ANALYSIS OF FERTILITY IN BROILER BREEDER FLOCKS – MALE SIDE APPROACHES

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Summary

The rapid fertility decline is a worldwide problem in broiler breeder production. The aim of the present study was to clarify the role of male ratio and age on the fertility of broiler breeders in the second half of the reproduction cycle. The effect of various mating strategies in 7 small flocks of ROSS 308 broiler breeder was analyzed by weekly monitoring of GD IPVL holes in freshly laid eggs in comparison with the results of candling and of the determination of true fertility.
80 females and 8 males/experimental flocks were used in the study. The keeping circumstances followed the management manual. In the flocks various sexual ratios (decreasing, increasing or unchanged number of males), spiking techniques (50-100 % replacements of the cockerels at the age of 44 weeks) and exchange of the cockerels between two groups were tested.
All the fertility level according to the candling (from the average of 95.1% to 90.4 %), the number of holes and the number of hatched chicks decreased significantly in each flock in the second half of the cycle independently from the number and/or age of males. Flock with 100 % spiking had significantly (P<0.05) more holes compared to 50 % spiking flock and flock with males with *unchanged* number in the second half of the cycle, but did not differ significantly from flocks with *increasing* or even with *decreasing* male number (control). Interestingly, the “true” fertility was higher in both flocks with young cockerels compared to the flocks with old ones with the same median values.
Neither the increasing or maintaining of the number of males nor the spiking or exchanging of males could not maintain the earlier level of IPVL holes in the second half of the cycle, which indicates definitive role of the female genital tract in the fertility decline process.

Keywords: broiler breeder, sperm transport, IPVL holes, spiking, mating efficiency

Introduction

The fast growth of human population demands more and more feed, thus animal protein worldwide. In the poultry industry the broiler production plays major role (87 %), which means 25 % of the total meet production in the world *(Brillard, 2001)*. The basic condition of the successful production is the best quality with the lowest costs.
In the last decades the fertility of broiler breeder flocks has been decreasing in such a degree which threatens the economical production - particularly in older flocks - kept according to the recommended management manual *(Essősy and Török 2004.* personal communication). The fertility decline is a worldwide problem (*McDaniel, 1986; Creel et al. 1990; Walsh and Brake, 1997)*. The main reason of the reduced fertility is the intensive selection for body weight, which results in the decline of reproductive traits *(Reddy and Sadjadi, 1990.)* Other suspected reason for this is generally considered to be due to a reduction of physical condition

of the males with a resultant decline in mating activity. This is, however, so far unsubstantiated *(Wishart et al., 2004).*

In order to avoid the rapid decrease of fertility in the second half of the production cycle different spiking techniques are used in the practice with more or less results. According to earlier studies 17 or even 50 % exchange of old cockerels for young ones could not improved significantly the fertility level in field condition *(Végi et al., 2006).*

The fertility of eggs above the environmental and rearing conditions is determined by the mating efficiency, that is, quality and quantity of sperm and the libido of the cockerels on the male side, and the sperm storage ability on the female side.

The sperm storage capacity of fowls depends not only on the genetic background but also on the age of the hens, that is, their stage in the reproduction cycle *(Bakst et al., 1994).* It is proved that the emptying of the spermatozoa from the SSTs gets faster after the peak production *(Brillard, 1993),* therefore it seems that for maintaining the fertility level more and more spermatozoa are needed from the middle of the reproduction period. Controversially, - according to the recommended management manual - in the second half of the cycle the number of males has to decrease due to various considerations, such as decreasing of competitions for females, sparing of females, and/or forcing the males to move more frequently *(Ross Breeders Limited, Newbridge, 1998).*

The aim of the present study was to clarify the role of males in fertility decline in broiler breeder flocks in the second half of the reproduction cycle.

Materials and methods

Animals

At the age of 26 weeks each flock of 80 females and 8 males of Ross 308 breeders was put in separated floor pens in the poultry house of the Research Institute for Animal Breeding and Nutrition, in Gödöllő. The birds were kept and fed according to the standards for broiler breeder parents stocks. The various experimental groups originated from the same parent stock reared in the same circumstances in a Hungarian poultry farm.

