Jellyfish venom capsule length association with pain

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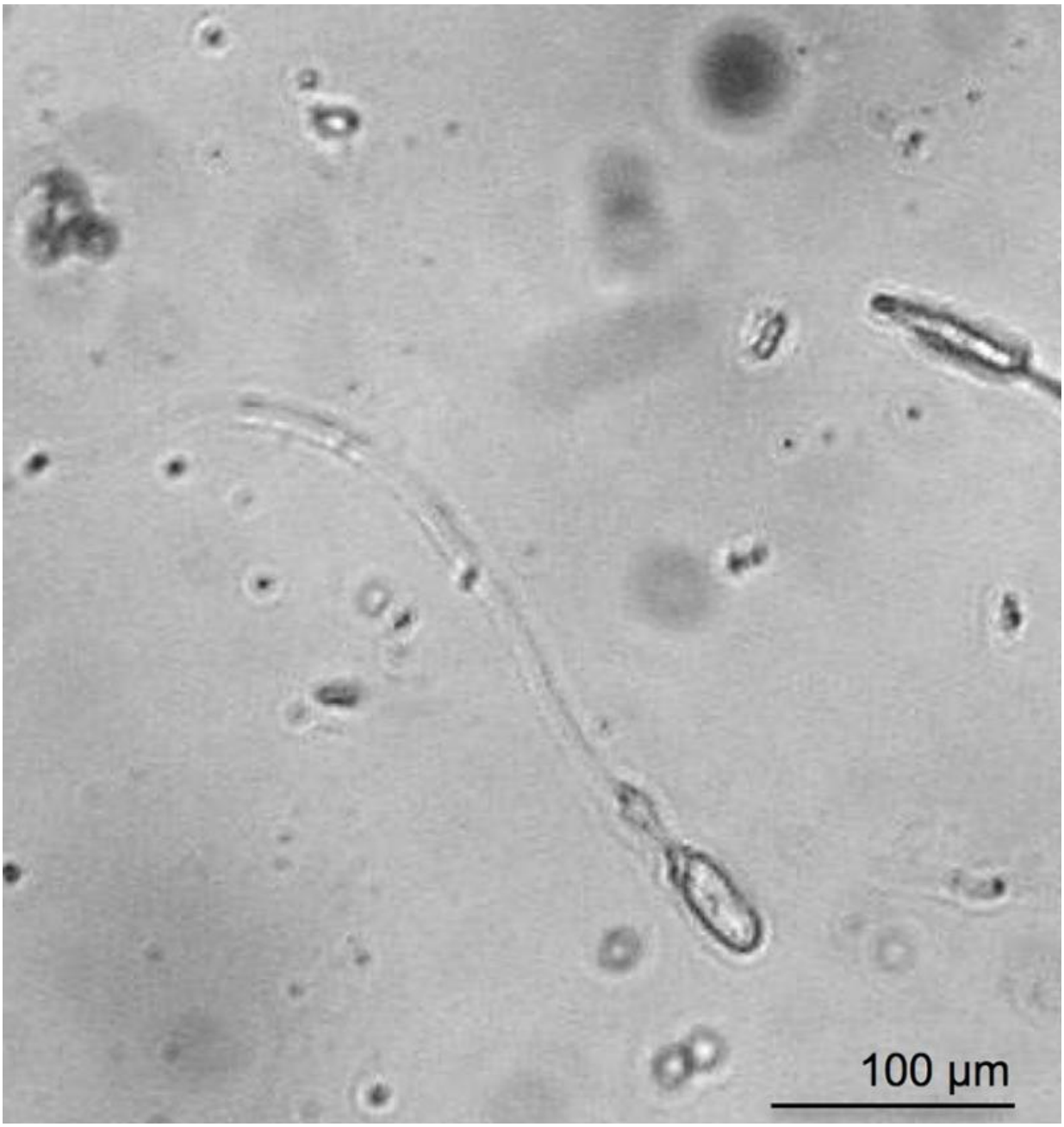
Since the PLOS San Francisco office is a quick car ride from the Monterey Bay Aquarium, so many of us at PLOS have been captivated by jellyfish movements. They are simply mesmerizing to watch as they

travel through the water. Unfortunately, close proximity to a jellyfish in open water can be nerve-wracking – contact with their tentacles triggers the discharge of venom. It only takes three milliseconds for jellyfish venom to transfer to a victim, which is one of the fastest movements in the animal kingdom. This sting can result in persistent pain and swelling, and sometimes even death.

Unless you know a good deal about jellyfish, it's hard to tell just by looking at them whether they are extremely poisonous or relatively harmless. Unfortunately, size and shape are not necessarily indicators of whether they are dangerous. However, scientists believe there may be other ways to tell how much a given sting may hurt.

