British Poultry Science (1997) **38**: 245–248

Inheritance of wing feather development rate in guinea fowl (*Numida meleagris*)

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Abstract 1. A study of primary wing feather development rate in guinea fowl revealed genetic control through a single pair of sex-linked alleles. The allele for slow feathering (K) was dominant over that for rapid feathering (k^+).

2. Wing feather sexing showed 94% accuracy in 10-d-old keets.

3. Incidence of rapid feathering allele (k^+) was higher in the population selected for high body weight compared to the unselected population.

INTRODUCTION

Inheritance of primary wing feather development (rapid and slow) in chickens and turkeys is determined by a single pair of sex-linked alleles (Warren, 1925; Asmundson and Abbott, 1961), although existence of a few other loci influencing feather development are also known (Somes, 1990). Micek and Malik (1970) described sex-linked inheritance for feather development in guinea fowl. The present investigation was undertaken to provide further information on the inheritance of wing feather development in the guinea fowl.

MATERIAL AND METHODS

This study included 2099 newly-hatched keets belonging to three populations selected on the basis of plumage and one unselected population. The Lavender, Pearl and White birds have been under selection for 12 week body weight for the last 5 generations; about 3000 keets are raised each year from the selected parents (male 30, female 180). Originally constituted from several local sources, this broad based stock has been maintained as a closed flock for 8 generations, while the unselected group is a recent addition. All keets were scored for slow or rapid phenotypes immediately after hatch (day 0). The first reconfirmation of the phenotypes was done at 4 d of age and again at 10 d. The last screening also included observations on the development of tail feathers. Sexes were confirmed either at postmortem examination or through a critical evaluation of the phenotypic and vocal differences observed at maturity.

An inheritance study was undertaken on the selected stock progeny of 24 sires and 34 dams whose genotypes were known. Artificial insemination was used for production of experimental keets whose sex was confirmed after post-mortem.

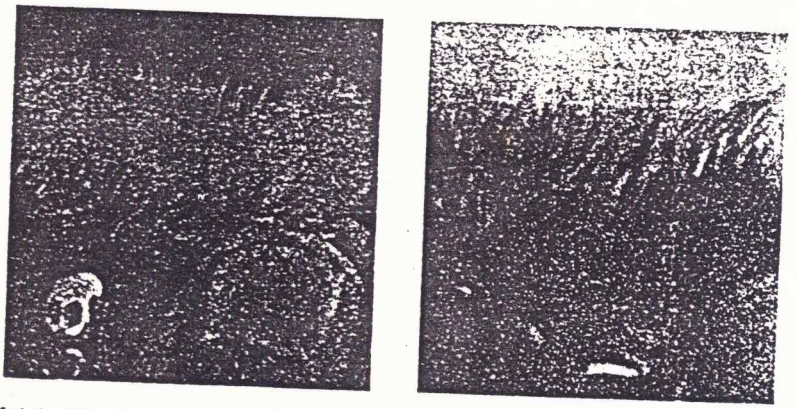

Figure 1. *Slow feathering (left) and rapid feathering (right) keets at hatching.*

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Accepted for publication 31st October 1996

0007-1668/97/030245-04

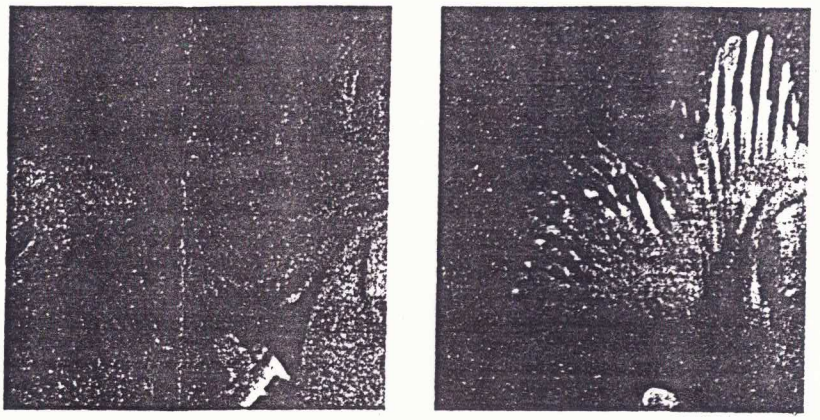

Figure 2. *Slow feathering (left) and rapid feathering (right) keets at 4 d of age.*