Experimental arrangements

The treatments with the various experimental groups and the time table see in ***Table 1.***

Sperm Penetration assay

The most practical and efficient method for analysis of the fertility of unincubated eggs is the counting of holes of inner perivitellin layer around the germinal disc (GD IPVL) produced by penetrating spermatozoa, namely the sperm penetration assay *(Wishart, 1999).*

Samples of approximately 30 eggs were collected from each flock weekly, from the age of 26 to the age of 60 weeks. Eggs were stored at 16 ºC for up to 1 week before assessment.

Eggs were cracked open and the separated yolk was placed into 1 % NaCl solution. Prior the membrane preparation the fertility was assessed by visual examination of the germinal disc at the animal pole of the egg *(Kosin, 1945*). The 1.5 x 1.5 cm piece of perivitellin layer from over the germinal disc was cut out and washed in 1 % NaCl. The yolk free piece of membrane was spread on a microscope slide. The IPVL-holes were viewed with the x4 objective using dark ground optics and the total of IPVL-holes from over the germinal disc was counted manually *(Wishart et al., 2004).* Since the data of holes do not show equal distribution the median values of holes' numbers were used for the statistical analysis.

Other fertility determinations

Flock fertility - the proportion of all eggs laid by each flock - was estimated by candling. Breakout of all 'clears' was done as well. For determination of 'true' fertility additional propidium iodide staining was used in 'clear' eggs according to the method of *Liptói et al. (2004).*

Statistical analyses

Data were analyzed by *Mann-Whitney test* and regression analysis.

Results and discussion

In all flocks the highest sperm transport was found between 32 and 38 weeks of age then it decreased continuously to the end of the examined period (61 weeks of age). The fertility and the 'true' fertility data followed the trends of the medians of GD IPVL holes.
In control flock (no spiking, decrease in male number from 8 to5 ♂) the median values of the number of holes decreased to the half of the highest values (30-40 holes) to the end of the cycle with slight fluctuations, while the true fertility decreased from 98 % to around 90 %, which indicates the reduction of the mating efficiency *(Figure 1).* This flock was kept according to the official technological recommendation of ROSS Breeders Company and served as the basis of comparisons among the flocks. Since the fertility data from candling results are always less than the true fertility, these results from the 50 weeks relate to the passive balance of production.

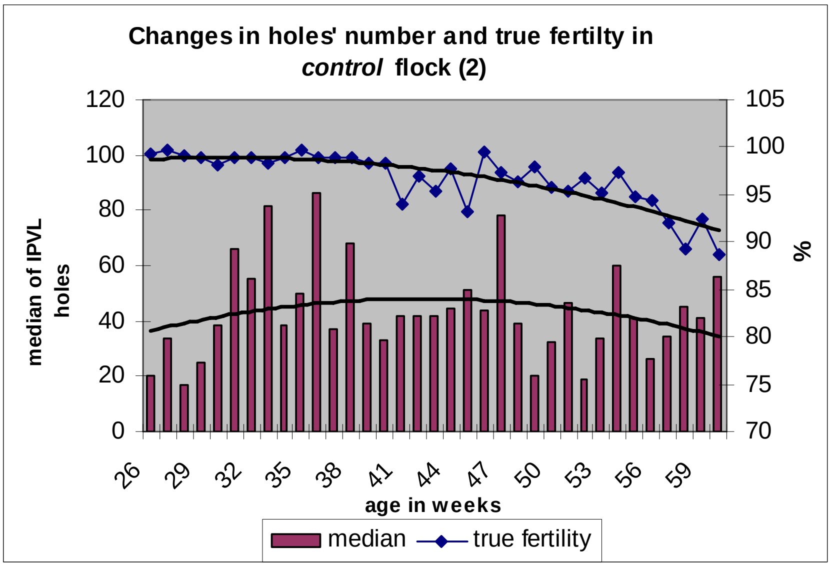

Figure 1
Age related changes in median IPVL holes and 'true' fertility from samples of 30 eggs taken weekly from control flock (2)

