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EFFECT OF EGG WEIGHT CATEGORIES, STORAGE TIME AND STORAGE TEMPERATURE ON INCUBATION LENGTH IN MUSCOVY DUCK EGGS (*Cairina moschata* L.)

By

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Abstract: The incubation length of Muscovy duck eggs was studied, according to a factorial experimental design, in relationship to storage time (3, 7 and 14 days), storage temperature (18±1°C and 15±1°C) and egg size (70.4g<>76.3g, 76.3g<>82-2g, 82.2g<>88.1g and 88.1g<>94.0g; average weight -2*std.dev., -1*std.dev., +1*std.dev., and +2*std.dev.). the experiment involved collection of 3396 eggs over a period of 2 days. Before storage the eggs laid were gathered, placed on metallic egg flats with their small ends down, washed and fumigated. During storage all eggs were daily turned and relative humidity was maintained at 70±5%.

Results showed that storage significantly prolonged the incubation time: at 18°C (near the physiological zero) the incubation time greatly differed between the different storage times (33.74, 34.18 and 34.60 days, for 3, 7 and 14 days of storage, respectively; $P<0.05$); at 15°C the average total incubation time differed only between 14 days and 3-7 days of storage (35.20 days *vs.* 33.91 and 34.00 days, $p<0.05$). The variation was described by the following linear (Hatch-time=33.48+0.097 storage; RSquare Adj 0.279) and polynomial (Hatch-time=33.38+0.099 storage + 0.004 (storage-8.713)^2; RSquare Adj 0.285) relationships. The size of the eggs influenced the incubation time but significant differences were observed only between the lighter eggs compared to all the other categories: 4 hours and 35' less than the reference category (76.3g-82-2g) in the incubation length; $p<0.05$.

Since optimum hatchability and duckling quality can only be achieved when chicks hatch contemporaneously, also in commercial duck hatcheries the "setting time correction" is needed to reduce the hatch spread of Muscovies. If the eggs are incubated once a week, the most widespread storage time, the correction for the storage length and at least for lighter eggs must be calculated so that fresh and stored eggs, and lighter than 76.3g eggs be set at different times.

Key words: Muscovy duck, egg storage, incubation length.

INTRODUCTION

Three factors influence the total incubation time of eggs. The first factor which affects incubation time is the age of the eggs. It is well documented that storing eggs reduces embryonic viability (hatchability of fertile eggs) and extends incubation (Decuypere et Michelis, 1992; Meijerhof, 1992; Proudfoot, 1969; Sauveur & De Reviers, 1988). Stored eggs take longer to incubate so that a "setting time correction" is commonly done in poultry (in broilers, for each day's storage beyond 2 days, one hour is added to the incubation time; Cobb 1991). Basal research indicates that during storage there is no discernible embryonic development and the embryo remains in a state of embryonic diapause when the eggs are held at temperatures below their physiological zero (19°-21°C). However, embryo development still occur during storage, although at a minimum rate. The stage of embryo development and the number of cells contained by the blastoderm determine viability and setting time (Lundy, 1969; Mayes et al., 1984; Meijerhof R., 1992Narushin & Romanof,2002). The number of cells contained by the blastoderm before incubation is affected by the length and temperature of the eggs in the storage period, since the environment in the storage room determine the rate of survival of the original cells and the rate of replacing with the new cells (Petitte, 1991). Therefore these facts contribute to the decline in viability as the storage period increases, the embryos need more time to restart their development and the embryo growth rate slows (Christensen, 2001). Finally longer periods of storage increases the spread of time over which hatching takes place and this may affect the total hatchabilty as well as the overall quality of chicks (Decuypere et al., 2001).

The second factor which affects the setting time is the size of the eggs. Larger eggs take longer to incubate. So that also for the size of the eggs a "setting time correction" is commonly done (in broilers, for each 2.5g above 50g, 30 minutes are commonly added to incubation time; Cobb, 1991). The setting time can also be influenced by time of the year, the number and type of other eggs in the setter and indeed, the type of setter used - single-stage, multi-stage rack or multi-stage trolley. Each of these may modify the "effective" incubation temperature, which is the third, and most important factor, which influence the total incubation time of the eggs.

