An examination of the effect of temperature on the rate of maggot movement

Introduction

This experiment aims to analyze the behaviour of maggots. Behaviour can be broadly defined as the way organisms respond to their environment. In particular, the orientation behaviour (the movement of motile organisms and gametes in response to external stimuli) of the maggots will be studied, using temperature as the external stimulus. Maggots are very simple organisms, and therefore react merely by instinct, a series of complex reflex reactions that are inherited. These inherited actions are essential for maintaining the individual in a favourable environment and therefore it would be expected that most maggots will react in a similar way, to show a general behavior trend.

One environmental condition which may affect the maggots is temperature. Maggots rely on the temperature of the environment to determine their internal temperature and therefore their rate of metabolism. Therefore they most likely move at a rate which is in accordance with the external temperature. This correlation, between temperature and movement, is what this experiment aims to determine. The rate of movement of a group of maggots will be measured at a selection of temperatures. A general trend can be established to show the effect of temperature on the rate of movement of maggots.

Hypothesis

As was mentioned before, maggots are very simple organisms and therefore rely on the temperature of their environment to determine their internal temperature and therefore their rate of metabolism. At higher temperatures, chemical reactions (such as metabolism) occur more quickly due to the increased kinetic energy of the particle. The particles are moving more quickly and therefore more collisions occur, causing a reaction. Since metabolism supplies the organism with energy, at higher temperatures more energy will be produced. Therefore, at higher temperatures maggots will move more quickly, since their faster rate of metabolism provides them with the energy to do so.

However, at very high temperatures, there will most likely be a decrease in the metabolic rate due to the denaturation of enzymes. Therefore, it would be expected that at higher temperature, maggots would move more slowly, once they could not be provided with as much energy from metabolism. However, for humanistic reason the maggots will not e heated to an abnormally high level, to prevent harming them. Therefore, this trend will probably not be represented by the result.

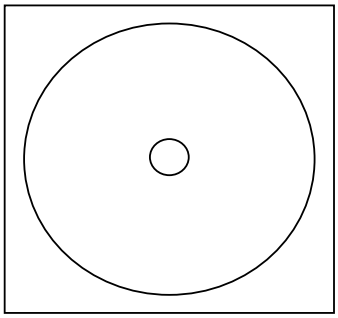
Materials

1 15cm by 15cm Piece of thick black paper
Sharp pencil
1 600cm^3 Glass beaker
Ice- enough to fill the beaker up to 2cm from the top
2 Table lamps
Tripod
Mercury thermometer
10 Maggots
Stop clock
2 Petri dishes

Method

Draw a circle, with a diameter of 1cm in the centre of the sheet of paper. Be careful not to push down on the pencil to hard to prevent denting the paper.

Draw a second circle, using the same centre point, with a diameter of 10cm.



COOL TEMPERATURE

Place maggots in a Petri dish in the refrigerator for 5 minutes.

Pour the ice into the beaker.

Place the piece of paper over the beaker so that the circles are centered over the beaker.

Let the beaker and paper sit for 5 minutes in order to cool off the paper.

Using the thermometer, measure the temperature of the paper and record the result.

Place a maggot inside the smaller circle and start the stop clock.

Replace the remaining maggots in the refrigerator immediately, to prevent them from warming up.

Record how long it takes the maggot to fully cross the line of the exterior circle.

Place the tested maggot in the second Petri dish, in order to distinguish which maggots have been used.

Repeat with the remaining maggots.

WARM TEMPERATURE

Place the maggots in a Petri dish under the table lamp for 5 minutes.

Place the sheet of paper on the tripod, so that the circles are centered.

Place the second table lamp centered, underneath the tripod so that it is 5cm from the paper.

Wait 5 minutes, then take the temperature of the surface of the paper and record the results.

Place a maggot inside the small circle and start the stop clock.

Record how long it takes for the maggot to fully cross the line of the outer circle.

Repeat with the remaining 9 maggots.

CONTROL

Leave the maggots in a Petri dish at room temperature for 5 minutes.

Lay the sheet of paper flat on the workbench and leave for 5 minutes.

Measure the temperature of the surface of the paper.

