Rapid Growth Phase of Ovum in the Guinea Fowl

Hiroshi OGAWA1), Takehito KUWAYAMA2) and Katuhide TANAKA2)

1) Fuji Zootechnical Station, Tokyo University of Agriculture,
Fujinomiya-shi 418-01
2) Department of Zootechnical Science, Tokyo University of
Agriculture, Tokyo 156

The length of rapid growth phase of ovum in the guinea fowl was estimated by the number of colored rings of the yolk of eggs obtained after daily feeding with Sudan Red 7B and Sudan Black B alternatively at a definite time of each day. The length of the rapid growth phase ranged from 7 to 11 days. It was 8–10 days in one third of the birds, and in about two thirds of which it was 9 days. The diameter of the yolk of boiled eggs was about 3 cm, and a little smaller in the yolk showing 7 or 8 rings than in that showing 9 or 10 rings. The daily increment of yolk mass, calculated on the basis of radius of the colored ring, was greater in the yolk showing a lesser number of rings. It increased from day to day, but showed a plateau during the last 3 days in the yolk of 8 or 9 rings, or during the last 4 days in the yolk of 10 or 11 rings.

(Key words : guinea fowl, ovum growth, yolk size, yolk increment

Introduction

Growth of ovum in the follicle of the ovary of birds is known to be consisting of slow and rapid growth phase (GILBERT, 1972 ; IMAI, 1993). The slow growth phase is a period from hatch to some days before the onset of egg-laying. During this period, ovum accumulates white yolk and the follicle enclosing the ovum enlarges a little. Shortly before the onset of egg-laying, the follicle starts to increase its size drastically by accumulating yellow yolk. The period from the start of the accumulation of yellow yolk to the expulsion of ovum from the follicle (ovulation) is called 'rapid growth phase' of the ovum or follicular growth. Since WARREN and CONRAD (1939) reported the length and aspects of the rapid growth phase in the chicken by counting the number of colored rings and measuring the radius of the rings in the yolk of boiled eggs obtained from hens receiving injections of a fat soluble dye, Sudan III at a 24-h interval, the length and aspects of the rapid growth phase have been reported by using similar methods not only on chickens (ZAKARIA et al., 1983, 1984) but also on turkeys (BACON and CHERMS, 1968 ; GRAU, 1976), quail (GRAU, 1976 ; BACON and KOONTZ, 1971) and geese (GRAU, 1976), but never on guinea fowls. The present study was performed to demonstrate the length of rapid growth phase and the daily increments of yolk mass during the rapid growth phase in the guinea fowl (Numida meleagris).

Materials and Methods

Fifteen female guinea fowls (18–20 month of age ; 2.30–3.38 kg BW ; Galor Strain

Received Feb. 13, 1996
obtained from Jafra Trading Co., Ltd., Ibaraki-ken) kept in individual cages under 14 h light (0800-2200 h) per day and laying 5-7 eggs in a sequence were used. The fat soluble dyes, Sudan Red 7 B and Sudan Black B (Merck Japan Ltd., Tokyo) were added (0.5 g/kg) to a commercial feed (mash for layer chickens; Nippon Formula Feed Mfg Co., Ltd., Yokohama). The Sudan Red 7 B added feed and the Sudan Black B added feed were given alternately once daily at 0900 h to 1000 h. After the feeding, the feed containing the Sudan was removed and the new feed not containing the Sudan was given in each day. Eggs were collected from two weeks later following the Sudan feeding for a period of 35 days. After eliminating the initial egg of the laying sequence, they were placed in boiling water for 20 min., and the coagulated yolk was cut through the center with a razor blade. Sections were color-photocopied (Acolor 635, Fuji Xerox Co., Ltd., Tokyo), and the number of colored rings was counted. The diameter of the rings was measured in mm along a slightly longer and a slightly shorter axis, and the average of two values thus obtained was regarded as the diameter of the yolk. When sections showed warped rings, they were eliminated from the measurements. Daily yolk increments were calculated on the basis of radius of colored rings regarding that the yolk is a complete sphere, and expresses as mm³.

**Results**

**Number of Colored Ring**

The number of colored ring ranged from 7 to 11 (Table 1). The number of birds having the yolk of 8-10 rings was more than that of the birds having the yolk of other number of the ring. In the eggs showing 8, 9 or 10 rings, about 65% of which was the eggs of 9 rings and about 94% was those of either 8 or 9 rings. In the eggs showing either 8 or 9 rings, either 9 or 10 rings, or either 10 or 11 rings, the percentage was greater in the eggs showing the less number of rings.

**Diameter of yolk**

Table 2 listed the average diameter of the yolk possessing different number of colored ring. The diameter of the yolk showing 7 or 8 rings was slightly but significantly (P<0.01) less than that of the yolk showing 9 or 10 rings. The diameters of the yolk showing more than 8 rings were not significantly different from each other.

**Daily increment of yolk mass**

The daily increment of yolk mass, obtained by calculation on the basis of radius regarding the yolk as a sphere, was greater in the yolk showing less number of the colored ring (Fig. 1). The slope of the curve appeared to be almost the same in the eggs having 7-10 rings. The slope in the eggs having 11 rings was not so steep as in the others.

**Discussion**

Days required for the rapid growth of ovum have been estimated in poultry by counting the number of colored rings of the yolk of egg laid by birds to which a fat-soluble Sudan dye is administered either by systemic injections or by feedings. The length of the rapid growth phase thus reported is 12 days (CONRAD and WARREN, 1937),
Fig. 1. Daily increments of yolk mass calculated on the basis of radius (mm) of the colored ring of the yolk in the guinea fowl.

