

Letter from the Desk of David Challinor
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Anteaters and pangolins both have evolved to feast on ants and termites. Although widely separated geographically and quite unrelated, they well-illustrate convergent evolution: the remarkably parallel evolution of two disparate mammals to exploit a specialized global food resource—in this case, ant and termite colonies. This month's letter is about these two groups of relatively large mammals—anteaters in the new world and pangolins in the old. Both have evolved to solve the problem of eating only insects. The three genera of American anteaters range in size from a retriever to a small monkey, whereas the seven pangolin species in Africa and Asia are closer in size to each other. The largest from head to tail-tip is about 135 cm (4.5 ft), the smallest about 85 cm (3 ft). The two groups are a striking example of convergent evolution in that they both have developed very similar habits and internal characteristics such as tongues, salivary glands and digestive systems that allow them to consume ants and termites. As relatively large predators of individually small prey, they need a concentrated food source to survive. Ant and termite colonies fill this requirement perfectly.

New world anteaters (family: Myrmecophagidae – Greek for ant-eater) are an ancient group that along with sloths and armadillos are the last survivors of the suborder Xenarthra, which peaked in the Tertiary era beginning about 70 million years ago. The largest of these relicts is the giant anteater, which I first saw in Venezuela the year Halley's Comet visited our solar system (1986). I was visiting a Smithsonian research project in the llanos (seasonally flooded grassy plains between the coast and the Orinoco) and one morning took advantage of the dry season to drive in a jeep along the trails through the fawn-colored grass. We were almost smothered by the fine pale grey dust swept aloft by the tires. Discomfort from dust was more than offset by such spectacular wildlife as the giant jaribú storks and the unexpected sight of a giant anteater shuffling along the dusty trail. The anteater was larger than I had expected, about 2.7 m (9 ft) long including the large bushy tail that displaced almost as much space as its body. I watched it intently, for it tolerated a close approach, and noticed that its front feet were twisted so that it was walking on the outside edge of its "hands," thereby keeping its long claws clear of the ground. The claws of its powerful forelegs seem to be primarily a defensive weapon with which to grasp an attacking dog or jaguar, but are also thought to be used for tearing apart termite nests. However, researchers in Brazil conducting a two-month intense study of these animals never observed this behavior.

Anteaters were seen digging into the shallow mounds of ant colonies. They poke their narrow heads into the depths of the colony and with their long (60 cm/2 ft) tongues lick out the insects. To consume the necessary mass of ants (6-7 lbs daily or 2.2-3.1 kg) to sustain such a large mammal, they have evolved some remarkable characteristics. Their long narrow, worm-shaped tongues are coated with sticky saliva to draw ants into

their toothless mouths where they chew them with their lower jaws, forcing their ant-coated tongues against the roof of their mouths and the inside of their cheeks, all covered with small horny knobs. Scientists do not know exactly how the crushed ants are swallowed, but the very flexible and muscular tongue must be a principal mechanism. It is so long that its base is anchored in the sternum and the nerves and muscles allow the tongue to be thrust in and out of the mouth up to 160 times a minute. This organ is so selective that remarkably little sand, soil or other detritus is ingested. Lining the tongue's passage are multiple salivary glands to keep it well-coated. Observers are still not sure whether ants also bite the tongue when it touches them, thereby reinforcing the stickiness of the saliva. Whatever the precise mechanism may be, it is hard to imagine a more efficient arrangement for eating ants, for it is estimated that an anteater consumes 35,000 ants each day—enough to fill several liter-sized jugs.

Giant anteaters seem to prefer ants to termites and confine themselves to relatively few ant species, avoiding large biting ones. When foraging, they follow a fairly straight path; radio-collared ones in Venezuela travel an average of 11 km (6 ½ mi) nightly. They smell for ant colonies and eat for only about 30 seconds before moving on. Evidently after this interval the ants either disperse beyond the reach of its tongue or the soldier ants organize to defend the colony with an aggressive attack. Feeding so briefly, furthermore, leaves the colony intact and thus available for subsequent visits.

Of the two other anteater genera in the American tropics, the tamandua, is about half the size of its giant relative and forages both on the ground and in trees. It too has a relatively pointed snout and long tongue, small eyes with thick eyelids for protection from ant bites and a long prehensile tail with which it hangs to feed on tree-nesting termites. I saw only one years ago in the late afternoon on Barro Colorado Island in Panama; they are primarily night foragers.

The third genus is the silky anteater—half again smaller than the tamandua. It spends the day curled up asleep, often on the top of tall palms and is thus hard to see. Like its tamandua relative, it has a prehensile tail, an extended sticky tongue and concentrates on ants rather than termites. Thus with their ancient lineage the new world anteaters have filled a broad niche of forests and grasslands to exploit an abundant year-round food source.

In the old world of tropical Africa and Asia live the pangolins, all within one genus and quite unrelated to anteaters. There are seven species, four African and three Asian, which differ from each other primarily in size. They, too, have evolved to live on the plentiful ants and termites of the old world just as anteaters did in the new.

The pangolin's coat is its most striking characteristic. Instead of being furred as in most mammals, pangolins have broad, overlapping, horny scales covering all except the underside of the neck, the stomach, the snout and the inside of the legs. It was once

thought that their scales originated as modified keratinous hair such as our nails or a rhino's horn, but they now seem to be two-sided symmetrical skin elevations according to Rahm (Grzimek's Animal Life Encyclopedia, Vol.11, p.183). In adults, as the scales wear they are replaced at the skin base so that the total number is constant. The hard scales protect pangolins when they curl into a ball, but only against small carnivores, not against leopards or tigers.

Despite the external dissimilarity between pangolins and anteaters, their diet, ecological niches, behavior and internal morphology are amazingly parallel. Both groups forage almost exclusively on ants and termites, and both have evolved highly modified organs to catch and digest their prey; thus the two groups share long sticky tongues with modified throat and sternum passages to house their tongues and unusually large salivary glands to keep their specialized tongues well-coated. Neither group has teeth, and both use methods similar to the giant anteater to "chew" their food. Both have terrestrial and arboreal members and both forage primarily at night. Both secrete extremely pungent urine, so strong that tamanduas are locally called "forest stinkers." All pangolins and all but the giant anteater have prehensile tails and almost all in both groups carry their young on their backs or, in the case of the pangolin, at the broad base of its tail.

I have recorded these similarities to illustrate an example of convergent evolution. Ants and termites are more ancient than mammals and have, therefore, had more evolutionary time to specialize. Thus there are orders of magnitude more species of ants and termites than mammals that prey on them. Their very multiplicity and colonial living habits concentrate their numbers sufficiently on trees and underground so that despite their small individual size, their aggregate mass makes them a food source for the current mammals that evolved to exploit them. Many small mammals are primarily insectivores such as moles, certain mice, shrews, etc., but they pale in size to anteaters and pangolins. Even large mammals such as grizzly bears occasionally eat beetle larvae. Humans, too, such as some California Indians, harvested sawfly larvae (a hairless caterpillar) for food, but the two specialized mammals discussed in this month's letter feed exclusively on ants and termites. The evolutionary paths followed by each group to achieve their present form may never be completely unraveled. But we do know that at some point in the distant past their two paths partially merged so that each has successfully gained a highly specialized diet.

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