Discovery reveals how remora fishes know when to hitch a ride aboard their hosts

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How do remora fishes sense when to hitch-on to their travel companions? Researchers say a new discovery within the suckerfish's adhesive disc is key to letting them know they've touched down on their host, and when it's time to tighten their grip. Credit: New Jersey Institute of Technology

Remoras are among the most successful marine hitchhikers, thanks to powerful suction discs that allow them to stay tightly fastened to the bodies of sharks, whales and other hosts despite incredible drag forces while traveling through the ocean. But how do these suckerfish sense the

exact moment when they must "stick their landing" and board their speedy hosts in the first place?

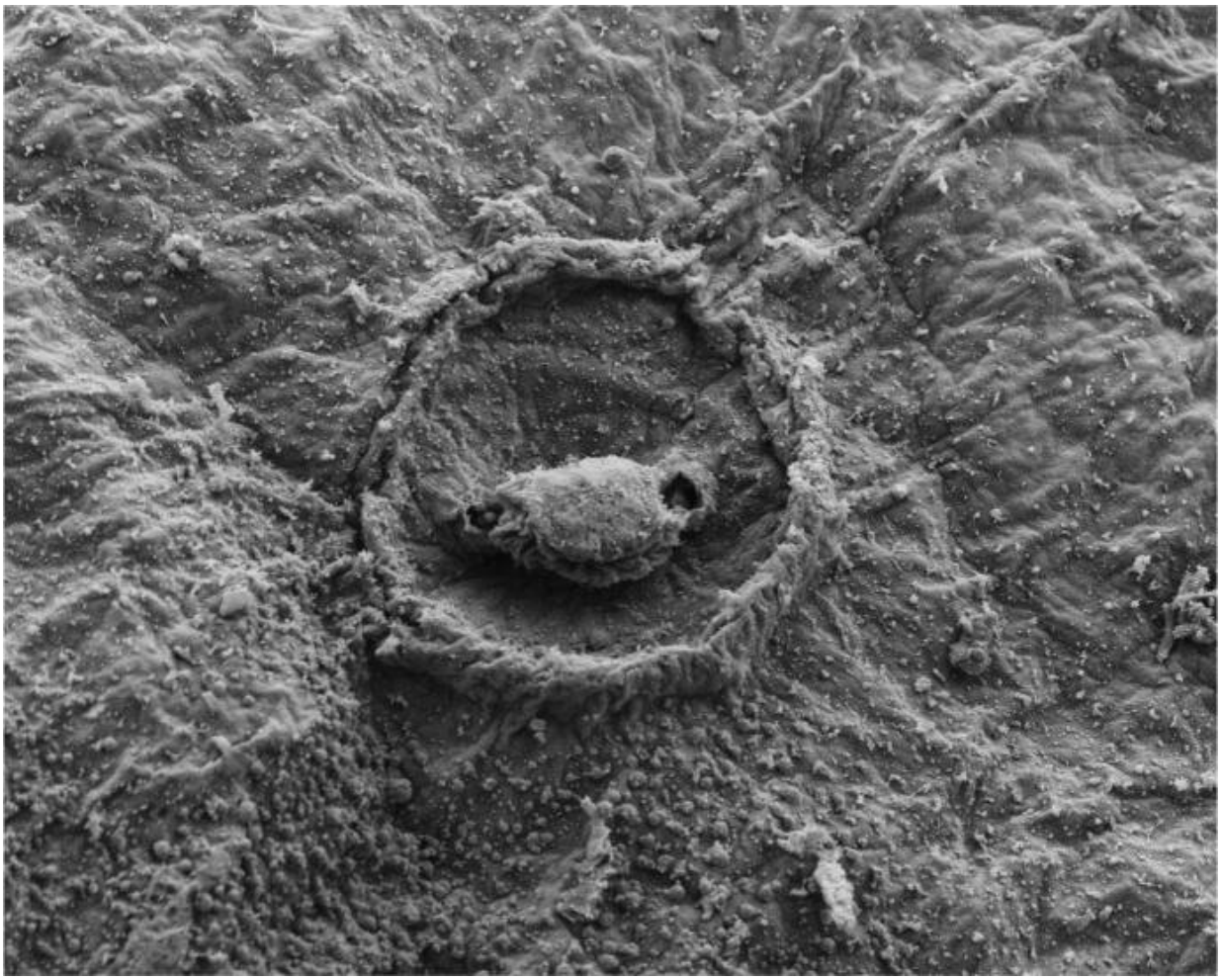
A team of biologists at New Jersey Institute of Technology (NJIT), Friday Harbor Labs at University of Washington (FHL-UW) and The George Washington University (GWU) now offers an answer.

