Section IV
Biological & Cultural Controls

Behavioral Responses of Female *Hippodamia convergens* (Convergent Lady Beetle) to different colors

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Introduction

Olfaction, vision and physical contact aid both the intermediate and short range-searching behavior of beneficial insects in locating a stimulus (Driesche and Bellows 1996). Hattingh and Samways (1995) demonstrated that the ladybeetle *Chilocorus niger* uses a complex system of vision and olfaction at a distance of 2.5 meters to locate habitat and prey. A study conducted by Obata (1986) indicated that the ladybird beetle *Harmonia axyridis* uses olfactory and visual cues to detect aphid-infested leaves. Some research suggests that the coccinellids *Coccinella septempunctata*, *Coleomegilla maculata* and 24 other non-*Hippodamia* species seem to be attracted to yellow sticky traps under field conditions (Maredia et al. 1997; Udayagiri et al. 1997; Ricci 1984). Other studies showed that the capture of *H. convergens* and *H. parenthesis* did not differ statistically among yellow, red, black, orange, and blue sticky traps under field conditions (Maredia et al. 1992; Capinera & Walmsley 1978). Agree et al. (1990) reported that the compound eye of *Coccinella septempunctata* was most sensitive to ultraviolet light at 365 nm and to green at 500 nm.

An overlying question that has not been looked at in detail is this: How does *H. convergens* find and locate prey habitat? The purpose of the research reported here was to determine the relative importance of colors in habitat selection by *H. convergens*. Specifically, I conducted experiments to determine the relative attractiveness of four colors (red, yellow, green and blue) to adult female *H. convergens*.

Methods

About 5000 *H. convergens* were collected on Moscow Mountain at an aggregation site on October 15, 1998. Beetles were placed in large paper cup containers and held in a cold storage unit at 40°F. They were fed a yeast and sugar mixture (Wheat) about once every two weeks.

The beetles used for testing responses to colors were sexed in the cold storage unit by examining them with a stereoscopic microscope. Sixty-five female beetles were placed in a container with an aerated lid so that air could circulate through the container. The containers with the beetles were placed in an environmental chamber at 30°C. The environmental chamber was programmed for a photoperiod of 17 hours of light and 7 hours of dark. This photoperiod mimics the longest day of the year (June 21) in Moscow, Idaho. The beetles were fed as many pea aphids and water as they could consume for three days. The beetles then were starved for 24 hours before testing in order to increase potential attraction to colors.
Custom-blown Y-shaped visionometers were used to test beetle responses to colors. Each Y-shaped visionometer consisted of ½-inch diameter glass tubing in the shape of a Y. The "V" area of the Y-shaped visionometer had two 4-inch long arms and the straight entrance of the Y was 7-inch long. The visionometer was placed into white box with an opaque divider between the two arms. A color treatment and control card was placed vertically at the end of each V arm. Cards were selected from a set of Color Aid artist color cards containing 220 colors. The experimental control card was gray and the treatments were blue, green, yellow and red. The opening at both ends of the arms of the "V" area were covered with plastic wrap so the beetles could escape but could still see the treatment and control color cards. A cork lined with plastic wrap was placed in the straight entrance of the Y-shaped visionometer so the insect could not escape. There were 10 white boxes with visionometers mounted horizontally on a 3 by 4-ft platform unit (5 on the two longest sides of the platform). When testing the beetles, 5 visionometers would be running at the same time. After each test was conducted the visionometers were cleaned in acetone to eliminate any odors that may have been left by the previous beetles.

Experiments were conducted in a white-painted walk-in controlled environmental chamber at 35°C with 2 banks of halide and mercury overhead lights at full intensity. A diffusion cloth was placed over the top of the white platform holding the visionometers and the entire unit was placed on the floor in the middle of the controlled-environment room so there would be an even light source illuminating each card.

Testing consisted of placing one beetle in the entrance of each visionometer and observing each for 10 minutes. A response was recorded when the beetle contacted the plastic wrap at the end of either V arm of the Y-shaped visionometer. If a beetle did not move to the distant end of either V-arm after 10 minutes, I recorded the arm that the beetle was in at the end of the time period.

