Controlling Lady Beetles at the Martin Observatory

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Abstract

We studied the nesting habits of the multicolored Asian lady beetles (Harmonia axyridis) which cause equipment malfunctions in the Martin Observatory 14-inch Telescope dome. At three hour intervals during the day and night, we recorded color images of a marked area in the dome using an ACME B28se Entomology Digital Camera, for two weeks during the overwintering period of the beetles. The number of beetles we counted in the images taken at night were greater than during daylight hours, by a factor approximately 10, on average. We think the beetles seek nighttime shelter in the observatory. We suggest that closing or blocking all entrances to the observatory, at sunset, could limit the number of beetles infiltrating equipment within the observatory.

1 Introduction

Insects are everywhere. So, it is not surprising that insects are common at observatories, where they can cause problems in electronic and optical instruments. Asian lady beetles (*Harmonia axyridis*), found in great quantities at the Martin Observatory[1], have caused failures of the dome control system and the telescope motion control system. We seek to prevent further damage to the observatory equipment by first discovering when and how these insects gain access to the observatory.

The U.S. Department of Agriculture first introduced the Asian lady beetle (Fig. 1) into the United States in the late 1970s and early 1980s, as a biological control agent. The Asian lady beetle has since inundated homes in the southeast during winter months. Interestingly, Jacobs attributes the largest increase in the lady beetle population to an accidental introduction in New Orleans by an Asian freighter [1] .

To find out if Asian lady beetles enter in the observatory during the day or during the night, we devised an experiment to count beetles at regular intervals throughout each day of a two week interval. This work is similar to previous studies done in natural environments [1-5]. For this first study, we made our observations during the overwintering period for these insects (i.e., February).

2 Observations

To sample the number of lady beetles inside the observatory, we counted lady beetles in images we took of a 4cm-by-4.5cm rectangular area on the inside wall of the observatory dome building, just above the entrance door. An example image is shown in Figure 2. We collected images at three hour intervals during the time period from 15:00 UT 4 February 2005 to 12:00 UT 10 February 2005.

We took images using an ACME B28se Entomology Digital Camera with a 160x180 CCD chip, controlled by TheBug software. The rectangular area was illuminated by a low-wattage (10W) bare bulb, which we set up near the center of the dome room; no other light entered the dome (day or night). We took images in red, green, and blue using standard Burchard RGB filters in a FlysEye rotary filter wheel system, also controlled by TheBug software. We used the red, green, and blue images to construct color images, so we could easily distinguish the multicolored beetles from other small scale imperfections in the wall.

[1]The Martin Observatory, located at the Miles C. Horton Sr. Center in Giles County, Virginia, is a project of the Mary Moody Northen Foundation and Virginia Tech.

The 50mm lens of the camera in combination with the 9μm CCD pixels, yields 0.6 arcminute image pixels. For a camera distance of 1.43m from the wall, these pixels correspond to a 0.25mm size on the wall, considerably smaller than a typical 5mm adult lady beetle. Images pixels were not binned. The camera temperature for all images was $-15°$C, which reduced dark current (and therefore noise) in the final results. All exposures were 0.2 seconds in length. Dark frames and flat-field frames, normally collected in the most exacting work, were not necessary; the signal-to-noise for all beetle images was very high, allowing for easy beetle counting. Details of the imaging sequence are shown in Table 1.

3 Data Reduction

We processed all images using the Bug Understanding Group's BUGme image processing program. While we did not use dark-correction and flat-correction procedures, we did use the hot-pixel reduction procedure to reduce some of the noise present in images.

In order to compensate for an unexpected dimming of the illuminating light bulb, we co-added a sequence of 6 images with start times from 3:00 UT 12 February to 18:00 UT 8 February. The bulb was replaced before subsequent imaging.

We made color composite images by combining the red, blue, and green images. We calibrated the individual color images using a colored test image. A typical final color image is displayed in Figure 2; in this figure the horizontal direction (in the dome) is displayed as horizontal in the figure.

Using the Entomologist's Helper program [6], we recorded beetle counts from the images. A plot of the counts as a function of time is shown in Figure 3. Note the diurnal variations: maxima at night, minima during the day. We noticed that other locations inside the dome seemed to sometimes have more, and sometimes less beetles than our marked location, but we were only rarely present during the image recording period.

To look at the typical diurnal variation, we averaged all the 0:00 UT counts across the two week period, all the 3:00 UT counts, etc., where we computed the average as

$$\langle x \rangle = \frac{1}{n} \sum_{i=1}^{n} x_i, \tag{1}$$

where n is the total number of counts averaged, with x_i being the ith count. Table 2 shows these mean values. The statistical uncertainty in each of the averages, σ_{mean}, shown in column 3, is

$$\sigma_{mean} = \frac{1}{\sqrt{n}} \sigma \tag{2}$$

where

$$\sigma^2 = \frac{1}{n-1} \sum_{i=1}^{n} (x_i - \langle x \rangle)^2. \tag{3}$$

It is readily apparent that more beetles are present at night (0:00–09:00 UT) than during the day (12:00–21:00 UT). Averaging the results for daytime hours and nighttime hours we find that the nighttime counts are about a factor of 10 larger than the daytime counts.

