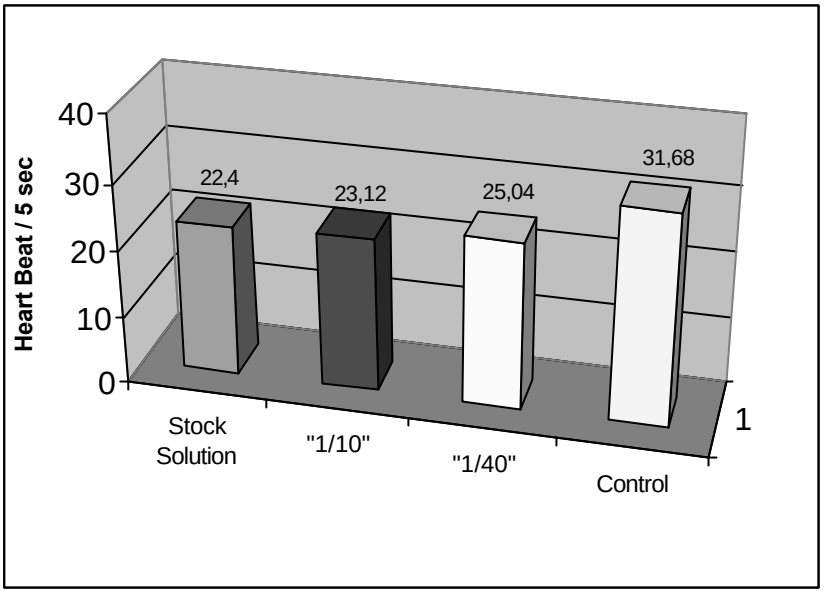

Chart 2 – Average Change of *Daphnia* Heart Rate under the Effect of Oestrogen. (Data from Table 2)

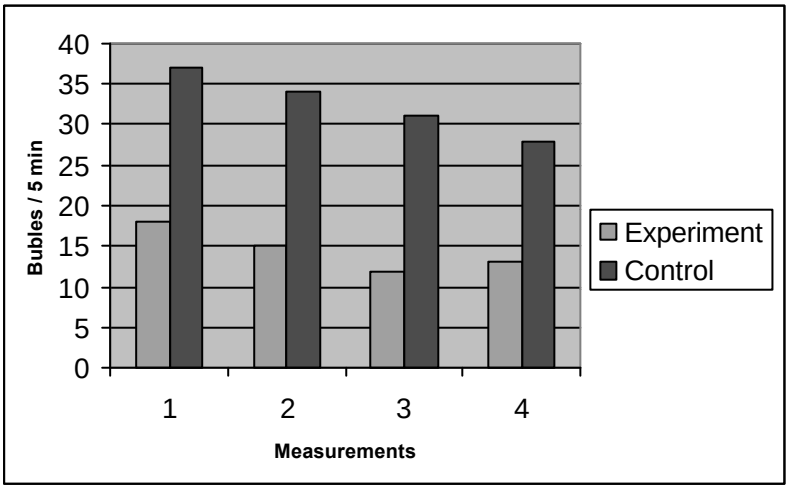

Chart 3 - Effect of Oestrogen on *Elodea* Photosynthesis Rate.
(Data from Table 3) (Method 2)

Table 3 – Measured number of bubbles/min.

Experiment	Control
18	37
15	34
12	31
13	28

CONCLUSION

Chart 2 clearly states the effect of oestrogen concentration on *Daphnia*'s heartrate. As the concentration incereases the heartrate of *Daphnia* decreases. In conjuction, chart 1 shows the slight changes between the averages within the groups which may be caused by stress factors other than oestrogen and differences in the metabolisms of the organisms. A uniform decrease was expected in *Daphnia*'s heart rate over time whereas Table 1 shows a slight variation only. This may be caused by the heat of the bulb of the microscope or other uncontrolled stress factors.

As for the effect of oestrogen on photosynthesis rate, Chart 4 is quite obvious. The volume of O_2 produced critically decreases as the concentration increases proving the inhibating effect of oestrogen on photosynthesis. Among the two methods which were used in this part; method 1 was more superior in accuracy than method 2 because in method 2 the volume of bubbles weren't actually equal to each other but method 2 also shows a decrease in photosynthesis rate.

To take this research a step further, the maximum amount of oestrogen that can be tolerated in the fresh water ecosystems should be found and following that, the oestrogen concentrations in water resources around factories should be tested. Also, reproduction rates of fishes that feed on *Daphnia* should be observed.

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