

CONCERNING POULTRY



LEGS – Part 2

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Above: German Krüper cock - in the background: Niederrheiner.
Photo by Dirk de Jong

In LEGS, part 1 - October 2009 we mainly discussed the chickens with 4 toes and the leg colour. In Part 2 we will have a look at the creepers, five toed chickens, foot feathering and things that come with it.

Creeper - Cp

Autosomal incompletely dominant

Of all the skeleton mutation genes, this gene has received more attention from researchers, and is present in various parts of the world as a distinctive characteristic of some breeds, like Jitokko and Nagasaki in Japan, Courtes-Pattes in France, Scots Dumpy in the United Kingdom, Krüper in Germany and Drentse Kruiper in the Netherlands. The Courtes-Pattes breed, which had completely disappeared several years ago, was recreated by Jean-Claude Périquet by crossing in the German Krüper.

Right: A German Krüper hen.
Photo: Dirk de Jong.

As early as 1925 Cutler had noticed that adult creepers were always heterozygous for this gene that later proved to be autosomal and homozygous lethal, causing the embryos to die around day 4. This early death is apparently due to inhibition of the development of the vascular system. Therefore there are no pure homozygous creepers.



When mating two short-legged birds, a quarter of their eggs will not hatch, 50% of the hatching chicks will be heterozygous for Cp , and the remaining $\frac{1}{4}$ of the chicks will be homozygous for $cp+$ meaning they have legs of normal length. These subjects are not to be discarded, because when - apart from the normal length of the legs- they carry all the other breed characteristics, they can be paired with the short legged chickens. In doing so again the percentage of short legged chicks will correspond to 50%.

Only very few of the homozygous chicks manage to be born, but they will die shortly after birth.

When breeding creepers you might notice that the length of the legs is not always the same, but may vary in shortness. In this case another gene may be involved. There are two more genes that influence the length of the legs:

Mp - ametapodia

Homozygote Mp/Mp = death of embryo.
Heterozygote $Mp/mp+$ = creeper, but the legs are shorter than in $Cp/cp+$.

Cl - Cornish lethal

Homozygote Cl/Cl = death of embryo.
Heterozygote $Cl/cl+$ = creeper, very short legs, and often also the toes are short.

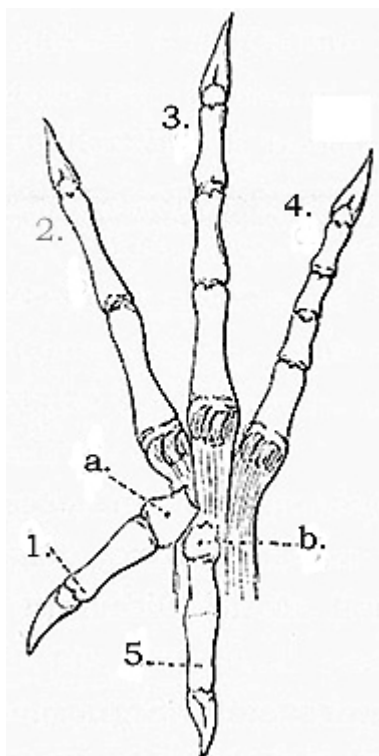
Right: Dorkings have five toes.

Photo: Klaas v.d. Hoek.

Polydactyly (more toes) - Po

Autosomal incompletely dominant

The word polydactyly comes from the Ancient Greek *polýs* (many) + *dáktylos* (finger).



First we will give you the commonly used numbers for the toes (digits), being:

- 1st - is posterior and has 2 phalanges
- 2nd - is the inner digit and has 3 phalanges.
- 3rd - lies between digit 2 and 4 and has 4 phalanges.
- 4th - is the outer digit and has 5 phalanges.

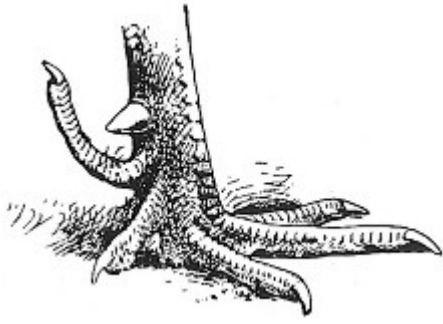
The last phalanx, like in humans, lies under the nail. As you can see, the number of phalanges differs in each toe. We will relate to this in the subject 'Brachydactyly'.

