Loose skin and 'slack volume' protect Hagfish from shark bites

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Chapman University and University of Guelph have published new research showing how hagfishes survive an initial attack from predators before they release large volumes of slime to defend themselves. Because the slime is released after they are attacked, this defense strategy is only effective if they survive the initial bite. Results show that hagfish skin is not puncture resistant; it is both unattached and flaccid,

which helps avoid internal damage from penetrating teeth.

Hagfishes are an ancient group of eel-like animals found at the bottom of the ocean. Video footage of hagfishes being attacked, lab studies of how their defensive slime functions, and the fact hagfishes are rarely found in the stomachs of other fish, suggest that fish predators are rarely successful when they attempt to eat a hagfish.

This three-minute video shows how hagfishes use slime as their defense mechanism.

"This video really was the inspiration for our entire study," said Douglas Fudge, Ph.D., associate professor of biological sciences at Chapman University and senior author on this study. (Sarah Boggett, University of Guelph, is the lead author) "A sizable slack volume in hagfishes, combined with minimal attachment of the skin to the muscle, allows the body to slip out of harm's way even when the skin is punctured."

Researchers studied the three layers of hagfish skin to determine how they survive the initial attack. They narrowed it down to two possibilities; the hagfishes have either puncture-resistant skin or a loose and flaccid body design that makes it more difficult for teeth to penetrate. The performance of hagfish skin is notable because they lack scales that help boost puncture resistance in many fishes.Hagfishes have a subcutaneous sinus system that runs the length of their body, containing 30 percent of their blood volume. Although previous research has found evidence that this sinus system is crucial to burrowing and knot-tying, this study shows that it also plays a role in predator defense.

The study, called "Flaccid skin protects hagfishes from shark bites," was published in the *Journal of the Royal Society Interface*. Researchers performed skin puncture tests of 22 fish species. They also used simulated shark bites on hagfish and their closest relatives, the sea

lamprey.

More information: Sarah Boggett et al. Flaccid skin protects hagfishes from shark bites, *Journal of The Royal Society Interface* (2017). DOI: 10.1098/rsif.2017.0765

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