

QUANTITATIVE TRAIT LOCUS (QTL) DETECTION FOR DURATION OF FERTILITY IN COMMON DUCK (*ANAS PLATYRHYNCHOS*) BRED FOR MULE DUCKS

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ABSTRACT

The selection experiment of Brown Tsaiya duck for increasing the duration of fertility showed that this selection was possible. Thereafter, a F₂ experimental design for a QTL analysis program was established with purpose of QTL detection for the duration of fertility in the Common duck bred for mule duck. In the F₀, two very different lines, the selected Brown Tsaiya line and the Ilan Pekin L-201 line were crossbred. The F₂ female duck progeny of six F₁ sires and according to the schedule of 36 F₁ dams, which were got in 4 hatches, were tested for duration of fertility at 26, 29 and 32 weeks of age. The amplified fragment length polymorphism (AFLP) technique was used for QTL studies on the reproduction of ducks. Eighteen *Taq/EcoR* primer combinations were employed for linkage analysis. Results showed that 465 peaks were generated in the AFLP fingerprints and 260 AFLP markers were dispersed in 32 linkage groups. The linkage groups covered 1,766 cM with an average interval distance of 6.79 cM. Preliminary statistical analysis of the phenotypic data of the F₂ female ducks showed favourable Pekin grand maternal effect for the duration of fertility traits. These results could provide the important information for genetic improvement in duck breeding.

KEY WORDS: Common duck, DNA fingerprint, Duration of fertility, Quantitative trait locus.

INTRODUCTION

The selection experiment of Brown Tsaiya duck for increasing the duration of fertility showed that this selection was possible (Cheng *et al.*, 2002, 2005). Consequently, it appeared useful to investigate genes with important effects on this trait in the selected Brown Tsaiya line. DNA markers are used to detect chromosomal regions with genes having an effect on

quantitative traits (QTL). The QTL detection are identified by their co-segregation with DNA markers and experimental schedules on the animals are necessary. The project was built in cooperation between Livestock Research Institute, the Department of Animal Science in National Chungshing University and INRA. The establishment of DNA markers linkage groups was a prerequisite for QTL detection and mapping. The main advantage of the AFLP markers, in the species where the microsataellite markers were not yet available, was the speed at which a map can be constructed when the technique is mastered. One of the drawbacks is that they should be dominant markers and they need special technique to be scored as co-dominant markers (Vignal, 1999). The AFLP markers were developed on the ducks of an F2 design for QTL detection. A first linkage map of AFLP markers is currently studied.

MATERIALS AND METHODS

An F2 design was followed with 6 families, crossing in the F0 two genetically different lines, in order to get F1 sires which are expected to be heterozygote for the QTL and for the markers. The Brown Tsaiya selected line of the 10th generation of the selection experiment on the duration of fertility and the I-Lan Pekin L-201 which is one parent of Kaiya duck were chosen to give the F0 breeding animals. In the F0, 3 Brown Tsaiya drakes from the G10 of selected line for duration of fertility were crossbred each one with 2 Pekin female duck of I-Lan Pekin L-201. Three I-Lan Pekin L-201 were crossbred each one with 2 Brown Tsaiya female ducks from the G10 of selected line for duration of fertility. For the mating F1×F1 three drakes F1 from sire Brown Tsaiya and dam Pekin were crossbred each one with six unrelated female ducks progeny of sire Brown Tsaiya and dam Pekin. Three drakes F1 from sire I-Lan Pekin L-201 and dam Brown Tsaiya were crossbred with unrelated female ducks progeny of sire I-Lan Pekin L-201 and dam Brown Tsaiya (Figure 1). The F2 female duck progeny of these mating, which were got in 4 hatches, were tested for duration of fertility. The F2 female ducks were artificially inseminated with 0.05 mL of pooled Muscovy semen at 26, 29 and 32 weeks of age. The eggs laid were collected in day 2-15 after AI and set. The number of eggs set, of fertile eggs, of dead embryos, of alive hatched mule ducklings, the maximum duration of fertility, were individually measured and registered. The Brown Tsaiya selected line of the 10th generation (G10) of the selection experiment on the duration of fertility and the ILan Pekin L 201 which is one parent of Kaiya duck were chosen to give the F0 breeding animals. In the F0, 3 Brown Tsaiya drakes from the G10 of selected line for duration of fertility were crossbred each one with 2 Pekin female duck of ILan Pekin L-201; Three Pekin drakes I-Lan L-201 were crossbred each one with 2 Brown Tsaiya female ducks from the G10 of selected line for duration of fertility. For the mating F1×F1 three drakes F1 from sire Brown Tsaiya and dam Pekin were crossbred each one with five unrelated female ducks progeny of sire Brown Tsaiya and dam Pekin; Three drakes F1 from sire I-Lan Pekin L-201 and dam Brown Tsaiya were crossbred with unrelated female ducks progeny of sire I-Lan Pekin L-201 and dam Brown Tsaiya, two of them with 5 females and one of them with 3 female ducks; In total 456 F2 female duck progeny of these matings, which were got in 4 hatches, were tested for duration of fertility. Measurements were body weights during growth (on male and female), number of egg laid up to 40 and 52 weeks of age, egg weights and egg