Left: Position of the fifth toe.

- 1. posterior toe
- 2. inner toe
- 3. middle toe
- 4. outer toe
- 5. fifth toe.

a = accessory normal metatarsal of the posterior toe.

b = small accessory metatarsal of the fifth toe.



Left: When a fifth toe is present, it is placed above the posterior toe and is turned back and up and is often longer than the posterior toe.

This drawing is used in many Poultry Standards.

Some five-toed breeds are: Dorking, Lincolnshire Buff, Houdan, Faverolles, Meusienne, Sultan and Silkie.

The fifth toe is present at the time of hatching, and in fact is already visible on the fifth day of incubation (Kaufmann-Wolf, 1908) and may vanish by subjecting the embryos to low temperatures at 14 days of incubation (Sturko, 1943; Warren, 1944).

Many researchers (Bond, 1926; Punnett and Pease, 1929; Landauer, 1948, Warren, 1944) have provided extensive information on the inheritance of polydactyly. 7 different forms are described, including the heterodactyly – where the number of toes on each foot is different, with the left foot normally supplied with supernumerary toes and right foot with the normal four toes - and the duplicate polydactyly Po^d . This type of polydactyly, which Warren (1941) called 'duplicate', is causing much more frequently a duplication of the first toe, with a wider variation of expression.

Right: The posterior toe of this Houdan bantam is too high on the leg and cannot reach the ground.

Below: Two nails at the posterior toe (Houdan bantam) is an often seen fault.



Left: In this Houdan bantam the fifth toe is placed under the posterior toe, instead of above it.

Photos: Dirk de Jong.

Polydactyly is complex and influenced by modifier genes and suppressors, and its inheritance is based on that of an autosomal incompletely dominant gene. Dunn and Jull (1927) have assigned to this locus the symbol Po .

However, there can be a drawback in the inheritance of this trait: it seems that some polydactyl

breeds, as well as some non-polydactyl breeds, are fitted with suppressor genes that can completely inhibit the expression of polydactyly in genotypically polydactyl chickens. (Punnett and Pease, 1929; Hutchinson, 1931; Warren, 1944).

Often fanciers think polydactyly is a too difficult and uncertain trait and they become discouraged in breeding five toed breeds. Of course there are some difficulties in obtaining a good selection of fine chickens with 5 toes. Certainly, chickens are found with the first and fifth toe too close together, and also sometimes with hints of a sixth toe, a double nail or a toe nail missing. You have to keep in mind that these chickens must be excluded from the breeding pen.



Left: This Silkie has a 6th toe developing between the posterior toe and the fifth toe.

Photo: Hans Ringnalda.

Right: This Silkie has a correct fifth toe, but there is an extra nail growing from the third toe. Photo: Hans Ringnalda.

Below: This is the leg of a Crève Coeur; a breed with the normal number of 4 toes. However, here the posterior toe has split. Could this be the start of developing a fifth toe? Photo: Dirk de Jong.



Recessive polydactyly po-2

A recessive type of polydactyly was found in some Rhode Island Red, in which 22% of the

examined birds had 5 toes, 31% had 6 toes, and the remaining 47% had a missing toe, which was later replaced by 2-3 additional toes on the tarso-metatarsus (thus higher on the leg). (Ibe and McGibbon, 1980).

The mortality of the affected chicks was approximately twice than that of normal chicks. About 25% died in the late embryonic stage, while a further 17% died at about six weeks of age. Those still alive beyond the usual six weeks showed deformities in the legs.

Ibe and McGibbon (1980) proposed the symbol *po* for this trait, but suggested it was a dominant allele of the locus of polydactyly (*Po*), and so subsequently assigned the symbol *po-2* (Somes, 1981).

Polydactyly also in the 'fingers'

Normally a bird – thus a chicken too – has 3 fingers, of which two are merged and one normal finger, completed with a nail. The whole is covered with skin and wing feathers. In chickens however sometimes a little 'thumb nail' sticks out.



Left: The 'thumb' nail at the wing. We removed some feathers to give a better view.

Photo: Dirk de Jong.

Homozygous five toed chickens are supposed to have not just an extra digit at the legs, but also one extra in the arms (wings), thus 4 fingers, of which two are merged and the other two both have nails. Still this trait is not always perceptible and there has been quite some research for this.