The synchronisation of the embryos is of fundamental importance to obtain good hatches. In fact before pipping the humidity must be reduced, after pipping the humidity must be increased (to avoid the dry of the shell membranes) and after hatch the humidity must be again reduced (to dry the wet chicks). Of course, if the embryos are not synchronised, the humidity conditions in the setter cannot be optimal for every egg and an increase of embryo mortality is sured.

For these reasons we wanted to study the incubation length in Muscovy duck eggs, so that a specific setting time correction could be applied. In addition to time and egg size we wanted to test also the storage temperature, since different temperatures are commonly used for different storage times of Muscovy duck eggs.

MATERIALS AND METHODS

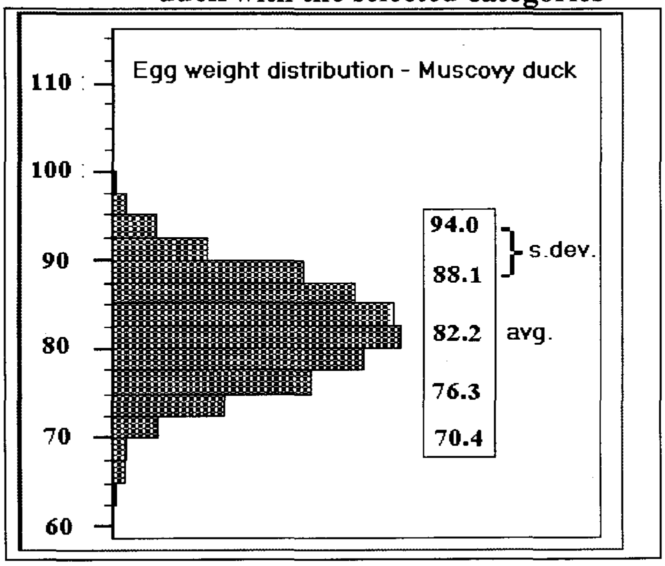
Stocks and Housing

Eggs were collected from an Italian strain of Muscovy duck. The birds were housed in pens with a room temperature of 20°C and a ratio of one drake to five ducks. Ducks were 55 wk of age during egg collection, photoperiod was 14h light:10 h dark with lights on at 07:00 h. Each deep litter rearing pen had 400 ducks and the eggs were laid on colony nests or on the litter. A typical layer diet containing 4.37% Ca, 0.69% P, 17% CP, and 11.24MJ/kg was *ad libitum* fed.

Experimental Design and Methodology of Storage and Incubation

The experiment involved collection of 3396 eggs over a period of 2 days. Each day the eggs laid were gathered, placed on metallic egg flats with their small ends down, washed and fumigated. The second day all eggs were transported to the hatchery for the storage and divided randomly into six experimental groups. The experimental groups were subjected to one of the three duration of storage: 3, 7, or 14 days. Half eggs were stored at a constant temperature of 18±1°C, the other half were stored at 15±1°C. All eggs were daily turned and relative humidity was maintained at 70±5%. The temperatures were chosen as it has been recommended that duck eggs be stored at 16-18°C for storage less than 7 days, and 11-15°C for storage longer than 7 days (Bagliacca et al. 1991, 1995; De Carville et al 1985, 1990; Sauveur & De Reviers, 1988). All eggs were weighed before storage. Incubation was carried out in an automatic incubator with hourly turning of ±60°. The eggs were daily sprayed from the 10th to the 30th days, according to the technology used for ducks eggs (Bagliacca et al. 1989, 1991; De Carville & De Croutte, 1985; Pingel et al. 1989; Sauveur & De Carville,). Candling was done at the 10th and the 30th day of incubation. Egg weight categories were decided after the incubation by calculating the distribution of the weight in the sample of fertile egg used for the experiment (avg. and standard deviations). Four categories were determined (see **figure 1**): average weight minus 2*std.dev., minus 1*std.dev., plus 1*std.dev., and plus 2*std.dev., see figure 1. For this reason 4.56% of the eggs were not used in the analysis since results reported for investigations into incubating eggs, whose weights are not within the average values are contradictory (Narushin & Romanov, 2002). At transfer each egg was put inside a gauze-bag and the incubator was checked every 4-6 hours starting from the 806th hour (33days and 14hours). The moment of hatch was estimated by the observation of the conditions of the hatched duckling compared with the former observation on the hatching egg.

