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Can the Pattern of the *Leucauge venusto* Webs Be Used to Indicate Environmental Contamination?

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Lead and lead compounds are toxic to humans and are found almost anywhere on earth. Few metals have been used in so many ways as lead has. Overexposure to lead can result in damage to vital organs that can lead to death. Mercury is also toxic to humans. Like lead, it has been used for many years. Though mercury is now controlled, it is still released into the atmosphere from the burning of fuels and garbage. (Harte et al, 1984) Carbon monoxide is a colorless, odorless gas that is produced from the incomplete burning of carbon based fuels. It causes harm by depriving the body of oxygen. (Kantrowitz et al, 1994) Each of these substances is dangerous to humans and even with increased regulations, they continue to be released into our environment where they have the potential to affect humans.

Testing for environmental contamination is expensive and, for this reason, is only performed in regions of high probability. In other studies, the *Araneus diadematus* spider was exposed to certain drugs that resulted in altered webs being spun. (Murchie, 1978) For this study, the *Leucauge venusto* spider and its inherent ability to spin circular orb webs was used to determine if certain environmental contaminants could be detected. No previous research has been identified that uses this species or the effects of environmental contaminants on them. The project exposed the spiders to carbon monoxide, lead, and mercury to determine the effect on the spider's ability to spin normal webs. It is known that these substances have severe health effects on humans. If the substances affect the spider's ability to spin a normal web, then it is possible they could be used as indicators of habitat quality.

MATERIALS AND METHODS

Leucauge venusto spiders were located and observed. The webs were monitored and photographed to determine the normal web pattern. It was noted these spiders would consume their web each night and spin a new one each morning. All testing was performed with the spiders left in their natural surroundings.

To expose the spiders to carbon monoxide, a 10 meter hose was run from the exhaust pipe of a vehicle to the location of the spider and its web. A gas monitor calibrated to measure carbon monoxide, hydrogen sulfide, and oxygen was used to measure the concentration of carbon monoxide to which the spider was being exposed. The hose was placed 1 m. below the web and spider with exposure times ranging from 3 to 15 min. Concentration levels ranged from 808 ppm to 939 ppm with the average being 882 ppm of carbon monoxide. The exposures were conducted at night just before the spider consumed its web and the reactions of the spider were observed during the exposure. The following morning, the newly spun web would be observed for changes in the pattern. The web observations were recorded and photographed along with the temperature, humidity, and rainfall, if any.

To expose the spiders to lead, a solution was made by allowing lead to ionize in water. Lead solution #1 was made by placing 85g of lead in 3.75L of water and allowing it to sit for 10 hr. Because of dramatic effects this solution had on the spiders, lead solution #2 was prepared by diluting it 50/50 with distilled water. The webs of spiders were first misted with the lead solution #1 at night before they were consumed. The subsequent webs were monitored for deviations from the normal pattern. Due to the effects of lead solution #1, other spiders were exposed to the diluted lead solution #2.

A standard 2 ppm solution of mercury was donated by the Fresh Water Fish Commission for use in this project. Webs were misted with the mercury solution at night before the spiders consumed them. All observations were recorded and the data entered into a spreadsheet program for analysis. One control spider was observed for each spider tested to ascertain that the effects were results of the exposures and not other influences such as weather conditions.

RESULTS AND DISCUSSION

By exposing *Leucauge venusto* spiders to carbon monoxide, lead, and mercury, it was found that their ability to spin a normal web was affected. Of the 178 exposures to the substances performed on 35 different spiders, 50% of the webs were abnormal. Of the control webs, 6% were spun abnormally with 12% being spun later in the day. The spiders normally spin webs just before or at first day break.

Thirty webs were spun after exposing the spiders to carbon monoxide. The most common effect was the spiders would not consume their web after the exposure. This occurred in 14% of the tests. Of the spiders that consumed the webs and spun new ones the next morning, 5% were very slow at spinning their web. Normally, a web is spun in thirty minutes or less. CO exposed spiders would take upwards to three hours to complete a web. Of the 21 webs that were completed, 81% had flaws that were not consistent with the pattern of a normal web. The predominant flaw was the pulling of spirals together resulting in holes in the web and less total web area. This occurred in 11% of the webs. In 8% of the webs, the overall diameter was smaller and 3% of the spiders spun incomplete webs. The spacing between the spirals of the web is determined by the size of the spider. The spider will use the distance from its leg to its abdomen as a gauge for the spacing. Normally, the spacing is one leg length apart and is very close to that distance throughout the web, but in 5% of the webs spun after exposure, they had sections with spaces upwards to twice the normal spacing in the spirals (Figure 1).

