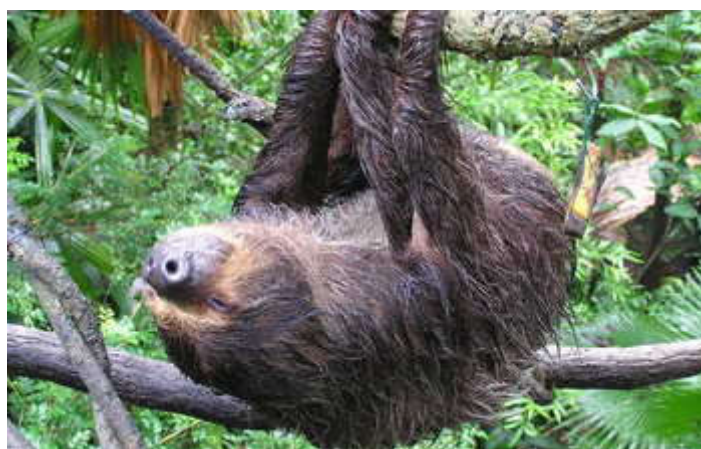


Discovery

Putting the sloth in sloths: Arboreal lifestyle drives slow pace

Sloths, one of few species that live in tree canopies, subsist solely on leaves



The diets of two-toed and three-toed arboreal sloths consist mostly of tree leaves.

[Credit and Larger Version \(/discoveries/disc_images.jsp?cntn_id=139231&org=NSF\)](#)

[View Additional Multimedia](#)

July 20, 2016

Although most of the terrestrial world is covered in trees, few vertebrates make the canopy their home - and even fewer subsist solely on a diet of leaves.

Tree sloths are among the most emblematic tree-dwelling mammals. They are best known for their pokey demeanor rather than the fact that they spend the majority of their lives in trees munching leaves. But the slow-motion lifestyle of tree sloths, according to a new study, is a direct result of the animals' adaptation to their arboreal niche.

"Among vertebrates, this is the rarest of lifestyles," says Jonathan Pauli, a University of Wisconsin-Madison wildlife ecologist and the senior author of a report to appear in the August 2016 edition of the journal *American Naturalist*. "When you picture animals that live off plant leaves, they are almost all big things like moose, elk and deer. What's interesting about arboreal folivores is that they can't be big."

Pauli and UW-Madison colleagues M. Zachariah Peery, Emily Fountain and William Karasov set out to measure the energetics of wild two- and three-toed sloths at a field site in northeastern Costa Rica.

"This study explains why eating leaves in the canopies of trees leads to life in the slow lane, why fast-moving animals like birds tend not to eat leaves, and why animals like deer that eat a lot of leaves tend to be big and live on the ground," says Doug Levey, program director in the National Science Foundation (NSF)'s Division of Environmental Biology, which funded the research.

Sloths: rare species

The study, Pauli says, aims to help explain why arboreal folivores are so rare and why more animals have not evolved to take advantage of a widespread ecological niche.

"Most of the world is forested, but the energetic constraints of a leafy diet seem to prevent adaptive radiation," Pauli notes, referencing the canon of evolutionary biology that helps explain the diversity of life on our planet. As organisms evolve and "radiate" from an ancestral group, they take on a variety of specialized forms that enable them to live a certain lifestyle or occupy a particular niche.

The evolutionary logic of living in trees on a diet solely of leaves, it seems, is less than robust.

"Think about it," says Pauli. "The food is only plant leaves. You have to exploit a very constrained niche."

To do so, tree sloths require specialized limb adaptations, reduced body mass, a slow metabolic rate and claws that act like fulcrums -- hooks to accommodate the animals' need to hang onto and traverse treetops.

Little energy expended

The scientists measured the daily energy expenditure of both two- and three-toed sloths, animals that co-exist in the tropical forest canopies of Central and South America.

Astonishingly, three-toed sloths, which are more specialized to their environment, expend as little as 460 kilojoules of energy a day, the equivalent of burning a mere 110 calories -- roughly the same number of calories in a baked potato.

It is the lowest measured energetic output for any mammal.

"The measurement was intended to find out what it costs sloths to live over a day," says Pauli, who explains that a diet of plant leaves has little nutritional value and that the animals' gut size limits them to small amounts per day, so sloths need to find ways to make the most of their skimpy diets.

That means expending minimal amounts of energy through a reduced metabolic rate, dramatic regulation of body temperature, and navigating the world in slow motion.

The researchers then compared their results with similar studies of wild arboreal folivores from other corners of the globe.

The take-home message, says Pauli, is that the more specialized the tree-dwelling animal, the lower the daily energy expenditure.

"The findings reinforce the concept that arboreal folivores are tightly constrained by nutritional energetics," Pauli notes. "It takes a suite of extraordinary adaptations to survive in forest canopies."

-- Cheryl Dybas, NSF (703) 292-7734 cdybas@nsf.gov (<mailto:cdybas@nsf.gov>)

-- Terry Devitt, University of Wisconsin-Madison (608) 262-8282 trdevitt@wisc.edu (<mailto:trdevitt@wisc.edu>)



Close-up of a two-toed sloth in northeastern Costa Rica, where the study was conducted.
[Credit and Larger Version \(/discoveries/disc_images.jsp?cntn_id=139231&org=NSF\)](/discoveries/disc_images.jsp?cntn_id=139231&org=NSF)



A mother and juvenile three-toed sloth in the tree canopy at the scientists' study site.
[Credit and Larger Version \(/discoveries/disc_images.jsp?cntn_id=139231&org=NSF\)](/discoveries/disc_images.jsp?cntn_id=139231&org=NSF)



A two-toed sloth moves along a cable in a cacao plantation in northeastern Costa Rica.
[Credit and Larger Version \(/discoveries/disc_images.jsp?cntn_id=139231&org=NSF\)](/discoveries/disc_images.jsp?cntn_id=139231&org=NSF)



Three-toed sloths lead slow-motion lives, in keeping with their adaptations to arboreal niches.
[Credit and Larger Version \(/discoveries/disc_images.jsp?cntn_id=139231&org=NSF\)](/discoveries/disc_images.jsp?cntn_id=139231&org=NSF)



Two-toed sloths are heavily-built animals with shaggy fur and slow, deliberate movements.
[Credit and Larger Version \(/discoveries/disc_images.jsp?cntn_id=139231&org=NSF\)](/discoveries/disc_images.jsp?cntn_id=139231&org=NSF)

Investigators

Per Palsboll
Jonathan Pauli
M Zachariah Peery

Related Institutions/Organizations

University of Wisconsin-Madison

Related Awards

[#1257535 The ABCs of Dispersal: Developing an Approximate Bayesian Computation Approach for Estimating Migration Rates from the Distribution of Related Individuals \(/awardsearch/showAward.do?\)](#)

AwardNumber=1257535)

Total Grants

\$500,000

National Science Foundation, 2415 Eisenhower Avenue, Alexandria, Virginia 22314, USA Tel: (703) 292-5111, FIRS: (800) 877-8339 |
TDD: (800) 281-8749