How the chicken lost its penis

Molecules that signal cell death quash nascent rooster genitals.

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The case of the missing bird penis is a long-standing mystery in evolutionary biology. But the identification of a molecular mechanism that controls penis loss in birds goes some way to solving this conundrum.

Roughly 97% of avian species sport little or nothing in the way of a phallus, despite reproducing by internal fertilization. A study published today in *Current Biology*¹ shows that the development of chicken penises is cut short by signals that promote cell death.

"This paper would be in *Nature* or *Science* if it were about people," says Richard Prum, an evolutionary ornithologist at Yale University in New Haven, Connecticut. "The whole result is entirely novel."

Male chickens, which possess only a rudimentary phallic nub, pump their sperm into females using a 'cloacal kiss' — a move that presses together the male and female cloacas, openings used for waste excretion and copulation. By contrast, ducks boast large and elaborately coiled penises that can measure about half the length of their bodies².

To better understand the signals that control penis growth, researchers led by Martin Cohn, a developmental biologist at the University of Florida in Gainesville, looked for differences between developing duck and chicken embryos.



Rooster genitals are an evolutionary puzzle.

Up close and personal

The scientists watched penile development through tiny windows cut into duck and chicken eggs. They found that chickens initially form penises similar to those of ducks, but that on about the ninth day of development, the nascent chicken penis — called a genital tubercle — stops growing and begins to shrink.

"We expected to find some critical outgrowth factor was missing," says Cohn, but the team discovered that many of the same genes that drive penis growth in ducks continued to be strongly expressed in chickens. There is a key difference between the two species, however. Chickens showed increased levels of Bmp4 — a protein that promotes cell death — near the tip of the tubercle. "We were very surprised," Cohn says.

Researchers were able to stave off genital cell death in chickens by treating one side of the tubercle with Noggin, a protein that blocks Bmp activity. After a day, the Noggin-treated side grew to about 6.5 times the length of the untreated side. Treating one side of growing duck tubercles with Bmp4 resulted in localized cell death and penis shrinkage, mimicking normal genital development in male chickens.

The results suggest that genital growth in birds is controlled by a common programme that has been customized by evolutionary tweaks in Bmp signalling, the authors say.

But the data do not explain why chickens shed their penises. Cohn suggests that phalluses may have been lost as a secondary consequence of evolution in other body parts such as limbs and teeth, the development of which is also affected by Bmp proteins.

Bob Montgomerie, an evolutionary biologist at Queen's University in Ontario, Canada, disagrees. He and others have suggested that because the cloacal kiss requires cooperation between willing partners, female chickens and other birds may have selected males with

smaller penises in part to escape forced copulation. Over time, that preference would have reshaped the genitalia of male birds.

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References

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