The effects on a spider's ability to spin a normal web after exposure to lead were different from those of exposure to CO with more dramatic results. Compared to the control spiders that spun 82% normal webs and 12% spun later, the lead-exposed spiders spun 74% normal and 5% late for the forty three tests. The number of normal webs after exposure to the lead solution was considerably higher than those of spiders exposed to CO and Hg. It was observed that after five consecutive days of exposure to lead solution #l, the web diameter dropped dramatically and the spiders disappeared. For this reason, the solution was diluted with an equal amount of distilled water and the test repeated. Again the spiders spun mostly normal webs until the

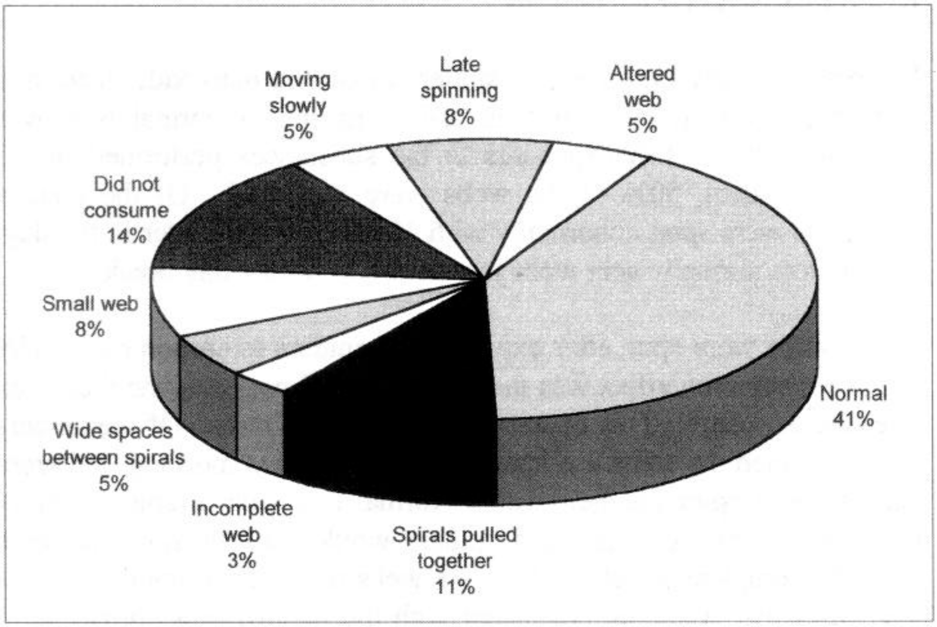

Figure 1. Effect of carbon monoxide exposure on the *Leucauge venusto's* web spinning behavior.

diameter decreased and they disappeared. The time from the first exposure to the disappearance had doubled for solution #2 that had been diluted to a 50% concentration. It is known that lead has a cumulative effect in humans. These results are an indication that the effects of lead are the result of an accumulation in the spider's system and are similar to the effects observed in humans. They spun nearly as many normal webs as the controls, then suddenly showed effects that resulted in smaller webs and disappearance (Figure 2).

Spiders exposed to the mercury solution in one hundred five tests demonstrated alterations in the web patterns similar to the other substances. The main defect that appeared in the webs was spirals being pulled together. This occurred in 23% of the webs. 40% of the webs were spun normally with spinning late webs accounting for another 17%. 10% of the webs were not consumed, compared to only 1% for the control spiders.

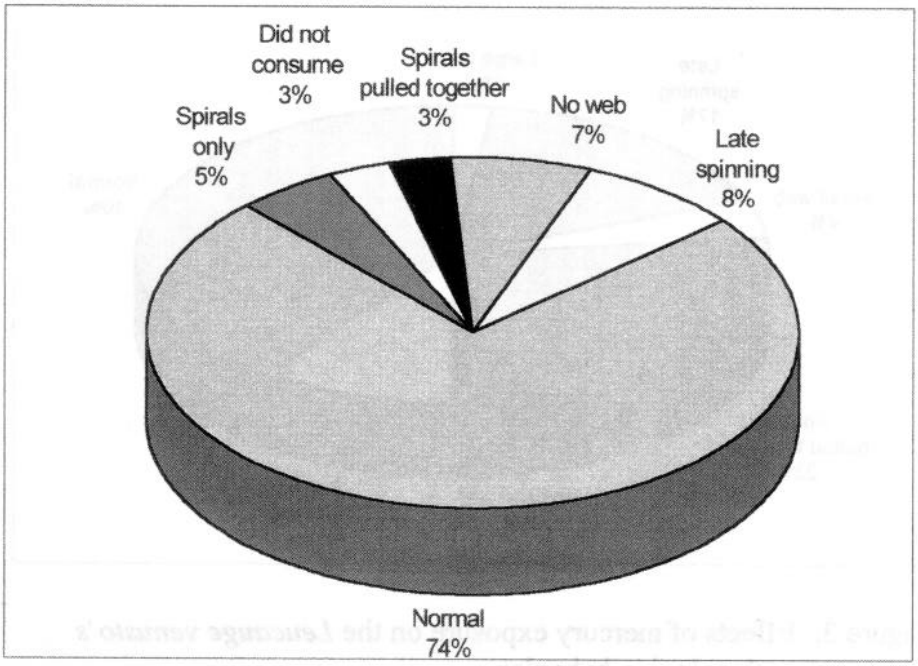

Figure 2. Effect of lead exposure on the *Leucauge venusto's* web spinning behavior.

