Termination of photorefractoriness in the chukar partridge 
(*Alectoris graeca chukar*) by low light intensity

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**Summary.** Adult females were maintained under controlled conditions (22°C, 60% relative humidity and 16 h light/day) within bioclimatic chambers throughout the test. For 6 weeks prior to photostimulation photorefractory birds were exposed to a light intensity of 1, 3, 5 or 7 lux. The intensity was then increased to 50 lux. Control birds were kept in 8L:16D and changed to 16L:8D, the light intensity remaining at 50 lux. The time to first egg and the rate of egg production were recorded.

A decrease in light intensity alone was able to terminate photorefractoriness in chukar partridge and the threshold light intensity required for a complete termination of refractoriness was less than 1 lux. Light intensities of 1, 3 or 5 lux resulted in a partial termination of refractoriness but 7 lux was completely ineffective in terminating photorefractoriness. The termination of photorefractoriness was therefore not an all-or-nothing response.

**Introduction**

During the photorefractory state the reproductive system of a bird cannot be stimulated by light which was previously stimulatory. Typically, photorefractoriness is terminated by exposure to short daylengths and subsequent exposure to long daylengths results in reproductive stimulation (Wolfson, 1958; Hamner, 1968). However, Siopes & Wilson (1978) have reported that photorefractoriness in the chukar partridge may be terminated by low light intensity, as well as short daylengths. A similar response has been reported for the golden-crowned sparrow (Turek, 1975) and the domestic turkey (Marsden & Lucas, 1963).

The threshold levels of light intensity required for photostimulation are known for many avian species but there is little information available about the threshold levels of light intensity to terminate photorefractoriness. Turek (1975) suggested that the intensity threshold for terminating refractoriness in the golden-crowned sparrow is near 0-2 lux, whereas Siopes & Wilson (1978) reported that 4 lux was sufficient to terminate photorefractoriness in chukar partridge. The purpose of the present study was two-fold: (1) to determine the threshold level of light intensity required to terminate photorefractoriness; and (2) to determine the effectiveness of various light intensities in terminating photorefractoriness.

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Materials and Methods

Adult female chukar partridge (*Alectoris graeca chukar*) were used in this study. Each bird had just completed a normal egg laying period while being exposed to 16 h light/day at an intensity of 50 lux and thus was photorefractory. The birds were divided into 4 experimental groups of at least 11 birds per group. For 6 weeks each group was exposed to a light intensity of 1, 3, 5 or 7 lux while being maintained on a photoperiod of 16 h incandescent light per day (16L:8D). At the end of this pretreatment period the intensity was increased to 50 lux for all birds; this photostimulation was to induce egg laying. The time to first egg and the rate of egg production were then recorded and compared to those of the control group which differed from the experimental group only by being pretreated for 6 weeks on short daylengths (8L:16D) of 50 lux intensity before photostimulation. Photostimulation of egg laying occurred when the lighting was changed to long daylengths (16L:8D) although the intensity remained at 50 lux.

The test was conducted under controlled conditions (22°C, 60% relative humidity) within bioclimatic chambers. All birds were maintained in individual wire cages (28 cm wide, 41 cm long and 33 cm high) and chicken breeder crumbles and water were provided *ad libitum*. Light intensity was controlled by using different wattage bulbs or with transistorized dimmers. All light intensity measurements were made with a Gossen panlux electronic photometer just inside the cage at the feed access openings. Statistical analyses were made by Student’s *t* test.

Results

The results are given in Table 1; the responses of birds in Groups 5 and 7 were poor, and the time to first egg was delayed in Group 3.

The rate of egg production for each of the test groups is illustrated in Text-fig. 1. Birds in Group 1 had the greatest rate of egg production, reaching a peak production of 30% at 8 weeks compared with 25.5, 3.9 and 0% for Groups 3, 5 and 7, respectively, and 46% in the controls.

