



Press Release

Horseshoe bats use echolocation to separate background echoes from those of fluttering prey

International team, including researchers from the University of Tübingen, “flew” with bats via GPS recording tags with microphones

Christfried Dornis
Director

Janna Eberhardt
Research reporter

Phone +49 7071 29-77853
janna.eberhardt[at]uni-tuebingen.de

presse[at]uni-tuebingen.de
www.uni-tuebingen.de/aktuell

Tübingen, 23.06.2026

Many bat species emit echolocation calls and use the returning echoes to find their way and to detect the presence of fluttering insects, locate and catch them. A new study investigates this behavior in greater horseshoe bats foraging in the wild. An international team including Dr. Annette Denzinger and Professor Hans-Ulrich Schnitzler from the Institute of Neurobiology at the University of Tübingen, Professor Yossi Yovel from Tel Aviv University, Israel, and Dr. Laura Stidsholt from Aarhus University, Denmark, found how foraging horseshoe bats use sophisticated echolocation to shift the frequencies of useful and masking echoes into different frequency ranges, thereby separating them from one another. This enables the bats to locate flying insects against background echoes. The study has been published in the journal *PNAS*.

Horseshoe bats got their name from a horseshoe-shaped protrusion around their nose, which they use to focus the echolocation calls. Horseshoe bats emit long, constant-frequency ultrasonic echolocation calls which are reflected by objects in their surroundings. From the returning echoes, the bats obtain such a precise picture of their surroundings that they can orient themselves and find their prey even in complete darkness. “Bats receive echoes not only from the flying insects they try to catch, but also from all the other structures around them, such as trees, shrubs, and the ground” Annette Denzinger explains. “These background echoes mask the echoes from the bats’ prey and must therefore be separated from them. We wanted to find out how the bats manage to do that.”

In the new study, the research team investigated for the first time how hunting horseshoe bats cope with this major challenge in the wild. The team captured greater horseshoe bats at roosting sites in Bulgaria and equipped them with tracking devices: miniature tags with GPS,

microphone and memory recorded the bat's position, echolocation calls and returning echoes. "These tiny tags are stuck onto the fur on the bats' backs, so they are properly on board," says Hans-Ulrich Schnitzler. After two to three days, the tags fall off. The researchers then recovered them and analyzed the data. "With the help of digital maps, we can virtually sit on the animal's back, fly with it over its hunting grounds in Bulgaria, see where it searches for prey, hear the sounds it emits, as well as the returning echoes," says Schnitzler.

Lower emission frequency to beat the Doppler effect

The recordings show that the bats always search for prey near vegetation, either while flying along forest edges and rows of bushes, or while hanging from a perch, such as an exposed branch. "When the bats fly along vegetation, the frequency of the echoes from the vegetation rises due to the Doppler effect," says Annette Denzinger. Doppler shifts occur due to the time compression of sound waves as the bat moves toward a reflective object. The faster the bat flies, the higher this shift of the frequency.

The research team found that greater horseshoe bats lowered the frequency of their calls so that the highest-frequency echoes from the vegetation ahead did not exceed a certain maximum. "This is how the animals compensate for the Doppler shifts, ensuring that the interfering echoes do not reach what we call the auditory fovea. This is a highly sensitive frequency range in the horseshoe bats' auditory system, just above the adjusted maximum frequency," says Hans-Ulrich Schnitzler. "The auditory fovea is reserved solely for prey echoes. It is specially adapted for the evaluation of echoes from the fluttering prey – or rather, the rhythmic frequency modulations generated by the movement of insect wings," Schnitzler adds.

"By skillfully adjusting their echolocation calls, horseshoe bats keep the background echoes at lower frequencies, where they do not mask the echoes of the fluttering prey. This strategy enables horseshoe bats to actively segregate the desirable signals indicating flying insects from masking background echoes, even in highly complex environments," says Annette Denzinger.

"Bats are fascinating animals, and research on them sparks the interest of many people. Since bat populations are endangered in many places, new insights into their way of life can also provide clues as to how they can be better protected," says Professor Karla Pollmann, President of the University of Tübingen.



A greater horseshoe bat (*Rhinolophus ferrumequinum*) catching a moth.
Photos: Dietmar Nill

Publication:

Yossi Yovel, Laura Stidsholt, Yotam Mirman, Mor Taub, Stefan Greif, Antoniya Hubancheva, Ivailo Borissov, Anthony J. Weiss, Annette Denzinger, Hans-Ulrich Schnitzler: Horseshoe bats foraging in the wild adjust sensing to separate prey echoes from background clutter. *PNAS*, <https://doi.org/10.1073/pnas.2525520123>

Contact:

Dr. Annette Denzinger and Prof. Dr. Hans-Ulrich Schnitzler
University of Tübingen
Institute of Neurobiology

annette.denzinger@uni-tuebingen.de

Phone +49 7071 29-72958

hans-ulrich.schnitzler@uni-tuebingen.de

Phone +49 7071 29-75345