THE RELATIONSHIP BETWEEN WATER TEMPERATURE AND RESPIRATION RATE IN MARINE FISHES

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Abstract

An experiment to determine what effect a change in water temperature has on the rate of respiration in fish.

Purpose

To determine what effect a change in water temperature has on the rate of respiration in fish.

Background

Counting gill cover movements is a way to calculate respiration rates in fish. Fish breathe by taking water in through the mouth and forcing it over the gills when the mouth closes. An oxygen-carbon dioxide exchange occurs. Then the operculum opens to allow the carbon dioxide-rich water to exit. By counting gill cover movements, students are getting an idea of a fishes' response to an ecological change.

Materials (For every 2 students)

- 1 goldfish
- crushed ice
- 1 large beaker
- hot water
- 1 thermometer
- timer
- plastic zip-lock bag
- graph paper

Procedure

1. Carefully remove a fish from the tank and place it in a bag that is half filled with the water from the tank that held the fish. Place the bag containing the fish in the beaker, which should be half full of tap water at room temperature.
2. Gently insert the thermometer into the plastic bag. Try not to disturb the fish, and be careful not to break the plastic bag. While allowing some time for the fish to settle, observe the movement of the gill covers of the fish. Notice how it opens and closes in rhythm with the opening and closing of the mouth. The fish takes water in through the mouth, then closes it, forcing water over the gills. After the oxygen-carbon dioxide exchange, the gill cover (operculum) closes. Record the water temperature on your data chart. Now count the number of times the operculum closes in one minute. Record the number of closings on your chart. Conduct 2 more trials and record them on your data chart.
3. Slowly lift the bag containing the fish out of the beaker. Add ice to the water in the beaker until the temperature is 10 degrees below the original room temperature. Place the bag containing the fish back into the beaker and wait for the temperature inside of the bag to reach 10 degrees below room temperature. If necessary, add more ice to the **beaker**. Count gill cover closings for one minute and record your result on the chart. Repeat this procedure 2 more times so that you have completed 3 trials.
4. Remove the bag containing the fish from the beaker. Pour off some of the cold water and slowly add hot water to the beaker until the temperature has reached 10 degrees above the original room temperature reading. Gently put the bag back into the beaker allowing some time for the fish to adjust. Make sure that the temperature in the bag does not rise more than 10 degrees above the starting temperature. Before each count be sure to let the fish adjust for a few minutes. Record the temperature and gill cover closings for one minute. Continue the procedure for 2 more trials.
5. Return your fish to the tank by floating the plastic bag in the tank water to give the fish time to adjust before you pour it into the tank. Calculate the average number of gill cover movements for each of the 3 different water temperature trials. Record your data on the class chart. Use your data to construct a graph showing the relationship between temperature and respiration in marine fishes.

Conclusions

1. What was the general trend between temperature and gill cover movement?

2. How did your team's results differ from other teams in the class?

3. Compare and contrast your class averages to the averages of the other classes.

4. An increase in water temperature means a decrease in dissolved oxygen available for the fish to breathe from the water. How do you think this might explain the results of the experiment?

Class Data
Number of Operculum Movements per Minute in
_____ Temperature Water

Start Temp.(^{0}C)	# of Operculum Movements Per Min.	#of Operculum Movements Per Min.	# of Operculum Movements Per Min.	Average # of Operculum Movements Per Min.

Class Data (periods 1,2,&3)
Number of Operculum Movements per Minute in Room Temperature Water

Start Temp.(C)	# of Operculum Movements Per Min.	#of Operculum Movements Per Min.	# of Operculum Movements Per Min.	Average # of Operculum Movements Per Min.
20	117	130	137	128
20	117	118	120	118
20	139	151	157	149
20	145	152	151	149
20	131	145	149	141
20	130	150	131	137
20	105	124	123	117
20	103	147	146	132
20	124	120	124	122
20	105	83	98	95
20	98	109	90	99

Class Data (Periods 1,2,&3)
Number of Operculum Movements in Water Below Room Temperature

