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Two Birds, One Song: Evolution at Work

by Jesse Richardson-Jones

Sometimes it pays to be a copycat — or copybird, as the case may be. You might not think it would make life easier for two birds to sing exactly the same song, but that's exactly what works for two species of antbirds in South America. Scientists Joseph Tobias and Nathalie Seddon at the University of Oxford studying the two types of birds — *Hypocnemis peruviana* and *Hypocnemis subflava* — recently reported in the journal *Evolution* that the two species have evolved to whistle the same tune while living in close proximity to each other. The birds have done it through a process called convergent evolution. Now their songs are so similar that even the birds themselves can't tell who's doing the singing.

Forest Rivalry

Antbirds are about 4-5 inches (10.2 to 12.7 centimeters) tall, with brownish backs and yellow or white chests. They are not particularly sociable birds: they live in pairs of two — a male and a female — and like to keep a reasonable distance from other pairs. In the dense undergrowth and bamboo forests of Peru and Bolivia where both *H. peruviana* and *H. subflava* live, the competition to find enough insects to eat is intense, which is why each pair lives and hunts for food in a well-defined territory of about a third of a square kilometer (0.2 square miles).

Courtesy of Joseph Tobias

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***H. subflava* (left) and the white-breasted *H. peruviana* (right).**

Naturally, when one bird encounters another inside its territory, things can get ugly. Antbirds signal to each other that they've crossed the line by singing a special territorial song — a sort of "Keep out!" For most species of bird, the song has unique characteristics that help to identify the singer, even if the birds can't see each other in the dense forest. This is where *H. peruviana* and *H. subflava* are different from other birds. Tobias and Seddon recently discovered that these birds have started to sing the identical song when their territory is threatened — in effect, making it so that they cannot tell each other apart.

Friend or Foe

Why is it usually important for bird species to be able to tell each other apart? To understand why it's so rare for two birds to sing the same song, it's important to know a little about what usually drives the evolution of social signals like birdsongs.

Evolution, or the process by which species change from generation to generation, favors "fitness" — traits that increase the ability to survive and breed. For social signals like birdsong, having different signals in different species usually increases fitness. This is true for a number of reasons. First, if one species resembles another species too much, they might start breeding together. This usually results in nonproductive hybrids (think, mules) and is a waste of resources. Second, the two species might waste energy fighting with each other over unshared resources because of the confusion. For example, if you're a bird that eats insects, you probably won't care if a bird that eats berries wants to forage in your territory. But if another insect-eater comes inside, you need to know so that you can warn them away and defend your food supply. This is usually accomplished by different species evolving different social signals so that everyone can tell who everyone else is.

Courtesy of Joseph Tobias

The white breasted male Peruvian antbird (*H. peruviana*) sang back to the loudspeaker playing an *H. subflava* territorial song, just as it would have done if it had heard a bird of its own species.

Tobias and Seddon tested whether *H. peruviana* and *H. subflava* could distinguish between each other's songs by playing recorded songs through a loudspeaker and watching how the birds reacted. If they played an *H. subflava* territorial song, *H. peruviana* would sing back to the loudspeaker and behave aggressively just as it would if it had heard a bird of its own species. The same was basically true for *H. subflava* listening to an *H. peruviana* song. They really couldn't tell each other apart.

But if species usually need to be able to tell each other apart, then why all the confusion in this case? The similarity between the songs might make sense if the birds were actually competing for the same resources and territory. This is exactly what Tobias and Seddon think has happened.

Overlapping Worlds

As it turns out, *H. peruviana* and *H. subflava* have territorial ranges that partially overlap. Where the birds live in the same place, and are competing for territory, they are said to be living in *sympatry*; where they live separately, they are said to be living in *allopatry*.

Courtesy of Joseph Tobias

Seddon (left) and Tobias study signal evolution and speciation in tropical birds in the Amazon rainforest.

Tobias and Seddon hypothesized that the *H. peruviana* and *H. subflava* that live in sympatry — i.e., close to each other and interacting frequently — were the ones that had evolved the same territorial songs because they were competing for the same territory. They tested this hypothesis by addressing three questions: 1) whether the birds had territorial songs that were more similar to each other than their other songs, 2) whether the birds that interacted, living in sympatry, had more closely related songs than those who never saw each other, and 3) whether the similarity in the songs could be explained simply by how closely related to each other the two species were.