A jellyfish stings by discharging a tubule shaft contained inside what's called the nematocyst, the stinging organelle of the jellyfish—which pierces the skin and injects the venom. The authors of a recently published PLOS ONE study were curious as to whether the length of the nematocyst capsules was a factor in the amount of pain felt after a sting.

The researchers collected four different species of jellyfish: Japanese sea nettle, a species of box jellyfish, the habu-kurage (another type of box jellyfish), and moon jellyfish from different locations in Japan. Habu-Kurage and box jellyfish are known to have extremely painful stings, Japanese sea nettle are moderately painful, and moon jellyfish are pretty much painless. Scientists removed and froze the tentacles from all four species immediately after collection. Later, they shook the tentacles in a saline solution for five minutes to release the nematocyst from inside the tentacle.

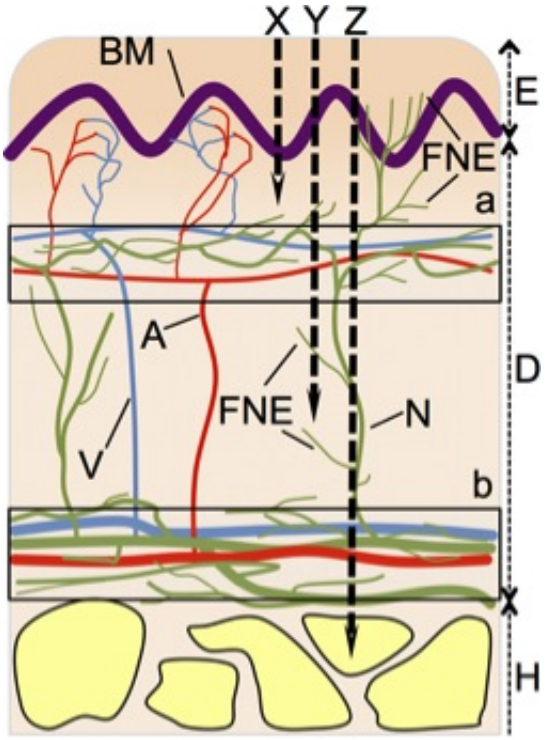


They then suspended the nematocyst in the saline solution and placed it under a microscope on a flat, glass slide, while holding another glass

slide above it. If the nematocyst did not discharge the venom capsule automatically, they lowered the top slide down until it did, as touch is often a trigger for the release of the venom. The microscope camera photographed the nematocyst before and after the venom was released. Following the release, the scientists measured the nematocyst capsules in micrometers. From there, they identified which jellyfish had the longest or shortest nematocysts. One of the habu-kurage's nematocyst capsules from Fig. 3 in the paper is pictured below.

The authors found that each species had approximately the same number of nematocysts per gram of tentacle, but that the species with the more painful stings tended to have longer capsules. The species from longest to shortest nematocysts were the box jellyfish, habu-kurage, Japanese sea nettle, and moon jellyfish.

The two jellyfish with the more painful stings, the box jellyfish and habu-kurage, also had the highest average percentage of nematocyst tubules longer than 200 micrometers, with 80% and 91%, respectively; while the somewhat less-painful Japanese sea nettle had only 6% of their tubules longer than 200 micrometers, and the practically painless moon jellyfish had 0%.



When it comes to sizes, importantly, the network of intersecting nerves beneath human skin, also known as the sub-epidermal nerve plexus, is 100 to 200 micrometers below it, and the authors suspect that longer nematocysts can more easily reach these nerves, which might explain why box jellyfish and habu-kurage deliver more painful stings to us than the other species tested.

The image above, also in the paper, demonstrates the length of the jellyfish nematocyst capsules and how far they could potentially penetrate into the skin. X represents tubule lengths less than 200 micrometers, Y represents tubule lengths between 200 and 600 micrometers, and Z represents tubules that are longer than 600 micrometers (found in the box jellyfish), which can potentially reach all the way to the innermost layer of our skin, what's called the hypodermis.

The researchers did find that the box jellyfish had longer nematocyst capsules and a more powerful toxin than the habu-kurage, but the habu-kurage is considered much more hazardous to its prey and to humans. The authors posit that this may be because habu-kurage has many more tentacles that are much longer than that of box jellyfish, which could mean that more toxin is injected into the body of its victim per sting. Regardless of the additional research that needs to be done to see why the habu-kurage can cause so much pain and can sometimes even be fatal, it would best be safe to swim far away from those tentacles' reach.

More information: "Length Is Associated with Pain: Jellyfish with Painful Sting Have Longer Nematocyst Tubules than Harmless Jellyfish." *PLoS ONE* 10(8): e0135015. DOI: 10.1371/journal.pone.0135015