



By Laura Finch

Illustration of the star-nosed mole that graphically portrays the importance of the star appendages by showing them at a size that is proportional to the amount of the mole's brain that is devoted to processing the information coming from them.

Marsh-dwelling mole gives new meaning to the term “fast food”

By David F. Salisbury

Published: February 2, 2005

The star-nosed mole gives a whole new meaning to the term “fast food.”

A study published this week in the journal *Nature* reveals that this mysterious mole has moves that put the best magician to shame: The energetic burrower can detect small prey animals and gulp them down with a speed that is literally too fast for the human eye to follow.

It takes a car driver about 650 milliseconds to hit the brake after seeing the traffic light ahead turn red. In only half that time, the star-nosed mole, operating in the Stygian darkness of its burrow, can detect the presence of a tasty tidbit, such as a small insect larva or tiny worm, determine that it is edible and gulp it down.

Mole gives fast food new meaning



Kenneth Catania

“Most predators take times ranging from minutes to seconds to handle their prey,” says Kenneth C. Catania, assistant professor of biological sciences at Vanderbilt, who directed the study of the mole’s foraging speed. “The only things I’ve found that even come close are some species of fish,” he says.

The secret to the star-nosed mole’s impressive foraging ability is the star-shaped set of appendages that ring its nose. Its fleshy star makes the mole one of the oddest looking members of the mammal kingdom. Despite its distinctive appearance—and the fact that it ranges from Canada, down through the Eastern United States as far as Georgia—people rarely see star-nosed moles because they live only in marshes and wetlands.

Catania, working with laboratory assistant Fiona E. Remple, captured the elusive moles’ feeding behavior with a high-speed video camera that records 500 frames per second, more than ten times faster than a normal camcorder. Because they live in darkness, the moles have very poor eyesight. So they continually survey their environment by repeatedly touching the objects around them with their star appendages. Timing the moles’ actions, the researchers found that after touching a small piece of food it took them only

230 milliseconds to identify it and eat it.



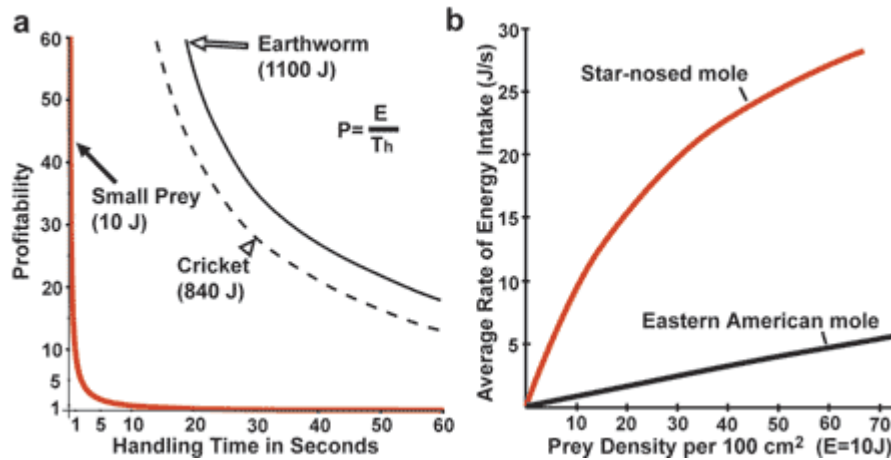
The researchers were surprised to discover that the unusual mole is not just a super-fast forager, but that it is moving almost at the speed limit set by its brain and nervous system. The star-nosed mole takes about 25 milliseconds to decide whether an object is edible. From this, it takes about 12 milliseconds to travel from the mole’s star appendages to its brain and another five milliseconds for the mole’s muscles to respond to signals from its brain.

This leaves only eight milliseconds for the mole’s brain to make an identification. Given the split millisecond timing, it is not surprising that it frequently makes mistakes. In a series of trials where the researchers set out worm sushi for the moles, they found that one third of the time the moles actually

Mole gives fast food new meaning

started to move in the wrong direction and had to suddenly reverse themselves, a sequence that the researchers call a double-take.

The researchers conclude that “This inefficient behavior suggests that the moles are operating at, or near, the limit set by the speed which the mole's nervous system can process touch information.”



Courtesy of Kenneth Catania

(a) Graphing the handling time against prey profitability shows how the star-nosed mole can profitably include very small into its diet by reducing its handling time for small prey to a fraction of a second. “J” stands for joules, a unit of energy. (b) The red and black curves show how the star-nosed mole's advantage over the eastern mole increases with the density of small prey in the area.

