Text should be double spaced. Use 12 point fonts and use 1 inch margins around the page. The sample shown here is smaller to allow for annotations to fit on the page

Your cover page should include your name, report title, course and section, instructor and date

The effect of external pH on respiratory movements in stoneflies. Jack Hodgins, lab partners, July 24, 2012, Biology 1100. Instructor: Maria Morlin

Use headings to outline your report

INTRODUCTION

Background Information

Background information should touch on relevant topics; here, respiratory movements are discussed.

In order to obtain enough oxygen for aerobic respiration, many organisms perform some sort of respiratory movement to bring more O_2 into the body (Schmidt-Nielsen, 1997). Common examples of such movements are breathing in humans, the movements of the gill covers in fish (Schmidt-Nielsen, 1997) and the "push-ups" performed by some stoneflies (Merritt and Cummins, 1987).

Support your statements with citations. Paraphrase from material from your sources, do not quote them directly

Stoneflies are insects that spend their larval stages in the water. Although a number of factors affect their distribution, the limiting factor in freshwater seems to be the availability of oxygen (Olive and Smith, 1975). Stoneflies increase the flow of water over their gills in times of oxygen stress by doing "push-ups" (Merritt and Cummins, 1987). What cues to the stoneflies use to increase these respiratory movements? In humans, it is well known that respiration is induced by a fall in blood pH. For stoneflies, it may be a lack of oxygen in the water, an increase in water temperature, or a build up of acid from respiration in their tissues.

Note that almost every sentence is backed up by a citation from books, lab manuals or other primary literature.

This paragraph goes from the general to the specific. It focuses on the variables being tested, and makes it clear what the your research is questioning.

Purpose

The purpose section should make it clear exactly what you expected to learn from the experiment, both in terms of science and in terms of technique. Write this section in the *past* tense (you have already done the experiment)

The purpose of this experiment was to determine if lowered pH levels are responsible for inducing respiratory movements in

Don't forget the page numbers!

Never leave a line or heading "orphaned" at the bottom or top of a page

stoneflies. Further, it was an effective way to learn about pH, how to measure pH with a digital instrument, and how to determine correlation from a set of data.

The hypothesis (or hypothoses) should be a clear, concise statement(s) predicting what you expect to find in the experiment, and why. Write this section in the *future* tense.

Hypothesis

Under uniformly high oxygen concentrations and at uniformly cool temperatures, stoneflies in lower pH water will have a greater number of respiratory movements, because pH is a known indicator of low oxygen levels in many organisms.

The material and methods section should explain how you did the experiment so that someone else could repeat the experiment, written in past tense. eg This is what we did.

MATERIALS AND METHODS

A total of 77 stoneflies of the genus *Macroneuria* were collected from Baker Run, a second-order stream in the Wayne National forest. The specimens were collected by kick-screen from a site at N39o 28.560' and W81o 19.838' (as determined by a Sony Pyxis GPS unit) on April 1, 1997. The specimens were placed in a bucket with water, substrate, leaves, and other organisms from the stream and returned to the lab, where they were held in a 40-liter glass aquarium.

Don't leave out details that might be crucial to someone else replicating the experiment.
Use of deionized Vs. tap water is one example.

The substrate, leaves, and other stream organisms were also added to the aquarium to provide food and refuge for the stoneflies. The total volume of stream water was 24 liters; deionized water was added as needed to maintain a constant water level. The aquarium was illuminated by a single 75-watt incandescent light bulb placed 30 cm above the aquarium. Light was measured using an Extech Model 101 light meter. The incandescent bulb

Specify model numbers for equipment whenever possible. Some equipment might have a well-known inaccuracy that could affect results.

provided 300 lumens of light at the water's surface. The light was controlled by a timer which was set to turn the light on at local dawn and off at local dusk. The tank also received indirect light from overhead fluorescent room lights (100 lumens) which were turned on occasionally during the day. Some light (50 lumens) reached the tank from north-facing windows on the far side of the room. The tanks were held at room temperature, which was monitored (every 10 seconds by a Vernier Systems DC-T temperature probe connected to a DTK 486 computer via a Vernier Systems MLPI interface. The data was recorded with the Vernier Systems Logger Pro software. Temperature over the course of the holding period fluctuated from 22o C to 25o C.

Aeration was supplied by a Challenger I air pump and a single 6 cm long airstone. Oxygen levels in the water were measured by a Vernier Systems dissolved oxygen probe using the same interface, computer, and software described above. Oxygen levels were monitored every 10 seconds by the software, and never fell below 7 mg/l. The airstone was placed at one end of the tank to create a current across the substrate on the bottom of the tank. Current speed at the bottom was estimated visually to be about 0.3 m/s.

