

ON THE LEFT-SIDED INCIDENCE OF THE SUPER-NUMERARY DIGIT IN HETERODACTYLOUS FOWLS.

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THE following results have been obtained by crossing representatives of certain five-toed with four-toed breeds of Fowls.

The breeds chosen were the Silky, Dorking and Faverolle on the one hand and the Old English Game, Wyandotte and Orpington on the other. The proportion of four-toed to five-toed and heterodactylous offspring (birds with five toes on one foot and four on the other) varied somewhat according as the male or female parent belonged to the five-toed breed and also in the F_1 as compared with the F_2 generation.

Out of a total however of 402 birds 172 developed four toes on both legs, 192 five toes on both legs and 38 were heterodactylous.

Of these heterodactylous birds 34 had the extra digit on the left side and only 4 on the right side.

The proportion between the numbers of four-toed, five-toed, and heterodactylous birds in the different matings and in the two generations is shown in the following table:

Mating	Generation	Four-toed	Five-toed	Heterodactylous
G. cock × Silky hens	F_2	8	5	2
Silky cock × Game hens	F_2	17	14	4
S. Dorking cock × Orpington hens	F_1	2	35	4
" × " "	F_1	16	22	4
(a) mating	F_2	15	17	1
(b) "	F_2	18	39	7
(c) "	F_2	30	18	5
(d) "	F_2	17	18	4
Cross back to parent 4-toed stock	F_2	29	12	2
Faverolle cock × Orpington hens...	F_1	8	7	0
" × "	F_2	12	5	5
Totals		172	192	38

The tendency of the Extra Digit to appear on the Left Side in the Asymmetrical Birds.

In the early matings the supernumerary digit appeared on the left side in all the asymmetrical birds and it was only on mating a heterodactylous cock with heterodactylous hens of the F_2 generation that the extra

digit appeared on the right side in two cases. Two more examples occurred in a mating between a heterodactylous cock and five-toed hens.

The tendency for the fifth digit to appear on the left side is evidently strong in birds which are heterozygous as regards number of digits.

Besides these heterodactylous birds a number of the symmetrical five-toed hybrids also showed a fuller development of the fifth digit on the left side. In some cases this left-sided extra digit was made up of a larger number of phalanges, and in some these phalanges were better developed. In two birds rudiments of six toes appeared, in one case on the left and in one on the right side.

This over-development in excess of the number of digits normally possessed by a five-toed breed is important and suggests that the fifth toe in the five-toed race is not transmitted to hybrid offspring as a stable unit character, but rather that the factor transmitted when a five-toed is crossed with a four-toed breed is a tendency to extra serial segmentation of the rudiments forming the digits and not a tendency to develop a fixed number of (five) digits.

This serial segmentation may affect the whole digit or the phalanges only, it may be complete or incomplete and in the latter case a fused metatarsal bone or phalanx may be common to two digits.

Although the numbers in which the reverse cross was tested are small they suggest that heterodactylism with the extra digit on the left side is more frequent when the female parent belongs to the five-toed breed.

This left-sided incidence of the extra toe in asymmetrical birds is confirmed by other workers. Thus Messrs Bateson and Punnett have kindly furnished me with the following records of extra toed chicks bred by them. In 89 asymmetric birds from different matings the extra digit appeared on the left side in 72 cases and on the right side in 17. In 49 birds the extra digit although present on both sides was unequally developed, the more fully developed toe occurred on the left side in 34 cases and on the right side in 15.

Since this paper was written Prof. Punnett has also called my attention to articles by D. Barfurth in the *Archiv für Entwicklungsmech. der Organismen*, XXXI and XXXIII. In a summary of different matings between normal and hyper-dactylous fowls carried out between 1908 and 1910 Barfurth gives a total of 1031 individuals of which 556 were four-toed and 475 hyper-dactylous. Of the hyper-dactylous birds 410 were symmetrical and 65 asymmetrical. Of the 65 asymmetrical birds the extra digit was present on the left side in 35 and on the right side

in 30 cases. In a later table (*ibid.* XXXIII) Barfurth tabulates 40 hyper-dactylous birds of which 8 were asymmetrical and of these 6 were left-sided and 2 were right-sided. In a final list of 18 asymmetrical birds 12 were left-sided and 6 right-sided.

