# RESULTS OF THE INRA RESEARCH CONCERNING DURATION OF FERTILITY OF THE COMMON DUCK *(Anas platyrhynchos)*

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## ABSTRACT

This article reviews two INRA programs devoted to the study of duration of fertility (DF) of the common duck: 1. An inter disciplinary program (1996-2001) aimed at studying the effect of the breeding system (female ducks inseminated with semen from either common or Muscovy drakes) and of the duck's age on the mean and genetic variability of several criteria of DF; 2. A five generation selection experiment (1998-2003) for the number of live mule embryos at candling with 1 insemination per week. A generalist QTL detection program (2005-2008) on a variety of mule duck traits, including DF of the common duck dam, is currently underway.

**KEY-WORDS**: Common duck, Duration of fertility, Genetics, Muscovy duck, Selection.

## INTRODUCTION

Mule ducklings come from the inter generic crossing between Muscovy drakes and common duck females. Mule ducks are of particular importance in France as well as in Taiwan. In 2005, the mule duck provided more than 90% of the fatty liver produced in France. Mule ducks (both sexes) are the main meat ducks in Taiwan. Application of artificial insemination (AI) has improved the efficiency of mule ducklings production (Tai, 1985). Female birds show the particularity to store the inseminated spermatozoa, allowing the ova fertilisation during several days after insemination, that is to say a certain duration of fertility (DF). In mule ducklings production, DF is short, resulting in the need for two AI per week. Increasing DF would allow reducing the insemination frequency. Many research efforts were devoted to DF, in Taiwan and as well as in France, bearing at first the effort on the female component. Some were performed in cooperation. The objective of this paper is to review the INRA programs.

## INTER DISCIPLINARY PROGRAM

This program conducted at the "Unité Expérimentale sur les Palmipèdes à foie gras" (UEPFG) in Artiguères (South West of France) between 1996 and 2001, involved physiologists and geneticists. At the beginning of the program, fertility of the common duck for mule duck production was poorly known. The low average value of fertility with two AI per week (0.70) could include fertilization problems as well as embryo mortality, which was supposed to be higher in an inter generic hybrid such as the mule duck. The purpose of the program was thus to compare fertilization and embryo mortality following AI of common

duck females with semen from either common or Muscovy drakes, i.e. either in pure breeding (PB) or in crossbreeding (CB), respectively. In order to assess the effect of the age of the dam on the mean and variability of DF traits, measurements were repeated at three ages of the duck (30, 40 and 50 wks). The experimental strain INRA44 was used. Three criteria of DF have been studied: the maximum duration of fertility (DM, i.e. the time lag between insemination and the last fertile egg (Lake, 1975), the number of fertilized eggs (F) and of hatched ducklings (H) following a single AI. Inseminations were performed with a pistol, after cloacae reversion, with 150-200 millions spermatozoa of pooled semen.

Over 11 fertile days following AI, fertility rate was 61.1% in PB and 42.8% in CB. DM was higher in PB (8.1 d vs. 6.4 d in CB). The corresponding values for F were 5.87 vs. 4.15 and for H, 4.79 vs. 3.47, respectively. In a complementary experiment, we demonstrated that the number of perivitelline spermatozoa was markedly lower in mule eggs compared to common eggs, a strong indication that initial sperm selection occurring in the lower oviduct is probably more intense after crossbred compared to purebred insemination (Sellier *et al*., 2005).

The age of the dam influenced DM, particularly in PB, with a longer duration at 40 wks compared to 50. On average, apparent early embryonic mortality (EEM), assessed by candling was 2.5% of the fertile eggs and did not differ between breeding systems. Observations performed by stereomicroscopy on apparently clear eggs indicated increased levels of EEM in mule embryos corresponding to Stages II-IV of the Eyal-Giladi and Kochav classification. An increase in EEM was observed in eggs from 50 wks old ducks in both Breeding systems. Both ova fertilization and very early embryo mortality explain the difference on apparent fertility rates between PB and CB, fertilisation being by far the more important factor.

Middle embryo mortality (MEM), assessed by a 2$^{nd}$ candling, on Day 25 in PB or 28 in CB was 5% of the D-6 surviving embryos. MEM was significantly higher in CB (6.3%) than in PB (3.9%). An increase in MEM was observed with the ageing of the common duck female and was particularly marked in CB. The increase of MEM with sperm storage duration was restricted to the eldest females. The mortality rate at hatching was 11.5% of the hatched eggs, and did not differ between breeding systems.

The phenotypic correlations between DM, F and H were similar in both breeding systems: r(DM,F)=0.74; r(F,H)=0.83 and r(DM,H)=0.58. They were similar at the 3 ages considered, except for r(DM,H) which was lower at the age of 50 weeks (0.50 vs. 0.60 at both other ages), due to higher embryonic mortality in eggs from the eldest ducks. The genetic correlations between the expressions of the same trait at different ages of the duck were generally high (> 0.80). The lowest values concerned Hc ranging between 0.60 and 0.70. The genetic correlations between traits were high and similar in both breeding systems. (For example, rg(DM, H) = 0.92 in PB and 0.96 in CB.) The correlations due to permanent environmental effects were lower.

