

Natural antioxidants give top barn swallows a leg on competitors

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A new University of Colorado at Boulder study led by Assistant Professor Rebecca Safran, shown here, indicates barn swallows that maintain a positive level of antioxidants outperform their peers in reproduction. Credit: Kevin Stearns

A new University of Colorado at Boulder study indicates North American barn swallows outperform their peers in reproduction -- the "currency" of evolutionary change -- by maintaining a positive balance of antioxidants commonly sold in health food stores.

The study is the first to track concentrations of carotenoids, which are

naturally occurring plant pigments, in a wild bird or animal species over the course of the grueling breeding season. Carotenoids can offer the benefits associated with over-the-counter nutritional supplements that protect cells from free radical damage, said CU-Boulder Assistant Professor Rebecca Safran.

Since American barn swallows migrate thousands of miles to their breeding grounds annually and immediately commence courtship, nesting and reproductive activities, many lose significant amounts of weight and become physiologically compromised during the intense spring activities, said Safran, lead study author. But the new study indicates some individuals can bear such costs better than others, she said.

While other studies have looked at carotenoid levels in captive birds at a single point in time, the new study is the first to monitor carotenoids within wild individuals as they feed, mate, nest, and rear young, said Safran of CU-Boulder's ecology and [evolutionary biology](#) department. "Our results indicate the concentrations of these molecules are highly variable within individuals over time," she said. "The season-long balance, rather than a sample at a single point in time, indicates which birds are the top performers as parents and mates."

A paper on the subject appears in the Feb. 25 issue of [PLoS One](#), a journal of the Public Library of Science. Co-authors on the study included Arizona State University Associate Professor Kevin McGraw, CU-Boulder doctoral students Matthew Wilkins and Joanna Hubbard and project volunteer Julie Marling.

"By monitoring wild populations of barn swallows during the breeding season, we determined how individual birds managed their own health while enduring the costs of parental care," said Safran. "Individuals who maintain a positive balance in their nutritional status through the

breeding and nesting season are those with the greatest reproductive performance and tend to be darker in color and larger in body mass."

Safran and her team, which included dozens of CU-Boulder students and volunteers from the community, trapped scores of barn swallows with mist nets in rural sites around Boulder County, measuring and weighing them and taking blood and feather samples before releasing them back into the wild. Each bird was sampled between two and four times over the breeding season. The blood analysis tests took place in McGraw's Arizona State University lab.

The three carotenoids measured in the study -- leutin, zeaxanthin and beta cryptoxanthin -- all are antioxidants that are sold in health food stores around the world. The swallows obtain carotenoids from insects that feed on plants rich in the nutrients.

Since the barn swallow reproductive season lasts about four months, it makes sense that individuals should be able to signal their abilities as parents and mates over time, rather than at the beginning of the season when pair formation takes place, she said. "The swallows that maintained high levels of carotenoids throughout the summer got more reproductive attempts and produced more offspring," Safran said.

Many of the high-quality barn swallow pairs, which weighed more than their peers during the breeding season, produced two clutches of eggs rather than one, producing a greater number of young that fledged, she said.

"Nutritional status is a 24-hour game, because many nutrients don't carry over beyond the next day," she said. The "top" barn swallows appear to be very efficient at foraging and dealing with the costs of reproductive success on a day-by-day basis, which includes guarding the nest and feeding the young, both of which are physiologically taxing activities,

Safran said.

"Our findings in this study contradict the prevailing scientific views regarding the immense physiological costs of reproduction in birds," Safran said. "While evolutionary theory says individuals that pay the greatest cost in parental care do so at the expense of self-preservation, we found some individuals are good at doing it all -- maintaining their own nutritional status while bearing the costs of reproduction."

The researchers also found that barn swallows carrying more carotenoids had deeper red breasts - a sign of healthy, robust individuals - and that those individuals darker in color had greater circulating levels of carotenoids at the start of the breeding season. Previous studies by Safran and her colleagues suggest females are more attracted to males with deep red breasts and that they "cheat" less on their male partners than other females. The breast coloring appears to be an indication of status, performance, testosterone and nutrition, she said.

The study was funded in part by the National Science Foundation, the Howard Hughes Medical Institute and CU-Boulder's Undergraduate Research Opportunities Program and the Biosciences Undergraduate Research Skills and Training. Both CU-Boulder programs offer undergraduates hourly wages or stipends to work with faculty members on innovative research projects.

"One of the most exciting things that I do in my job is train students both in the field and in the lab," said Safran. "Because this work requires many hands, it would be impossible to do these kinds of studies without them."

A 2008 study by Safran and her colleagues showed the testosterone of male North American barn swallows skyrocketed early in the breeding season when their breast colors were artificially enhanced to the deep

red most attractive to females. The birds likely had more testosterone racing through their bodies because of amorous interactions with the opposite sex and more run-ins with competing males.

Provided by University of Colorado at Boulder

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