CALIFORNIA STATE SCIENCE FAIR
2013 PROJECT SUMMARY

Name(s)

Saige J. Manier

Project Number

33341

Project Title

Jumping Galls: A Novel Mechanism for Motility

Abstract

Objectives/Goals

This research aims to discover how and why the Neuroterus saltatorius wasp larvae cause galls jump and how this mechanism of motility can be applied to other areas of science, including the design of a Mars rover.

Methods/Materials

To discover why the galls jump, the temperature range for jumping was found by measuring jumping rates from 0-45*C using an ice and hot water bath. Gall jumping rates in varying levels of relative humidity were recorded using CaCl(s) and various saturated salt solutions to create known relative humidities. Time lapse photographs were taken of the galls to approximate the distance jumped/month. The fuel efficiency of the galls was calculated through completing two lipid extraction procedures, before and after the galls completed their jumping cycle. The proposed mechanism of motility for the galls, momentum transfer, was modeled using mousetraps set off with varying amounts of weight attached.

Results

Between 20 and 40*C is the temperature range at which galls jump. As relative humidity decreases from 90 to 0%, the jumping rate increases by 780%. While jumping, galls lose 21% of their weight as water. The galls jump 0.57-1.2 cm/min, or 0.13 mi/month. Through lipid extraction, it was found that trial 1 galls 0.06 mg fat/gall, and each 2nd trial gall contained 0.0821 mg fat. Each jump requires 3.1 x 10^-8 J. Each gall jumps ~90,000 times before hatching. Each gall must contain 7.3 x 10^-8 g fat in order to sustain this jumping rate. Compared to the measurement that a gall contains 6 x 10^-5 g fat, a gall has 760x the amount of fat needed to jump for one month. Each gall would get 8 million mpg of gasoline! The mouse trap jumped farthest at two weights.

Conclusions/Discussion

Galls jump to escape heat and becoming dried out. The larvae are sensitive to changes in humidity. Galls jump to reach cooler areas of higher humidity where survival is more likely. Galls lose water without completely drying out to maintain a consistent internal humidity in an arid environment. The galls use so little fat to jump that there is no noticeable fat loss, leading to an extremely fuel efficient mechanism of motility. The galls contain more than enough fat to jump, allowing for variation in jumping rate and environment. The mousetraps support the concept that momentum transfer can be used as transportation. This leads to the consideration of using momentum transfer to power a Mars rover.

Summary Statement

This project is about how and why the Neuroterus saltatorius galls jump and how their mechanism of motility can be applied to the design of a Mars rover.

Help Received

Dr. David Deamer mentored-allowed me to work in his lab, provided feedback, and provided some materials. Yann Nichols and Larkin Wilson assisted in creating poster. Two fellow students assisted in counting jumps in one of the experiments.

Preliminary