TYPES OF LEGFEATHERING IN PIGEONS

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THIS paper is based partly on results from experiments carried out by the Late Dr. W. CHRISTIE and C. WRIEDT, partly on results obtained in the writer's experiments with material started by the Late C. WRIEDT.

CHR. WRIEDT and W. CHRISTIE (1925) have published results on the inheritance of one type of legfeathering found in Danish Almond pigeons and named in the German text »Hosen»; we will refer to it in this paper as the »grouse» type of legfeathering. It is characterized by smooth adhering feathers on the tarse and toes, the feathers not exceeding 3—4 cm. Description and picture of this feathering are found in the above mentioned publication. It was found that one factor (*H*) was responsible for the grouse feathering, the heterozygote having a covering of short feathers mainly on the tarse. Later results have confirmed these findings and we need not discuss this type further.

CHR. WRIEDT and W. CHRISTIE mention that several matings of cleanlegged birds have given 26 offspring all without legfeathering. In other material most matings have given the same results, but in a few matings of cleanlegged birds individuals with a slight feathering on the tarse, resembling the little developed F_1 grouse type, have appeared. The data are few and accidental, but they indicate the existence of a recessive type of slight feathering of the tarse. Six matings of cleanlegged birds have given 14 clean : 5 with feathers, and 2 matings of slight feathered × clean have given 6 feathered : 6 clean. DONCASTER (1913) also mentions that cleanlegged birds may give offspring with slight feathering.

Boots. — There is in pigeons another type of legfeathering with long feathers (5—8 cm.), stiff and often directed towards the side; we will refer to it here as Boots (German: Latschen). It is found in a large number of breeds; in the present crosses have been used: Shields, Swallows and Ice pigeons, which have been crossed with cleanlegged breeds, mainly French bagadettes and Danish Tumblers. Fig. 1 represents the well developed feathering (boots) of a shield pigeon. Intercrosses of shields and swallows gave offspring all with booting, show-

ing that the same factors are present in both breeds. In the segregations the three breeds behaved similarly and the results from all three are lumped together. The length of the boot feathers were, however, considerably longer in the shields than in the swallows, indicating a genetic difference in this respect. Some measurements were taken of the longest feather in the boot, but it is difficult to get any exact

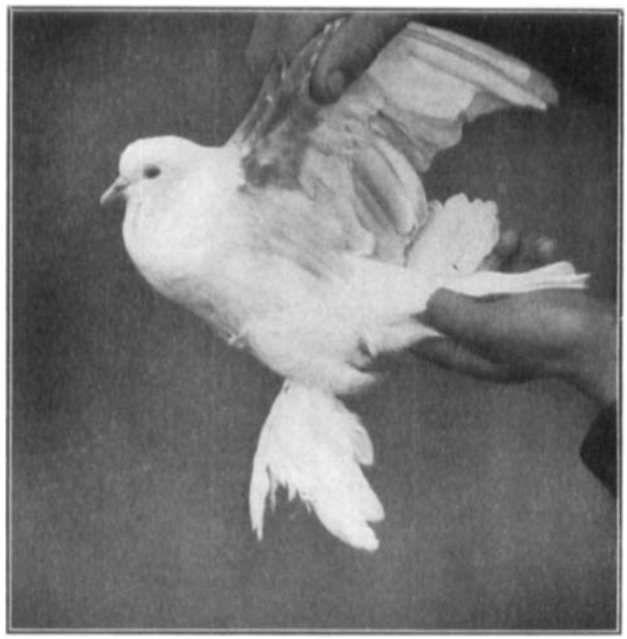

Fig. 1. Shield female with boots and vulture hocks.

measuring, as the feathers are easily worn and broken when fully developed. Below are given some average feather lengths:

Shields	7,50 cm.	Swallow	3,69 cm.
F_1 (shield × swallow) ..	4,08 »	F_1 (swallow × clean-legged)	1,56 »
F_1 (» × cleanlegged)	1,98 »		
Feathered from back-cross to boots	6,07 »	Feathered from back-cross to boots	5,00 »

F_1 had the tarse more or less covered with feathers, the toes carried short stiff scattered feathers, sometimes the feathering was very little developed resembling the F_1 grouse type, especially in the swallow crosses. F_1 was backcrossed to both parent types, the results of the

backcrosses are given in table 1. Before discussing the mode of segregation, we may point to the fact that there is apparently little or no genetic variation as regards length of feathers. The feathered individuals from the backcross to shields do not obtain the same length as the parents, but this is probably due to the fact that the backcross offspring were measured before the feathers had attained their full length. The backcross swallows had somewhat longer feathers than the purebred individuals, which probably means that there was present in the swallows some factor reducing feather length.