shell strength; the duration of fertility traits were measured as in the selected Brown Tsaiya line: The F2 female ducks were artificially inseminated with pooled Muscovy semen at 26, 29 and 32 weeks of age. The eggs laid were collected in day 2-15 after AI and set. The number of eggs set, of fertile eggs, of dead embryos, of alive hatched mule ducklings, the maximum duration of fertility, were individually measured and registered.

AFLP were performed in Professor Mu-Chiou Huang's Laboratory, National Chungshing University, as described by Vos *et al.* (1995) and Herbergs *et al.* (1999) with minor modifications and on an ABI PRISM 3100 Avant Genetic Analyzer (Applied Biosystems). Runs and fragments were analysed and scored as dominant markers with Genescan 3.7 and Genotyper 3.7 softwares (both from Applied Biosystems). Deviation from expected Mendelian marker segregation was tested with a χ^2 test ($\alpha = 0.05$, $\chi^2 < 3.84$). Linkage analysis was carried out with markers from 18 primer combinations. The framework maps were built with CarteBlanche 1.5.0 (Keygene, 2003) and MapChart 2.2 (Voorrips, 2001).

RESULTS AND DISCUSSION

Huang *et al.* (2003) developed the AFLP markers using a multicolour fluorescent labelling technique within his Ph.D thesis research work. Thereafter, blood samples were taken on F0, F1 and F2 animals. The genomic DNA was extracted. An application was made for AFLP fingerprinting for paternity testing in ducks, the results showed that in sixteen different combinations of *EcoRI/TaqI* primers, 13-24 signal peaks were detected in size range from 40 to 350 bp. Increased numbers of polymorphic bands were amplified using the *EcoR+ACA/Taq+AC* primer compared with the *EcoR+ACA/Taq+ACA* primer (Huang *et al.*, 2006, submitted). Currently a first preliminary linkage map of AFLP markers in the ducks is under construction. The linkage map was built through genotyping six F2 families with 18 AFLP primer combinations. A total of 260 (55.9%) AFLP markers were dispersed in 32 linkage groups (Figure 2). The linkage groups covered 1,766 cM with an average interval distance of 6.79 cM (Table 1). The Brown Tsaiya selected line of the 10th generation (G10) of the selection experiment on the duration of fertility and the ILan Pekin L 201 which is one parent of Kaiya duck were chosen to give the F0 breeding animals. In the F0, 3 Brown Tsaiya drakes from the G10 of selected line for duration of fertility were crossbred each one with 2 Pekin female duck of ILan Pekin L-201; Three Pekin drakes I-Lan L-201 were crossbred each one with 2 Brown Tsaiya female ducks from the G10 of selected line for duration of fertility. For the mating F1×F1 three drakes F1 from sire Brown Tsaiya and dam Pekin were crossbred each one with five unrelated female ducks progeny of sire Brown Tsaiya and dam Pekin; Three drakes F1 from sire I-Lan Pekin L-201 and dam Brown Tsaiya were crossbred with unrelated female ducks progeny of sire I-Lan Pekin L-201 and dam Brown Tsaiya, two of them with 5 females and one of them with 3 female ducks; In total 456 F2 female duck progeny of these matings, which were got in 4 hatches, were tested for duration of fertility. Measurements were body weights during growth (on male and female), number of egg laid up to 40 and 52 weeks of age, egg weights and egg shell strength; the duration of fertility traits were measured as in the selected Brown Tsaiya line: The F2 female ducks were artificially inseminated with pooled Muscovy semen at 26, 29 and 32 weeks of age. The eggs laid were

collected in day 2-15 after AI and set. The number of eggs set, of fertile eggs, of dead embryos, of alive hatched mule ducklings, the maximum duration of fertility, were individually measured and registered. Preliminary statistical analysis of the phenotypic data measurements of F2 female ducks showed favourable Pekin grand maternal effect for the duration of fertility traits. The general averages of duration of fertility traits were superior to the averages of the Brown Tsaiya selected and control lines in the 10th generation of the selection experiment. These results could provide the important information for genetic improvement in duck breeding.