The respiration experiments were carried out on April 8, 1997 from 3:30 to 5:30 p.m. The experimental apparatus consisted of a white plastic dishwashing tub measuring 50 cm long by 30 cm wide

The entire procedures section should be written in the past tense, The example is in the passive voice, but it is better to use the active voice: I, we, us, our, and so on.

It sometimes helps to imagine yourself hovering over a team of people carrying out the experiment, and recording the procedures as a story of what they did.

by 20 cm deep. Water was withdrawn from the holding tank and used to fill the tub to a depth of 10 cm. No substrate was added. The tub was then placed in a larger (70 cm by 50 cm by 30 cm) plastic bus tray, which had 5 cm of crushed ice lining its bottom. Aeration, temperature monitoring, and dissolved oxygen monitoring were all the same as those used in the holding tank. In addition, a Vernier Systems pH probe was employed to monitor pH. Lighting was provided by the overhead room lights and incident light from the windows; light levels were 125 lumens at the start of the experiment, and 103 lumens at the end, as measured at the surface of the water.

The pH of the water for the first trial was 7.6; this was the same as the pH in the holding tank. Once the water in the experimental tank had stabilized at a temperature of 8o C, 4 *Macroneuria* were randomly chosen and removed from the holding tank. The insects were allowed to acclimate for a period of 10 minutes.

When an experiment is repeated, you only need to tell the reader what was different. Don't repeat yourself if you can avoid it.

Each student in the team of 4 chose one of the individual insects to monitor. At the end of the acclimation period, a laboratory timer was set to sound an alarm every minute. The number of "push-up" style respiratory movements made by each individual stonefly was recorded every minute for 5 minutes.

The fate of the experimental organisms is not necessarily an important part of a lab report, but it can be included. On the other hand, if you dumped them down the sink....

After the observation period, the stoneflies were transferred to a temporary holding tank, and the experiment was repeated

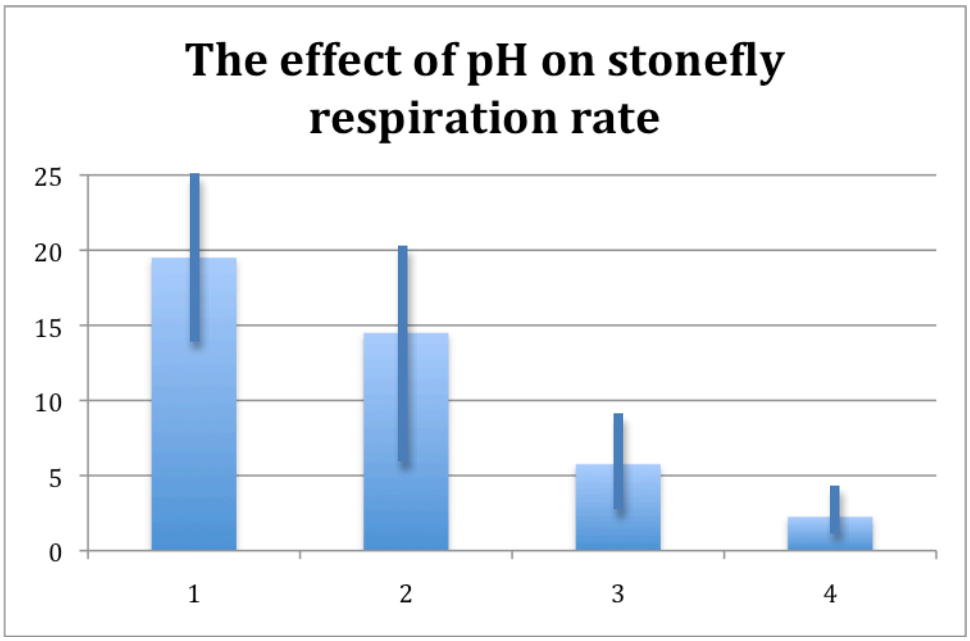
with a second and a third group of 4 stoneflies. After the first 12 stoneflies had been observed and removed, the pH in the tank was lowered using nitric acid until the pH level was 6.0. An additional 12 stoneflies were observed, using the same protocol as was used for the pH 7.6 observations. Likewise, the pH was lowered two more times, to pH 5.0

Don't forget the page numbers!

If you had more than one hypothesis, do the results in the same order as you explained your experiments in the hypothesis and materials and methods section.