TABLE 1. *Inheritance of Boots in Pigeons.*

	Number of offspring with				Total number of offspring
	full boots	F_1 boots stiff feathers	F_1 grouse soft feathers	clean-legged	
F_1 (Boots × cleanlegged), 11 matings	—	47	7	—	54
F_1 × boots, 10 matings	33	33	5	—	71
		38		—	—
1 : 1 exp.	35,5	35,5		—	71
F_1 × cleanlegged, 22 matings	—	45	33	35	113
		78		—	—
3 : 1 exp.	—	84,75		28,25	113
		D = 6,75		—	—
		D/m = 1,38		—	—

Backcross to boots has given 33 with boots and 38 with intermediate (F_1) type of feathering, apparently a 1 : 1 segregation. Backcross to cleanlegged has given 45 with intermediate, stiff feathers (F_1 booting type), 33 with less developed feathering and no stiff feathers, similar to the F_1 grouse type and 35 cleanlegged. In all we have 78 feathered : 35 cleanlegged, on a two factor basis we should expect 84,75 : 28,25. There is an excess of cleanlegged, though not significant, D/m being only 1,38. The data may be explained on the basis that the booted individuals carry two factors for feathering, but only one of these is necessary for the production of the long boot feathers, or boots may in any case develop even if the second factor is in heterozygous condition. This second factor is then responsible for the segregating

out of the F_1 grouse type, and the factor may be identical with the gene (*H*) for grouse feathering; we will return to this point later.

Inheritance of vulture hock. — The shields, swallows and ice pigeons also had a well developed vulture hock (fig. 1), data on the inheritance of this character are given in table 2. They show that vulture hock is a simple recessive character, determined by one factor. As was the case with the legfeathering the vulture was somewhat shorter in the swallows than in the shields, but otherwise there was little evidence of genetic variation in length of feathers, the vulture hock factor is apparently capable of producing vulture hocks of full length, without the assistance of special length factors.

TABLE 2. *Inheritance of Vulture Hock.*

	Number of offspring		Total number of offspring
	with vulture hock	without vulture hock	
F_1 (vulture hock—no vulture)	1 [1]	36	37
$F_1 \times$ vulture hock, 11 matings	20	25	45
1 : 1 exp.	22,5	22,5	45
$F_1 \times$ no vulture hock, 13 matings	—	65	65
0 : 1 exp.	—	65	65

[1] Marked on map: Indication of vulture feathers, only.

With regard to the relation between booting and vulture hocks, it was found that *all individuals with boots had vulture hocks, while all with F_1 feathering or clean legs had none.* This complete correlation between the two characters was not only found in the backcross, but also in other crosses segregating out booted individuals, crosses which were, however, complicated by the presence of other types of feathering. Apparently the vulture hock factor is closely linked to or identical with one of the factors for feathering. Twenty-one breeds with boots listed in O. WITTIG-CHEMNITZ: Mustertaubenbuch (Fritz Pfennigstorff, Berlin) also show vulture hocks, which speaks in favour of the latter alternative.

Two matings may throw some light on the relation between boots and grouse feathering. A grouse feathered male nr. 698 that had been used in the crosses on this character reported by CHR. WRIEDT and W. CHRISTIE, was mated to a booted shield female nr. 823 and gave

3 booted with vulture hocks and 3 with grouse feathering and no vulture hock. A female from this mating with boots and vulture hocks nr. 825 was mated to a male of similar type nr. 1030 and produced 13 offspring all with boots and vulture hocks, showing that nr. 825 was homozygous for this character. An F_1 booting male nr. 954 was mated to an F_1 grouse female nr. 254 and gave 2 with boots and vulture hocks and 8 with F_1 booting feathers and no vulture hocks. As vulture hocks has proved to be so completely recessive, it must be concluded that the grouse feathered birds have carried the factor for vulture hocks + boots in heterozygous condition. As full grouse feathering has been produced in these matings, it seems probable that the second factor carried by the booted breeds is identical with the grouse feather factor. On account of the scarcity of the material, these suggestions can only be tentative, but all the data seem fully and easily explained on this basis.

