

Effects of Music Exposure on the Feeding Patterns of *Schistocerca americana* (Drury)

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Abstract: The destructive nature of *Schistocerca americana* (Drury) feeding and the undesirable consequences of heavy insecticide use make the search for alternative methods of deterring grasshoppers and similar insect pests one of the utmost importance. This study sought to determine the overall effects of music exposure on the feeding patterns of grasshoppers, to evaluate the *S. americana* the efficacy of music exposure as a non-chemical deterrent. Male American grasshoppers, *S. americana*, were exposed to a variety of aural conditions, including music of various genres and volume levels, to determine if the average amount of plant material consumed per individual grasshopper was significantly affected. While a comparison of experimental trials indicated a possible correlation between reduced feeding and rhythmic, energetic genres of music played at a high decibel level, an anomalous control trial gave an inconclusive result for the overall effects of music exposure of any kind on the typical feeding patterns of *S. americana* (Drury)

Keywords: *Schistocerca americana*, music, feeding, decibels, deterrent

S. americana (Drury) are widely considered to be some of the most economically important pests worldwide, with voracious appetites so fear-inspiring and economically devastating that locusts (a specialized type of grasshoppers) even found infamy in the form of a Biblical plague (RF, 2017). The USDA estimates that grasshoppers are annually responsible for the destruction of “21 to 23% of available range forage in the Western U.S.” and goes on to warn that chemical insecticides can be costly, unpredictable, harmful to the environment, and may exacerbate that problem in some cases (USDA, 2016). Thus, non-chemical methods of grasshopper deterrence could offer a

practical solution to a problem thousands of years in the making. Music, something nearly as old as the conflict between grasshoppers and humans itself, could provide this solution. A previous research study on the effects of noise pollution on predatory insects found that prolonged exposure to a mixture of urban sounds and high-octane rock-and-roll music reduced the appetite of lady beetles (Barton et. al, 2018). This study sought to find if the appetite of grasshoppers could be curbed in a similar manner by exposing various sample groups of American grasshoppers, *Schistocerca americana*, to several different noise conditions: no music at all (ambient noise), classical music played

at a reduced volume, classical music played at a higher volume, rock music played at a reduced volume, and rock music played at a higher volume. The mass of romaine lettuce consumed by each group of three male *S. americana* (Drury) was measured and used to calculate the average consumption of plant material per grasshopper. In addition to their prevalence as economically important pests, grasshoppers served as an excellent candidate for this type of deterrence due to their prominent tympanums, membranes that allow the insect to “hear” by sensing vibrations in the environment, something that could potentially be greatly affected by loud music. *S. americana* (Drury) and certain other members of the order Orthoptera are also known for their characteristic “chirping” sounds used for communication; chirping songs are often unique among grasshoppers and could potentially be disrupted by exposure to music (Skovmand and Pedersen, 1983). This led to the initial hypothesis that grasshoppers exposed to loud rock music would consume less plant material than grasshoppers subjected to quieter rock music, classical music, or no music at all.

This experiment only sought to find if exposure to various genres of music had any measurable effect on the feeding patterns of grasshoppers in a controlled environment; further research would be necessary to truly compare the efficacy of music as a grasshopper deterrent in a more natural setting with the efficacy of traditional insecticides and deterrent methods.

Materials and Methods

15 male *S. americana* (Drury) were obtained from the Song Lab (located in the Texas A&M University Biological Control Facility) and transported to the Texas A&M University Heep Center in a small mesh container (Tinsda Inc., Henderson, NV) for the duration of the experiment. Grasshoppers of the same biological sex were used to ensure consistency among all of the experimental groups. A plastic tub (including a lid with several drilled air holes) was prepared to house the experimental group of grasshoppers; two smaller separate containers were used to hold grasshoppers that had already received experimental treatment, while those not yet used in an experimental group remained in the mesh enclosure (Tupperware Brands, Orlando, FL). Prior to the start of each experimental trial, the mass of a small amount of romaine lettuce was measured on a scientific balance (Ozeri, San Diego, CA) and recorded, and the lettuce was placed on a paper towel (Johnson & Johnson, New Brunswick, NJ) within the larger plastic container. Three male grasshoppers were randomly selected from the mesh enclosure and placed inside the large plastic tub before the lid was replaced. In the case of the control group, during which the grasshoppers were only exposed to ambient noise, the large plastic container was placed on the ground partially under a table to reduce exposure to extraneous noises, such as preparations for the next trial. For all other trials, the large plastic container was kept on the table next to the laptop being used to play the music in order to ensure thorough exposure (Dell, Round Rock, TX). For these trials, music exposure began simultaneously with the start of the hour-long timer. For