The heritabilities of DF traits were higher in PB. Estimates for DM were 0.27 and 0.16 in PB and CB, respectively. The latter was lower than those estimated in CB by Poivey et al. (2001) in two lines of the Taiwanese breed ‘Brown Tsaiya’ (0.20 and 0.28). The heritabilities for F were 0.25 and 0.23 in PB and CB, respectively; those for H, 0.17 and 0.13, respectively. The permanent environmental effects had little contribution to the total variance of DMp (4%). The contribution was higher for the other traits studied, of which DMc, amounting to 14-17%. The purebred-crossbred genetic correlations were high: 0.85 between DMp and DMc, 0.79 between Fp and Fc and 0.88 between Hp and Hc. This means that most genes influencing

duration of the fertile period in PB also control this trait in inter generic CB. An anatomical or histological basis such as the number, or the size, of utero-vaginal tubules might explain these high correlations. To sum up, the pattern of the genetic variability of DF traits was rather similar in PB and in CB. However, DMp was the most heritable trait. Its high genetic correlation with the number of hatched mule ducklings (rg=0.68) makes it a selection criterion worth being considered.

## SELECTION EXPERIMENT

Between 1998 and 2003, a selection experiment on a criterion of DF was performed at the UEFPG. One of the purposes was to get complementary results from the first selection experiment for DF in the Brown Tsaiya duck which was going on in other conditions in a cooperative research program (Cheng *et al.*, 2002, 2005). Its principle was to select within the desired insemination rhythm of 1 AI per week. It aimed at experiencing a selection method potentially useful in the breeding practice, avoiding the drawback of long unproductive times occurring when selection is based on maximum duration of fertility. It also aimed at validating the genetic correlations estimated in the previous experiment by the measure of realised correlated responses. The 3rd objective was to evaluate the genetic relationships between duration of fertility and a number of economically important traits of the mule duck, such as force-feeding performances.

The selection criterion was the number of live mule embryos (on the 1$^{st}$ candling), within a sequence of 10 to 11 inseminations performed at a weekly interval, and located at the beginning of the laying cycle. This experiment involved a selected line (110 females and 33 males) and a control line (44 females and 33 males), a generation interval of 1 year, a selection rate of the female of 30%. Five selection generations were performed. The selection experiment has not been fully analysed yet. At the end of the selection experiment, in 2004-2005, an additional generation was performed in order to evaluate various correlated responses (in PB, in the late laying cycle, in other AI rhythms, etc…) and yielded the following results (Brun *et al*., 2006).

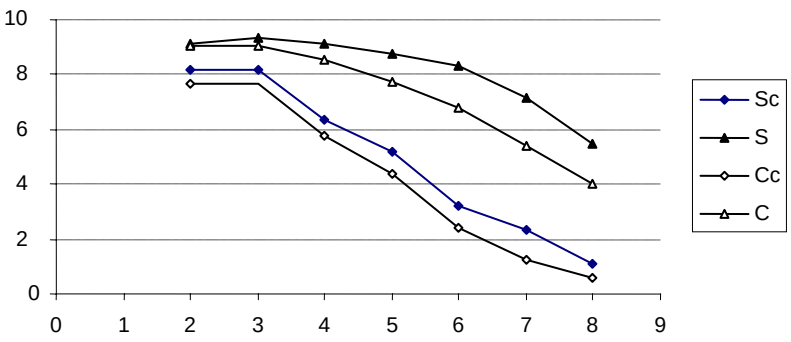


Figure 1. Egg fertilisation after AI in the selected (S) or control (C) strain with pure or cross breeding inseminations. (indice p or c)

Correlated responses were observed on laying performances, with more eggs laid in the selected strain (partly due to earlier laying), but lighter eggs. Positive correlated responses were observed on DF criteria measured in PB (Figure 1) in agreement with the high genetic

correlations estimated in the previous experiment. Again, the genetic improvement obtained in the early laying cycle was reproduced at higher ages of the ducks, in agreement with the high genetic correlations between DF performances expressed at different ages. At last, a correlated response was observed on the proportion of inseminations with no fertilised eggs at all, indicating that this trait is not genetically independent from the DF traits estimated on fruitful AI.

## PERSPECTS

Genetic markers, such as microsatellite markers, have been recently developed in the common duck (Marie-Etancelin et al, this symposium), constituting landmarks in the genome. The study of the association between markers and performance enables to locate the chromosomal regions involved in the variability of quantitative traits (QTL). A program currently underway aims at detecting QTL in Common duck strains for a number of economically important traits including reproduction traits of the common duck. The experimental design relies on the constitution of Common duck informative families. The principle is to use sires as much heterozygote as possible throughout the genome, especially for the markers and to perform measurements for the largest possible number of offspring for each sire. We chose to maximise the heterozygosity of the sires by crossing genetically different strains. The design is a backcross between the experimental lines INRA444 line, selected for DF and the heavy synthetic line INRA37. It involves about 400 dams distributed among 7 F1 sires families. Concerning the measurements of DF, we could limit to the study in pure breeding due to its higher heritability. Nevertheless, the measurements will consist in three measures of DM at the beginning of the cycle in CB, 3 measures in PB, then again 3 measures in CB at the end of the cycle.

The sire lineage of the mule duck, the Muscovy duck, is likely to contribute to duration of fertility through quantitative and qualitative components of semen production. Further improvement of DF may come from the study and the utilization of the between- and within strain genetic differences as well as the effect of crossbreeding on this sire component.

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