Study of parrotlets hopping offers clues on how dinosaurs might have developed flight

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A 40 centimeter level flight of a parrotlet, with a snapshot shown at the start of each downstroke. Credit: Diana Chin, Lentink Lab

(Phys.org)—A pair of researchers from Stanford University has studied the energy used by a type of small parrot as it hops from branch to branch during foraging. As they note in their paper uploaded to the open access site *Science Advances*, Diana Chin and David Lentink found that the bird's techniques optimized energy expenditure and may have been similar to techniques used by dinosaurs that led to flight.

Parrotlets are, as their name implies, small parrots that live from Mexico to southern parts of South America—and four of them live in the lab operated by Chin and Lentink. Prior research has shown that parrotlets tend to hop from branch to branch while foraging, though sometimes, the distance is great enough that they must fly, as well. In this new effort, the researchers began by wondering if the hopping was random, or if it was optimized. To find out, they created force-sensitive perches and filmed their charges as they hopped from branch to branch.

In studying the data and watching how the birds foraged, the researchers found that when distances between branches were small enough, the birds simply hopped. When the distance was greater, the birds used their wings to give them an added push, a sort of accented hop. By comparing the amount of energy expended, the researchers found that the strategy used by the birds did, indeed, optimize energy usage—using their wings as a partial assist during a hop required less energy than simply taking flight. The research pair concluded that the birds were very efficient in their hopping and jumping.

Parrotlets rely on their legs to long jump short distances between branches. Credit: Diana Chin, Lentink Lab

But then the researchers made a bit of a leap themselves: They wondered if the wing-assisted hopping they observed might have been used by dinosaurs, which could have led to full flight. They built a model that replicated four particular dinosaurs and their behaviors, and found that for two of them, wing-like boosted flight could have increased their jump length by 20 percent. This

edge, they suggest, could very well have led to increasingly long jumps as the dinosaurs grew smaller and lighter over time, eventually leading to fully realized flight.

Parrotlets can assist and extend their long jumps with small “proto-wingbeats,” which bird ancestors may have used to develop their foraging flight capabilities. Credit: Diana Chin, Lentink Lab

By directing their jumps at energy-efficient takeoff angles and making additional wingbeats, birds can fly effectively over longer distances to forage in trees. Credit: Diana Chin, Lentink Lab

More information: Diana D. Chin et al. How birds direct impulse to minimize the energetic cost of foraging flight, *Science Advances* (2017). DOI: 10.1126/sciadv.1603041

Abstract
Birds frequently hop and fly between tree branches to forage. To determine the mechanical energy trade-offs of their bimodal locomotion, we rewarded four Pacific parrotlets with a seed for flying voluntarily between instrumented perches inside a new aerodynamic force platform. By integrating direct measurements of both leg and wing forces with kinematics in a bimodal long jump and flight model, we discovered that parrotlets direct their leg impulse to minimize the mechanical energy needed to forage over different distances and inclinations. The bimodal locomotion model further shows how even a small lift contribution from a single proto-wingbeat would have significantly lengthened the long jump of foraging arboreal dinosaurs. These avian bimodal locomotion strategies can also help robots traverse cluttered environments more effectively.