Georgia Tech scientists figured out how maggots can eat so much, so fast

Enlarge / Studying the collective feeding behavior of black soldier fly larvae.

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How do the larvae of black soldier flies eat so much, so fast, despite their tiny size? Scientists at Georgia Tech have been studying this "collective feeding" behavior and found that one strategy for maximizing the larvae's feeding rate involves forming maggot "fountains." The scientists described the results in a recent paper in the *Journal of the Royal Society Interface*, along with an entertaining video showing a swarm of larvae consuming an entire pizza in just two hours.

"This is the first time, as far as I know, that we've really tried to quantify how much they were able to eat, and how they are able to do it," said graduate student and co-author Olga Shishkov, who demonstrated the research on Saturday at the American Association for the Advancement of Science meeting in Washington, DC. It's not the first time she's had fun demonstrating the maggots' hearty appetite in creative ways: last year, she videotaped the critters devouring a heart-shaped donut for Valentine's Day.

Shishkov's advisor is David Hu, who runs a biolocomotion laboratory at the Georgia Institute of Technology studying how

various creatures move. He is perhaps best known for his work with fire ants, but his lab also studies cat tongues, water striders, snakes, various climbing insects, mosquitos, and, of course, black soldier fly larvae.

Shishkov was drawn to studying the collective dynamics of the creatures because of her background in fluid mechanics. “I was interested in seeing whether I could apply the fluid mechanics techniques I know to study how animals move,” she said, with the hope of one day applying the principles she uncovers to robotics.

The lab got its black soldier fly larvae from a startup called Grubbly Farms in Atlanta that raises them as a sustainable source of chicken and fish feed. The larvae eat food waste, especially fruits and vegetables, and are capable of devouring twice their body weight every day. Since humans produce 1.4 billion tons of food waste each year, these larvae are one possible solution for dealing with it. The maggots eat consumer food waste and are fed to the chicken and fish in turn. It’s a win-win all around.

- Ten thousand larvae mid-meal in David Hu’s lab at Georgia Tech.
  O. Shishkov et al.
- A close-up image of a black soldier fly larva’s mouth.
  O. Shishkov et al.
- Larvae devour a 16-inch pizza in two hours.
  O. Shishkov et al./Grubbly Farms

A pile of larvae is both small and densely packed, making it a bit of a challenge to study. For the feeding experiments, the larvae were placed in a 10-gallon aquarium with cameras placed at the top and bottom to capture the feeding frenzy in action. Then Shishkov and her collaborators used a technique called particle image velocimetry to track the flow of the critters to get an idea of what was really going on inside the hungry

horde.

They found that the surface area of whatever food item, like a pizza, was offered limits how many larvae can feed at the same time. Larvae also take frequent breaks from their feeding frenzy and yet block their fellow larvae from moving in on their meal. The other hungry critters get around this behavior by generating fountain-like behavior: “new larvae crawl in from the bottom and are ‘pumped’ out of the top,” the authors write. Shishkov *et al*. then developed a mathematical model to predict the eating rate.

There’s one more practical offshoot from this research. Black fly larvae are raised in giant bins, which can be a problem given their high metabolisms. They can easily overheat while feeding. In the wild, they can just crawl away, but their movement is much more limited in the bins, and an entire colony can easily overheat and die. So larvae farmers air condition the entire warehouse in which the beasties are raised. That’s costly and inefficient, which is why Shishkov *et al*. have also invented an aerating bed—patent pending—that blows cool air through the feeding mass of larvae. This keeps them from over-heating and ensures farmers still get high yields.

[embedded content]
Time-lapse video of black soldier fly larvae devouring a pizza.
DOI: *Journal of the Royal Society Interface*, 2019. 10.1098/rsif.2018.0735 (About DOIs).

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