Copper Sulfate's Effect on the Opercular Rate of Mosquito Fish

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ABSTRACT:

My hypothesis is that the presence of copper sulfate in water causes stress on fish. Stress is commonly measured by observing the opercular rate of fish during an exposure to copper and other chemicals. The effect copper or other chemicals have on the opercular rate of mosquito fish from Sparkill Creek have not been tested prior to this study. By using a video camera the opercular rate of mosquito fish was measured when lead or other chemicals were not present. This was then compared to the opercular rate of the mosquito fish when lead or other chemicals were present. A relationship seems to exist between opercular rate and the presence of lead or other chemicals in the water demonstrating that metals can cause stress in fish.

HYPOTHESIS:

The opercular rate of the mosquito fish may be affected by exposure to copper.

INTRODUCTION:

Since stress can often be measured by observing the opercular rates of fish and copper sulfate has been proven to be an agent that causes fish stress. Stress in fish can often be measured by observing the opercular rate. Usually when a fish is under stress the opercular rate increases so the fish can take in more oxygen. This experiment observes the opercular rate of mosquito fish from Sparkill Creek when copper sulfate ($CuSO_4$-$5H_2O$) is present. Copper sulfate is often used in algaecides and bactericides and in high levels it can prove toxic to fish. Copper has been known to cause mortalities in fish populations, lower the percentage of circulating lymphocytes in fish, and change gill

structure. Copper also has been associated with causing osmoregulatory problems, and change in fish growth.

MATERIALS AND METHODS:

Mosquito fish were collected from the Sparkill Creek using a seine. The mosquito fish were placed in a 30 gallon tank with filtration.

The temperatures of the tanks were kept between 67.5 and 73 degrees Fahrenheit when opercular rates were measured. Fifteen ml of water was taken from the thirty gallon tank with a pipette and placed in a glass cup. A mosquito fish was then caught from the same tank using a small net and placed into the glass cup. The glass was then placed under the camera and focused. The 11 x 8 x 8 inch paper barrier was placed over the glass with the mosquito fish. The stopwatch was started. The opercular movements were counted using a counter for the initial twenty seconds of every minute for thirteen minutes. The opercular rates were counted by observing the movement of the gills or mouth. If the fish became too active during a twenty second interval and the opercular rate could not be measured, then it was recorded as "off."

After the thirteen minutes finished, the sex and length of the fish was then recorded. The fish was taken out of the glass and place in the ten gallon tank so it would not be confused as to which fish had been recorded.

To make the copper solution, one gram of copper sulfate was dissolved into one liter

of tank water in a beaker to make a 260 molar solution. Once the copper sulfate was completely dissolved, a pipette was use to measure out one milliliter. This was placed in a jar with 259 milliliters of tank water to make one ppm solution. Ten milliliters was measured from the stock, which was placed in another jar with 250 milliliters of tank water to make a ten ppm solution. 100 milliliters was measured from the stock and placed in a jar with 160 milliliters of tank water to make a 100 ppm solution. Later the solutions were measured with a spectrometer. There was an error in the when making the copper sulfate solutions. The solution that was supposed to be 1 ppm was actually 0.92 ppm. The solution that was supposed to be 10 ppm solution was 4.46 ppm and the solution that was supposed to be 100 ppm was 44 ppm. The reason for this error was probably do to sediment still in the stock. Sediment with a light blue color lied on the bottom of the stock. This was caused by either the tank water having sediment in it that the copper sulfate attached to or the beaker had not been cleaned thoroughly enough with acid, soap, and water. To keep the sediment from interfering with the concentrations samples measured by the spectrometer were from the top of the copper sulfate solution. The samples used on the fish were also taken from the top. This kept the sediment from causing affecting the experiment.

The 4.46 ppm solution was rejected because of the limited supply of fish available. The 44 ppm solution and 0.92 ppm solution were chosen because they were the two extemes of the copper sulfate solution concentrations.

15 ml was taken from the 0.92 ppm solution carefully so as not to stir up any sediment on the bottom. This was placed in a jar and shaken for approximately 2-5 seconds so oxygen would diffuse back into the solution. This step was not done on the

first fish tested of the0.92 ppm. The solution was then put in the glass under the camera. A fish was taken from the 30 gallon tank and placed in the glass. The paper barrier was placed over the glass and its opercular rate was measured the first twenty seconds of every minute for thirteen minutes. The fish was taken from the glass and measured. Its sex was recorded. The solution was dumped from glass and was filled with tank water. The fish was placed back in the glass to rinse off any copper on its exterior and to prevent it from contaminatoing the 10 gallon tank it was then placed in. The glass was then washed with soap and water. These steps were repeated for fish tested in the 44 ppm solution. When the concentrations placed in the glass were changed from 0.92 ppm to 44 ppm or visa-versa the glass was washed with acid, soap, and water. The ten gallon tank was split by a piece of plexy-glass and if the fish had been in a 0.92 ppm solution it was place on the left side and the right side if it had been in the 44 ppm solution. If the fish died within two days of being tested it was be recorded. (filter on right side.) This was done for seven fish.

