**[No Strain, No Gain: Filter Feeding Mantas](http://www.sciencefriday.com/video/10/23/2014/no-strain-no-gain-filter-feeding-mantas.html)**

**Science Friday, October 23rd, 2014**

***(Unedited Transcript)***

**Description:**

Effortlessly, manta rays glide through the ocean gulping down plankton and fish eggs by the mouthful. However, until recently, it wasn't clear how they managed to do so without clogging the filters that surround their gills. Marine biologist and biomechanist, Dr. Misty Paig-Tran details her research into these graceful giants and reveals the multiple methods of filtration they use to sift a meal from the water.

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LUKE GROSKIN: With gentle flaps of its fins and slow, arching turns, manta rays exude a sort of grace. Even the way it eats seems almost effortless.

MISTY PAIG-TRAN: It's going to swim through the water with its mouth open, big and wide, and it's going to continuously pull little particles from the water.

LUKE GROSKIN: These particles are actually tiny creatures, like plankton or fish eggs.

MISTY PAIG-TRAN: Some of them you can see with your naked eye, and some of them are much smaller that you could only see them with a microscope.

LUKE GROSKIN: Yet just by gliding forward, manta rays and their smaller cousins, the mobula, can pick out enough of these tiny creatures to make a meal.

MISTY PAIG-TRAN: How they do that is what I'm actually studying.

LUKE GROSKIN: Dr. Misty Paig-Tran is a marine biologist and biomechanist at CalState Fullerton.

MISTY PAIG-TRAN: For most fish that are considered filter feeders, we think of them swimming through with a filter that's much like your colander at home.

LUKE GROSKIN: The water flows in, and the pasta gets caught.

MISTY PAIG-TRAN: But it doesn't actually work the way you would think that it works.

LUKE GROSKIN: For one, their filters are on the front and back of their gills, so having food caught there, away from their gullet, would be a problem. Dr. Paig-Tran knew that these filters somehow kept particles flowing to the back of their mouth, but studying how on a live animal was nearly impossible.

MISTY PAIG-TRAN: Getting video inside a manta's mouth is much more difficult than you would expect, so that required me to go and look at a preserved specimen.

LUKE GROSKIN: They're definitely not as majestic as the whole animal, but these are the filters, known as gill rakers. The water flows through these slits and then through the gills behind them, and the shape of these slits actually varies a lot based on the species.

MISTY PAIG-TRAN: So some of them we found had little tooth-like structures all over the filter, while others were completely smooth.

LUKE GROSKIN: Dr. Paig-Tran catalogued all the different textures and structures in the finest microscopic detail, and discovered that two species actually use tiny hairs and sticky mucus to help move particles to the back of their mouth. The other species seemed to use a different mechanism.

MISTY PAIG-TRAN: So now that I have a good idea of what the anatomy looks like, I could then go to a computer and start to build these filters in a 3D model.

LUKE GROSKIN: Working with her undergraduate student, Ashley Peterson, they tested models inside the controlled conditions of a flow tank. Here, blue dye was used to represent the water carrying plankton and fish eggs. Immediately, they noticed that the flow needed to change directions almost 90 degrees in order to enter the filter slits.

Known as cross-flow filtration, this process prevents particles from collecting on the filter's surface by keeping them moving towards the manta's throat. But mantas go one step further. While particles larger than the opening hit and are immediately carried away by the cross-flow, tiny particles get trapped inside these little cyclones created by the shape of the filter. And as these particles are whirled up and away from the filter--

MISTY PAIG-TRAN: The water that's still coming in on the streamline will then just push it back towards the end of the pipe. And in this case, the pipe is the esophagus.

LUKE GROSKIN: This is known as vortex filtration, and it's what enables an animal the size of a car to subsist off fish eggs smaller than a pencil eraser.

MISTY PAIG-TRAN: This is the natural way to filter, and these things are incredibly successful. They've been doing it for millions of years, and they do it well.

LUKE GROSKIN: For *Science Friday*, I'm Luke Groskin.