Place a maggot inside the small circle on the paper and start the stop clock.

Record how long it takes for the maggot to fully cross the line of the large circle.

Repeat with the remaining maggots.

Variables

Independent variable:

Temperature

Dependent variable:

Rate of movement of the maggots

Controlled variables:

Maggots move as a result of the light, not merely of the temperature. A piece of black paper was used between the maggots and the lamp in order to minimize the amount of extra light that they receive.

Maggots move as a result of other environmental stimuli rather than temperature. A control experiment was run, so that the other two experiments could be compared to it, to find out the differences in movement, due merely to the change in temperature.

Some maggots may not have inherited the gene coding for the correct response to light. A fairly large sample size is used in order to restrict the influence of abnormal maggots.

The same maggot is used more than once, thus limiting the sample size. The used maggots were placed in a separate Petri dish in order to distinguish them.

Different maggots move at different speeds. The same maggots were used throughout the three experiments, so that their change in speed is what is recorded.

Results

A table to show the length of time it took 10 maggots to cross the line of the large circle under different temperatures; cool, room temperature and warm.

Time taken for maggots to cross line of circle (seconds)										
Maggot Number	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Cool 17˚C	112	67	88	65	75	105	96	107	87	91
Room 19.5˚C	23	25	49	39	41	20	17	25	30	23
Warm 35˚C	16	18	21	40	25	17	25	17	23	26

Errors and uncertainties:

Temperatures accurate to + or - 1^{o}C (limit of accuracy of the thermometer used)

Times accurate to + or - 1 second (limit of accuracy of the timer used)

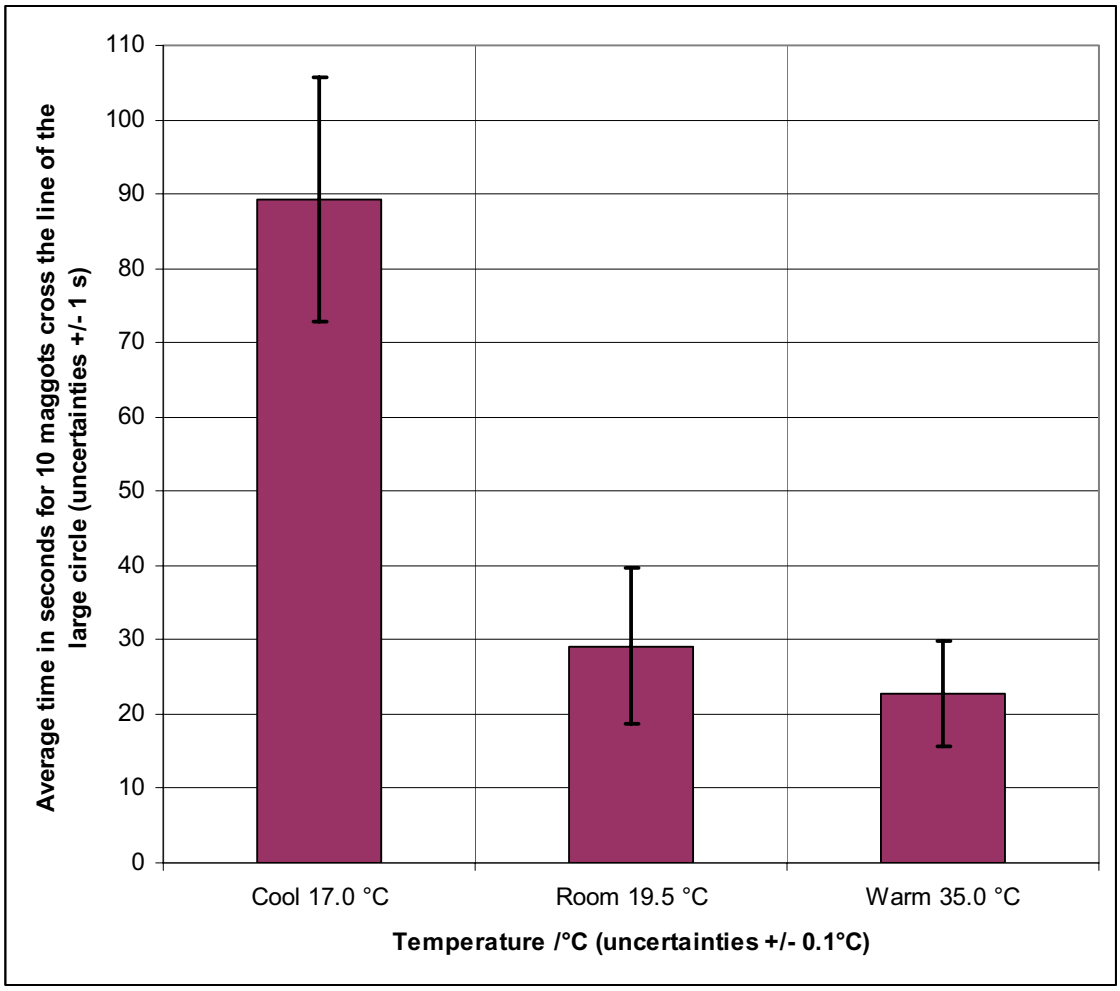
A table to show the mean and standard deviation of the length of time it took each maggot to cross the line of the large circle under different temperatures; cool, room temperature and warm.

