Savanna habitat drives birds, and perhaps others, to cooperative breeding

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Delaying having kids to help raise the offspring of others seems like a bad choice if you want to reproduce, but many African starlings have adopted this strategy to deal with the unpredictable climate of their savanna habitats, according to a new study by University of California, Berkeley, and Cornell University biologists. It appears in the Aug. 21 issue of the journal *Current Biology*.

This behavior, called cooperative breeding, is typical of many animals, from insects and shrimp to birds and even humans, but the reasons underlying its evolution and distribution among such a wide array of species have been unclear.

In the new study, behavioral ecologist and evolutionary biologist Dustin Rubenstein, a Miller Fellow in the Department of Integrative Biology and the Museum of Vertebrate Zoology at UC Berkeley, looked at the complete group of African starlings and found that all of the cooperative breeders among these birds live in savannas - highly seasonal habitats with great variation in rainfall, and thus food, from one year to the next. The species that do not engage in cooperative breeding are found mostly in forests, which have more reliable annual food resources.

"Faced with an uncertain and unpredictable environment, it pays evolutionarily to live and breed in social groups that will help you weather the bad times and make the most of the good times," he said. "Living in cooperative family groups may be like a form of insurance against the unpredictable nature of the environment, because it allows

individuals to maximize their reproductive success over the course of their lifetimes."

Cooperative breeding is defined as one member of a group delaying breeding to assist another breeding couple. Because cooperative groups in most birds consist of extended families with grandparents, parents, offspring and other close relatives, helpers are typically related to the group members. Among most birds, females leave the group to try to breed elsewhere, so it is the males who often hang around for a year or two as helpers, primarily bringing food to the nestlings. Although they may occasionally breed with females in the group, the helpers often don't reproduce until later in life.

Helping relatives feed their kids increases the chances of passing on some of your genes, since siblings share a large proportion of their DNA. Yet, despite decades of research, it is still not clear why some animal species, including nearly 10 percent of bird species worldwide, show this apparently altruistic behavior, while other closely related ones do not.

In an attempt to answer this question, Rubenstein looked at the 45 species of starlings endemic to Africa to see if there was any relationship between cooperative breeding and the environment in which the birds live.

"Starlings are a model system in which to test this question because they are one of the most socially diverse groups in the world, exhibiting a wide range of social systems and living in a variety of different habitats across Africa," said Rubenstein.

Of the 117 known starling species worldwide, those in Africa, where savannas are extremely common, are the only ones known to engage in cooperative breeding. Those in the more temperate or jungle

environments of Europe, Africa and Asia, including the European starling Sturnus vulgaris introduced to America, do not.

For much of the past decade, Rubenstein has intensively studied the social behavior of a variety of starling species in Kenya, home to 26 species - the most of any country in the world. Noting an apparent correlation between cooperative breeding and habitat in this family, he decided to use this socially diverse group to test several hypotheses about how environmental factors may have influenced the evolution of cooperative breeding.

Rubenstein and colleague Irby J. Lovette, director of the Fuller Evolutionary Biology Program at the Cornell Laboratory of Ornithology in Ithaca, New York, constructed a family tree of the African starlings using DNA from samples they captured on expeditions to Africa, from birds housed in zoos and from museum specimens. They used this evolutionary tree to determine whether specific lineages were associated with savanna or non-savanna habitats.

"What's important here is how many times behavior changed," said Lovette. "If you find the same pattern consistently repeated, you can be confident of cause and effect. In this case, we found cooperative breeding evolved when different starling species moved from forests to savannas."

The researchers found that more than one-third of the African starlings are cooperative breeders, and all live in savanna environments - semi-arid grasslands characterized by unpredictable rainfall patterns. In contrast, they found that most of the non-cooperative species live in forests, which are much more predictable and stable environments.

"If we saw just a single evolutionary origin of the behavior and a single switch in habitat, it would be very weak evidence of a relationship

between these factors. But we found that cooperative breeding and habitat changed repeatedly in the same direction at the same points in the tree, so we can make a much more powerful statistical argument that the factors are related," Rubenstein said.

Using long-term rainfall data from the National Oceanic and Atmospheric Administration collected from over 2,000 sites across Africa and going back nearly 150 years at some locations, the researchers showed that African savannas are not only highly seasonal environments, but that rainfall is unpredictable and varies greatly from year-to-year. Statistical analyses and the researchers' evolutionary tree helped them isolate the specific environmental characteristic of savannas that might be responsible for this pattern: temporal, or year-to-year, variability in rainfall.

"Since rain equals food to the birds because it drives patterns of insect availability," said Rubenstein, "we think that by living in family groups with helpers that aid in feeding babies, these birds can cope better in these unpredictable savannas."

Rubenstein noted that this social strategy also helps in good years with lots of rain. Helpers bring enough extra food back to the nest to allow the cooperatively breeding species to breed longer and raise more broods of young than the non-cooperative ones.

"In some cases, the more social species tend to breed longer in benign years and thus produce more offspring," he said. "Often, parents don't have to spend so much time and energy going out and getting food because helpers compensate and do a lot of the parenting."

The origin of cooperative breeding in a savanna habitat may extend beyond starlings, Rubenstein said, noting that the first humans also lived in the savannas of East Africa.

"We think this relationship between sociality and temporal variability in rainfall and, hence, food availability, might help explain the distribution of cooperative breeding in other groups of birds, and even some mammals, living in semi-arid environments around the world," he said.

He added that with global warming, weather patterns are expected to become more variable worldwide and could possibly drive social behavior more toward cooperative breeding among temperate species that don't normally live in family groups.

Source: University of California - Berkeley