LETTER TO THE EDITOR

EFFECTS OF COLORED LIGHT ON OVIPOSITION IN JAPANESE QUAIL

Hosick (1966. *Wilson Bull.*, 78:434–443) has attempted to assess the effects of colored light upon oviposition in the Japanese Quail (*C. coturnix japonica*). The summary states that "intensities at which laying took place were found to be independent of light color." For a number of reasons this assertion is totally unjustified on the basis of the experiments reported.

Using wide-band cellulose filters across a low wattage tungsten source at one end of the cage, the author noted the number of eggs laid at various distances from the source. The "intensities" along the illumination gradient in the cage were measured with an unspecified photometer. Graphs (Fig. 4, p. 438) were then made of the number of eggs in each measured "intensity" range for each of five colors of filters employed. Most of the eggs were laid at the dark end of the cage.

To begin with, "intensity" is an entirely ambiguous term in this experiment. "Intensity" can refer to the source or stimulus (measured in energy or number of quanta per unit time), or it can refer to the stimulative effect on the receiving organism. Since the latter depends upon the spectral sensitivity of the receiver, which is unknown for quail (and is presumably being determined in this experiment), the proper measure of intensity should have been radiometric (i.e., energy or quantum flux). The measurements given in the paper are in foot candles, which is a photometric unit related to the spectral sensitivity of man. Two stimuli of different wavelengths having the same photometric intensity (brightness) will appear equally bright to a human observer, whereas the same two wavelengths having identical quantum intensities will not (except for certain pairs of wavelengths to which the eye is equally sensitive).

If one assumes that the quail's spectral sensitivity is identical with that of man, a photometric measure would be acceptable (as a measure of apparent brightness to the quail). Even granting this unlikely assumption, the reported experiment is ambiguous because of another source of error. Nearly all photometers have a spectral sensitivity different from that of man's eye (most photometers are far more sensitive at shorter wavelengths than is our eye). The foot-candle calibration on these meters may be used only for white light, and then the values are only approximate. Therefore, the "intensities" used in this experiment with colored lights are entirely meaningless: they correspond neither to physical intensities nor to subjective brightness intensities.

It is impossible from the data given to compute even a rough estimate of the effect of color upon oviposition. There are two ways in which this might be done, but both require further information: the spectral transmission curves of the filters plus either the spectral output of the source or the spectral sensitivity of the meter used.

There are additional matters for concern about the experiments on colored lights, and some of these matters also apply to the experiments with white light. For instance, there are no statistical analyses of any data given. The histograms of Figure 4, which plot the number of eggs versus the "intensity" for each of the five colors of illumination used do *not* appear to be identical. Picking the data from the published histograms, I cast the values into a one-by-two table for each color: number of eggs at "intensity" range 0.5 to 2 versus eggs at 2 to 20 units. (The lumping is necessary because of the low expected values in each of the separate categories within this range. The lumping, by the way, biases the comparison *away* from establishing any differences.) Each 1×2

table was then compared with all the others in turn, so that 10 comparisons were made between pairs of colors. The 2 × 2 tables thus formed were tested with the standard Chi-square method.

The results show that three of the 10 comparisons were indeed significant (two with probabilities less than 0.005) and a fourth comparison nearly significant (p between 0.10 and 0.05). Thus, despite that statistical method that biases the outcome away from providing a difference, the distribution of eggs in violet light is significantly different (or nearly so) from the distribution of eggs in all other colors. (Other differences might also prove significant with a more sensitive test.) In sum, even if the "intensity" given is taken to mean something, the position of laying is not proven independent of color.

Apparently the author concluded that there were no differences due to color because the modes in all of the histograms occur at the lowest "intensity" provided. This fact seems to indicate only that the wrong range of illumination was chosen for the experiments, since the hens always laid in the darkest place provided. Would complete darkness be yet preferred over these low illumination levels?

Actually, all the histograms are grossly misleading due to the unequal amounts of floor-space available in each intensity range plotted on the graphs. The diagram of the apparatus (Fig. 1, p. 435) shows that in more than half of the area of the cage the illumination was less than 2 "foot-candle" units. The histogram for violet light in Figure 4 shows that about 26 eggs were laid at less than 2 units and about 32 eggs at greater than 2 units. Therefore, my conclusion about intensity for this graph is just the opposite from that of the author. The measure employed should not have been the number of eggs at each "intensity," but, rather, the number of eggs *per unit area* at each "intensity." Thus, the 60.8% of eggs laid at less than 2 units (Fig. 2, p. 436) were laid in roughly 60 per cent of the total space available at any intensity, which fact practically eliminates the claim for any effect of intensity at all!

Finally, it might be mentioned that a number of important parameters of the experiments are not specified. For instance, how long was each experiment run: for a set number of days, or until a certain total number of eggs had been collected? Of the "approximately twenty birds to a cage" (p. 434) how many never laid an egg? Were the modes due to a few prolific individuals? The fact that "several of the female quails were becoming blind" (p. 440) during the tests is more than mildly disturbing.

In sum, the author's two main conclusions appear to be just the opposite of what the data may show, namely, (1) that it *cannot* be proved that quail prefer the lowest illumination provided, and (2) it *can* be shown that differences occur between the experimental groups with different colors (although what these differences mean must be left unresolved).

I am indebted to Drs. Wolfgang Schleidt and Douglass Morse for discussion concerning these matters; responsibility for the above comments is, of course, mine.—JACK P. HAILMAN, *Department of Zoology, University of Maryland, College Park, Maryland.*