Cocktail novelties inspired by nature's designs

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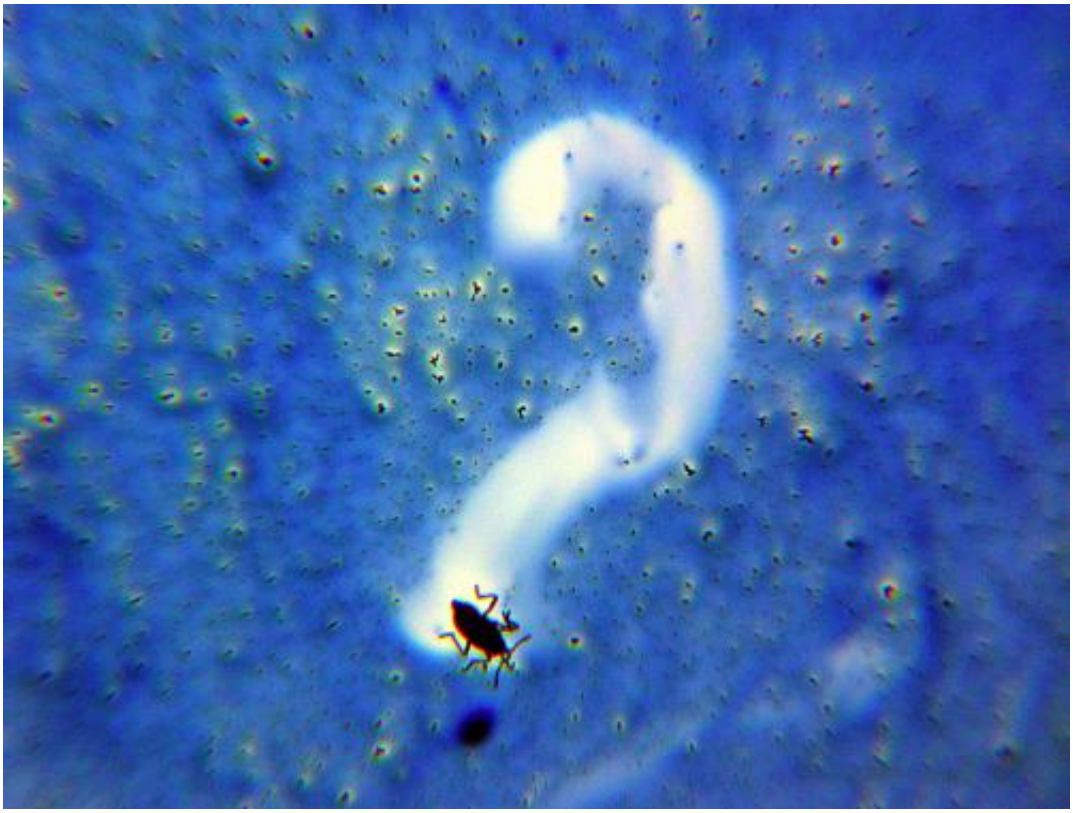

A new cocktail novelty is inspired by certain water bugs that release chemicals to propel them across water. Credit: MIT

An MIT mathematician and a celebrity chef have combined talents to create two culinary novelties inspired by nature. John Bush, a professor of applied mathematics, and renowned Spanish chef José Andrés have designed a cocktail accessory and a palate cleanser based on the

mechanics of water bugs and water lilies, respectively.

The cocktail accessory—an edible "boat" produced by 3-D printing—motors around on the surface of an alcoholic drink, propelled by the same fluid mechanics as certain water bugs. About the size of a raisin, the boat is filled with alcohol of a higher proof than the drink in which it floats. The boat steadily releases alcohol through a notch at one end, creating a difference in surface tension that propels it forward. This approach mimics one used by some insects, which release a chemical that drives them toward shore after an accidental fall into water.

The team also designed a "floral pipette" resembling an upside-down flower. When dipped into a drink, the pipette captures and closes around a drop or two of liquid, which a diner can sip as a palate-cleanser. The device is the opposite of a water lily, which closes its petals when submerged, keeping liquid out. Both mechanisms work via surface tension and hydrostatic forces.

Bush, who has published the details of both designs in the journal *Bioinspiration & Biomimetics*, says the culinary novelties stem from his group's attempts to rationalize nature's designs.

"Nature tends to come up with ingenious mechanisms that are optimized over evolutionary time," Bush says. "Engineers often take it to the next step by asking, 'How can we apply this?' In this collaboration, scientists and engineers have combined with chefs, allowing us to follow the entire route from nature to the kitchen."

Is that a boat in my drink?

This particular collaboration began when Bush attended a science and cooking lecture at Harvard University, where Andrés was invited to speak. After the talk, Bush approached the chef with ideas from his

work in fluid mechanics. The concept attracted Andrés, and the two began to brainstorm ways to apply Bush's designs to the culinary arts.

The cocktail boat, their first project together, is propelled by a phenomenon called the Marangoni effect, which arises when two liquids with different surface tensions come into contact: When a floating object is in contact with two such fluids, it is pulled towards the fluid with the higher surface tension.

When certain bugs accidentally fall into water, they release a chemical that reduces the surface tension behind them, pushing them forward, toward the shore. Bush's cocktail boat works via this same principle, taking advantage of the difference in surface tension between higher- and lower-proof alcohol to make the boat move.

To make the cocktail boats, Lisa Burton and Nadia Cheng—at the time, graduate students in mechanical engineering—fabricated silicone molds using a 3-D printer. They filled the molds with various edible materials, such as gelatin and melted candies, and cast them in the shape of small boats. The boats were filled with alcohol, which leaked onto the surface through a notch at the rear of the boat, reducing the surface tension and propelling the boat forward.

The researchers then experimented with various liquors and boat designs to optimize both the speed and duration of the boat's motion. The team found that the boats could motor around for up to two minutes before running out of fuel.

Printing petals for your palate

The team's floral pipette is based on the behavior of certain water lilies, which float at the surface of ponds or lakes while anchored to the floor. As water rises, hydrostatic forces act to close a lily's petals, preventing

water from flooding in. Taking the water lily as inspiration, Pedro Reis, the Esther and Harold E. Edgerton Assistant Professor of Mechanical Engineering and Civil and Environmental Engineering, designed an upside-down flower that does the opposite, grabbing water as it's pulled up, thereby reversing the role of gravity.

Reis and Bush calculated the optimal petal size for capturing a small sip of liquid, then used a 3-D printer to form molds of the flower, each of which is about 35 millimeters wide—about the size of a small dandelion.

"By pulling this out of liquid, you get something that seals shut and looks like a cherry. Touch it to your lips, and it releases its fluid," Bush says. "It turns out to be an elegant way to serve a small volume of palate-cleansing liquor between courses."

The group has handed off the molds for both the cocktail boat and the floral pipette to Andrés' management company, ThinkFoodGroup, where chefs are experimenting with the molds, filling them with various edible materials.

Bush says that in many ways, scientists and chefs are like-minded in their approach to innovation.

"Both should be familiar with a rich culture of all that has come before them," Bush says. "The challenge, then, is not to create something from nothing, but rather to combine things in novel, interesting ways."

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