4 Results

Asian lady beetles are a major problem at the Martin Observatory. More beetles are present in the Martin Observatory at night than during the day, by a factor of approximately 10 in our counting experiment. Thus, one strategy to reduce the number of lady beetles inside the observatory—which might help protect the equipment—would be to make sure the observatory is sealed at sunset. Besides closing the door and slit, it is probably important to block all cracks that lady beetles can use as entrances.

To extend this study we would count more often, try other locations within the dome, and try other seasons. An additional experiment would be to put food in the observatory, at different times, to see if this changes the results. Finally, counting beetles before and after sealing the observatory would test the effectiveness of the measures taken.

References

1 Jacobs, S. 2001, "Multicolored Asian Lady Beetle," retrived January 14, 2010, from http://www.ento.psy.edu/extension/factsheets/multc_asian_ladybeetle.htm

2 Halley, E., Viter, K., Stewart F., Greasy, B., Beetle, B., Winthrop, W., and Emerson, A. 1985, "Really Interesting Beetles," Entomology Today, 238, 475.

3 June Simonetti, private communication.

4 Buggman, K., and Worthy, V. 1995, The Lives of Bugs, (New York: Prentice Hall).

5 Beetle, B. 1997, "Beetles: Why we hate them," Newsweek, 23, 97.

6 Shakey, G., no date of publication, "My Entomology Programs," retrieved January 15, 2010, from http://www.www.www.edu

Table 1: Imaging Log

Date (UT)	Number of RBG Image Sets	Exposure Time (s)
2005 Feb 4	7	0.2
2005 Feb 5	8	0.2
2005 Feb 6	8	0.2
2005 Feb 7	8	0.2
2005 Feb 8	8	0.2
2005 Feb 9	8	0.2
2005 Feb 10	8	0.2

Table 2: Average Counts at Specific Hours

Time (UT)	Average Count $\langle x \rangle$	Uncertainty σ_{mean}
00:00	300	12
03:00	290	6
06:00	310	13
09:00	278	4
12:00	38	4
15:00	20	5
18:00	34	6
21:00	25	6

Figure 1: An Asian lady beetle.

Figure 2: An image of the region surveyed, showing the presence of the lady beetles.

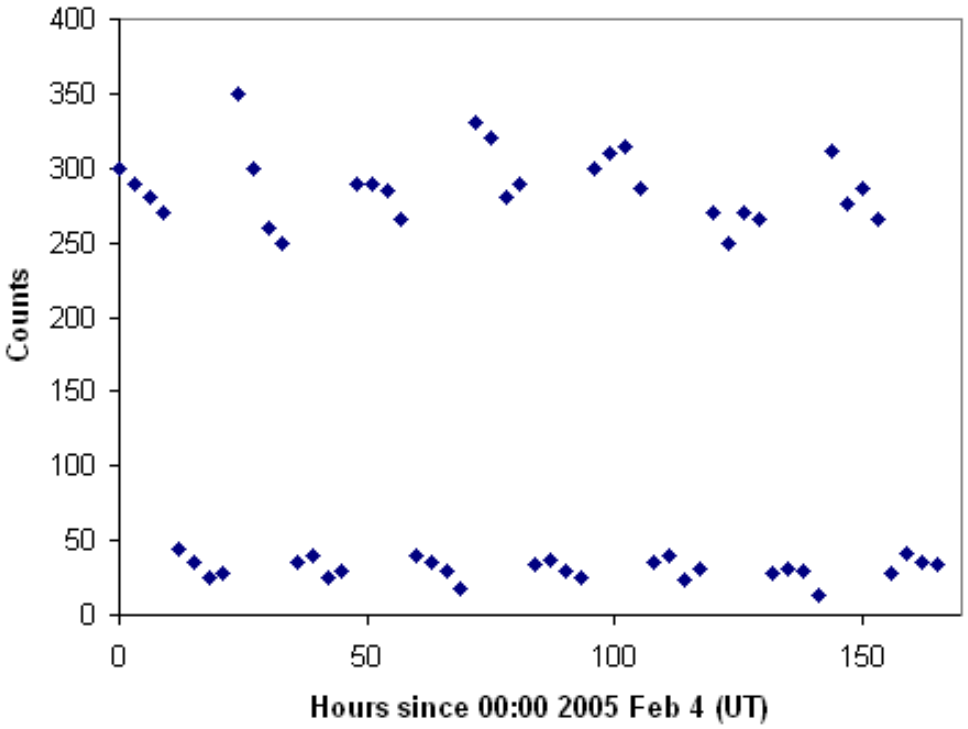

Figure 3: The number of beetles counted in each image versus the time elapsed from the start of the experiment. An obvious diurnal variation is present in the data.