Trials 2 and 4, a recording of Gustav Holst's "The Planets: Venus, the Bringer of Peace" was played on a continuous loop for the duration of the trials. For Trials 3 and 5, a recording of Guns N' Roses' "Welcome to the Jungle" was played in a similar manner. Both recordings were chosen as representative examples of their respective genres. For all trials, an online decibel meter program was used to continuously monitor the noise level of the environment, with decibel readings recorded at the start of the trial and approximately every 10 minutes to allow for the calculation of an average decibel level for each trial (EA LAB, Ljubljana, Slovenia). After an hour had elapsed, the music was turned off in Trials 2-5 and in all trials, the lid was removed from the large plastic container and the three grasshoppers were transferred to one of the two smaller plastic containers for the duration of the experiment (there was no discernable difference between the two smaller containers; two containers were just needed to hold all 15 grasshoppers). The remaining lettuce was then removed from the large plastic container and its mass was recorded using the same scale (the paper towel from the large container was placed on the scale first and the scale was zeroed before the remaining lettuce was massed). Supplemental lettuce was added to prepare for the next trial, and the process was repeated. At the conclusion of Trial 5, all 15 grasshoppers were transferred from the two small plastic containers to the original mesh enclosure and transported back to the Song Lab. All remaining lettuce and used paper towels were disposed of.

Results

During the first trial (control group), in which the first sample group of three male grasshoppers were only exposed to the ambient noise conditions of the lab, (an average of 42.97 dB), no lettuce was consumed, meaning each individual grasshopper consumed an average of 0.00 g. of plant material. The grasshoppers in this group were observed spending the duration of Trial 1 clinging to the lid of the large plastic container and did not notably interact with the lettuce sample. In Trial 2, the "Quiet Classical Music" trial, a new group of three male grasshoppers were exposed to "The Planets: Venus, the Bringer of Peace" at an average volume of 56.03 dB. The grasshoppers in this group consumed 0.40 g. of lettuce, meaning that each individual grasshopper consumed an average of 0.13 g. of plant material. In Trial 3, the "Quiet Rock Music" trial, a new group of three male grasshoppers was this time exposed to "Welcome to the Jungle" at an average volume of 58.37 dB. A total of 0.30 g. of lettuce were consumed, meaning each individual grasshopper consumed an average of 0.10 g. of plant material. In Trial 4, the "Loud Classical Music" trial, yet another new group of three male grasshoppers was exposed to the classical music selection at an average volume of 62.80 db. 0.30 g. of lettuce were consumed, meaning each individual grasshopper consumed an average of 0.10 g. of plant material. Trial 5, the "Loud Rock Music" trial, saw a final new group of three male grasshoppers exposed to the rock music selection at an average volume of 75.77 dB. 0.20 g. of lettuce were consumed, meaning

that each individual grasshopper consumed an average of 0.067 g. of plant material. Across all five trials, the average amount of plant material consumed per individual grasshopper was the greatest when those grasshoppers were exposed to classical music played at a quieter volume (Trial 2). Grasshoppers consumed the least of amount

of plant material when exposed to no music at all in Trial 1 (however, amongst the trials that received experimental treatment, Trial 5, in which the grasshoppers were exposed to rock music at a louder volume, saw the least amount of plant material consumed per individual grasshopper).

Table 1: Amount of Plant Material Consumed and Average Decibel Level per Trial

	Initial Mass of Lettuce (g)	Final Mass of Lettuce (g)	Total Mass of Lettuce Consumed per Trial (g)	Avg. Plant Material Consumed per Individual Grasshopper (g)	Avg. Decibel Level (db)
Trial 1: No Music	1.0	1.0	0.00	0.00	42.97
Trial 2: Quiet Classical Music	1.0	0.60	0.40	0.13	56.03
Trial 3: Quiet Rock Music	1.3	1.0	0.30	0.10	58.37
Trial 4: Loud Classical Music	1.5	1.2	0.30	0.10	62.80
Trial 5: Loud Rock Music	1.4	1.2	0.20	0.067	75.77