Selective Pressure

To answer the first question, the scientists relied on the fact that both species of birds use songs for different purposes. While some songs are aggressive — i.e., are used to warn other birds away — other songs are used for non-territorial reasons. If *H. peruviana* and *H. subflava* had evolved similar territorial songs because of competition for territory, it would make sense that only their territorial songs would be similar; there would be no evolutionary advantage for non-territorial songs to be affected. In fact, this is exactly what the scientists found. Non-territorial songs were far less similar between the two species.

Familiarity Breeds Contempt

To examine the question of direct interaction and rivalry, the scientists relied on the fact that some pairs of *H. peruviana* and *H. subflava* live in *sympatry* — in overlapping regions — while others live in *allopatry* — in non-overlapping regions. If frequent fights over territory were responsible for making the songs so similar, then birds that lived in allopatry and had no interspecies contact should have less similar songs. Again, this is exactly what the scientists observed. *H. peruviana* and *H. subflava* that never interacted with each other had less similar territorial songs than those that lived in sympatry and directly competed for territory. This suggested that frequent territorial disputes had a big effect on song similarity.

It's Not Just Genes

Finally, Tobias and Seddon wanted to make sure that *H. peruviana* and *H. subflava* didn't just sing the same song because they were genetically related. To test this, they examined the degree of genetic similarity between the two species, and also — for control purposes — compared songs and genes of two other species of antbirds in the region. The results indicated that the similarity of the songs between *H. peruviana* and *H. subflava* couldn't be accounted for by genes alone. This means that there has to have been some evolutionary advantage for the birds to have started singing the same song.

A Common Language

Tobias and Seddon reason that singing similar songs makes for more reliable identification of competitors. Given the high degree of interaction between the two species, if they sang different songs, the chances that one might misunderstand another would increase. This might lead to more territorial fights than necessary, and decrease the overall fitness of the birds. As it stands, *H. peruviana* and *H. subflava* only have to be able to identify one song that means "Keep out!" And it seems that this is simply easier to do.

This tale of two antbirds is exciting to scientists for two main reasons: first, it's a relatively rare case where species become more similar over time instead of more different — called convergent evolution. Second, it's an even rarer case where social signals are shared by two separate species. Tobias has likened it to humans and chimpanzees speaking the same language while arguing over food. While this might seem a little far-fetched, imagine if we routinely had to fight with another species over resources that we both needed. After a while, speaking a common language might make sense.

Tobias and Seddon think that their work points to the fact that evolution toward shared traits between species might be more common than people now think. Although there are very few documented cases of interspecies convergence, some scientists believe that this is simply because we haven't been looking hard enough or at the right species. In the end, studies like this one may provide the motivation to reconsider the way we think about evolution.

Joseph Tobias: Rethinking Evolution in the Amazon

Joseph Tobias currently is a lecturer in the department of zoology at the University of Oxford, England. Prior to joining the Oxford faculty in January 2009, Tobias earned a Ph.D. from Cambridge University in 1996 and worked as a research biologist for BirdLife International and the International Union for Conservation of Nature (IUCN), co-authoring a series of action plans and books. Since January 2006, he has been a member of the Edward Grey Institute of Field Ornithology (EGI). For the last few years, Tobias has worked closely with ornithologist Natalie Seddon.

Tobias does research in "evolutionary ecology, with a particular focus on speciation and the evolution of signals and signaling behaviour in tropical birds." He is particularly concerned with four things: the "role of sexual and ecological selection in signal evolution and speciation; evolution of dichromatism and communal signals; processes underlying patterns of abundance and species richness; and avian taxonomy/systematics, and conservation of threatened species."

Below are Tobias's October 9, 2009 responses to questions posed to him by Today's Science.

Courtesy of Joseph Tobias/University of Oxford

"As a biologist, I travel to remote corners of the Amazon to watch birds, I analyze data with quantitative skills, write papers with writing skills, and give lectures and seminars using public speaking skills. The tasks involved are many and varied, and leave no room for apathy or boredom."

Q. When did you realize you wanted to become a scientist?

A. I wanted to become an ornithologist at about age 12. After my Ph.D. I spent several years wondering whether I really did want to be a scientist, and trying my hand instead as a conservationist and a freelance writer. But my interest in science kept coming to the fore in the shape of unanswered questions, and now I can't imagine doing anything else.