Barfurth also records in the same journal some observations on extra rudimentary digits in the wing bones of chicks. Of 21 individuals so characterised 2 were asymmetrical, the extra rudimentary digit in both cases affected the right wing. In another group of 79 birds 6 asymmetrical cases occurred all with the extra digit on the left side.

It is of interest to compare this asymmetry of toe development in heterozygous fowls with other characters which under normal conditions are symmetrically distributed.

In *Polydactylous Guinea Pigs* there is a slight but definite tendency for the supernumerary digit to appear on the left side, thus Castle (*The Origin of a Polydactylous Race of Guinea Pigs*, Pub. Carnegie Instit., May 1906) states that out of a total of 1219 individuals the extra toe appeared on the left side in 630 and on the right side in 582. Attempts to increase this asymmetry however failed.

In an unpublished enquiry into the prevalence of *Supernumerary Nipples in Guinea Pigs*, Mr Pechey of Leicester finds that out of 56 individual offspring of parents with supernumerary nipples 17 possessed supernumerary nipples or teats. Of these 17, 10 were asymmetrical, the extra nipple being placed on the left side in 7 cases and on the right side in 3 cases. In 6 individuals with extra nipples on both sides the larger and more fully developed teat was situated on the left side. One individual (a female) had four extra nipples symmetrically placed. These records show that a tendency exists for the supernumerary nipple to appear on the left side in guinea pigs.

Asymmetric Tail Feather Pattern in Pigeons.

A blue-barred Homer cock with the normal number (12) of tail feathers was mated with an inbred Fantail hen having 25 tail feathers. From this Homer-Fantail cross 21 individual birds of the F_1 generation gave 140 tail feathers on the left side and 140 on the right.

In 50 F_2 birds from the same cross there were 902 tail feathers, 456 on the left side and 446 on the right.

Although the distribution of fully developed tail feathers in these hybrid Fantail birds only shows a slight preponderance of numbers on the left side in the F_2 generation, further evidence of asymmetry is

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obtained in the distribution of certain abnormal double tail feathers which occur in these Fantail hybrids. Morgan has drawn attention to the occurrence of these double tail feathers in cross-bred pigeons but does not mention any inequality of distribution.

In the above cross these abnormal tail feathers appeared in 12 cases in the F_1 offspring, 5 being on the left and 7 on the right side. In the F_2 generation however out of 11 examples 8 occurred on the left side and only 3 on the right.

In a total of 38 abnormal tail feathers from this and other matings 21 occurred on the left side and 17 on the right.

Evidently the condition of unstable equilibrium in the number and distribution of tail feathers in hybrid pigeons, the result of crossing a fish-tailed with a fan-tailed breed occurs on both sides of the body, but the numbers suggest a slight excess of meristic variation away from the normal 12 feather arrangement on the left as compared with the right side of the body.

Taking the facts concerning heterodactylism in fowls and tail-feather pattern in hybrid pigeons together we find that (in birds at any rate) there is a tendency during the early cleavage of the ovum which separates the organism into a right and left half, for the factor or factors which control meristic variation to pass to the left rather than to the right half of the developing zygote.

In this article it is not intended to discuss the question whether any association exists between the left-sided incidence of asymmetrical characters and sex. The atrophy of the right ovary in normal female birds is important in this connection, so also is the fact that in a certain number of female heterodactylous fowls the extra digit on the left side is associated with the development of a spur on the same side. Heinrich Poll (*SB. Ges. Naturf. Fr. Berlin*, 1909) states that in true hermaphrodite birds the male secondary sex character tends to appear on the right side, that is the side on which the primary sex gland is male in these abnormal birds. There are difficulties in accepting the hormonal theory as a full and complete explanation of the occurrence and distribution of secondary sex characters in birds. The case of the hermaphrodite pheasant with hemilateral asymmetry of secondary sex characters recorded in the *Journ. Gen.*, Feb. 1914, together with other examples recorded by other observers suggests that (in birds at any rate) in addition to the influence exercised by sex hormones on the *development* of secondary sex characters other factors are concerned in their *origin and distribution*. One other such factor may be a capacity

on the part of the body cells of the zygote to respond in a different way to the hormonal substances formed by the female and male primary sex glands respectively. In normal individuals this capacity of tissue response is distributed symmetrically on both sides of the body, whereas in these abnormal hermaphrodite birds it would seem to be located asymmetrically, and it is of interest to find that other examples of hemilateral asymmetry such as the extra digit in heterodactylous fowls also occur in birds.