The increment of Day 1 was calculated by \( \frac{4}{3} \pi (r_y^3 - r_0^3) \), Day \( n \) by \( \frac{4}{3} \pi (r_{n-1}^3 - r_n^3) \), and Day final by \( \frac{4}{3} \pi (r_o^3 - r_f^3) \) where \( r_y \) is the radius of the yolk, and \( r_o \) is the radius of the most outer ring. Each radius of the colored ring was determined from the inside border of colored zone.

Each symbol represents the mean (○: \( n=8 \), ●: \( n=33 \), □: \( n=127 \), ◇: \( n=33 \), △: \( n=12 \)). The vertical bars represent SEM, and when not shown SEM fall in the symbol. The different letters represent a significant difference between means by Duncan's new multiple range test (\( P<0.01 \)).

6.5–8.5 days (Zakaria et al., 1983) or 6–11 days (Imai, 1983) in the chicken, 10–12 days (Grau, 1976) or 12–15 days (Bacon and Cherms, 1968) in the turkey, 6.1 days (Bacon and Koontz, 1971) or 4–6 days (Grau, 1976) in the quail, and 12 days in the goose (Grau, 1976). In the guinea fowl, it was found to be 7–11 days in the present study (Table 1). There seems to exist a little difference in the length of the rapid growth phase among various species of poultry. However, exact comparisons may not be possible unless the birds have the same rate of egg-laying, because the length of the rapid growth phase is dependent on the rate of egg-laying (or ovulation) resulting from the ovarian follicular growth (Zakaria et al., 1984).

In the guinea fowl, eggs having different numbers of colored ring in the yolk were obtained from same bird (Table 1). In other words, the bird must be in laying an egg resulting from a different length of rapid growth phase. This may be interpreted as suggesting that more than one ovum enter the rapid growth phase, because the eggs examined were those of intra-sequence of an egg-laying sequence. This seems discrepant to the fact reported on the chicken that one ovum enters the rapid growth phase on each of several successive days (Imai, 1983), and therefore, needs further examinations on each of successive eggs of the egg-laying sequence in individual...
Table 1. Percent of eggs showing different numbers of colored ring (R) of the yolk in the guinea fowl

<table>
<thead>
<tr>
<th>No. of colored rings</th>
<th>No. of birds</th>
<th>No. of eggs</th>
<th>Percent of eggs</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>7R</td>
</tr>
<tr>
<td>7-9</td>
<td>1</td>
<td>19</td>
<td>31.6</td>
</tr>
<tr>
<td>7-10</td>
<td>2</td>
<td>39</td>
<td>5.5</td>
</tr>
<tr>
<td>8-9</td>
<td>2</td>
<td>43</td>
<td>—</td>
</tr>
<tr>
<td>8-10</td>
<td>5</td>
<td>96</td>
<td>—</td>
</tr>
<tr>
<td>8-11</td>
<td>1</td>
<td>5</td>
<td>—</td>
</tr>
<tr>
<td>9-10</td>
<td>1</td>
<td>15</td>
<td>—</td>
</tr>
<tr>
<td>9-11</td>
<td>1</td>
<td>16</td>
<td>—</td>
</tr>
<tr>
<td>10-11</td>
<td>1</td>
<td>16</td>
<td>—</td>
</tr>
</tbody>
</table>

Range 7-11 Total 15 263

Values represent the mean when more than one bird were employed.

Table 2. Diameter of yolk showing different numbers of colored ring in boiled eggs of the guinea fowl

<table>
<thead>
<tr>
<th>No. of colored rings</th>
<th>No. of yolk</th>
<th>Diameter (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>7</td>
<td>8</td>
<td>29.2±0.43 a</td>
</tr>
<tr>
<td>8</td>
<td>83</td>
<td>29.4±0.11 ab</td>
</tr>
<tr>
<td>9</td>
<td>127</td>
<td>30.1±0.10 c</td>
</tr>
<tr>
<td>10</td>
<td>33</td>
<td>30.3±0.17 c</td>
</tr>
<tr>
<td>11</td>
<td>12</td>
<td>29.8±0.34 bc</td>
</tr>
</tbody>
</table>

# Mean±SEM
## Means with a different letter are significantly different (P<0.01) by Duncan’s new multiple range test.

A statistically significant difference was found in the diameter of the yolk between the eggs showing 7 or 8 rings and those showing 9 or 10 rings (Table 2). This may suggest that the shorter the rapid growth phase is the smaller the yolk size is. However, because of that the difference is very minute, it might be appropriate to regard the data shown in Table 2 as only showing that the size of ovulated ovum (yolk) is about 3 cm in diameter in the guinea fowl.

Aspects of the rapid growth phase were found to be a little different among ova (yolks) having different numbers of colored ring as shown in Fig. 1. The difference may reflect a difference in the ability of the ovarian follicle to deposit yolk material into the ovum.

Acknowledgments

The authors wish to express their sincere appreciation to Prof. Dr. Kiyoshi IMAI and Dr. Yutaka SONODA, Nihon University, for their kind technical advice, and also to Ms. Sachiko MARUYAMA Ms. Mikako MIURA and Ms. Yukiko HARANO for their technical
This study was supported by Grant-in-Aid for Scientific Research (C) from Ministry of Education, Science and Culture (No. 06660345), and by Grant for General Project Research from the Tokyo University of Agriculture. This work was reported on XX World's Poultry Congress in India, September 1996 with the aid of the travel grant of Japan Poultry Science Association.

References