Figure 1 - Egg weight distribution in Muscovy duck with the selected categories



Statistical Analysis

The data were analysed using least squares analysis (SAS, 2002). Source of variation were days of storage (3, 7 or 14 days), storage temperature (15°C or 18°C) interaction storage-time* storage-temperature and egg weight categories (70.4≤eggs<76.3, 76.3≤eggs<82.2, 82.2≤ eggs <88.1 and 88.1≤ eggs <94.0).

RESULTS AND DISCUSSION

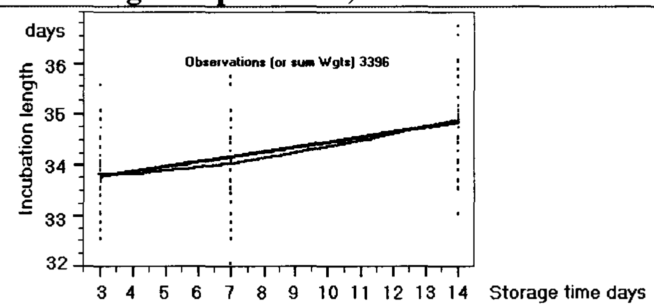
Storage significantly prolonged the incubation time (see table **1**) and the increase of length was different at different temperatures. When the eggs are stored at 18°C (around the physiological zero) the incubation time greatly differs between the different storage times (33.74, 34.18 and 34.60 days, for 3, 7 and 14 days of storage, respectively; $P<0.05$). When the eggs are stored at 15°C, the average total incubation time differs only between 14 days and 3-7 days of storage (35.20 days *vs.* 33.91 and 34.00 days; $p<0.05$). Interesting to note also the overall effect of the temperature. The lower storage temperature induces a longer incubation time (34,37 *vs.* 34.18). The longer incubation time observed in the eggs stored at 15°C than that observed in the eggs stored at 18°C, cannot be explained only by the longer time the former need to reach the incubator temperature (37.61°C). The dormiency of the embryo (the development of the embryo is arrested during cool storage) seem to became "deeper" with lower temperatures so that a delay in the initiation of development following storage or a slower growth rate, probably related to a shrinkage of the blastoderm, might explain the observed prolonged incubation time. Regarding the general effect of the storage time (independently to the particular temperature), significant differences can be observed for each category of storage (33.83, 34.09 and 34.90 days, for 3, 7 and 14 days of storage, respectively; $P<0.05$). The phenomenon can be explained either by a linear or polinomial regression (see **figure 2**) so that the incubation times for every storage length between 3 and 14 days can be easily estimated.

Table (1): Muscovy duck incubation length, response in relationship to temperature*storage-length, least squares means table.

Interaction: Temperature *		Storage Length 3 days	7 days	14 days	Main Effect Temperature
	Number	405	395	250	1050
15°C	Least Sq.Mean days	33.91 **d**	34.00 **d**	35.20 **a**	34.37 **a**
	Std Error	0.050	0.051	0.064	0.032
	Number	442	362	267	1071
18°C	Least Sq.Mean days	33.74 **c**	34.18 **e**	34.60 **b**	34.18 **b**
	Std Error	0.048	0.053	0.062	0.031
Main	Number	847	757	517	2121
Effect	Least Sq.Mean days	33.83 **c**	34.09 **b**	34.90 **a**	34.18
Storage	Std Error	0.035	0.037	0.045	0.022

Note: means with different letters differ per $P<0.05$.

Figure 2: Relationship between incubation length and storage time (overall effect on storage temperatures).