Temp. 10 Degrees Below Start	# of Operculum Movements Per Min.	#of Operculum Movements Per Min.	# of Operculum Movements Per Min.	Average # of Operculum Movements Per Min.
10	83	69	84	79
10	82	85	87	85
10	93	101	107	100
10	67	53	79	66
10	45	42	44	43
10	81	80	44	68
10	83	72	73	76
10	77	99	85	77
10	92	83	70	81
10	76	70	70	72
10	101	55	52	67

Class Data
Number of Operculum Movements in Water Above Room Temperature

Temp. 10 Degrees Above Start	# of Operculum Movements Per Min.	#of Operculum Movements Per Min.	# of Operculum Movements Per Min.	Average # of Operculum Movements Per Min.
30	134	145	175	151
30	170	170	167	169
30	111	122	112	111
30	161	142	140	148
30	160	152	150	154
30	134	126	125	128
30	174	170	170	170
30	135	136	160	143
30	131	143	156	143
30	177	172	168	172
30	150	150	161	153

Fish Respiration Rates, in Water at Ten Degrees Below Room Temperature (10 ^{0}C) and Water at Room Temperature (20 ^{0}C)

10 c	20 c	Sign of 10 c-20 c
79	128	-
85	118	-
100	149	-
66	149	-
43	141	-
68	137	-
76	117	-
77	132	-
81	122	-
72	95	-
67	99	-

Fish Respiration Rates in Water at Ten Degrees Above Room Temperature (30 ^{0}C) and Water at Room Temperature (20 ^{0}C)

30 c	20 c	Sign of 30 c-20 c
151	128	+
169	118	+
111	149	-
148	149	-
154	141	+
128	137	-
170	117	+
143	132	+
143	122	+
172	95	+
153	99	+

Data Analysis

The effect of water temperature on respiration rates of marine fishes was tested by the students of Mrs. McKay's period 1,2, and 3 science classes. Students counted operculum movements of fish in water at room temperature, water at ten degrees below room temperature, and water at ten degrees above room temperature. The data are presented on tables following this summary. The null hypothesis, when testing the data with the Sign Test, is that there is no difference in the respiration rates of fish under the three testing conditions.

When using the Sign Test table to examine data comparing the below room temperature sample to the room temperature sample, 11 minuses and 0 pluses are found. Therefore, the null hypothesis can be rejected and a conclusion can be made that water that is ten degrees below room temperature makes a fish breathe more slowly than water that is room temperature. When using the Sign Test table to examine data comparing the above room temperature sample to the room temperature sample, 8 pluses and 3 minuses are found. Therefore, the null hypothesis can be rejected and a conclusion can be made that water that is ten degrees above room temperature makes fish breathe at a faster rate than water that is room temperature.

After reading for information on fish respiration and conducting the laboratory exercise to determine the effects of water temperature on fish respiration rates, the students of Mrs. McKay's classes found that an increase in water temperature means a decrease in dissolved oxygen available for the fish to breathe. Students were able to conclude that because the water at 30 ^{0}C contained less oxygen than the water at 20 ^{0}C, the fish had to take more breaths in the warmer water to get as much oxygen as it did in the cooler water. Also, the water at 10 ^{0}C contained even more oxygen than the water at 20 ^{0}C, therefore, the fish did not need to breathe as quickly in the colder water as it did in the water at room temperature.

References

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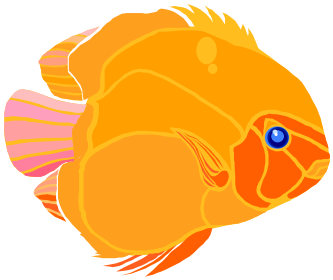

Name:_____
Date:_____
Class:_____

The Effects of Water Temperature on the Rate of Respiration in Marine Fishes

Water Temperature	**# of Operculum Movements Per Minute**	**# of Operculum Movements Per Minute**	**# of Operculum Movements Per Minute**	**Average # of Operculum Movements Per Minute**
Room Temperature				
10 Above Room Temperature				
10 Below Room Temperature				