



## ScienceWatch – A Walking (Sloooow) Ecosystem

### “Sloths are bizarre.” – J. Pauli

An ecosystem is a community of organisms interacting with non-living components in the environment. Rainforests and deserts are ecosystems. So are sloths. Sloths are also notoriously slow. The leaves they eat are nutrient and calorie poor. So sloths have evolved a slow metabolism to make miserly use of their small energy budget. They have also figured out how to get energy from an unlikely source—their own fur.

Writing in the January 22, 2014 issue of the *Proceedings of the Royal Academy B*, a team of biologists led by Jonathan Pauli and M. Zachariah Peery, University of Wisconsin-Madison, Madison, WI, started out trying to answer a potty question.

About once a week the three-toed sloth (*Bradypus variagatus*), but not its cousin the two-toed sloth (*Choloepus hoffmann*), leaves the safety of its home tree and descends to the forest floor to defecate. A squatting sloth is a sitting duck, prey to harpy eagles, jaguars and coyotes. Half of all sloth mortality occurs at this time. So why not just stay in the canopy like their cousins? Pauli *et al.* think they have the answer.

Sloth fur hosts a variety of invertebrates and microbes, including the pyralid moth (*Cryptoses spp.*). The moths subsist on green algae (*Trichophilus spp.*) that only grows on sloth fur. The algae can grow there because each hair shaft is specially adapted to hold water. The moths' life cycle is completely dependent on the sloth. When it descends to defecate, gravid female moths leave the sloth and lay their eggs in the fresh dung. There the coprophagous larvae develop into adults and fly up into the canopy to spend their entire lives on another sloth.

The sloth-moth-algae relationship seemed to be an example of commensalism: one side (moths and algae) benefits, while the other (sloth) neither benefits nor is harmed. Pauli *et al.* however, believed that the sloth wouldn't be so altruistic, putting itself at great risk by leaving its favorite tree and using up about eight percent of its scant daily energy budget for nothing. They suspected that the sloth was “farming” the algae to gain some extra energy, and the tripartite relationship was an example of mutualism, *i.e.*, everyone benefits.



To find out, the team captured ten three-toed and ten two-toed sloths and vacuumed off all the fur inhabitants. The three-toed sloths had 3.5 times more moths in their fur than the two-toed sloths. As dead moths decompose, they release nutrients, especially

nitrogen-containing ammonium ( $\text{NH}_4^+$ ), which fosters the growth of algae. Chemical analysis of fur rinse water showed higher  $\text{NH}_4^+$  levels coming from the fur of three-toed sloths. Three-toed sloths also had fifty percent more algae on their fur than two-toed sloths. The team found that the algae are readily digestible and contain three times the amount of fat present in leaves.

Were sloths consuming algae? Sloth stomach contents showed significant levels of algal cells. Evidently, the potty trips are worth the risk because they increase moth numbers which in turn enhance the growth of algae. The latter provide a high energy source lacking in the leaves the sloth eats. "It seems like the sloths are potentially obtaining something in terms of a nutritional input from cultivating or at least helping algae to grow on their fur," said Pauli.

The authors conclude that a series of "linked mutualisms" involving sloths, moths and algae creates an ecosystem. The moths are decomposed by fungi living on sloth fur. That decomposition provides the link between the non-living environment and the living zoo that is the sloth's fur.

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