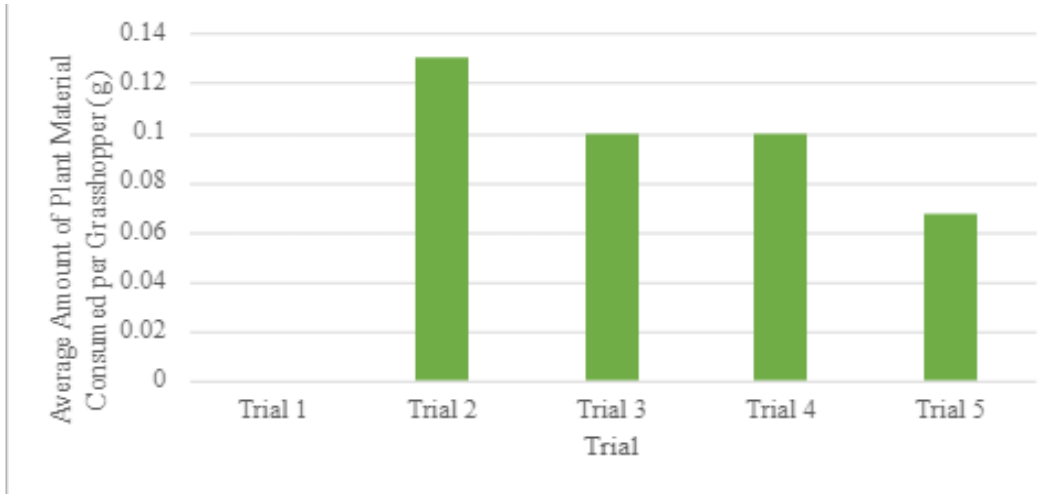


Figure 1: The average amounts of plant material consumed per individual grasshopper per trial.

When compared in terms of the volume of music exposure, the grasshoppers in the “quiet music” trials (Trials 2 and 3) consumed an average of 0.12 g. of plant material per individual grasshopper with an average decibel reading of 57.20 dB, while

the grasshoppers in the “loud music” trials (Trials 4 and 5) consumed an average of 0.083 g. of plant material per individual grasshopper with an average decibel reading of 69.29 dB.

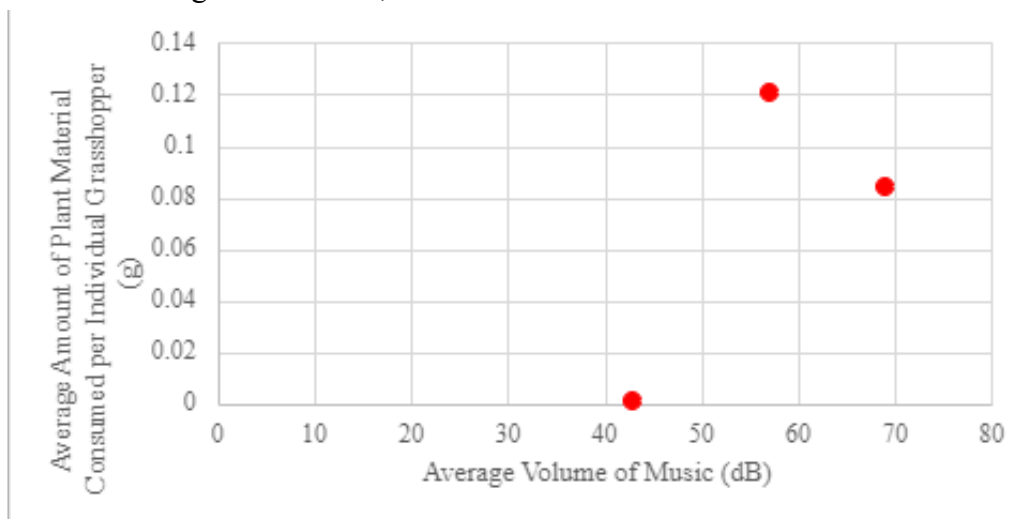


Figure 2: Average amount of plant material consumed per individual grasshopper according to the volume of music exposure.

When compared in terms of the genre of music exposure, the grasshoppers in the “classical music” trials (Trials 2 and 4) consumed an average of 0.12 g. of plant material per individual grasshopper (with an

average volume of 59.42 dB), while the grasshoppers in the “rock music” trials (Trials 3 and 5) consumed an average of 0.083 g. of plant material per individual

grasshopper (with an average decibel reading of 67.07 dB).

