

# Why some cuckoos lay blue eggs

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This reed warbler suddenly has a big mouth to feed. But the cuckoo chick has pushed the warbler's offspring out of the nest. Credit: Per Harald Olsen, NTNU

Cuckoos are nest parasites, meaning they lay their eggs in other birds' nests. The female cuckoo has to lay eggs that mimic the color, size and shape of the eggs of the host bird. Using a massive data set, including data from museum eggs that are over 100 years old, researchers from the Norwegian University of Science and Technology (NTNU) have figured out how the ability to lay blue eggs is inherited.

For roughly a century, researchers have been trying to figure out how different female [cuckoos](#) manage to lay such a variety of different egg colors to match different host birds. Now, a group of researchers at the Norwegian University of Science and Technology (NTNU) has come up with an answer to this puzzle, in cooperation with researchers from all over Europe and Asia.

The short answer is that "the female bird decides everything," says researcher Frode Fossøy.

Fossøy is part of the cuckoo research group at the Department of Biology at NTNU. The results of the group's work have just been published in *Nature Communications*.

"We've been able to show for the first time that the blue egg color is inherited via the female cuckoo only. The father has no effect on the color of his daughter's eggs," says Fossøy.

Researchers have investigated a wide variety of samples from Europe and Asia. They found a clear relation between blue eggs and genetic

material that only comes from the mother (mitochondrial DNA), and no relation between egg color and genetic material that comes from both parents (nuclear DNA).



This illustration shows the wide variety of colours and patterns in eggs laid by cuckoos. Cuckoo eggs may be slightly different in size to a host bird's eggs, but otherwise it is almost impossible to tell the difference, especially for humans.  
Credit: NTNU

Cuckoos (*Cuculus canorus*) are parasitic. Female cuckoos lay their eggs in the nests of other bird species, as is well known.

The young cuckoo then usually throws the other chicks out of the nest, getting rid of any competition for the parents' attention.

Potential host birds develop traits to prevent being tricked by the parasites—they get rid of eggs that don't look like their own. To avoid this, female cuckoos need to lay eggs that look identical to that of the host bird's, both in color and shape.

This means that there is a sort of evolutionary arms race going on between cuckoos and host birds, where cuckoo eggs come to resemble that of their host birds' more and more over time.



Different cuckoos can therefore lay eggs of many different colors and patterns. They can be blue, brown, green or grey, and have different combinations of spots and patterns. But each individual female cuckoo can only lay eggs in one color, so different females specialize on different host species. This is part of the reason why egg color is a trait inherited only from the [female birds](#).

## **Males may make a mess of things**

The research group doesn't have definitive proof that all egg characteristics are inherited from the female bird, just that blue eggs are. Whether other egg colors are also only inherited via females is currently not known.

There has been speculation that cuckoos that lay blue eggs may actually be a different species, but no other characteristics indicate this. The nuclear DNA of the birds that lay blue eggs is the same as any other cuckoo—meaning that the species is the same.

A single male cuckoo can mate with several female birds that lay eggs of different colors. This could make a mess of things. If a male with genes for one color mated with a female with a different egg color, their daughter's eggs could be an intermediate color that doesn't match any host, meaning that host birds would be able to spot the difference and get rid of the parasitic egg.



This marsh warbler has a cuckoo chick in its nest. It was undoubtedly unable to differentiate between the cuckoo egg and the rest of the eggs in its nest. Credit: Per Harald Olsen, NTNU

For this reason, there are evolutionary advantages for both the male and female birds that only females carry the genetic trait for egg color. That way, their offspring will have a much greater chance of surviving.

## Sex chromosomes

Egg color traits are therefore most likely connected to the bird's sex chromosomes. In birds, these are the W and Z chromosomes (similar to X and Y in mammals).

Male birds have a ZZ chromosome pair, while females have a ZW pair. In other words, only female birds have W chromosomes. Thus, if the gene for blue egg color is located on the W chromosome, this gene will

be inherited unchanged from mother to daughter.

Another possibility is that egg color is connected to mitochondrial DNA, or mtDNA, which is also inherited only from the mother.

## **100 per cent certainty**

Using a massive data set, including data from museum eggs that are over 100 years old, the researchers have been able to conclude with 100 percent certainty that blue egg color is inherited solely from the mother.

As a biologist, it isn't often you can come to a conclusion with 100 percent certainty. But this is an exception.

## **Spread from Asia**

The researchers' results have mainly come from Finland, and cuckoos that lay eggs in redstart (*Phoenicurus phoenicurus*) nests, as well as material from blue eggs in China.

The blue egg color has most likely originated in Asia.

"It happened about 2.6 million years ago," Fossøy explains.

This trait was developed so long ago that four new species of cuckoos have evolved after blue eggs appeared.

The blue egg trait thereby spread from Asia west to Europe, as female birds mated with local males and found local hosts to trick with their blue eggs. Because blue eggs are inherited only from female birds, this geographic spread hasn't affected egg color.

## More work ahead

Just a few years ago, Fossøy published a study of three species of cuckoos in Bulgaria that indicated that male birds could affect egg colors. While the trait for blue eggs is certainly only inherited from female birds, this may not be the case for other colors.

**More information:** Frode Fossøy et al. Ancient origin and maternal inheritance of blue cuckoo eggs, *Nature Communications* (2016). [DOI: 10.1038/ncomms10272](https://doi.org/10.1038/ncomms10272)

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