![Text-fig. 1](image-url)
Table 1. The effects of different light intensities given for 6 weeks on the threshold for termination of photorefractoriness and the time to egg production in chukar partridge

<table>
<thead>
<tr>
<th>Group</th>
<th>Prelighting treatment</th>
<th>No. of birds</th>
<th>No. of hens producing eggs (%)</th>
<th>Mean ± s.e.m. no. of days to first egg</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Duration</td>
<td>Intensity (lux)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control</td>
<td>8L:16D</td>
<td>50</td>
<td>9</td>
<td>8 (88.8)</td>
</tr>
<tr>
<td>1</td>
<td>16L:8D</td>
<td>1</td>
<td>11</td>
<td>9 (81.8)</td>
</tr>
<tr>
<td>3</td>
<td>16L:8D</td>
<td>3</td>
<td>14</td>
<td>11 (78.6)</td>
</tr>
<tr>
<td>5</td>
<td>16L:8D</td>
<td>5</td>
<td>13</td>
<td>2 (15.4)</td>
</tr>
<tr>
<td>7</td>
<td>16L:8D</td>
<td>7</td>
<td>13</td>
<td>0 (0)</td>
</tr>
</tbody>
</table>

Values with different superscript letters indicate significant differences, $P < 0.05$ (Student's $t$ test).

Discussion

The termination of photorefractoriness in feral and laboratory birds requires an appropriate exposure to short daylengths (Wolfson, 1958; Hamner, 1968; Turek, 1972). However, it has also been demonstrated that photorefractoriness may be terminated by exposure to low light intensity without a change in daylength (Marsden & Lucas, 1963; Turek, 1975; Siopes & Wilson, 1978).

In the present study it was determined that 5 lux was the maximum allowable intensity level for terminating refractoriness as only 2 of 13 birds in this group became photosensitive and produced eggs (Table 1). Exposure to a higher light intensity (7 lux) did not terminate refractoriness and egg laying did not recommence. Turek (1975) reported that a light intensity of 6 lux would not terminate photorefractoriness in the golden-crowned sparrow. The termination of photorefractoriness in the chukar partridge was not an all-or-nothing response because exposure to less light intensity (3 and 1 lux) resulted in an increased number of photostimulated (egg-producing) birds.

The effectiveness of the prelighting treatment in terminating photorefractoriness was also shown by the rate at which the birds returned to egg production after photostimulation. Prelighting treatment with 1 lux intensity resulted in the first egg at a time similar to that of the controls but egg laying was delayed in birds exposed to 3 and 5 lux.

The time to first egg and the number of egg-laying birds were directly related to how effectively photorefractoriness had been terminated and were inversely related to the intensity of light exposure during the prelighting treatment. Periods of absolute darkness are clearly not essential to terminate photorefractoriness and recycle hens back into egg production. However, a certain threshold of light must not be exceeded.

The rate of egg production of chukar partridge is dependent on the termination of photorefractoriness and is proportional to the effectiveness of termination of the refractoriness, not an all-or-nothing response (Text-fig. 1). The lowest light intensity pretreatment (1 lux) resulted in the best rate of egg production of the experimental groups over the 8-week testing period, but this was not as high as that of the control birds pretreated with short daylengths. Marsden & Lucas (1963) reported that 0.1 lux prelighting treatment resulted in a rate of egg production comparable to that of birds exposed to short daylength prelighting. Turek (1975) suggested that 0.2 lux was the threshold for termination of photorefractoriness in the golden-crowned sparrow. It is likely that a light intensity less than 1 lux is needed to terminate refractoriness completely in the chukar partridge in order to obtain a normal rate of egg production.

We have reported previously that the threshold for photostimulation of egg production in chukar partridge was 2 lux (Siopes & Wilson, 1978). In the present study the threshold for
terminating photorefractoriness was found to be less than 1 lux. It is established that photorefractoriness is terminated by exposure to short daylengths (Wolfson, 1958; Hamner, 1968). However, it is not the short daylength per se that is required to terminate photorefractoriness but rather an absence of light from within the photosensitive phase of the circadian rhythm in photosensitivity (Turek, 1972). A decrease in light intensity below the threshold of the photoreceptors or a decrease in daylength are both methods by which photostimulation can be eliminated within the photosensitive phase and thus terminate photorefractoriness.

The observed termination of photorefractoriness by a decrease in light intensity without a change in daylength (16L:8D) most probably occurred as a result of the light stimulus falling below the threshold of photoreceptors mediating the photosexual response. In this event the bird would, in effect, be exposed to total darkness and therefore would effectively be changed from the photorefractory to the photosensitive state. Higher levels of light intensity (≥1 lux) resulted in variable degrees of the removal of refractoriness and at 7 lux the refractory condition remained unchanged. This variability in termination of photorefractoriness between 1 and 5 lux may be due to an actual variability in the photoreceptors or a difference in the transmittance of light to the receptors.

From a practical point of view, these data demonstrate that it is not necessary to have light-tight environmental houses or total darkness in order to recycle birds into a new egg production cycle.

References


Received 31 October 1980