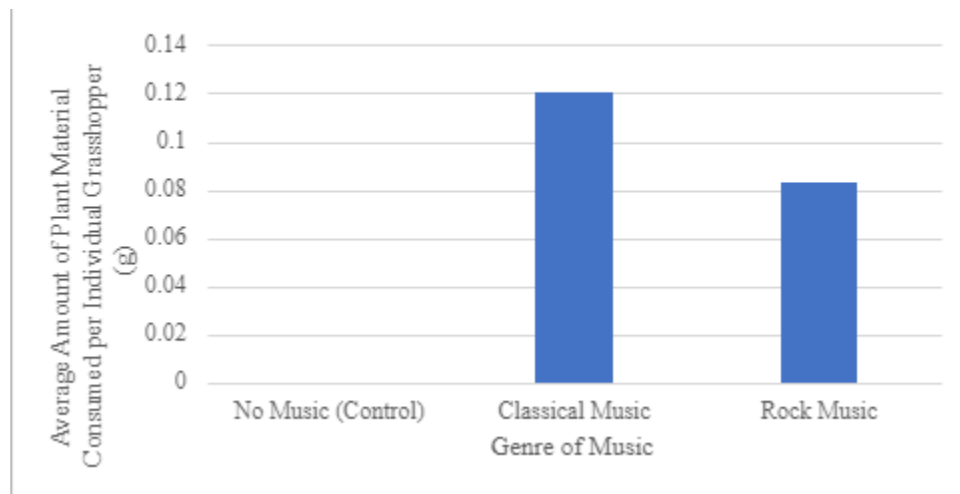


Figure 3: Average amount of plant material consumed per individual grasshopper according to the genre of music exposure.

Discussion

When analyzing the results of this experiment, three important questions emerge: did the genre of music played have any effect on the feeding patterns of the grasshoppers, did the volume of music played have any effect, and did the very presence of music make any difference at all? A comparison of the average plant material consumed per individual grasshopper in Trials 2-5 can begin to answer the former two questions. Grasshoppers exposed to rock music consumed, on average, 0.034 fewer grams of plant material than those exposed to classical music across all decibel levels. This seems to indicate that, in a manner consistent with the lady beetle study (Barton et. al, 2018), the cacophonous sounds of the rock music had a more disruptive effect on the feeding patterns of *S. americana* than classical music. Similarly, when compared using the metric of volume, grasshoppers

exposed to music of both genres played at a higher decibel level consumed, on average, 0.034 fewer grams of plant material than those exposed to music at a consistently lower decibel level. These findings seem to indicate a negative correlation between decibel level of music exposure and the amount of plant material consumed, indicating that music becomes more disruptive to the feeding patterns of this species as its volume increases. Among the four experimental trials, these two phenomenon interacted simultaneously; grasshoppers exposed to classical music at a lower decibel level consumed the most plant material, while those exposed to rock music at a higher decibel level consumed the least plant material (a 48% decrease in the average amount of plant material consumed per individual grasshopper). The genre and volume of music exposure seem to have had a clear effect on the experimental group of grasshoppers; however, it is more difficult to

determine whether the presence of music itself had any effect on the natural feeding habits of this species due to the nature of the control trial. The grasshoppers exposed to the ambient noise of the room alone did not consume any lettuce, spending nearly the entirety of Trial 1 clinging to the sides and lid of the large plastic container. If the validity of these results are to be accepted, they seem to suggest that the presence of music of any volume or genre is correlated with the increased consumption of plant material for this particular species. Following this line of reasoning, the decreased consumption of plant material in the grasshoppers exposed to music at a higher volume would seem to indicate some sort of “optimal decibel zone” where the grasshoppers consume the most amount of plant material, especially if the music played at that optimal level is classical in nature. However, it is perhaps more likely that some other factor or combination of factors influenced the lack of feeding in the control trial, since these grasshoppers did not merely show reduced feeding but the absence of any detectable feeding whatsoever. There are several possible explanations for this. The grasshoppers were transported between buildings on a relatively cool day, and as the control trial was conducted first, the grasshoppers may have shown reduced feeding as a consequence of a reduced body temperature. Alternatively, the control group may have shown reduced feeding due to the slightly different light conditions that were an unintended consequence of placing the experimental enclosure in a quieter area (the table cast a partial shadow over the experimental enclosure during the control trial, but all the other trials received

unobstructed exposure to the fluorescent lights of the lab). Other factors, such as the general stress of the experiment and natural variations in the feeding patterns of individual grasshoppers, could also be partially at fault, but should have either been equal amongst all five trials or minimized by the use of random assignment to trial groups. Regardless of the exact cause, operating under the assumption that the validity of the control group’s data is questionable makes it impossible to determine whether the very presence of music alone had any significant effect on the feeding pattern of insects, leaving the experimental hypothesis only partially supported. Ultimately, in an environment where music exposure is an inevitability, the data seems to suggest that energetic rock music played at a high volume will serve as a better grasshopper deterrent than the same music played at a reduced volume or classical music played at any volume. Further study is necessary to conclusively determine the effects of exposure to music of any variety on the feeding patterns of grasshoppers in an environment where exposure is elective.

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