Structural protein essential for ciliary harmony in comb jellies

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Researchers from the University of Tsukuba's Shimoda Marine Research Center and the Japanese National Institute for Basic Biology have identified a protein that keeps millions of tiny surface organelles moving in harmony to control the gliding locomotion of ctenophores.

These organelles, called comb plates, beat in coordinated, undulating

waves to propel ctenophores—more commonly known as comb jellies—through the ocean. At less than two mm in length, tens of thousands of cilia are grouped onto comb plates, which in turn are organized into eight neat rows arranged lengthwise around the body of the jelly. As they move, the comb plates refract light, producing a pulsating rainbow of color.

In the study published this month in *Current Biology*, the researchers explain that while the structure of motile cilia has been well studied, less is known about how the organelles are organized and the implications of slight structural differences between species.

"In comb jellies, adjacent cilia on the comb plates are connected by structures called compartmenting lamellae, which have not been well characterized," explains lead author of the study Kei Jokura. "To better understand the role of these structures, we first extracted and examined the proteins required to form the compartmenting lamellae."

One of these proteins, which the researchers called CTENO64, had not previously been identified and was unlike any protein studied to date. Interestingly, while CTENO64-like proteins were found in closely related species, they appeared to be unique to ctenophores, perhaps suggesting that they perform a specific role in marine-adapted ciliary locomotion.

By blocking the expression of the CTENO64 protein in comb jelly embryos, the researchers showed that it was essential for the formation of the compartmenting lamella linkers, and that jellies missing these structures could no longer swim.

"The protein knockdown assays confirmed that intact compartmenting lamellae are essential for orienting the cilia on the comb plates," says corresponding author of the study Kazuo Inaba. "In the absence of

CTENO64, the cilia were misaligned, and comb plates began beating out of formation, causing aberrant ciliary waveforms. This lack of harmony among the comb plates stalled the locomotion of the comb jellies."

"These findings are important because they shed light on the mechanisms governing the arrangement of cilia on comb plates," explains Inaba. "We hope that a better understanding of structural differences between species will help uncover how different organisms have adapted to various aquatic environments."

More information: Kei Jokura et al. CTENO64 Is Required for Coordinated Paddling of Ciliary Comb Plate in Ctenophores, *Current Biology* (2019). DOI: 10.1016/j.cub.2019.08.059

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