RESULTS

Observations on the development of the primary wing feathers and the relative length of coverts among 1-d-old keets revealed rapid and slow feathering phenotypes. The primary coverts were narrower and about two thirds in length of the primary flight feathers in rapid-feathering keets. In slow-feathering keets both the coverts and primaries were about the same length (Figure 1). This phenotypic differentiation became more discrete during the subsequent screenings at 4 d of age (Figure 2) and again at 10 d of age (Figure 3). Rapid-feathering keets also showed relatively better developed tail feathers (Figure 4) compared to the slow-feathering keets.

At hatch, only 85% keets showed definitely correct phenotypes; subsequent screenings identified definitely correct phenotype for 9% more keets but the remaining 6% appeared to shift from one phenotype to other. Among the expected slow-feathering homozygote males, at least 4 keets showed very poorly-developed primary feathers (Figure 5). The observed distribution of the feathering phenotypes and sexes among the progeny from sires and dams with known genotypes showed good agreement with the expectations for inheritance through a single pair of sex-linked genes (Table 1). The allele for slow feathering (K) was found to be dominant over the rapid feathering allele (k^+).

The distribution of slow and fast feathering

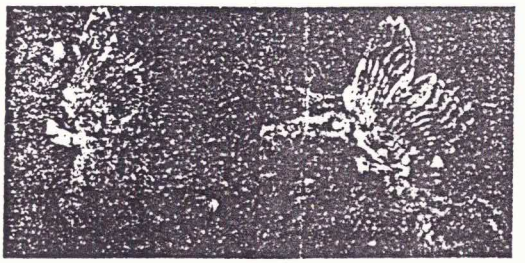

Figure 3. *Slow feathering (left) and rapid feathering (right) keets at 10 d of age.*

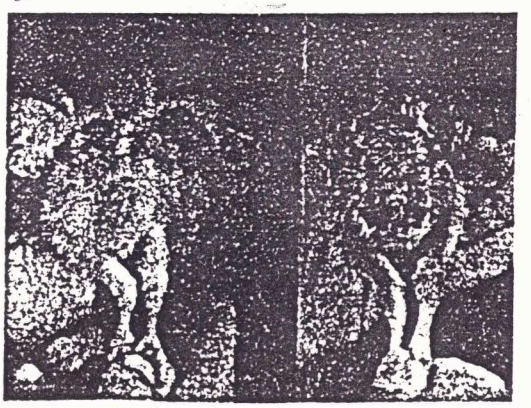

Figure 4. *Tail feathers of slow feathering (left) and rapid feathering (right) keets at 10 d of age.*

Figure 5. *Keets with poorly developed primary feathers at hatching.*

Table 1. *Inheritance of feather development rate variations*

Parents				Number of progeny				
				Male		Female		
Sire	Dam	n		SF	RF	SF	RF	χ^2
K^-K^- (Slow) (3)	K^- (Slow) (6)	27	Obs	15	—	12	—	0·4444
			Exp	13·5	—	13·5	—	
K^-K^- (Slow) (4)	k^+ - (Rapid (5)	36	Obs	20	—	16	—	0·4444
			Exp	18·0	—	18·0	—	
K^-k^+ (Slow) (5)	K^- (Slow) (7)	63	Obs	28	—	18	17	0·6666
			Exp	31·5	—	15·7	15·7	
K^-k^+ (Slow) (5)	k^+ - (Rapid (6)	63	Obs	20	17	12	14	1·3952
			Exp	15·7	15·7	15·7	15·7	
k^+k^+ (Rapid (4)	K^- (Slow) (5)	44	Obs	20	—	—	24	0·3636
			Exp	22·0	—	—	22·0	
k^+k^+ (Rapid (3)	k^+ - (Rapid (5)	26	Obs	—	15	— 11	0·6152	
			Exp	—	13·0	—	13·0	

Numbers of birds in parenthesis; SF = slow feathering; RF = rapid feathering; Obs = observed; Exp = expected

phenotypes and the two gene frequencies showed a similar trend among the three selected stocks (Table 2). However, the unselected population revealed a higher ($P < 0·01$) incidence of rapid feathering gene.

