Hummingbirds catch flying bugs with the help of fast-closing beaks (w/ video)

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The shape of a hummingbird's beak allows for a "controlled elastic snap" that allows it to snatch up flying insects in a mere fraction of a second —with greater speed and power than could be achieved by jaw muscles alone, says a new study in a forthcoming issue of *Journal of Theoretical Biology*.

Hummingbird beaks are built to feed on flowers, but hummingbirds can't live on nectar alone. To get enough protein and nutrients they need to eat small insects too, said co-author Gregor Yanega of the National Evolutionary Synthesis Center in Durham, North Carolina.

"Hummingbirds need the equivalent of 300 fruit flies a day to survive," Yanega said.

But how can a long, slender bill so well suited for sipping nectar also be good at catching insects, and often in mid-air?

In 2004 in the journal *Nature*, Yanega and University of Connecticut biologist Margaret Rubega reported that part of the answer lies in the hummingbird's flexible bill. Using high speed video of three hummingbird species catching fruit flies, the researchers found that the hummingbird's bendy lower beak flexes by as much as 25 degrees when it opens, while also widening at the base to create a larger surface for catching insects.

While watching the ultrafast videos, however, Yanega also noticed

something else: As soon as the hummingbird's beak is maximally bent, it suddenly springs back to its original position and snaps closed.

"Their beaks snap shut in less than a hundredth of a second," he explained. "It's fast."

Yanega teamed up with engineers Matthew Smith and Andy Ruina of Cornell University to unlock the secret to the hummingbird beak's sudden snap. Armed with data on the length, thickness, and density of the bones and muscles in the hummingbird's head, the researchers developed a mathematical model of the elastic energy in the beak from the time it flexes open to the time it snaps shut.

Part of the trick lies in how the hummingbird's beak is built, the authors said. While other insect-eating birds such as swifts and nighthawks have a cartilaginous hinge near the base of their beaks, hummingbird beaks are solid bone.

"They're also incredibly thin," Yanega said. "This makes their lower beaks stiff yet springy, like a diving board."

The researchers' mathematical model revealed that the downward bend of the hummingbird's lower beak puts stress on the bone, storing elastic energy which eventually powers its sudden snap closure, explained first author Matthew Smith, now at the Air Force Research Laboratory at Wright-Patterson Air Force Base.

"The extra speed likely leads to greater success in catching insects," Smith said.

Known as snap-buckling, the phenomenon is similar to the opening and closing of a snap hair clip, Smith said. "Or, remember those little pop-up toys that consist of a half sphere made of rubber? When you invert one

and set it on a hard surface it will eventually snap back into place and jump off the surface," Smith added.

Snap-buckling has also been observed in plants and insects. "The classic example of snap-buckling in plants is the venus flytrap, which uses this trick to catch insects," Smith said. "Cicadas, too, have tiny ribs which they snap-buckle to produce their distinctive song."

This study marks the first time snap-buckling has been observed in vertebrates, the authors added.

More information: Smith, M., G. Yanega, and A. Ruina. (2011). "Elastic instability model of rapid beak closure in hummingbirds." Journal of Theoretical Biology 282: 41-51. doi:10.1016/j.jtbi.2011.05.007

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