The effects of mercury did not appear to be cumulative because the spiders would occasionally spin normal webs throughout the tests (Figure 3).

Control spiders were monitored throughout the experiment. They were in the general vicinity of the test spiders, but 10 to 15 meters away so as not to be affected by the test solutions. Controls had normal webs 82% of the time and were late spinning 12% resulting in 94% of the webs being spun normally throughout the tests. Often the late spinning of webs was due to very high humidity or heavy fog in the early morning when the webs are normally spun. Food supply and weather conditions are also factors which affect a spider's ability to spin a normal web (Figure 4).

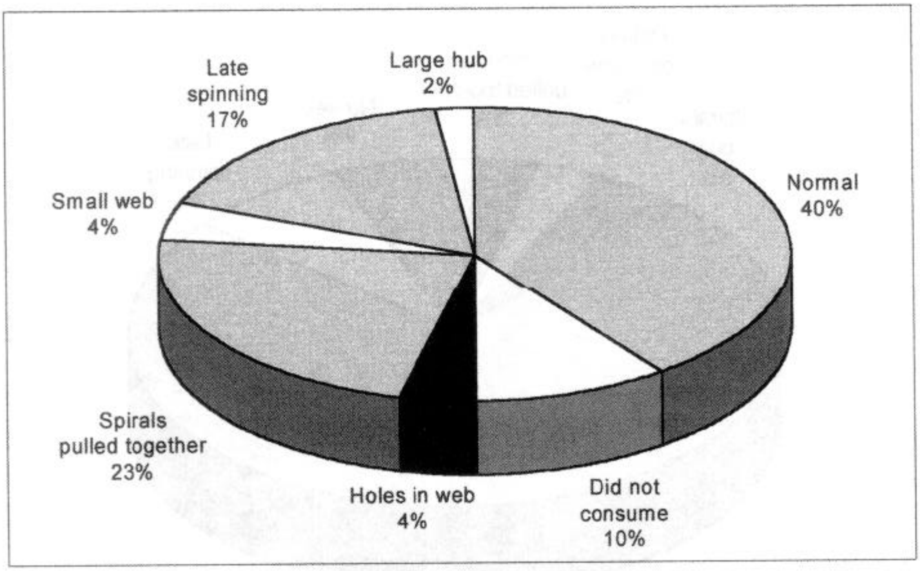

Figure 3. Effects of mercury exposure on the *Leucauge venusto's* web spinning behavior.

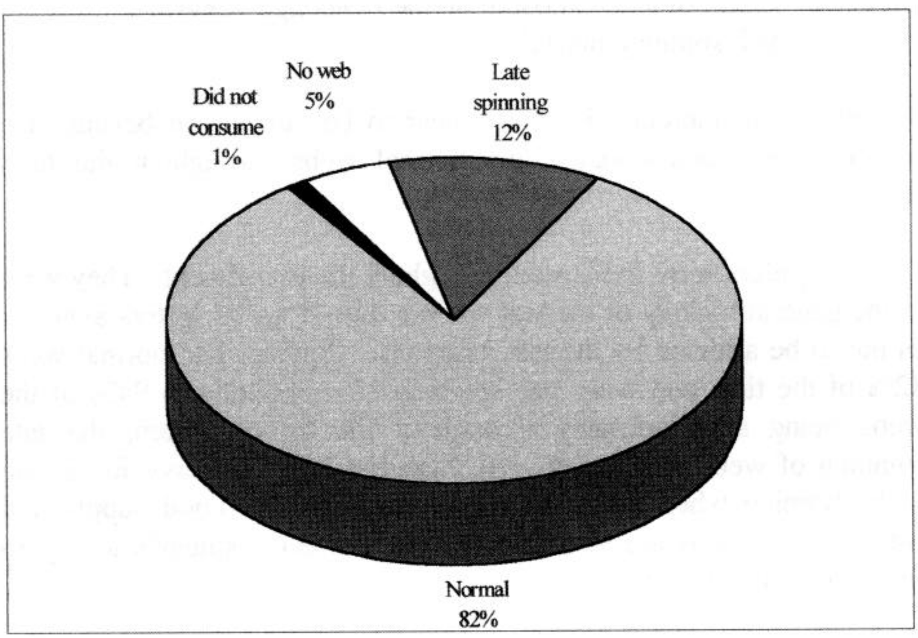

Figure 4. Control spiders web spinning behavior.

From the results of exposing the *Leucauge venusto* spider to these environmental contaminants, it has been determined that their ability to spin normal webs is affected. Results and observations of previous research by the author has shown that caffeine, nicotine, and alcohol has effects on the *Leucauge venusto's* ability to spin a normal web. The effects were similar to previous findings. (Murchie, 1978) No other research *has* been found where the *Leucauge venusto* spider has been used to study the effects of exposure to substances. By studying web patterns in nature, it may be feasible to determine areas that have potentially dangerous levels of these contaminants. From these observations, it can be determined that more in-depth studies are warranted. It can be concluded the *Leucauge venusto* could serve as indicators of habitat quality.

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