An inter disciplinary program is currently being implemented by INRA, Animal Genetic Department, Station d'Amélioration génétique des Animaux (Brun *et al.*, present symposium 2006). It aims at detecting QTL in Common duck strains for a number of economical traits including reproduction. Two Common duck strains of different origin were utilised for a backcross design, microsatellite markers were developed (Christel *et al.*, symposium 2006). The two programs in Taiwan and at INRA (France) are complementary. Both parts are interested in continuing scientific cooperation for QTL analysis in ducks.

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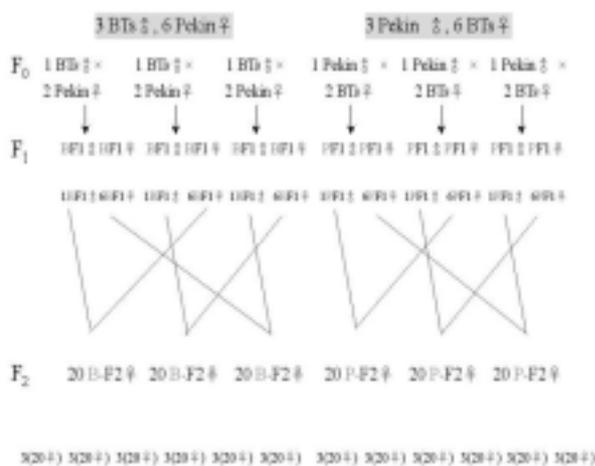


Figure 1. F₂ design for QTL mapping for duration of fertility in ducks Brown Tsaiya and Pekin. The aim is to get 20 F₂ daughters from each F₁ dam, to be performance tested by AI for duration of fertility and for egg laying traits.

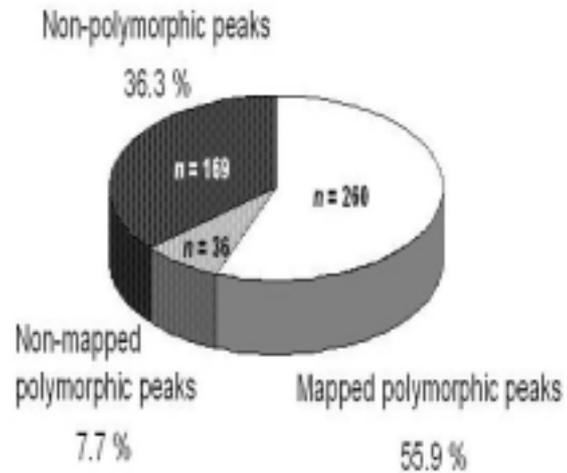


Figure 2. A pie chart representing the distribution of AFLP peaks (n = 465) based on the polymorphism and linkage mapping.

Table 1. Linkage group location of AFLP markers mapped in the duck population

Linkage groups	Length (cM)	No. of markers	Distance between two consecutive markers	No. of markers each length (cM)	Linkage groups	Length (cM)	No. of markers	Distance between two consecutive markers	No. of markers each length(cM)
LG-1	171.9	63	2.73	0.37	LG-17	47.9	4	11.98	0.08
LG-2	81.0	24	3.38	0.30	LG-18	45.2	4	11.29	0.09
LG-3	78.5	20	3.93	0.25	LG-19	44.0	3	14.65	0.07
LG-4	75.3	9	8.36	0.12	LG-20	42.9	3	14.29	0.07
LG-5	71.7	13	5.51	0.18	LG-21	42.5	3	14.17	0.07
LG-6	71.3	10	7.13	0.14	LG-22	41.9	3	13.97	0.07
LG-7	68.1	4	17.02	0.06	LG-23	41.9	3	13.97	0.07
LG-8	67.9	16	4.24	0.24	LG-24	41.7	3	13.89	0.07
LG-9	66.3	9	7.36	0.14	LG-25	41.5	3	13.83	0.07
LG-10	66.1	11	6.01	0.17	LG-26	41.2	3	13.72	0.07
LG-11	61.4	3	20.47	0.05	LG-27	40.4	3	13.47	0.07
LG-12	60.4	9	6.72	0.15	LG-28	40.3	3	13.44	0.07
LG-13	60.1	7	8.59	0.12	LG-29	39.8	3	13.26	0.08
LG-14	52.5	3	17.50	0.06	LG-30	21.5	4	5.37	0.19
LG-15	51.5	4	12.88	0.08	LG-31	20.3	3	6.76	0.15
LG-16	49.4	4	12.35	0.08	LG-32	19.9	3	6.64	0.15