Could smell play a role in the origin of new bird species?

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An IU Bloomington researcher collects preen oil from a junco's uropygial gland into a small glass tube. The procedure is painless. Credit: Jonathan Atwell

Two recently diverged populations of a southern California songbird produce unique odors, suggesting smell could contribute to the reproductive isolation that accompanies the origin of new bird species. The Indiana University Bloomington study of organic compounds present in the preen oils of Dark-eyed Juncos is described in this month's *Behavioral Ecology*.

"There's so much we don't know about the role of smell in bird behavior," said biologist Danielle Whittaker, the study's lead author. "Differences in smell could be affecting sexual behavior, parental care and even contribute to speciation."

Whittaker is a postdoctoral researcher in IU Bloomington biologist Ellen

Ketterson's research group.

Led by Whittaker, a team of IU Bloomington biologists and chemists examined the chemical composition of preen oil, which is a compound birds secrete and spread around their bodies to straighten, protect and waterproof their feathers. To analyze the odor chemistry of preen oil, the scientists isolated 19 volatile molecules that can achieve a gaseous, more sniff-friendly state. The chemical isolation and analysis portion of the interdisciplinary project was led by IU Bloomington Department of Chemistry Distinguished Professor Milos Novotny and Senior Scientist Helena Soini.

The scientists found that each junco possesses a unique and recognizable odor profile that was stable over a two-week period and that could be used to distinguish it from other individuals. The odor profiles of male birds differed from those of female birds, and birds' odor profiles differed depending on which population they were from.

"This is the most comprehensive study of its kind," Whittaker said. "And as far as we know, it is the first time anyone has looked closely at these chemical compounds at the population level in any bird."

Last year, Whittaker, Ketterson, and others reported in the *Journal of Avian Biology* that juncos can use preen oils to distinguish members of their own species from other species, and between individuals of their own species. The present Behavioral Ecology study went a step further to see whether the chemical composition of preen oil varies among individuals, sexes and populations -- which might be meaningful in an evolutionary context.

The team collected juvenile juncos from two populations, one that resides in and around the University of California San Diego campus in La Jolla, Calif., and another that lives in the Laguna Mountains, about 42

miles east. After capture, the birds were transported to aviaries in Bloomington, Ind., and raised under identical environmental conditions. The scientists used gas chromatography-mass spectrometry to isolate 19 volatile compounds from the preen oils which are secreted from the birds' uropygial glands near the base of the tail.

The researchers confirmed that individual birds sampled over time produce levels of each of the volatile compounds that remain more or less constant. They also found gross differences between males and females, and between juncos from the UC San Diego population and birds from the mountains. These population differences were found even though the birds were raised in identical conditions, suggesting that the odors have a genetic, rather than an environmental or developmental basis.

The particular suite of 19 compounds is, as far as the scientists know, unique to juncos. However, this area of research is so new that odor chemistry profiles have been documented for only a few species. This field of research is growing rapidly as biologists realize the potential importance of scent in bird communication and evolution.

Until just a few years ago, most bird biologists believed that smell played little or no role in bird behavior. The olfactory bulb -- a portion of vertebrate brain known to interpret odors -- is small relative to birds' brain sizes. Birds also lack the vomeronasal organ that many mammals (and reptiles) use to sense pheromones specifically.

Then came the discovery that sea-faring petrels can smell so well that they can identify other birds through sense of smell alone. This discovery kicked off a re-examination of several bird species, and preliminary results suggest smell in birds is a behavioral cue that has been overlooked for far too long.

"We still don't know how common it is for birds to use smell," Whittaker said. "The evidence so far suggests there is much for us to learn."

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