In findings published in *Royal Society Open Science*, researchers have detailed the discovery of a tactile-sensory system stowed within the suction disc of remora, believed to enable the fish to acutely sense contact pressure with host surfaces and gauge ocean forces in order to determine when to initiate their attachment, as well as adjust their hold on hosts while traversing long distances.

Specifically, the study describes the discovery of groupings of push-rod-like touch receptors, or mechanoreceptor complexes, embedded in the outer lip of the remora adhesive disc, which have been known to aid other organisms in responding to touch and shear forces.

Researchers say the finding marks the first time such touch-sensory complexes have been described in fishes, as the structure was previously only known in extant monotremes— platypus and echidnas.

"One of the wildest things about this work was not only finding a mechanoreceptor complex not previously known to fishes, but that the only other organisms known to possess them are monotremes," said Brooke Flammang, NJIT professor of biological sciences and lead author of the study. "This is exciting because it shows how much we as integrative comparative biologists still have to learn about the sensory world of organisms."



Scanning electron microscopy displaying the epithelial topography of the push-rod receptors found along anterior and posterior sections of the remora disc lip. Credit: NJIT, FHL-UW, GWU.

"When I was in graduate school, conventional wisdom was that fishes did not have such mechanoreceptors," said Patricia Hernandez, one of the study's authors at The George Washington University. "The discovery that these fishes share convergent receptors with echidnas is really exciting and points us in the right direction for discovering similar convergence in other fishes."

While conducting various imaging studies to examine the head and disc of Echeneis naucrates, a common sharksucker remora, the team successfully identified the complexes: dome-like protrusions along the surface of the soft tissue lip surrounding the remora's adhesive disc. Each dome packs below it a column of cells with three vesicle chains containing sensory nerves that stretch from the disc's epidermal layer down to its dermal layer. In addition to sensing contact, these complexes are thought to respond to shear stress, which would provide feedback information to the remora if it was losing its grip and sliding backward on its host.

"When we first noticed these structures we were a little thrown off," said Karly Cohen, a Ph.D. biology student at FHL-UW and an author on the study. "We knew they had to be sensory because of the plethora of nerves, but they didn't look like lateral line structures, which are one of the main ways fishes sense their environment. We dove into the literature to try and find structures that fit the morphology of those we saw in the remora histology. Finally landing on the push-rod receptors known in echidnas was so exciting. ... It was validation of the morphology we were seeing and it took us into a realm of mechnosensation that we were not necessarily considering when thinking about how the remora stick."

Notably, in further examining seven other remora species, the team found that those species known to frequently piggyback on larger and faster hosts, like pelagic billfish, are equipped with nearly double the mechanoreceptor complexes of remora species that typically hitchhike on slower swimmers, such as reef fishes.

"On animals swimming very fast where the remora may be under increased drag conditions, the need to recognize loss of contact and make an instant correction is more crucial than on slower swimming hosts," noted Flammang.

Flammang and colleagues say that the touch-signaling complexes found in remoras suggest not only that fishes may be able to sense their environment in ways not previously realized, but that specialized mechanoreceptors may also be a much more common feature among basal vertebrates than was previously thought as well.

"The interesting aspect here is that push-rods are only otherwise known in platypus and echidnas," said Flammang. "Obviously, there is no close phylogenetic relationship between remoras and monotremes, so this likely means that there are a lot of mechanoreceptors in vertebrates that just haven't been found in a wide breadth of organisms. We hope this paper brings this structure to the attention of other researchers for comparative study on how their organisms sense the environment."

More information: Karly E. Cohen et al, Knowing when to stick: touch receptors found in the remora adhesive disc, *Royal Society Open Science* (2020). DOI: 10.1098/rsos.190990

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