Learning from bats' ultrasound

Some bat calls are recorded in the laboratory.

Bats use their ears in much the same way as we use our eyes. And to 'see' in the dark, bats illuminate their world with ultrasound.

The ultrasonic sonar of bats is extremely well developed, and some species can detect very small objects — perhaps as fine as a spider web — while on the wing.

Such an ability draws the admiration of Dr Dedee Woodside, a zoologist at the University of New South Wales, and Dr Ken Hews-Taylor, a physicist with the CSIRO Division of Applied Physics, who are collaborating in a research project on the ultrasound of bats. Dr Hews-Taylor is developing methods of non-destructive testing using ultrasound, and is looking to bats to teach him a thing or two about how to do it.

With present techniques he can just manage to detect a flaw, deep inside a metal casting, that may be the size of a finger-nail clipping. Whereas Dr Hews-Taylor can only say it's a flaw of unknown shape, a bat, using sound of the same wavelength (say 1 mm), might be able to do very much better on a task of equivalent difficulty. It could discriminate outline and orientation.

How does the bat do it? 'Bats must use extremely sophisticated signal processing to manage their feats of echo-location', he says. 'It's jolly good physics, and through a close study of their calls we may be able to identify and copy some of their echo-location strategies.'

The two researchers have recorded bat calls on a high-speed tape recorder and analysed the high-frequency signals (they range up to 200 kilohertz) to understand what sort of sound the bat was broadcasting. Some 20 species have been placed in front of the microphone.

Dr Woodside has set obstacle courses for bats to negotiate, and she has trained some to recover food from underneath different grades of sand-paper. She found that she could train a specimen of *Nyctophilus gouldi* (Gould's long-eared bat) to distinguish fine-grade sand-paper from medium-grade by secreting food under only the former!

The research pair have found that bats use a number of techniques to extract extra information from their ultrasonic echoes. Some (usually those with plain faces) emit a vocalization that sweeps in frequency. Others (commonly with nose leaves and other ornaments on their faces) use a constant frequency. Many produce signals with strong harmonics (overtones), and a few emit through both mouth and nose.

Dr Woodside has found a good correlation between the type of signal a bat emits and the sort of information it's after. A bat that forages in a cluttered environment (among bushes, for example) detects its prey by uttering a pulse swept quickly in frequency, whereas one that catches insects in flight gets a good fix on the speed and direction of its prey by a chirp of constant frequency.

Dr Woodside found that one rare bat, *Kerivoula papuensis* (the golden-tipped bat), emitted a unique very-wide-band chirp without any harmonics. Curiosity aroused, she investigated the stomach contents of specimens from the wild: they comprised only orb-weaving spiders.

It seems this bat hovers and deftly plucks its prey from the web, suggesting that it can even detect the web filaments with its special sonar signal. Dr Woodside's mist nets, used to catch birds, have never been successful in snaring the species, supporting the idea that it really does possess this remarkable web-detecting ability.

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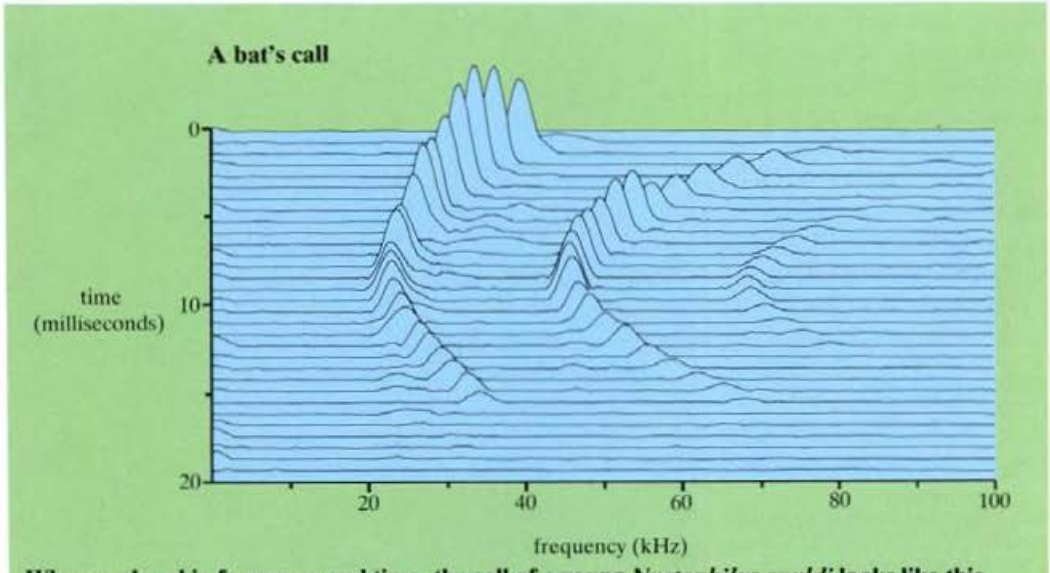

When analysed in frequency and time, the call of a young *Nyctophilus gouldi* looks like this.

The flight, echolocation, and diet of the golden-tipped bat, *Kerivoula papuensis* (Chiroptera: Vespertilionidae), recently rediscovered in Australia, D.P. Woodside, K.J. Taylor, and S.K. Churchill. *Journal of Mammalogy*, 1985, **66** (in press).