Mystery of broadbills' wing song revealed

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Waking up to the bubbling melody of a dawn chorus is one of life's simple pleasures, but not all birds indulge in vocal displays of virtuosity. Some, like hummingbirds, produce exotic buzzing sounds as their wing feathers vibrate while they bustle around. Fascinated by several wing-singing species, Richard Prum and Christopher Clark from Yale University, USA, were keen to expand their repertoire of birds that produce song with their feathers.

"We knew broadbills were reported to make fantastic sounds", says Clark. But it was unclear how the klaxon-like 'brreeeeet' emitted as they make territorial circular flights was produced - and the only way to find out was to film the birds in their natural surroundings. And this only became feasible when Prum met Alexander Kirschel from the University of Cyprus at a conference. "Alex had extensive experience with field work in East Africa and knew places to try to find the birds", explains Clark, so the trio teamed up with Louis Hadjioannou and headed to Uganda in 2011 in search of African broadbills and their close cousins, rufous-sided broadbills. The team publishes their discovery that the strange call is produced by the 6th and 7th primary feathers on the wing vibrating as they birds bring the wings down abruptly at the start of each wingbeat in *Journal of Experimental Biology*.

However, Clark admits that locating African broadbills in the Kibale region of Uganda was particularly gruelling, recalling that the team was on the verge of abandoning the search after days of fruitless effort when they turned down a particularly muddy track: "All of a sudden we heard one", he laughs, remembering how the team then had to retrace their

steps to collect the cumbersome high-speed camera before filming two of the elusive animals. "That's all we found that we could film", he laments, although the team had more success locating rufous-sided broadbills. "They only live in lowland Congo jungle and there was only one patch of this type of habitat in Uganda", says Clark, recalling the treacherous drive to the Semliki National Park. There, the team was fortunate to film one bird for 45 uninterrupted minutes as it displayed enthusiastically in the undergrowth. "It was the type of angle that documentary filmmakers would fall all over themselves for", chuckles Clark.

Analysing the movies back in the lab, Clark saw that each pulse of sound was produced during the wing downbeat, with the wing tips moving at speeds of 16m/s as the 8th, 9th and 10th primary feathers bent at high speed. However, when Clark tried to reproduce the sounds by positioning the feathers in a wind tunnel, they only ever produced whispers and nothing that sounded like the wing song. "I spent a long time trying to get those feathers to make sound", says Clark. It was only when he mounted an intact wing in the tunnel that the secret was revealed. Positioning the wing as if it was flying and blowing air over it at speeds up to 17m/s, Clark was amazed to see the 6th and 7th primary feathers begin to flutter and make sound. "We had been testing the wrong feathers the whole time!" exclaims Clark, adding that when he tested the 6th and 7th primary feathers individually they fluttered and sounded like the birds in the jungle.

Kirschel and Hadjioannou then returned to Africa in 2013, where they trapped three African broadbills, carefully trimmed off the tips of the 6th and 7th primary feathers and found that the birds no longer produced a klaxon-like call, sounding instead more like a ratchet. So, broadbills produce their distinctive territorial wing song when the 6th and 7th primary wing feathers flutter in the wind, adding them to Darwin's roll-call of birds that produce 'instrumental music' with their feathers.

More information: Clark, C. J., Kirschel, A. N. G., Hadjioannou, L. and Prum, R. O. (2016). Smithornis broadbills produce loud wing song by aeroelastic flutter of medial primary wing feathers. *J. Exp. Biol*. 219, DOI: 10.1242/jeb.131664

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