Skeletal analysis by Kenjiro Arisawa et al. in 2006 revealed that an extra cartilaginous digit was apparent transiently in the wing bud of Japanese Silkie embryos between stages 32 and 37. Comparing Silkie and White Leghorn embryos, not only demonstrated the development of an extra digit in the leg formation of Silkie embryos, but also a rudimentary extra cartilaginous digit in the wing

bud. There was no corresponding region of expression apparent in the wing bud of White Leghorn embryos. This was expressed in the earlier stages of development. In Japanese Silkie embryos the formation of the extra wing digit was initiated at the anterior tip of the wing bud at stage 32 but it had disappeared at stage 37 with unknown reasons.

You can read the research file at http://www.jstage.jst.go.jp/article/jpsa/43/2/126/_pdf

The article is completed with X-ray photos showing Japanese Silkie and White Leghorn embryos, the wing of the Japanese Silkie manifesting a – temporary - extra digit (arrowheads) bifurcated from the root of digit .

This should mean that Silkies don't show this extra wing digit, but in 1947 Walter Landauer already confirmed the existence of such an extra wing digit: " From our Silkie-Houdan-outbred stock a line has been produced by selection in which supernumerary digits are prominently developed in the wings. Such well-developed supernumerary 'fingers' occur only in birds which are homozygous for polydactylism".

When asking several Silkie breeders to have a close look, we did receive from the US some photos of Silkies who really have this 'extra' digit, situated on the wing where it bends at the point/joint. The mentioning of the extra digit ranged from a bump or little claw, to an actual digit that reached 1/4 of an inch long. Others examined all their birds and found none.

Right: Here is a close-up of a Silkie showing TWO 'finger nails' – see the full photo in the next page.





Above: A Silkie rooster showing TWO thumb nails. Photo courtesy of Diana Hedrick and Paula Shephard, USA.

Feathered Legs - Pti-1 - Pti-2 - pti-3 – ptilopody

Autosomal genes with single or combined action

The presence of feathers at feet receives different names: feathered tarsi, feathered legs, feathered feet, ptilopody. It is a characteristic which is common in various breeds, and in them it expresses itself with different phenotypes, varying also from one subject to the other. If considered from an ontogenetic point of view, the feathers as well as the horny scales grow from the dermic papillae (extensions of the dermis into the epidermis). Let's step back in history. The phylogenesis (the study of evolutionary relatedness) teaches that the feathers developed from horny scales and this is confirmed by the fact that the legs of the birds are often covered by scales, which in some species, or in groups of species, turn into feathers: Rough-legged buzzard (*Buteo lagopus*), Tengmalm's owl (*Aegolius funereus*). In the domestic chicken this - so to speak 'ancestral'-characteristic, can be maintained through the selection.

Obviously such a concept goes to bang against the monophyletic origin of Darwinian inspiration, since the Red Jungle Fowl has featherless legs. Therefore we would admit the existence of a 'super ancestor' in which all the scales had become feathers.

Right: Marans have minor foot feathering. Photo: Dirk de Jong.



Breeds as Breda, Croad Langshan and Faverolles, show the minor degree of leg feathering: they are only present at the outer side of the legs and the outer toe. Even Brahma and Silky only have feathered outside legs, but also feathered 3rd and the 4th toe. The Bearded d' Uccle, Cochin and Sultan have feathers both outside and front side of the legs, with rich feathering at the 3rd and the 4th toe.

In Pavlov the leg feathering is completely different: even if the feathers do not have particular stiffness, they are present on the anterior, external and internal leg, in addition also the four toes are feathered.

Right: Pavlovs in Russia.

Photo: Willem van Ballekom.

From the studies performed by crossing Croad Langshan, Brahma, Cochin and White Leghorn with Sultan, it was found that Croad Langshan and Brahma, each carry one pair of dominant genes, and Cochin China and Sultan possess two pairs.



Left: Sultan hen.

Sultans have it all: Crest, beard, vulture hocks, feathered legs and five toes!

Photo: Klaas v.d. Hoek.

Additionally to these studies, some deduced that in certain strains some genes are present

that inhibit the leg feathering, explaining in this way the appearing of legs without feathers, when on the contrary the offspring should have been leg feathered.

Therefore we have to conclude that – fundamentally - in leg feathering, which is so different from one breed to another, 3 loci are acting: two dominant genes in separate loci, contemporarily present in giving the extreme degree of feathering in Cochin, Sultan, Bearded d'Uccle and Booted bantam; one or the other of these same genes, alone, gives the scarce feathering characteristic of Langshan, Faverolles and Breda.

