JUMPIN' JEHOSHAPHAT —

Study: Mexican jumping beans use random walk strategy to find shade

It's not the fastest strategy, but it maximizes the likelihood of success.

JENNIFER OUELLETTE - 2/9/2023, 3:29 PM

Devon McKee and A. Pasha Tabatabai/APS 2023

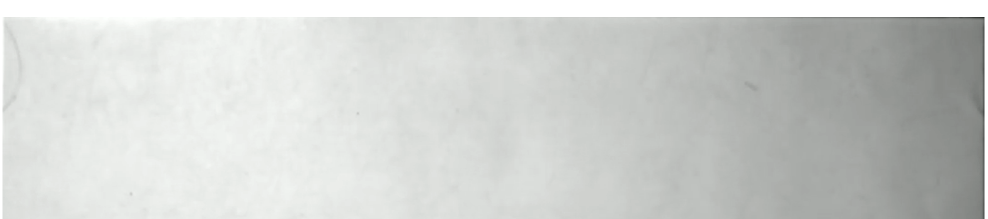
Enlarge / **Mexican jumping beans are actually seed pods from a shrub native to Mexico with moth larvae living inside.**

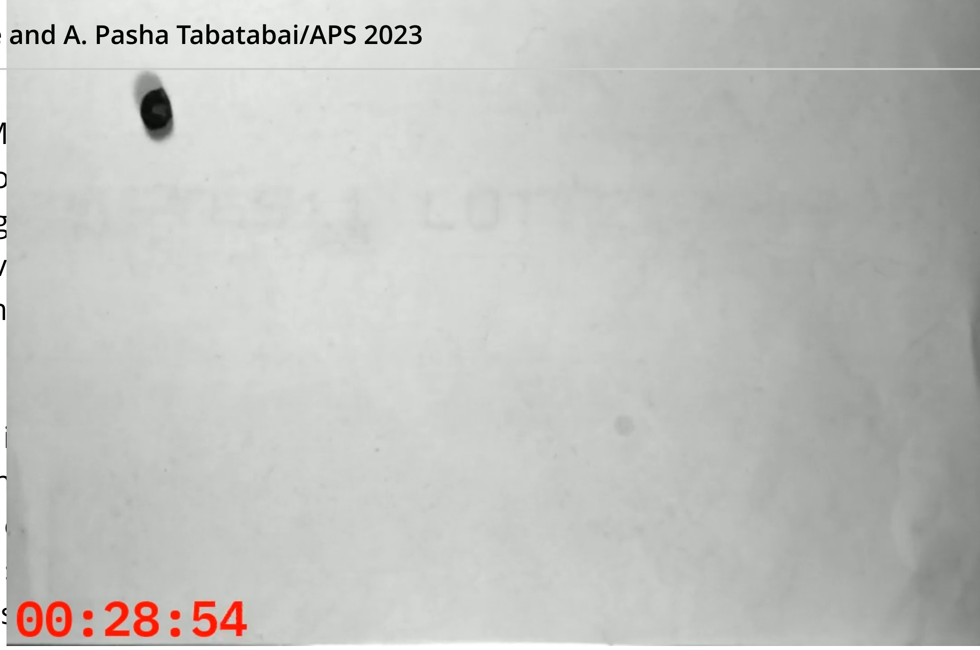
Mexican jumping beans have been a curiosity for many an inquisitive child, and yes, they really do "jump," thanks to the presence of tiny moth larvae inside the seed pods. According to a recent paper published in the journal Physical Review E by physicists at Seattle University, those jumps can help the moth larvae inside find shade to survive on hot days. And the jumping movements seem to follow a random walk strategy in order to do so.

The notion of a random walk is based in part on the physics concept of Brownian motion. Even though this technically describes random collisions between particles, it's a useful model that can easily be adapted to lots of different systems, biological, physical, or otherwise. The concept dates back to 1827, when a scientist named Robert Brown was studying pollen particles floating in water under a microscope. He noted a strange jittery motion and thought the pollen might perhaps be alive. But when he repeated the experiment using particles of dust, which he knew were not "alive," he still saw the jittery motion.

Brown never determined what caused the motion, but Albert Einstein did, in a 1905 paper in which he sought to confirm the existence of atoms and molecules. Einstein's relevant insight was that molecules in a fluid like water would randomly move about and collide with other small particles suspended in the fluid, like pollen or dust, giving rise to the "jittering" Brown had observed some 80 years earlier.

Imagine you are walking along a straight line. Each time you take a step, you flip a coin. If it's heads, you step forward; if it's tails, you step backward. Because the outcome of each coin flip is independent of all the others, there is always an equal chance that it will land on heads or tails with each toss. That means that your future final position is independent of your original starting position—hence the term "random walk." The concept has since been adapted to model stock market fluctuations, population genetics (specifically genetic drift), and neuron firing in the brain, among other applications. And during World War II, Brownian random walks were used to model the distance that an escaped prisoner would travel in a given time, since it can be an effective search strategy, particularly over a small, densely populated area.