In flock 1, where all the old cockerels (44 weeks of age) were replaced to young ones (27 weeks of age) the number of holes and fertility rate also decreased but in less degree *(Figure 2).* There were significantly more holes (P<0.05) in this flock after spiking compared to the flock with 50% spiking and to the flock with *unchanged* male number (7) (not shown), however, considerably, that compared to the other flocks, such as control group, there were no significant differences. In two weeks after spiking the fertility rate began to increase again with higher fluctuations but it could not reach the level of the first half of the cycle and could not excel the values of control flock.

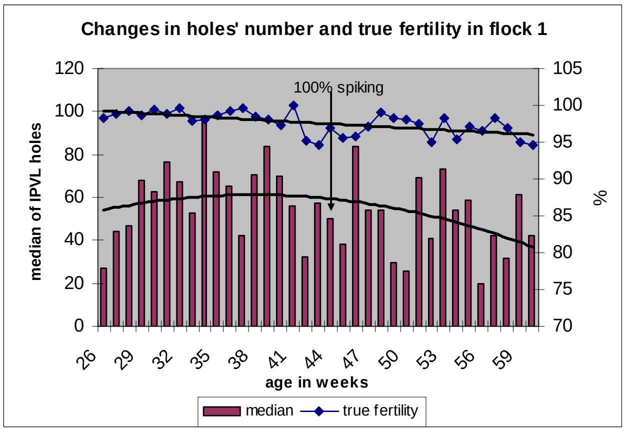

Figure 2
Age related changes in median IPVL holes and 'true' fertility from samples of 30 eggs taken weekly from flock 1

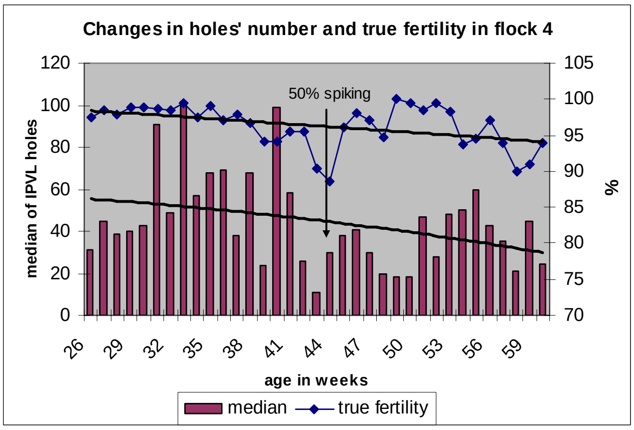

Figure 3
Age related changes in median IPVL holes and 'true' fertility from samples of 30 eggs taken weekly from flock 4

After two weeks of exchange of the half of the cockerels for young ones in flock 4 (50% spiking) the number of holes could increase slightly but only two months later could reach a higher level *(Figure 3)* which was enough for inducing slight but not significant improvement in true fertility.

Statistical analysis of the data showed that the *true* fertility in flocks with young cockerels (1, 4) was higher than those of old flocks *with the same holes' number*, which may suggest that the fertilizing ability of spermatozoa of young males can be better than that of old ones. It seems, that the spermatozoa of old males - after penetration - little able to fuse with the nucleus of ovum. Since the hatching data of these flocks were not better than that of flocks with old males, it means practically that the number of 'clear' eggs was lower here.

In flock 5 the number of cockerels was increased by one male monthly until 49 weeks of age to a final sexual ratio of 80 ♀ **:** 13 ♂. In spite of the narrowed sexual ratio the sperm transport that is the fertility could not increase *(Figure 4)* similarly to the flock 7 where number of males was maintained at the same level (80 ♀ **:** 8 ♂) during the whole cycle (not shown).