The feathering of intermediate degree, observable in Brahma and Silky, can be due to a different allele present in one of the loci (as suggested by the studies of Somes), or it can be due to a segregation of the two above-mentioned loci.

The feathering of Pavlov is due to a recessive gene, that is, to *pti-3*.

Vulture hocks – v

Autosomal recessive

Several breeds also have feathers on the rear of the thighs, called the vulture hocks. In some breeds they are stiff and long, for instance in Breda, Sultan, Bearded d'Uccle bantams and Booted bantams.

Right: Breda cockerel.

Below left: Sabelpoot bantam.

Photos: Aviculture Europe.



In other breeds the vulture hocks are wanted soft, such as in Silkies and Cochins. Also Brahmas have vulture hocks, but they are preferably to be soft, although that differs a bit in the various countries.

The Brahma cock in the photo on the right is showing splendid foot feathers and vulture hocks that are soft enough to flow with the leg feathering and the soft feathering of the abdomen. Feathering like this can be obtained by selection.

Photo: Bobo Athes, who is also the breeder of this magnificent cock.

The vulture hocks are projecting backward from the heel joint, pointing toward the ground and parallel to the outer edge of the wings.

Although it is commonly believed that there are two independent genes for vulture hocks and feathered legs, it is also thought that you cannot have the vulture hocks without feathered legs.





Opinions differ on domination, as some have been able to observe a typical recessive behavior, but others say it is incompletely dominant.

Left: This Cochin pullet is an example of the extreme degree of leg and foot feathering.

Photo and breeder: Bobo Athes (Romania)

Brachydactyly (missing toe/toe part) - By

Autosomal incompletely dominant

Brachydactyly literally means 'shortness of digits', from the Greek *brachys* (short) and *dáktulos* (digit). This gene affects the 4th toe (outer toe), which in normal

chicken is about 10% longer than the 2nd toe (inner toe), and consists of 5 phalanges. In this anomaly, the outer toe is equal in length to the inner toe, or is even shorter. Homozygotes are missing several phalanges and often - but not always - also the nail. The extreme form is represented by only 2 phalanges with absence of the nail. Heterozygotes have minor anomalies. It seems that this is showing at a larger scale in the males than in the females.

Right: A young Marans bantam cockerel with a very short outer toe, without nail.

Photo: Dirk de Jong.

The malformation is already recognizable in the embryo of 9-10 days, and is more common in leg-feathered breeds such as Brahma and Cochin. Warren (1940) affirmed the existence of an inverse relationship between size and length of feathers on the 4th toe. Often the birds with best foot feathering are also those who have the 4th toe shorter.

Because of these correlations, Schmalhausen proposed only one gene as cause of the different phenotypes, hypothesizing that the growth of the feathers in legs can interfere with a normal development of the toe.

There is, however, another hypothesis. According to this one, the two traits are transmitted independently. In other words, there is no connection between the gene of leg feathering and the one related to the length of toes. Thus, it is suggested that these two characteristics have more in common with certain processes during embryonic life.





Left:
The extreme form is here represented by only two phalanges with absence of the nail. Photo: Dirk de Jong.

Going back to the first hypothesis, the idea that both traits (leg feathering and brachydactyly) are conditioned by the same gene cannot be excluded, since a better leg feathering seems to be the result of the two different loci being shared. Hence, it seems likely that one of the two genes of leg feathering is the same with the gene of brachydactyly.

Danforth went as far as stating that both the genes involved in leg feathering can cause brachydactyly.



Above: Another extremely short toe, this time with a little nail. This is a Marans bantam cockerel with only scarcely feathered legs. Photo Dirk de Jong.

Brachydactyly can be bred out. From test crosses we learned that only two crosses will produce homozygous normal toed birds: Heterozygous brachydactylous ($By/by+$) crossed with a homozygous normal ($by+/by+$) will produce 50% normal toed offspring. Heterozygous brachydactylous ($By/by+$) crossed with a heterozygous brachydactylous ($By/by+$) will produce 25% normal toed offspring; however, this cross should be avoided if you have access to normal toed birds.

In case the brachydactyly is deep into your line, you have to cross out to another line. Still it is obvious that to obtain the expected ratios resulting from the crosses as mentioned above, you will need to breed a large number of birds – or you just have to be lucky.