DISCUSSION

These findings confirm the earlier reports of Micek and Malik (1970) which indicated sex-linked inheritance for remex length. They identified remex development at 4 d of age in 25% of the males and 68% of females. Remiges of male and female keets averaged 25·1 *vs* 32·0 and 38·5 *vs* 41·3 mm respectively at 8 and 12 d of age. Existence of a dosage effect is also probable. No specific matings were carried out to investigate this possible dosage effect in the present study. Identification of an 'extreme' slow feathering phenotype in male keets possible homozygotes) is interesting, although the expected number of male homozygotes among experimental progeny was much higher.

Significantly higher k^+ gene frequency observed in the selected groups could be an associated effect of selection for body weight or a pleiotropic effect of the major gene. Existence of a similar effect of feathering allele on body weight has been reported in chickens and turkeys (Asmundson and Abbott, 1961; Merat, 1990), but the present observations need further confirmation in other guinea fowl populations.

Sexing of keets by feathering phenotypes showed about 94% accuracy; the remaining 6% discrepancy could be the influence of some background genes on phenotypic expression. In domestic fowl, Hurry and Nordskog (1953) and Siegel *et al.* (1957) reported that most of the genetic variation of feathering within a sex-linked genotype was the result of additive genes. Smyth and Claussen (1976) also reported a polygenic trait which could lead to sexing errors in chickens. In another study, Edriss *et al.* (1988) established a fast feathering and a slow-feathering broiler line during two generations of divergent selection on a K^- background. The wing feather development mutation in guinea fowl has autosexing potential because male and female keets look alike and sometimes cannot be sexed with certainty even at 20 weeks of age. Slow feathering offspring from specific crosses involving rapid-feathering males (k^+/k^+) mated to slow-feathering females would be males and the rapid feathering ones would be females. In case of domestic fowl, feather sexing carries an appreciable risk because the close linkage between the slow-feathering allele (K^- and the endogenous proviral *ev-21* gene enhances susceptibility to ALV infection. This concern might not be relevant in guinea fowl because molecular genetic studies by Resnick *et al.* (1990) established the absence of the *ev-21* gene in this species.

Table 2. *Feathering phenotypes and gene frequencies in guinea fowl populations*

Population	n	Phenotypes		Gene frequency	
		Slow	Rapid	K^-	k^+
Selected populations					
White variety					
Male	161	72	89	0·257	0·743
Female	81	35	46	0·432	0·568
Overall	242	107	135	0·316	0·684
Lavender variety					
Male	123	52	71	0·241	0·759
Female	130	48	82	0·369	0·631
Overall	253	100	153	0·281	0·719
Pearl variety					
Male	193	65	128	0·186	0·814
Female	199	59	140	0·296	0·704
Overall	392	124	268	0·222	0·778
Unselected population					
Male	39	27	12	0·446	0·554
Female	47	29	18	0·618	0·382
Overall	86	56	30	0·503	0·496

The sex-linked determination of feathering variants in guinea fowl reveals an interesting phenotypic and genetic similarity to feather growth rate mutation in chickens and turkeys. Accordingly, the guinea fowl feathering genes have tentatively been assigned k^+ and K symbols, as suggested by Somes (1990). Existence of sex-linked loci with similar effects in three domestic Galliform species is certainly of interest for comparative genetic reasons. It does suggest that some feather development related DNA may be highly conserved on the Z chromosome in this order of birds.

ACKNOWLEDGEMENT

This investigation is a part of the Ph.D dissertation of SKP approved by the Indian Veterinary Research Institute, Izatnagar. Thanks are due to Dr S. C. Mohapatra, Director of the Central Avian Research Institute, Izatnagar for his constructive suggestions.

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