RESULTS:

Baseline opercular rate of mosquito fish

SEX	LENGTH centimeters	Temperature degrees Fahrenheit	1	2	3	4	5	6	7	8	9	10	11	12	13
F	3.6	68	54	51	51	49	off	/	/	/	/	/	/	/	/
F	3.7	68	64	57	54	52	off	/	/	/	/	/	/	/	/
F	3.6	68	59	48	49	46	45	/	/	/	/	/	/	/	/
M	2.8	68	57	off	off	55	off	off	45	57	off	off	/	/	/
F	3.8	68	60	63	59	59	off	off	60	59	55	51	48	46	46
F	3.6	68	66	off	65	57	52	44	48	44	40	off	54	45	off
F	3.6	68	52	51	44	57	46	off	46	off	64	61	62	60	58
F	2.2	68	70	66	off	off	54	52	50	46	46	70	60	54	50
F	3.7	68	64	57	58	50	off	off	off	off	61	off	of	53	47
F	3.6	67.5	65	64	65	62	55	off	off	57	52	off	53	51	off
F	3.4	67.5	56	57	off	53	off	53	off	off	off	off	off	off	52
F	3.7	67.5	68	63	62	57	off	58	off	off	off	57	off	56	56
F	3.4	67.5	67	61	62	off	off	off	off	off	off	off	off	off	off
F	4.2	67	53	49	48	off	51	44	off	off	59	49	off	off	off
F	3.3	67	56	50	47	49	53	47	44	44	off	off	39	off	off
F	3.9	67	59	58	51	49	off	43	off	off	off	42	off	off	off
F	3.3	67	53	off	off	off	off	off	off	off	off	off	off	off	off

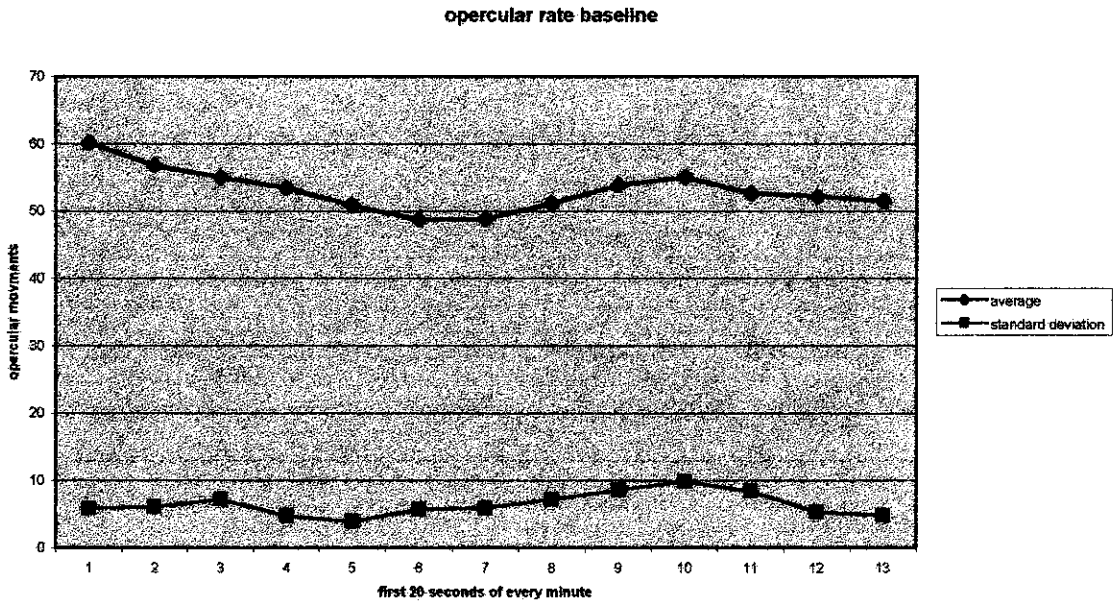
AVERAGE:

1	2	3	4	5	6	7	8	9	10	11	12	13
60.	56	55	53.	51	49	49	52	54	55	53	52.	51

(Total average = 53.08935)

STANDAR DEVIATION:

1	2	3	4	5	6	7	8	9	10	11	12	13
.8	6.1	7.3	4.7	3.9	5.7	5.9	7.2	8.6	9.9	8.4	5.3	4.8



Opercular rates of mosquito fish in 0.92 ppm copper solution

SEX	LENGTH Centimeters	Date of death noticed	Temperature degrees Fahrenheit	1	2	3	4	5	6	7	8	9	10	11	12	13
F	4.1	/	73	48	off	off	off	off	46	44	off	off	off	49	off	off
F	3.6	/	73	68	54	51	53	47	51	51	48	49	45	45	44	42
F	3.5	/	69	48	47	50	46	46	44	49	48	46	48	45	44	43

AVERAGE:

