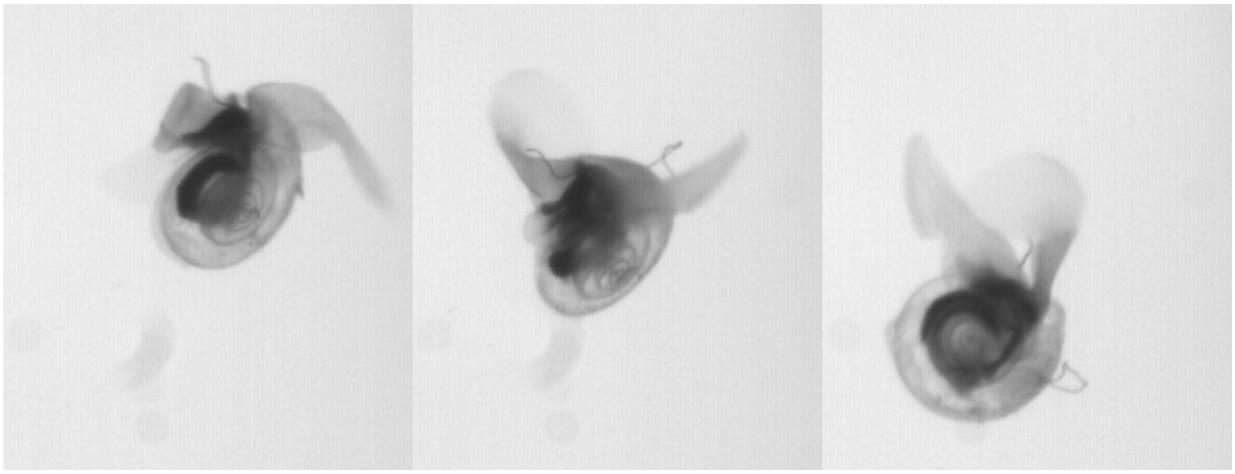
Bizarre snail that swims like a flying insect

February 17 2016



A time lapse picture of a seabutterfly at different stages of a wing beat. Credit: David Murphy

Snails usually lumber along on their single fleshy foot; but not sea butterflies (*Limacina helicina*). These tiny marine molluscs gently flit around their Arctic water homes propelled by fleshy wings that protrude out of the shell opening. But little was known about how they move through water. "Most zooplankton swim with a drag-based paddling technique," explains David Murphy from the Georgia Institute of Technology, USA, and even though one of Murphy's thesis advisors - Jeannette Yen - had filmed one of the enigmatic snails swimming while it was attached to a wire in 2003, it had not been possible to observe how fluid flowed around the animals to explain how they move. So, when Murphy built a new 3D system to visualise fluid movements around

minute animals, Yen and Don Webster were keen to test more sea butterflies as they swam freely to discover more about their exotic mode of propulsion.

They publish their discovery that the snails swim using the same technique as flying insects, beating their wings in a figure-of-eight pattern, in *Journal of Experimental Biology*.

Working with the delicate animals in land-locked Atlanta posed a unique set of challenges. Murphy explains that sea butterflies are scarce at the best of times and that transporting the fragile gelatinous creatures across the continent from their ocean home was tricky. "You have to ship them overnight in an insulated cooler to keep them cold and if the water is too dirty particles will stick to them, so the water has to be very clean", he says. Yen then devised a cunning V-shaped structure at the bottom of the tank to ensure that the freely swimming snails repeatedly ascended through the middle portion of the tank - where four high-speed cameras were focused to capture every detail of the wings' movements. Even then, Murphy admits that it was a miracle that they were able to collect any data and he recalls that the team only had a few short hours to film the molluscs, explaining that they could only be sure that the swimming conditions were ideal then.

However, by the end of the afternoon the snails had serendipitously crossed the path of the cameras on four occasions. "In this sort of free-swimming experiment it's normal to take 30 passes to get three usable ones, but we got really lucky! The animals even cooperated by swimming in different orientations, so we could see different perspectives", chuckles Murphy, who then began visualising the snails' wing beats and the fluid movements around their bodies with Deepak Adhikari.

After months of painstaking analysis - interrupted by Murphy's

relocation from Georgia to Johns Hopkins University in Baltimore, Maryland - the team was astonished when they realised that the snails were swimming just like fruit flies fly. "I said to myself, "Its wing stroke is just like what an insect is doing"", recalls Murphy, describing the snails' characteristic figure-of-eight wing beat that was only apparent after he took account of the molluscs' extraordinary bobbing motion. And when he investigated how water flowed around the snails' wings, he was impressed to see that the molluscs generated the same low-pressure system that produces lift in flying fruit flies. Murphy explains that the snails (and fruit flies) clap their wings together at the top of a wing beat before peeling them apart, sucking fluid into the V-shaped gap between the wings to create low-pressure vortices at the wing tips that generate lift.

He says, "No one has actually been able to measure the flow around an insect doing this while it is flying, and so that was kind of the holy grail of this area of research". And he adds, "It really surprised me that sea butterflies turned out to be honorary insects".

More information: Murphy, D. W., Adhikari, D., Webster, D. R. and Yen, J. (2016). Underwater flight by the planktonic sea butterfly. J. Exp. Biol. 219, DOI: 10.1242/jeb.129205

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