The ability to handle prey so quickly and efficiently appears to provide the star-nose mole with a real competitive advantage.

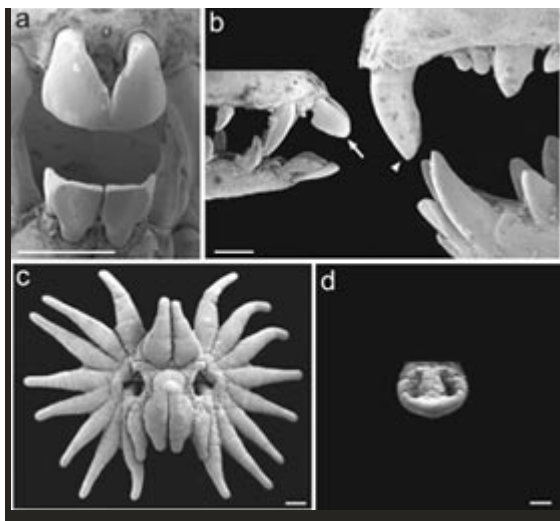
Researchers in the field of behavioral ecology have invested considerable time and thought studying how different animals eat. It's fairly obvious that it is more efficient to kill a 1,000-pound beef cow for meat than it is to kill 125 eight-pound rabbits. That is because it takes more time and energy to kill and consume the rabbits. Ecologists have formalized this relationship with a factor called prey profitability. They define prey profitability as the ratio between the energy a predator gains from eating a prey animal and its “handling time,” where handling time is defined as the time between detecting an animal and eating it.

Mole gives fast food new meaning

According to the prey profitability formula, by reducing its handling time to a fraction of a second, the star-nosed mole can gain energy from chowing down on small insect larvae, tiny worms and other small food sources. Predators that take a few seconds to handle each prey animal, on the other hand, actually use more energy in the process of catching and eating such small prey than they gain from eating it. Of course, that doesn't mean that star-nosed moles turn their noses up at larger prey, like long, luscious earthworms.

The insight that the star-nosed mole has specialized in minimizing handling time for small prey helps clear up a number of the mysteries that have surrounded this unusual mammal, Catania says.

One central mystery has been the purpose of the mole's unusual nasal decoration. For a number of years, scientists advanced a number of different theories about the mole's star-shaped appendages. Some proposed that they were a super-sensitive olfactory organ that helps the nearly blind moles to sniff their way around underground. Others have suggested that it serves as an extra "hand" for grasping prey or other objects. Still others argued that it serves as an antenna that detects electric fields as the moles swim through muddy marsh water. It wasn't until 1995 that the weight of evidence from studies performed by Catania and other researchers finally led scientists to agree that the star appendages were in fact super-sensitive touch organs. [See "[Neuroscientist studies bizarre animals](#)"]



Courtesy of Kenneth Catania

(a) Frontal view of the star-nosed mole's teeth; (b) Sideview that shows how different the star-nosed mole's teeth, left, are from those of the eastern mole; (c) Front view of the star-nosed mole's appendages shows how much larger they are than the nose of the eastern mole shown in (d).

Now Catania thinks he knows why the star appendages have grown so large: The 22 appendages that ring its nose have a surface area that is eight times greater than the nose of its close cousin, the eastern mole. Its flexible fingers also allow the star-nose to tap objects in its surroundings at a faster rate, 13 times per second compared to the eastern mole's more leisurely eight times per second. Taken together, these advantages mean that the star-nosed mole can find 14 times the number of small snacks than its close cousin can in a given amount of search time.

This advantage really pays off where small prey animals are abundant, as is often the case in the marshy areas that the star-nose inhabits, Catania calculates.

Specialization for small-prey handling can also explain the mole's unusual teeth. "The star-nose has the strangest teeth," Catania says. Its incisors are very small, compared to other moles, and are formed like tweezers. "This allows them to grasp very small prey precisely," he says.

Mole gives fast food new meaning

SCIENTIFIC JOURNAL ARTICLES

Some links may require subscriptions for access.

[Catania KC, Remple FE. Tactile foveation in the star-nosed mole. Brain, Behavior and Evolution. 2004;63\(1\):1-12.](#)

[Crish SD, Comer CM, Marasco PD, Catania KC. Somatosensation in the superior colliculus of the star-nosed mole. Journal of Comparative Neurology 2003 Sep 29;464\(4\):415-25](#)

[Catania KC. Barrels, stripes, and fingerprints in the brain - implications for theories of cortical organization. Journal of Neurocytology. 2002 Mar-Jun;31\(3-5\):347-58. Review.](#)