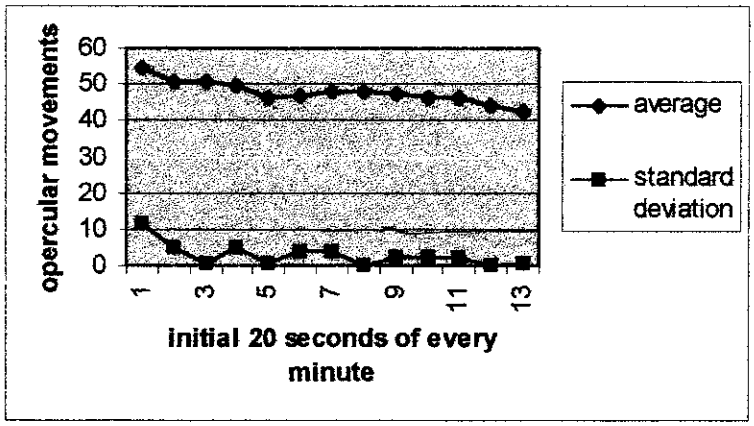
1	2	3	4	5	6	7	8	9	10	11	12	13
55	51	51	50	47	47	48	48	48	47	46	44	42

(Total average = 47.80769)

STANDARD DEVIATION:

1	2	3	4	5	6	7	8	9	10	11	12	13
12	4.9	0.70	4.9	0.70	3.6	3.6	0.00	2.1	2.1	2.3	0	0.70

Opercular movements for the initial 20 seconds of every movment in a 0.92 ppm copper sulfate solution



Opercular rates of mosquito fish in 44ppm copper solution

SEX	LENGTH Centimeters	Date of death noticed	Temperature degrees Fahrenheit	1	2	3	4	5	6	7	8	9	10	11	12	13
F	4.0	1/6/04	72	46	45	off	42	42	37	36	off	off	off	off	off	off
F	3.7	/	72	53	48	46	off	44	off	off	46	46	off	50	46	off
F	3.4	1/11/04	71	47	46	39	40	44	39	40	41	41	42	42	45	44
	3.5	1/11/04	71	54	48	48	48	off	42	48	51	42	off	off	off	45

AVERAGE:

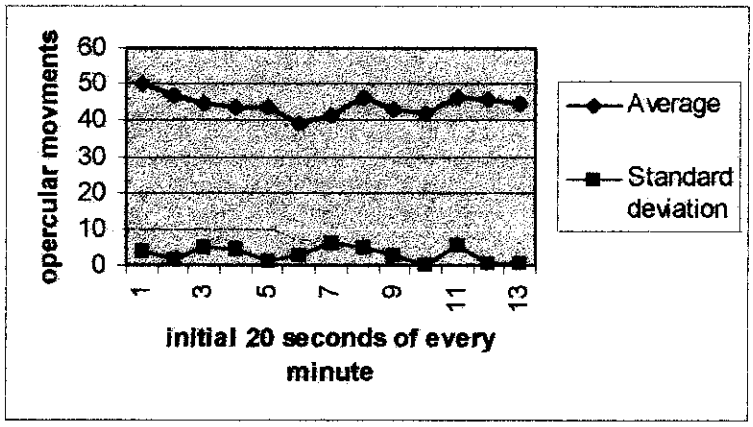
1	2	3	4	5	6	7	8	9	10	11	12	13
50	47	44	43	43	39	41	46	43	42	46	45	44

(Total average = 44.26282)

STANDARD DEVIATION:

1	2	3	4	5	6	7	8	9	10	11	12	13
3.5	1.3	3.9	3.4	0.94	2.05	5.0	4.1	2.2	0	4	0.5	0.5

Opercular movements for the initial 20 seconds of every movment in a 44 ppm copper sulfate solution



CONCLUSION:

The opercular rate of mosquito fish was reduced when they were placed in the copper sulfate solutions. The total average opercular rate of the baseline data was 53 opercular movements for every initial twenty seconds. This value dropped by 5.3 opercular movements when the fish were placed in the 0.92 ppm copper sulfate solution making the total average 48 opercular movements per initial twenty seconds. The total average of fish in the 44 ppm copper sulfate solution was 44 opercular movements for every initial twenty seconds. This is a difference of 8.82 opercular movements lower than the total average of the baseline data total average.

Three of the four fish tested in the 44 ppm copper sulfate died within two days after they were tested. This suggests that a high copper sulfate concentration proves harmful to mosquito fish from the Sparkill Creek.

DISCUSSION:

The copper sulfate seems to affect the rate of opercular movements by reducing it, although more fish should be tested to verify this conclusion. Additional testing could be done by dissecting other mosquito fish and grinding up organs such as the heart, brain, muscles, and digestive track, and placed in the portable datalogging spectrophotometer separately. This would allow the study to further examine where copper sulfate reached its highest concentration in the fish. In addition, it would give insight to how the fish were internally affected by copper sulfate.

Water samples from Sparkill Creek could also be taken and measured for copper concentrations in order to conclude whether the mosquito fish may be affected by the copper concentrations in the creek.