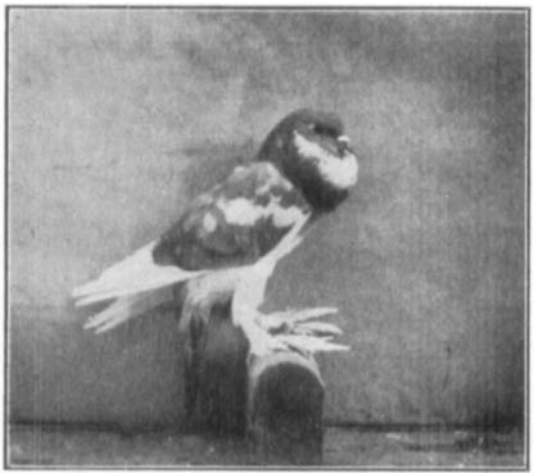

Fig. 2. Pigmy female with pigmy legfeathering.

DONCASTER (1913) crossed Red Tumblers which apparently had boots with cleanlegged Blue Homers. F_1 was halffeathered and F_2 consisted of 12 fully feathered + 15 halffeathered + 7 cleanlegged, some of the fully feathered proved to be heterozygous. From the descriptions it cannot be ascertained whether this type is the same as the one dealt with here.

In Pigmy Pouters we have examined a type of legfeathering different from boots and grouse feathering both pheno- and genotypically. The data on its inheritance are yet incomplete, but it must be listed here as a third distinct type of legfeathering. Fig. 2 shows a bird with the pigmy feathering, the shanks are covered fully, except on the inside, with soft feathers and the toes carry 4—6 cm. long stiff narrow feathers that are directed forwards, not sidewards as in the booted type. There is no vulture hocks.

Pigmy pouters were mated to cleanlegged maltese pigeons, F_1 (19 birds) showed sparse feathering, but was rather variable, some had many

stiff feathers on tarse and toes, while others only had rudimentary feathers on the tarse. 2 birds had no feathering. F_1 has been backcrossed to maltese and given 14 cleanlegged : 4 with sparse feathering, indicating that probably two factors must cooperate to produce feathers. F_1 crossed to pigmy have given 2 with full pigmy feathering + 5 of F_1 type + 1 cleanlegged. Pigmy pouters have been crossed to frillback pigeons with grouse legfeathering, but the results are yet too few and the relations too complicated to allow any interpretation of the relation between these two types. It may be mentioned only that by backcrossing F_1 (pigmy × frillback) to frillback 8 of 23 individuals had the full pigmy feathering indicating that the frillback carried some factor necessary for the production of the pigmy legfeathering.

If we compare the types of legfeathering in pigeons with these in the fowl, we find a striking case of parallel variation. The heavily feathered (booted) breeds Brahmas and Silky were found by DAVENPORT (1909) as interpreted by PUNNETT and BAILEY (1918) and by DUNN and JULL (1927) to carry two factors for legfeathering. The less heavily feathered Langshan breed was found by PUNNETT and BAILEY to carry only one factor for feathering. This disagrees, however, with the results obtained with the same breed by LAMBERT and KNOX (1929) who found two factors in Langshan, D. C. WARREN, on the other hand, found only one factor in light Brahma and Silky Bantam. It must be remembered, however, that the two-factor condition is usually induced from the percentage of cleanlegged in F_2 or in backcross to cleanlegged. A two-factor ratio here may mean not that both factors are concerned in the production of the type in question, but simply that the breed carried two factors that each in heterozygous condition is capable of producing some degree of feathering. On this basis one may expect heavily booted birds sometimes to contain two factors, sometimes only one. In fact, the interpretation of DAVENPORT's data given by PUNNETT and BAILEY (1918) involves that some of the feathered birds carried two factors (A and B), others only one (A). Vulture hock was found by DAVENPORT (1906) and JULL and QUINN (1931) to be dependent on one recessive gene, just as has been shown to be the case in these pigeon crosses. Vulture hock was found by DUNN and JULL (1927) and by JULL and QUINN (1931) to be in some way associated with legfeathering, although the genetic relation is not yet clear.

Both in pigeons and in chickens matings of cleanlegged birds have sometimes produced offspring with slight feathering. These cases have usually been interpreted as a suppression of feathers in the cleanlegged

parents that are supposed to be heterozygous for the dominant (or rather intermediate) type of legfeathering. It may also be interpreted, and in the present case of pigeons more probably, as a recessive type of slight feathering.

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