

POCKETFUL OF SUNSHINE: New discoveries on bioluminescence within the elusive American Pocket Shark

By Claire Griffin

In a new paper titled “Histological evidence for secretory bioluminescence from pectoral pockets of the American Pocket Shark,” marine biologists answer the question that *The Hobbit*’s Gollum could not: what has it got in its pocketses?

Mollisquama mississippiensis is a shark species seemingly plucked out of a child’s imagination: they’re rare and mysterious, arguably adorable, have convenient pockets, and, according to scientists at the Université Catholique de Louvain, they even glow.

The pocket shark is a deepwater oceanic shark, and an extremely rare one at that. Only two specimens, each its own distinct species, have ever been found: one from the southeast Pacific (*M. parini*) and the other from the Gulf of Mexico (*M. mississippiensis*). Pocket sharks get their name from the slits that sit above each pectoral fin and serve as an opening to a pocket-like space. The unique feature has puzzled scientists for decades, and given the shark’s rarity, one could only speculate what the pockets’ biological function might be.

That is, until now. A recent [histological](#) analysis by Julien M. Claes, Laurent Duchatelet and Jérôme Mallefet gives us a better understanding of pocket morphology and purpose than ever. Their experiments using light and fluorescence microscopy revealed that a pocket is a “pigmented sheath” within which lay an assortment of brightly fluorescent cells. The organization of these cells was indicative of a process known as [holocrine](#) secretion: when a produced substance (in this case, fluorescent material) accumulates in a cell’s cytoplasm and is later secreted into a structure’s [lumen](#) once the cellular plasma membrane ruptures.

The scientists suspect the pockets themselves are a sort of modified [photophore](#), as that is consistent with pocket shark phylogeny and photophore function in closely related shark species. Their observations led them to conclude that pocket sharks possess “[exocrine](#) holocrine glands, capable of discharging a bioluminescent fluid.” Translation: these sharks’ pockets help them glow in the dark!

Holocrine secretion is a relatively rare occurrence in marine animal species, the only other known case being with tubeshoulder fishes. Scientists suspect this similarity is a case of [convergent evolution](#) rather than the species being close in relation to pocket sharks. And though general bioluminescence is pretty common in marine organisms, only two shark families are known to possess the capability: the Etmopteridae family, better known as lantern sharks, and the Dalatiidae family, of which the pocket shark is a member.

Important note: [bioluminescence](#) is categorically different from [biofluorescence](#), another common trait in many marine species.

So now that we know what the pockets do, the next step is to ask *why* they do it. What is the evolutionary advantage of bioluminescent pockets? To answer this, scientists first considered what might physically trigger the pockets to emit light. Given the close proximity and

connectivity of the pockets to the shark's pectoral fins, they hypothesized that fin movement is key to the onset of bioluminescent activity. They were able to eliminate sexual courtship as a factor, as the examined specimen was a juvenile shark who would have no such use for it. And knowing that production and secretion of the pocket material has a relatively high energy cost, they also assumed bioluminescence could only be used on a short-term basis, akin to the "bioluminescent cloud emission" trait present in many marine taxonomic groupings.

With all this in mind, the scientists' final hypothesis was that the pocket's bioluminescent fluid shared the same function as most instances of marine animal bioluminescent cloud emission: being a "last-minute, short-distance defensive behavior to facilitate escape," activated by a given movement of the shark's pectoral fin.

The authors acknowledged that further studies with additional observations and biological specimens would be needed to confirm their hypothesis. Given the rarity of pocket sharks, such a feat would likely take great patience and quite a bit of luck. While we may never know exactly how these elusive sharks behave in the deep sea, we do know their extraordinary combination of physiological traits (and, let's be honest, their downright cuteness) will fascinate scientists for many years to come.



The only known specimen of the American Pocket Shark, discovered in the Gulf of Mexico in 2010. (Photo by Tulane researcher Michael Doosey)

Useful Definitions

- **Histology:** the study of the microscopic structure of tissues
- **Holocrine:** the mode of secretion in exocrine glands in the study of histology. Holocrine secretions are produced in the cytoplasm of the cell and released by the rupture of the plasma membrane, which destroys the cell and results in the secretion of the product into the lumen.
- **Exocrine:** glands that secrete their products through ducts opening onto an epithelium rather than directly into the bloodstream. Examples: sweat glands, salivary glands, etc.
 - Epithelium: thin tissue that comprises the outer layer of a body's surface (e.g. skin), as well as the surface of certain hollow structures within the body
- **Lumen:** interior of a structure/vessel; in this case, the pocket
- **Photophore:** a light-producing organ in certain fishes and other animals
- **Bioluminescence:** when a chemical reaction allows an organism to produce their own light
- **Biofluorescence:** when ambient light is absorbed and re-emitted by an organism
- **Convergent Evolution:** when organisms that are not closely related evolve similar traits independently, as a result of experiencing similar environmental conditions or filling similar ecological niches.

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