

# Closer look at emperor penguin feathers dispels popular folklore notions

October 21 2015, by Bob Yirka



Feather types of emperor penguins: tail feather, or rectrice (1); dorsal, base of the tail (2); dorsal, base of the leg, or leg fringe (3); ventral, base of the leg, or

leg fringe (4); dorsal contour (5); ventral contour with afterfeather attached (6); fringe of brood patch (7); distal, dorsal primary—double-layered with a dorsal and ventral primary (8); dorsal primary (9); ventral primary (10); dorsal primary (11); dorsal secondary (12); ventral secondary (13); dorsal covert (14); ventral covert (15); leading edge covert (16); skull (17); auricular patch contour (18); dorsal neck contour (19); ventral neck contour (20); dorsal plumulaceous (plumules) (21); ventral plumulaceous (22). See Rutschke [1] for further details on specialized feather morphology. Credit: *Proceedings of the Royal Society B*, Published 21 October 2015. DOI: 10.1098/rspb.2015.2033

(Phys.org)—A trio of researchers, Cassondra Williams, of the University of California, Julie Hagelin, of the University of Alaska and Gerald Kooyman with the Scripps Institute of Oceanography, has found that contrary to popular notions that emperor penguins have the densest outer feathers, they actually don't, and that they also have different types of feathers that other researchers have said they don't. In their paper published in the journal *Proceedings of the Royal Society B*, the team describes their study of penguin feathers on penguins that had died naturally and what was revealed by their efforts.

For many years it has been said that emperor penguins are able to withstand the extremely cold and harsh Antarctic environment because they have more feathers per square inch than any other bird, but when the researchers with this new project searched the literature, they couldn't find any studies that had actually shown this to be true, so they decided to conduct a study of their own.

The study consisted of first plucking feathers from penguins that had died naturally—they'd been collected by other researchers and stored in freezers—and then by cutting off feathered areas to count the number of shafts that remained. In so doing, they discovered that [emperor penguins](#) do not have the densest feather coat—at roughly 9 per square centimeter,

they lagged far behind birds like the white-throated dipper. Furthermore, they found that the birds had more types of feathers than have been documented. Underneath the visible contour feathers, they found after-feathers, which are downy-looking feathers that attach to the contour feathers. They also found plumules, which are also downy-looking feathers, but they attach directly to the skin—the penguins had approximately four times as many of them as they did contour feathers, suggesting that they serve an important role in helping keep the bird warm and dry in all kinds of cold and wet conditions. And that wasn't all, after looking even closer (with a microscope) the researchers found filoplumes, a type of microscopically small feather—they have barbs on them—in birds that fly they are used to alert their host to the need for fixing plumage that has become disheveled.

The study shows that common ideas about emperor feathers are not correct, and that much more research will need to be done to find out how the combination of [feathers](#) allows penguins to keep water away from the skin when diving in icy water and cold air out when standing in sub-zero conditions.

**More information:** Hidden keys to survival: the type, density, pattern and functional role of emperor penguin body feathers, *Proceedings of the Royal Society B*, Published 21 October 2015. [DOI: 10.1098/rspb.2015.2033](#)

### **Abstract**

Antarctic penguins survive some of the harshest conditions on the planet. Emperor penguins breed on the sea ice where temperatures drop below  $-40^{\circ}\text{C}$  and forage in  $-1.8^{\circ}\text{C}$  waters. Their ability to maintain  $38^{\circ}\text{C}$  body temperature in these conditions is due in large part to their feathered coat. Penguins have been reported to have the highest contour feather density of any bird, and both filoplumes and plumules (downy feathers) are reported absent in penguins. In studies modelling the heat transfer

properties and the potential biomimetic applications of penguin plumage design, the insulative properties of penguin plumage have been attributed to the single afterfeather attached to contour feathers. This attribution of the afterfeather as the sole insulation component has been repeated in subsequent studies. Our results demonstrate the presence of both plumules and filoplumes in the penguin body plumage. The downy plumules are four times denser than afterfeathers and play a key, previously overlooked role in penguin survival. Our study also does not support the report that emperor penguins have the highest contour feather density.

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