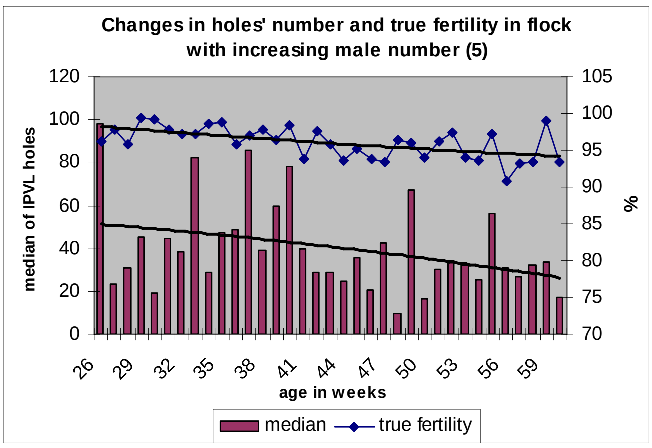

Figure 4.
Age related changes in median IPVL holes and 'true' fertility from samples of 30 eggs taken weekly from flock 5

According to the data of flocks 3 and 6 the complete exchange of the cockerels between the groups could not increased the sperm transport that is mating efficiency (not shown), which suggests that the mating activity of cockerels could not be forced by the new females. After exchange neither the holes numbers nor the fertility showed significant differences compared to the control (and other) flock data.

Conclusions

From the results of the continuous examination of 7 flocks during the whole reproduction cycle can be drown several conclusions. The results indicate that considering the recommended technology (widening the sexual ratio during the production period) nor the narrowing (increasing the number of males) or the maintenance of male/female ratio and the expensive and labour intensive spiking technique used in the broiler breeder's practice could not increase significantly the mating efficiency, that is could not maintain the earlier level of IPVL holes in the second half of the cycle. Even the 100 % spiking could not increase the fertility rate significantly, though due to the very high cost of such a spiking technique is generally not used in the practice. The present study justified again that even in these days wide-spread used practice of spiking is absolutely useless *(Bramwell et al., 1996; Végi et al., 2006).*

To solve the problem the exchange of cockerels between flocks is not suitable either. All the results indicate a definitive role of the female genital tract in the fertility decline process. The precise analysis of mating efficiency in the various mating strategies reported here support the presumptions of some earlier studies whereas for the shortened persistency of fertility in broiler breeder - above the genetic, rearing and other managements' reasons - rather the females than the males are responsible *(Pierson et al., 1988; Fasenko et al., 1992; Brillard, 1993; Bramwell et al., 1996; Gumulka, and Kapkowska, 2005; Végi et al., 2006).*

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Table 1

Experimental flocks		1	2	3	4	5	6	7
Treatments		**100 %** spiking	**control** (managemen t manual)	Complete exchange of cockerels	**50 %** spiking	**Increasing** of male number	Complete exchange of cockerels	**Maintaining** of male number
Sexual ratio at the age of 26 weeks		80 ♀ + 8 ♂						
Changes in sexual ratios	36 weeks of age	- 1 ♂	- 1♂	- 1♂	- 1♂	+ 1 ♂	- 1 ♂	-
	40 weeks of age	- 1 ♂	- 1♂	- 1♂	- 1♂	+ 1 ♂	- 1 ♂	-
	44 weeks of age	- 1 ♂	- 1♂	- 1♂	- 1♂	+ 1 ♂	- 1 ♂	-
	49 weeks of age	-	-	-	-	+ 1 ♂	-	-
Spiking (exchange of old cockerels for young ones)	44 weeks of age	100 %			50 %			
Exchange of cockerels	44 weeks of age			x			x	
Final sexual ratio at the age of 49 weeks		*80 ♀ + 5 ♂*	*80 ♀ + 5 ♂*	*80 ♀ + 5 ♂*	*80 ♀ + 5 ♂*	*80 ♀ + 13 ♂*	*80 ♀ + 5 ♂*	*80 ♀ + 8 ♂*