Temperature	Average time taken for maggots to cross large circle (seconds)	Standard Deviation
Cool 17˚C	89.3	16.4
Room 19.5˚C	29.2	10.4
Warm 35˚C	22.8	7.1

Rate
Cool temperature: 5 cm in 89.3 sec = 0.056 cm/sec
Room temperature: 5 cm in 29.2 sec = 0.171 cm/sec
Warm temperature: 5 cm in 22.8 sec = 0.219 cm/sec

Graph to show the average time it took maggots to cross the line of the larger circle under different temperatures; cool, room temperature and warm.

(The line through each bar represents the value of the standard deviation for each set of results)



Errors and uncertainties:
Temperatures accurate to + or - 1^{o}C (limit of accuracy of the thermometer used)
Times accurate to + or - 1 second (limit if accuracy of the timer used)

Conclusion

The results show that the maggots moved at a rate in direct proportion to the temperature. At higher temperatures the maggots moved faster than at lower temperature. This result supports the hypothesis.

Evaluation

Although the results show an increasing trend of rate with increasing temperature, this trend is not even, i.e. it is not a straight line. This could be explained in several ways. First of all, maggots could have neared their fastest rate at room temperature, and therefore an increase in the temperature would not increase their rate substantially. Whereas under cool conditions, any slight increase in temperature would have a dramatic increase in their rate (despite the small difference in temperature between the cool and room temperatures, the rate of the maggots increased significantly.)

Also, the warm temperature may be higher than the optimum temperature of the maggots. Therefore, although it may be closer to the optimum temperature than room temperature, and is therefore slightly higher, the maggots' rate may have been faster at cooler temperatures, since the warmer temperature may have caused some denaturation of enzymes.

In order to test this theory, the experiment could be repeated at a temperature between that of room temperature and the warm temperature, perhaps 38˚C. If the maggots' rate at that temperature was higher than that at both the room and warm temperature, then it would suggest that the warmer temperature was past the optimum temperature for the maggots.

Errors

Although the results were expected, errors may still have occurred. One error concerns the direction taken out of the circle by the maggots. If the maggots did not move in a straight line across the circle, them the time it took them to cross the line of the outer circle does not necessarily reflect their rate of movement, but merely their distance travelled from their point of origin. The maggots were carefully observed throughout the experiment, and although they appeared to move primarily straight across the circle, it was observed that this error did occur to a certain extent.

Although this error cannot be obliterated, in the future, trials in which it was observed that the maggot did not move in a straight line could be repeated, so that the results would show their rate of movement.

Also, with the time allowed, as many trials were repeated as possible, however given sufficient time, the experiment should be repeated with a larger number of maggots, so that the results would be more likely to show the general trend in a maggot population.

In addition, the temperature in the room (and therefore the air temperature) did not necessarily remain constant throughout the experiment. Therefore maggots tested at different times, could have been exposed to slightly different temperatures, which, as this experiment shows, would affect their rate of movement.