Q. How did you choose your field?

A. I chose my field first and foremost because I love natural history, wildlife, and working in wild places, particularly in the tropics. As time has gone by I have become more interested in understanding the ecological and evolutionary forces that combine to shape species and the biological communities they impact, and it is that passion that drives me now.

Q. Are there particular scientists, whether you know them in person or not, that you find inspiring?

A. Biologists are an interesting bunch. I find a lot of them inspiring. I am inspired by those whose fascination in ecology and evolution has led them to spend decades in the field, carefully gathering data to answer big questions; people like John Terborgh, Peter and Rosemary Grant, Jonathan Losos. [See Evolution's Poster Children: Galapagos Finches Change Their Beaks, August 2006; Songbird Declines May Affect Forest Growth, January 1995]. At the same time, I am inspired by biologists that never look for the easy route to the incomplete answer, but instead use careful thinking and elegant experimentation to disentangle complex problems, and in that category I would include the likes of Nick Davies and Dolph Schluter. [See The Biology of Better Beaks, October 2004; Duped Birds Heed The Cuckoo's Call, September 1998].

Q. When you tell people you study bird song evolution, what is their reaction? What do you think is the biggest misconception about your profession?

A. Many people are fascinated by birds and bird song, so the reaction is normally positive. A common misconception is that I might be able to revive their ailing parrot.

Q. Some animals can understand the warning cries of animals of other species, even very different kinds of animals. Why in this case did the two species evolve their (territorial) songs to be the same, as opposed to developing the ability to recognize each other's songs?

A. Recognizing a warning cry from another species and diving for cover is of clear benefit to the receiver, but this is more a kind of 'eavesdropping' and doesn't benefit the signaler in any way (who is signaling to its own species, and its own relatives in particular). The situation is different in our system, because territorial songs are deterrent signals, so it is not just receivers that benefit from recognizing the signal, but signalers that benefit from using a signal that is most easily detectable and identifiable. In conditions of interspecific competition, convergence in signals might therefore be expected because it maximizes the success of territory holders not only in deterring territorial rivals from their own species, but from a second species as well.

Q. Where do you spend most of your workday? Who are the people you work with?

A. For part of the year I am stuck in an office most of the day, and for another part I am in the rainforest.

Q. What do you find most rewarding about your job? What do you find most challenging about your job?

A. I like the variety, the people, the intellectual challenge, the adventure. As a biologist, I travel to remote corners of the Amazon to watch birds, I analyze data with quantitative skills, write papers with writing skills, and give lectures and seminars using public speaking skills. The tasks involved are many and varied, and leave no room for apathy or boredom. Even teaching, which I used to find the most unwelcome part of the job, is now in some ways also the most satisfying.

Q. What has been the most exciting development in your field in the last 20 years? What do you think will be the most exciting development in your field in the next 20 years?

A. To me, the development of genetic techniques for uncovering evolutionary history has been the most exciting advance of recent years. Over the last few years we have started to uncover the tree of life, which is raising a lot of key questions about how lineages evolve. Most excitingly, it also provides us with the tools to answer those questions.

Q. For young people interested in pursuing a career in science, what are some helpful things to do in school? What are some helpful things to do outside of school?

A. Read books by the old masters. If you are interested in evolution or nature, you could do worse than reading the tales of [Alfred Russel] Wallace, [Theodosius] Dobzhansky, [Ernst] Mayr. If you like more modern writing, then go for science writing like *Tropical Nature* by Adrian Forsyth or the *Beak of the Finch* by Jonathan Weiner. [See Finches' Beaks Evolve Rapidly in Galapagos, September 1994].

Most importantly, if you want to be a biologist, spend time in the field and learn about nature. That knowledge will provide you with intuition, which while not foolproof, can often guide you more faithfully than books towards the right questions, and the right answers.

Discussion Questions

Tobias and Seddon argue that their study provides good evidence that the birds' songs are similar because of convergent evolution, driven by interspecies competition for resources. Can you think of another reason that two birds might happen to sing the same song? How might you investigate this possibility?

Journal Abstracts and Articles

(Researchers' own descriptions of their work, summary or full-text, on scientific journal websites).

"Signal Design and Perception in *Hypocnemis* Antbirds: Evidence for Convergent Evolution via Social Selection." www3.interscience.wiley.com/ journal/ 122526544/ abstract.

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