Fit	equations	Std Errors	
Polynomial Fit Degree = 2 RSquare Adj 0,284596	Hatch-time = 33,38 + 0,0989 storage + 0,0043 (storage-8,7132)^2	Intercept Storage (storage-8,7132)^2	0,059 0,00539 0,00171
Linear Fit Degree = 1 RSquare Adj 0,279171	Hatch-time = 33,48 + 0,0973 storage	Intercept storage	0,044 0,00537

The size of the eggs influenced the incubation time but significant differences were observed only between the lighter eggs compared to all the others ($p<0.05$). Within the central categories (egg weight ± 1*std. dev. = 68,37% of the eggs), the eggs of the category 76,3g<>82.2g did not differed from the eggs of the category 82.2g<>88.1g in the total incubation time and the least square means of the former was greater than the latter (the general phenomenon where larger eggs take longer to incubate was not observed within these categories). Also the eggs of the heaviest tested category required to hatch only 0.07 days (1h and 28') more of the reference category (76.3<>82-2g), with no statistically significant difference.

Table (2): Muscovy duck incubation length: response in relationship to egg weight categories, least squares means table.

Egg weight categories:	70.4≤ <76.3	76.3≤ <82.2	82.2≤ <88.1	88.1≤ <94.0
Number	315	797	697	312
Least Sq. Mean	34.02 **b**	34.21 **a**	34.16 **ab**	34.28 **a**
Std Error	0.070	0.044	0.047	0.070

Note: means with different letters differ per $P<0.05$.

The corrections which must be done at incubation-start to obtain the contemporaneous hatch of Muscovy duck eggs are summarised in **table 3**. For storage temperature of 15°C or 18°C, the specific values found in the experiment can be adopted, while, for different storage temperature, the overall effect of storage temperature is the best estimation of the correction. Regarding the egg weight the only significant correction which must be done is the correction for the lighter eggs. (contrast of the category 70.4<>76.3 *vs.* all the others statistically significant for $p<0.05$).

Table (3): Corrections which must be done at incubation-start to obtain the contemporaneous hatch of Muscovy duck eggs (Zero represents the reference category, anticipated times are represented by "minus" and delayed times are represented by "plus").

Storage temperature	**15°C**	**18°C**
Effect Temperature	**+4h:43'***	0

Storage length	**3 days**	**7 days**	**14 days**
Effect storage time at **15°C**	0	+2h:08' ns	**+30h:48'***
Effect storage time at **18°C**	0	**+10h:42'***	**+20h:45'***
Overall effect of storage temperature	0	**+6h:24'***	**+25h:46'***

Egg weight categories	**70.4≤eggs<76.3**	**76.3≤eggs<82.2**	**82.2≤eggs<88.1**	**88.1≤eggs<94.0**
effect egg weight	**-4h:35'***	0	-1h:12' ns	1h:28' ns

*correction statistically significant; ns Correction not statistically significant.

Conclusions:-

The total incubation time of Muscovy duck eggs is strongly influenced by the storage length. On the contrary, in Muscovy duck, the egg size seem to show a reduced effect on the total incubation time. Since optimum hatchability and duckling quality can only be achieved when chicks hatch contemporaneously, also in commercial duck hatcheries, the "setting time correction" is required to reduce the hatch spread.

If the eggs are incubated once a week, the most widespread storage time, the correction for the storage length and at least for lighter eggs must be calculated so that fresh and stored eggs, and lighter than 76 g eggs be set at different times.

Table (4): Bivariate Fit Of Setting Time By Storage.

Fit	equations	Std Errors	
Polynomial Fit Degree = 2 RSquare Adj 0.284596	Hatch-time = 33.38 + 0.0989 storage + 0.0043 (storage-8.7132)^2	Intercept Storage (storage-8.7132)^2	0.059 0.00539 0.00171
Linear Fit Degree = 1 RSquare Adj 0.279171	Hatch-time = 33.48 + 0.0973 storage	Intercept storage	0.044 0.00537

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ABSTRACTS

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