Mosquitos fail at flight in heavy fog

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Mosquitos have the remarkable ability to fly in clear skies as well as in rain, shrugging off impacts from raindrops more than 50 times their body mass. But just like modern aircraft, mosquitos also are grounded when the fog thickens. Researchers from the Georgia Institute of Technology present their findings at the 65th meeting of the American Physical Society's (APS) Division of Fluid Dynamics, Nov. 18 - 20, in San Diego, Calif.

"Raindrop and fog impacts affect mosquitoes quite differently," said Georgia Tech researcher Andrew Dickerson. "From a mosquito's perspective, a falling raindrop is like us being struck by a small car. A fog particle – weighing 20 million times less than a mosquito – is like being struck by a crumb. Thus, fog is to a mosquito as rain is to a human."

On average during a rainstorm, mosquitos get struck by a drop once every 20 seconds, but fog particles surround the mosquito continuously as it flies. A mosquito's interaction with a raindrop is therefore brief, but the interaction with fog particles is continuous and inescapable once the mosquito is in a fog cloud.

Regardless of their abundance, water droplets in a fog cloud are so small that they should not weigh down a mosquito enough to affect its ability to fly.

To explore this puzzle, Dickerson and his colleague David Hu used high-speed videography. They observed that mosquitoes have a reduced wing-

beat frequency in heavy fog, but retain the ability to generate sufficient force to lift their bodies, even after significant dew deposition. They are unable, however, to maintain an upright position required for sustainable flight.

The reason for this is the impact that fog has on a mosquito's primary flight control mechanism. Known as halteres, these small knobbed structures evolved from the hind wings and flap anti-phase with the wings and provide gyroscopic feedback through Coriolis forces (the perpendicular force generated by a rotating object).

These halteres are on a comparable size to the fog droplets and they flap approximately 400 times each second, striking thousands of drops per second. Though the halteres can normally repel water, repeated collisions with 5-micron fog particles hinders flight control, leading to flight failure.

"Thus the halteres cannot sense their position correctly and malfunction, similarly to how windshield wipers fail to work well when the rain is very heavy or if there is snow on the windshield," said Dickerson. "This study shows us that insect flight is similar to human flight in aircraft in that flight is not possible when the insects cannot sense their surroundings." For humans, visibility hinders flight; whereas for insects it is their gyroscopic flight sensors."

More information: The talk, "Mosquito Flight Failure in Heavy Fog," is at 5 p.m. on Monday, Nov. 19, in Room 28A.
http://absimage.aps.org/image/DFD12/MWS_DFD12-2012-001215.pdf

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