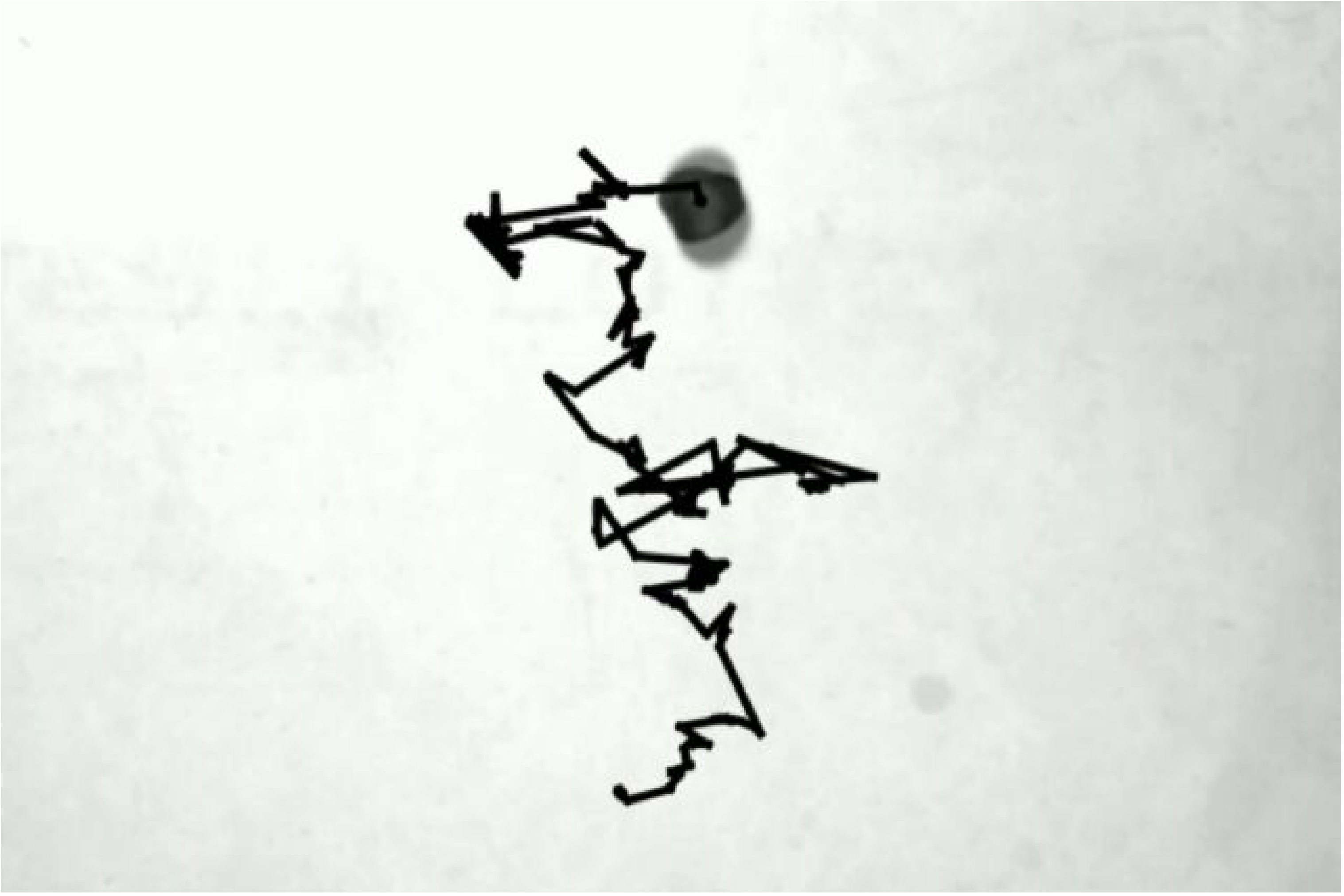


Credit: Devon McKee and A. Pasha Tabatabai/APS 2023

That's where the M … a shrub native to
Mexico and are mo … nown as beans.
Moths lay their egg … When the eggs
hatch, the new larv … ds ripen and fall to
the ground, splittin … s Mexican
jumping beans.

The larvae are still … periodically, and
when their heads h … es start to rise, and
hot direct sunlight … order to move to a
cooler, shady spot … -grown moth
emerges from the s … e of life.

Prior research identified the ideal range of temperatures that initiate the jumping behavior of the larvae. Beans subjected to temperatures in the 20-30° Celsius range (68-86° F) are the most active compared with jumping beans at higher or lower temperatures. Another study classified the three basic types of motion: flipping, rolling, and jumping, with jumping being the most common by far (87 percent). Devon McKee and Pasha Tabatabai of Seattle University wanted to build on that earlier work to quantitatively describe the statistical behavior of the jumps.



Devon McKee/A. Pasha Tabatabai

Enlarge / **Example of experimental data: a photograph of a bean overlaid with that bean's trajectory over time.**

McKee and Tabatabai bought some Mexican jumping beans from an online commercial supplier and stored them at room temperature in individual containers. Then, they built a temperature-controlled flat recording platform out of electrically heated mats covered by an aluminum sheet to ensure even heat dispersal, and a sheet of white paper on top of the aluminum for image contrast. An infrared thermometer tracked the temperature, kept within that "sweet spot" range to ensure the most activity. They then recorded the jumping behavior over an hour or so to collect positional data for each of the 37 beans used in the experiment and created a computer simulation from that data to describe the various trajectories.

Almost all the jumps by the beans took place within 10 seconds, and their trajectories were in keeping with a random walk, regardless of the degree of friction between the beans and the platform's flat surface. But was this the most effective strategy for the beans to escape direct sunlight? When McKee and Tabatabai compared the random walk to a less random pattern of movement, they found that while the alternate pattern let a bean find shade more quickly, only a small fraction of the beans succeeded in doing so. With the random walk strategy, it took a little longer for the beans to find shade, but they were much more likely to succeed in their quest—and therefore survive.

"These results suggest that diffusive motion [random walks] in Mexican jumping beans does not optimize for finding shade quickly," the authors concluded. "Rather, Mexican jumping beans use a strategy that minimizes the chances of never finding shade when shade is sparse."

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