

The effects of temperature on respiration rates of *Vicia faba* and *Blaberus gigantea*

**Introduction**

Gas exchange of carbon dioxide and oxygen maintain the atmosphere in a steady state for all life. Plants have evolved the atmosphere to what it is today by using the abundant supplied of carbon dioxide in the atmosphere. Plants to convert carbon dioxide to sugar carry out photosynthesis and a byproduct is oxygen (Campbell et al 1999). This process involves the stomata to open and close from guard cells due to the effects of light, temperature, and environmental conditions. Light intensity affects this process yet how does temperature affect the respiration and carbon dioxide and oxygen exchange? In the winter month's plants tend not to grow as much as during the summer. This occurrence could be a result of more light intensity during the summer months. Also temperature can affect the rate of chemical reactions. If the light and other environmental factors are controlled, how does the change in temperature affect the gas exchange in plants?

In contrast to the byproduct of oxygen in plants respiration, insects' intake oxygen and excrete carbon dioxide. This is done in a three-phase process with spiracles opening and closing during the gas exchange (Lighton 1996). The exchanges of gases start with the closed-spiracle phase. This phase oxygen is consumed. Next the fluttering-spiracle phase uses the oxygen and finally carbon dioxide is given off during the open-spiracle phase. The influx of carbon dioxide and oxygen is independent upon body mass (Lighton 1996). Yet metabolism is influenced by the respiration rate.

Dehydration has been shown to increase the oxygen uptake of insects (Guthrie et al 1968). The metabolism rate of the insect affects the oxygen uptake and carbon dioxide excretion. Metabolism can be affected by temperature. What effects does temperature have on the respiration of the insect? As the temperature increases it makes sense for the respiration to increase. The overall question is how does temperature affect the excretion of oxygen from a plant and relate to the intake of oxygen from an insect.

We hypothesized, as temperature increases, respiration rate increases until a maximum or threshold gas exchange rate. The effects between cockroaches and bean plants will be similar, but the threshold and respiration rate will differ.

### **Material and Methods**

To test the effects of temperature on *Blaberus gigantea* and *vicia faba*, we used the IRGA to measure carbon dioxide exchange rates at fixed temperatures. All the experiments were performed in the dark: a control at 23-24 C; a cold at 13-15 C; and a hot at 34-36 C. Bean leaves were coated with fusicoccin the day before the experiment to lock the stomata in the open position. Data was collected for 40-60 minutes for each specimen.

### **Results**

*Blaberus gigantea* respiration cycles frequency increased and shortened as the temperature increased (Figure 1). The cold temperature test the respiration cycle appeared to disappear, giving no cycles. The amount of carbon dioxide released decreased in the cold experiments. The control groups of cockroaches held a constant respiration cycle about every 20 minutes. During this test the carbon dioxide level during the open spiracle stage to 50ppm. The hot temperature experiment resulted in the

maximum carbon dioxide level. The graph also showed the respiration cycle also increased from 20 minutes at room temperature to 5-10 minutes at about 35 C.

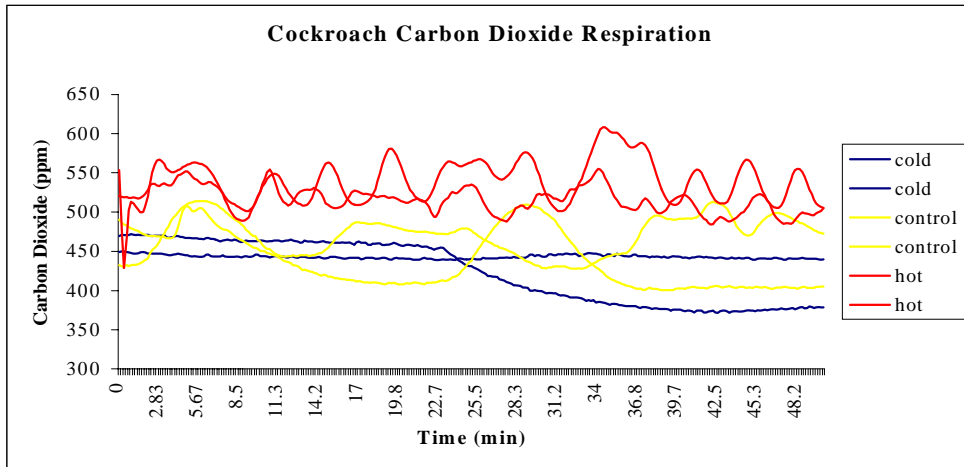


Figure 1: *Blaberus gigantea* respiration

*Vicia faba* showed little deviation of carbon dioxide levels between all the temperatures (Figure 2). There was an increase of 10-20ppm of carbon dioxide level at the cold temperatures. The control groups showed no change from the cold experiment. The inspiration and expiration levels of carbon dioxide were equal. Varied levels of carbon dioxide levels resulted from the heat experiment. One of the tests indicated a decrease in the carbon dioxide level.

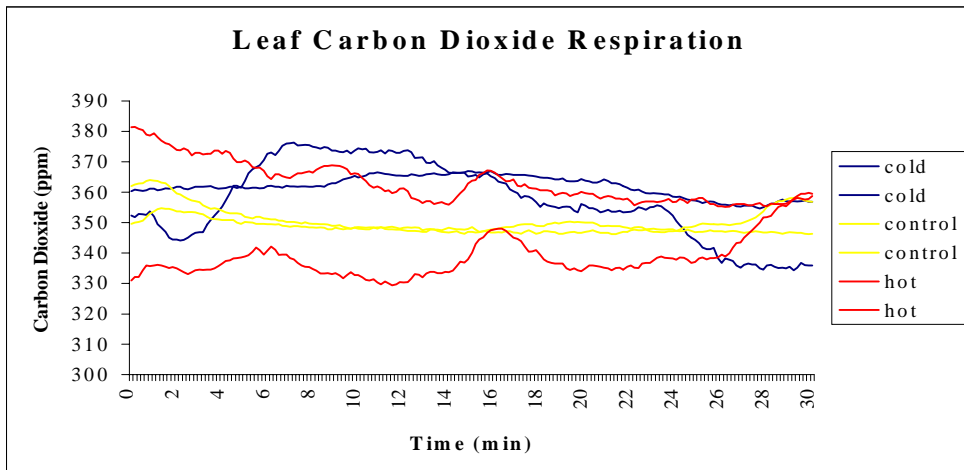


Figure 2: *Vicia faba* respiration

## Discussion

Figure 1 indicates that as the temperature increases, expiration of carbon dioxide by the cockroach also increases. This could be related with the increased in respiration cycle that was observed in the experiment. The peaks appear more frequently, and as a result the carbon dioxide level seemed to overcome the smaller peaks of carbon dioxide levels. The data supported our hypothesis of temperature increasing the respiration rate of *Blaberus gigantea*.

Figure 2 results of *Vicia faba* did not support our hypothesis. The levels of carbon dioxide appear to decrease as the temperature increased, which could mean the leaf is fixing more carbon dioxide than discharging of oxygen. This could be a result of photosynthesis being activated by the heat lamps. The light could have penetrated the barrier causing photosynthetic activity. The heat experiment showing no carbon dioxide levels change, made it hard for comparison purposes. We were unable to conclude from this data collected any relationship between temperature and respiration.

## Literature Cited

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Guthrie, DM, and Tindall, AR. 1968. The biology of the cockroach. Great Britain: Edward Arnold Publishers Ltd. 355-363.

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