RESULTS

Figure 1.



Summary of results

It is not enough to list the data in a table or graph it out. You need to explain it as well. Always refer to your tables or graphs in the text.

As pH increased, the number of respiratory movements of the stoneflies decreased (Fig 1).

This is where you would discuss your statistics, if you did them.

DISCUSSION

The results of this experiment support the hypothesis that a lower pH will result in more respiratory movements of dragonflies. The mean number of respiratory movements for each lower pH increased significantly over that of the next higher pH, (Fig. 1)

Include a statement of whether the hypothesis was supported or refuted by the experiment. If a well-thought out hypothesis is not supported by the facts, say so, and explain why. (It may have been real, or due to error in methods)

In humans, higher CO_2 levels act on the medulla in the brain to trigger respiration at the lungs (Schmidt-Nielsen, 1997). This allows the blood to vent excess CO_2 into the atmosphere, raising

the pH of the blood. The results of this experiment are consistent with such a mechanism; however, other explanations must be considered.

The discussion section should explain why you got the results you did.

Several possible factors that might affect the number of respiratory movements were controlled for in this experiment. Light levels, water chemistry (aside from pH), temperature, and handling were the same for all trials. Oxygen levels were maintained at a high level throughout the experiment. Lack of oxygen, therefore, should not have triggered respiratory movements, since there was high oxygen saturation throughout the experiment. Likewise, temperature, which might be expected to increase respiration through an increased in O_2 demand as metabolic rates increase, was held constant in all trials.

Sources of error

f there were errors that led to erroneous results, say so here. Provide experimental and procedural errors

In this experiment, nitric acid was used to lower pH. It is possible that the negative ions in this case, nitrogen oxides, might trigger the respiratory movements rather than the H + ions. However, I was not able to find any evidence that nitrogen oxides trigger increased respiration.

Future experiments

The future experiments section should be written in the future tense. It should address any shortcomings of the current experiment (such as increasing the number of replications or fixing a flaw in the experiment's design).

Another test would more definitively control for the possible effects of the nitrogen oxides; in this experiment the trials carried out here would be replicated, but with another acid, such as HCl,

This example is long. Yours can be just a paragraph.

used in place of nitric acid. As in the trials reported here, the organisms should respond to the additional acid with increased respiration.

Further controls in this vein would include an experiment where nitric acid and a base would both be added so that nitrogen oxide levels would rise but pH would be unaffected. In this case, respiration rates should not change if in fact nitrogen oxides are not responsible for the change in respiratory rates.

Finally, one cannot help but wonder at the implications of this study for organisms exposed to acid rain. If further tests support the hypothesis, it would be instructive to examine stoneflies in streams to see if stoneflies living in acidified streams show higher respiration rates due to the acid. If so, it could be predicted that the higher respiration rates would lead to lower production rates in such streams (since the respiratory movements waste energy that could otherwise go into growth), and a corresponding decrease in food for fish. In fact, it has been shown (Kharman, Frankel and Jackson, 1993) that fish production is dropping in streams affected by acid rain. This effect is seen even in streams where fish reproduction and physiology do not seem to be directly affected by the increased acidity (Kharman et al. 1993). Perhaps the decreased fish production is due to loss of energy in the system caused by increased respiratory movements of prey invertebrates such as stoneflies?

This last paragraph is more like the traditional conclusion of an essay. Toward the end of your discussion, you can go out on a limb and speculate, as well as put the results of your experiment into a larger context.

Conclusion

The conclusion reiterates the purpose, hypotheses, and outcomes of the experiment. This would appear in the abstract if you are required to include an abstract.

The purpose of this experiment was to determine if lowered pH levels are responsible for inducing respiratory movements in stoneflies. We hypothesized that lowered pH levels would induce greater respiratory movements in stoneflies, given that all other possible factors were kept constant. Our results showed that stoneflies respiratory movements are increased by low pH levels, but further studies should be performed to verify whether other factors play a part.

The Literature Cited section should contain a list of all the works actually cited in the text. Hint: As you proofread, be sure that every citation in the text has an entry in this section and that every entry here is cited in the text.

LITERATURE CITED

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Merritt RW, Cummins KW (Eds.) 1987. An introduction to the aquatic insects of North America, 2nd ed. Dubuque, Iowa: Kendall/Hunt Publ. Co.

In this example, only primary literature is used. However, you may use your textbook, the lab manual, other textbooks, one or two web sites, and primary literature.

Use the libraries resources online to find primary literature (ask the instructor).