

The Effect of Water Temperature on Goldfish Respiration Rate

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Introduction

The purpose of this experiment was to identify the effect of cold water temperature on the respiration rate of a *Carassius auratus*—goldfish. Respiration (breathing) is the way organisms exchange gases with their environment. Aerobic respiration, also known as aerobic metabolism in the Kingdom Animalia, occurs when oxygen is taken into the body and sent to all its cells; it is then used to break down food for energy (White and Campo 2004). All organisms experience respiration differently; lungs, gills, tracheae, and integument are all different structures equipped for making respiration possible. Animals that depend on their environment for body temperature are called ectotherms. Endotherms are warm blooded organisms that regulate their body temperatures internally, despite their environment. All aquatic ectotherms adapt to their environments in several diverse ways. According to R. Aiden Martin (2003), “The resting metabolic rate of an animal is known as its Basal Metabolic Rate (BMR). BMR is usually the minimal rate of energy expenditure necessary to maintain life processes. When BMR for a given animal is subtracted from its ‘active’ rate, the difference represents the amount of energy it can direct toward greater levels of activity.” For example, a shark’s respiration rate is dependent on the amount of food necessary to maintain its body temperature; if the water is too cold/hot a shark must decelerate/accelerate its metabolism to maintain life functions. Goldfish, like the shark, are aquatic ectoderms, but it is possible they regulate their metabolism in a different way. It is thought that aquatic ectotherms can only regulate their body temperature through adapting

their eating habits or physical endurance, but respiration regulation is also important. “Goldfish may be coldwater fish, but this does not mean they can tolerate rapid changes in temperature. The sudden shift in temperature that comes at night, for example in an office building where a goldfish might be kept in a small office tank, could kill them, especially in winter” (“Goldfish”). The dependent variable for this experiment was the respiration rate of the goldfish, and the independent variable was the temperature of the water. The null hypothesis is that the water temperature will not affect the respiration rate of the goldfish; this means that despite all our efforts to slow, accelerate, or halt the animal’s respiration rate, change in water temperature will not promote a change in respiration. The alternative hypothesis suggests that a change in water temperature will affect the normal respiratory patterns of the goldfish; the hypothesis suggests that this treatment, given to a goldfish normally kept in a room-temperature environment, will have a significant impact on the rate of respiration.

Materials and Methods

This experiment began by filling two 600 mL beakers with 150 mL of aged water. Two goldfish were each introduced into a separate 600 mL beaker. The beakers containing goldfish were referred to as “Beaker A” and “Beaker B.” Beaker A contained the control fish and Beaker B contained the fish exposed to the experimental treatment. Two more beakers were filled, one with ice water and the other with aged water (amounts not specified). The water temperature of both Beaker A and Beaker B was measured using a thermometer and then recorded. Counting the number of breaths each goldfish made in a given minute ensured accurate data. Goldfish breaths can be identified by either counting the number of times the fish opens and closes its mouth or by counting the number of times the goldfish’s operculum contracts. Once the temperatures of both

Beaker A and Beaker B were recorded, ice water was added to Beaker B (experiment fish) until the temperature of that beaker decreased by 2° C. Aged water was then added to Beaker A (control) in order to make the water level in both Beaker A and Beaker B equal levels. After new temperatures were recorded, the number of breaths taken by both fish within a one minute timeframe was also counted and recorded. This process was repeated six more times and each time the water temperature in Beaker B was lowered two more degrees. The water temperature in Beaker B ranged from 20° (at the beginning) to 8° C (at the end), and as the temperature decreased, the goldfish's respiration rate also decreased drastically.

Results

The average respiration rate for all six control goldfish ranged from 120 to 99 breaths per minute (not a significant change). The average results for all groups that experimented using a control fish showed that water temperature did promote changes in the goldfish's respiration rate. Through cold water treatments, on average, the respiration rate of the experimental fish ranged from 120 breaths per minute at the beginning of the experiment to 28 breaths per minute towards the end of the experiment. The experimental fish in Group #3 ranged from 95 to 11 breaths per minute. The only variable that changed throughout all six groups was the water temperature; this factor was induced on each experimental goldfish before its respiration rate was measured. The data collected provided evidence that the independent variable for this experiment truly was the water temperature.

Discussion

After completion of the experiment the null hypothesis and alternative hypothesis were reviewed once more, and because the water temperature did affect the normal respiratory patterns of the goldfish, the null hypothesis was rejected and the alternative hypothesis was accepted. Although other environmental factors may play a small role in the respiration rate of aquatic ectotherms, the experiment provided evidence that water temperature was greatly responsible. The biological significance of the experiment was that scientists may conclude that many other freshwater fish, of a similar nature, become inactive during the winter months due to the drop in water temperature. The results of the experiment may be applied to the real world by concluding that perhaps water temperature is responsible for why sport fishing in Louisiana occurs predominantly in the spring and summer months; the water is warmer and the fish require more food to maintain their respiration and metabolism. Although the results of this experiment were concise, several errors could have occurred. For example, if the fish did not remain calm long enough to accurately measure its respiration rate, an inaccurate measurement may have been documented which could easily compromise the entire experiment. Before and after the experiment all the fish used were kept in the same aquarium, which excites the question of whether or not any of the fish were diseased. Some of the fish may have processed certain diseases or defects that could have already impacted their respiration rates. A more accurate experiment may have taken place had there been more groups testing it; the more an experiment is replicated the more accurate the results. This experiment could have been adapted or modified to show that as respiration rate decreases, so does the fish's metabolism rate. Metabolism rate could easily be added to the experiment by testing the readiness for the fish to eat at each temperature tested. The experiment would be more time consuming because the fish would need

to be kept at each tested temperature for a much lengthier time period, and the fish would theoretically need to be hungry every time the metabolism rate was tested.

Literature Cited

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