An experiment consisted of one color treatment tested against the grey-colored control. Sample size was 100 female beetles (except for one of the green experiments where n was 73). Fifty beetles were tested in the morning (8:00 a.m. – 10:00 a.m.) and fifty beetles in the afternoon (1:00 p.m. – 3:00 p.m.). Differences in responses were analyzed statistically by computing chi-square tests.

Results: Beetles Responses to Colors

All *H. convergens* moved to either the treatment or control arm of the visionometer. Most of the beetles responded in the first 5 minutes. However, there were a few beetles that took most of the 10-minute time period to respond.

*H. convergens* was not attracted to green (Figure 1). There was no significant difference in the number of beetles at either V-arm in both experiments ($X^2_{exp.1} = 1.54, P > X^2 = 0.2145, N= 73$; $X^2_{exp.2} = .98, P > X^2 = 0.3222, N= 100$). When data from the two experiments were pooled there was also no significant response ($X^2_{pooled} = 0.003, P > X^2 = 0.9571$)
Similarly, *H. convergens* was not significantly attracted to red ($X^2_{\text{Exp. 1}} = 2.88$, $P > X^2 = 0.089$, $N = 73$; $X^2_{\text{Exp. 2}} = 2.42$, $P > X^2 = 0.1198$, $N = 100$) (Figure 2). Note that there were always more respondents to red. However, when response data from the two experiments were pooled, the $X^2$ test showed that beetles were significantly attracted to red ($X^2_{\text{pooled}} = 5.29$, $P > X^2 = 0.0214$, $N = 200$).

Figure 3 shows that *H. convergens* in experiment 1 was significantly attracted to blue whereas in the second experiment they were not ($X^2_{\text{Exp. 1}} = 3.92$, $P > X^2 = 0.0477$, $N = 73$; $X^2_{\text{Exp. 2}} = 1.62$, $P > X^2 = 0.2031$, $N = 100$). Note that as with red there were more respondents to the blue in experiment 2. However, when response data from the two experiments were pooled, the $X^2$ test showed that beetles were significantly attracted to blue ($X^2_{\text{pooled}} = 5.29$, $P > X^2 = 0.0214$, $N = 200$).
Figure 2: Responses of *H. convergens* in green and gray choice test.

Figure 4 shows that *H. convergens* significantly responded to gray compared to yellow in both experiments ($X^2_{\text{exp. 1}} = 25.92$, $P > X^2 = < 0.001$, $N = 73$; $X^2_{\text{exp. 2}} = 1.62$, $P > X^2 = < 0.001$, $N = 100$). When response data from the two experiments were pooled the $X^2$ test showed there was an even stronger response by beetles toward gray ($X^2_{\text{pooled}} = 47.62$, $P > X^2 = < .001$, $N = 200$).

**Discussion:**

Maredia et al. (1992) and Capinera & Walmsley (1978) conducted field studies on responses of *H. convergens* and *H. parenthesis* to red and blue sticky traps in the field and discovered no significant differences. In contrast, we discovered that *H. convergens* moved toward these colors under laboratory conditions. But the level of “attraction” was subtle and depended on using large ($n = 200$) numbers of *H. convergens*. Only when data from the 2 red experiments were pooled could we detect a strong statistically significant attraction by the beetles. Likewise, only when data from the 2 blue
experiments were pooled could we detect a strong statistically significant attraction by the beetles.

Maredia et al. (1997), Udayagiri et al. (1997) and Ricci (1984) stated that 26 non-Hippodamia coccinellid species seemed to be attracted to yellow sticky traps under field conditions. In contrast, our lab studies showed that *H. convergens* seemed to be highly deterred by yellow and so suggest that yellow is a poor choice for *H. convergens* traps. However, we need to determine if *H. convergens* is really deterred by the yellow hue or if instead beetle response is due to the intensity of the reflected light from the yellow card. We also need to test yellow in pair-wise comparisons with other colors to determine the potential role of contrast in beetle responses.

References:


