How fancy pigeons grow feathery feet

Feral pigeons (*Columba livia domestica*), also known as rock doves, are often disparaged within urban areas as pests or vermin, but their domesticated cousins, known as 'fancy pigeons', are considered prize animals, bred and shown for their distinctive characteristics. Breeds are distinguished by many characteristics, including the presence or absence of 'muffs', or feathering on their feet.

Foot feathering is an uncommon trait among bird species, and most birds have scaly feet. Some raptors and boreal birds have feathered feet, and among chickens and pigeons, birds can have feathery or scaly feet, depending on their breeds. This intraspecific variability presents an opportunity for scientists to explore how breeding and genetics effect discrete changes in phenotypes.

Building on the defined and pedigreed history of pigeon breeding, biologist Mike Shapiro (University of Utah, Salt Lake City) and colleagues investigated the molecular basis for why some breeds have feathered feet and others have scales (*eLife* **5**, e12115; 2016). To narrow down some target chromosome regions, they crossed a muffed breed, the Pomeanian pouter, with a scaled breed, the Scandaroon, and analyzed the genomes of second-generation offspring. They also carried out whole-genome scans and analysis of a variety of feather- and scale-footed birds. From these analyses, Shapiro *et al.* identified that foot feathering hinges on regulation of two genes, *Pitx1* and *Tbx5*. These genes are generally involved in the development of forelimbs and hindlimbs, respectively, which suggests that feathering accompanies broader changes in limb development and identity.

In agreement with this finding, when they examined muscular and skeletal morphology they noticed discernible differences in that of muffed pigeons. In a press release, Shapiro explained that feathered feet express some characteristics that one might find in a forelimb: "It's not a complete transformation of a leg into a wing. Rather, components of the leg are more winglike, including feathers and a larger leg bone."

As Shapiro and his coauthors note in their manuscript, these findings suggest that

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"limb-type identity is not a simple binary choice between two global fates" but rather a complex state that develops from a variety of factors, including regulation of *Pitx1* and *Tbx5*. Now that they've pinpointed the sequences that mediate feathering in feet, Shapiro notes that future efforts could use pigeons to home in on how skin knows to develop scales or feathers. Such questions might someday even reveal how saurian ancestors first developed feathers from a scaly reptilian epidermis.

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MINIMALLY INVASIVE BRAIN RECORDINGS WITH A 'STENTRODE'

Long-term intracranial electrode implants have become a crucial tool for measuring and manipulating neural activity in patients that suffer from neurological disorders ranging from Parkinson's disease to seizure disorders and spinal cord injuries. Traditional implants, however, require invasive surgical approaches, such as open craniotomies, which can cause brain trauma, chronic inflammation and disruptions to the blood–brain barrier. Additionally, these invasive approaches limit the placement of electrode arrays to superficial areas of the brain. To circumvent these obstacles, a team led by Thomas Oxley at Melbourne University (Australia) has developed an endovascular stent-electrode array (the 'stentrode') that enables stable long-term recordings in the brain using a minimally invasive surgical approach (*Nat. Biotechnol.* **34**, 320–327; 2016). With this new stentrode, which they implanted in freely moving sheep, the research team reports successful recordings of cells in motor cortex for 190 days.

Oxley *et al.* developed their endovascular electrode array using stent technology that is currently in clinical use. These self-expanding stents served as a scaffold to which 750-μm platinum electrode discs were attached as recording contacts. To ensure that the stents maintained their superelastic properties, which allow them to conform to various blood vessel sizes and shapes, the platinum discs were attached at repeating stent strut cross-links and separated by 2.5 mm. The self-expanding stents were compressed for minimally invasive delivery through a catheter and guided into the superior sagittal sinus immediately adjacent to the motor cortex. The researchers had to overcome several difficulties inherent to catheterization of the cerebral vascular system, including maneuvering the stentrode through valves, chordae and arachnoid granulations. They confirmed placement of the stentrode near the motor cortex using MRI and post-implantation computerized tomography.

Long-term stability of stents depends on their incorporation into the walls of blood vessels, so Oxley *et al.* monitored incorporation of the stentrode using x-ray imaging and impedance measurements from the platinum electrode discs. This monitoring suggested that stents had indeed been successfully incorporated within vessel walls. The researchers assessed the electrical recording properties of successfully implanted stentrodes using cortically generated evoked potentials and by measuring baseline electrical activity under awake and anesthetized conditions. They also found significant improvements in the number of electrode discs with measureable electrical responses over the course of a one-month testing period. This improvement in recording quality over time, combined with the minimally invasive catheterization procedure for implantation, makes the stentrode an exciting new technology for long-term intracranial recordings with important potential clinical applications.

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