

CONCERNING POULTRY

BLUE EGG GENETICS UNSCRAMBLED

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Still taken from the DVD 'En la Ruta del Huevo Azul'

No doubt most of us have seen those strange-looking blue chicken eggs and marvelled at their strange appearance.

The egg colours in all birds are caused by ancient pigments called pyrroles. The two principal pyrroles are protoporphyrin - the pigment that brown chicken eggs have and biliverdin - a blue/green bile pigment (Igic, 2009). Just how the rare blue chicken eggs came about was previously unknown, however new research has discovered the truth behind the phenomenon.

Researchers from the University of Nottingham's School of Biology have found the real cause of the blue egg shells. By studying the genome of blue-egg-laying domestic chickens such as the Araucana, they were able to isolate a genetic mutation which causes the unique shell colour.

The scientists discovered that an ancient retrovirus had combined with the DNA of the original South American Mapuche fowls, resulting in the blue eggs.

A retrovirus carries its genetic code as ribonucleic acid (RNA) and reproduces itself in a host cell using a process known as reverse transcriptase - an enzyme which changes RNA into deoxyribonucleic acid (DNA). Once the conversion to DNA occurs, it is possible for the retrovirus to permanently insert its genetic code into the host DNA.





Above: Araucana. Photo: Archives AE-Anne Cushing, USA. Besides blue-shelled egg, two distinguishing characteristics of the Araucana breed are rumpless and tufts of feathers which protrude from each side of neck.

In the case of the South American chickens, this caused an increase of biliverdin - a blue/green bile pigment - to accumulate in the eggshells as they developed in the hen's body. The researchers found the retrovirus (*EAV-HP*) expresses on the *SLCO1B3* gene in the hen's oviduct and shell gland, possibly by influencing a particular oestrogen modulator which limits the effect to the reproductive system.



Above and right: Blue Araucana eggs and dark brown Marans eggs. The green ones are the result of crossing both breeds. Photo: Evert van Dijk.

By studying all the Gallus species Jungle fowls, the scientists were able to prove that the mutation occurred after chickens were domesticated by humans. Of course, when the blue eggs first appeared, astute breeders carefully bred the birds to fix the trait in future generations.



Above: The eggshell colour of homozygous blue-shelled, heterozygous blue-shelled and brown-shelled Dongxiang chickens. Blue eggshell colour exhibits an autosomal dominant inheritance and eggs laid by homozygotes are a darker blue than those from heterozygotes.

Another study in 2012, found the same effect in Dongxiang and Lushi chickens from China (Wang, 2013).

Right: The Dongxiang Blue Egg Chicken is an ancient indigenous chicken breed from Dongxiang town, Jiangxi province of China. They have a single comb and black skin, muscle and bone and usually come in black plumage. They are a small dual purpose bird with cocks weighing about 3 ½ lbs. and the hens weighing about 3 lbs. The original heritage breed of Dongxiang chicken is currently maintained in a Conservation Farm. Hybrid blueshell layers are raised for commercial production.



Photo: www.dxlkd.com



Left and below: Lushi chicken is another local breed laying blue eggs, from Lushi town, Henan province of China. Their history can be traced back to the Zhou Dynasty. Lushi chicken has not been systematically bred, so feather colour does not show homogeneity; 80% is black red; others are white or yellow.



Although historically selected for their blue eggs, the blue eggshell phenotype has not been fixed in these breeds, which still produce brown eggs at low frequency. Photos Lushi Fowl: China Wikipedia www.86wiki.com

Both studies found the retrovirus insertions affected the DNA of unrelated flocks from different parts of the world, however the results showed distinct differences between the Chinese and South American breeds, proving that both mutations had occurred independently of each other.

The comparisons then made with blue egg-laying hens in Europe found that the ancestors of those flocks had originated in South America.

The researchers noted that blue eggs are common across many avian species, and suggested that further study may show retroviruses play an important role in the diversity of egg colours in birds.

There is no doubt however, that for as long as humans continue to breed chickens for unusual traits, the *EAV-HP* retrovirus will stay in the genome, continuing to give us those wonderful blue eggs.

Note: The effect of endogenous retrovirus (ERV) on hosts is extensive. It can also cause some phenotype variants, such as recessive white (Chang et al. 2006), henny-feathering mutation (Matsumine et al. 1991), and the sex-linked late-feathering mutation (Bacon et al. 1988).

See explanation of 'retrovirus' on <http://en.wikipedia.org/wiki/Retrovirus>

References

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