



THE
CURIOUS,
BLOODY
LIVES OF
VAMPIRE
BATS

Among the most highly specialized mammals on the planet, vampire bats display a host of fascinating adaptations to their blood diet.

BY BILL SCHUTT
ILLUSTRATIONS BY PATRICIA WYNNE



EVERY DAY, I and my undergraduate assistant Kim Brockmann fed a Snapple bottle full of cow's blood to our captive vampire bats. Our colony consisted of twenty-two

animals—eleven common vampire bats (*Desmodus rotundus*) and eleven white-winged vampires (*Diaemus youngi*)—and we maintained them for two years while I was doing my graduate work at Cornell University. One of the keys to our success was giving them the opportunity to feed on a live hen once a week.

It was on one of the first of those special feeding days that I noticed two of the white-winged vampires doing something incredible. They crawled across the floor of their feeding enclosure like a pair of spiders, and then one of the bats made a bold approach to a rather large hen. The bird cocked her head to one side, eyeing the bats. Her beak could have severely injured or even killed them, so I got ready to intervene. Sharing my concern, perhaps, one of the vampires stopped a couple of inches beyond pecking distance. The other bat, however, crept even closer, and then, amazingly, it nuzzled against the hen's feathery breast. Instead

of becoming alarmed or aggressive, the bird seemed to relax. The vampire responded by pushing itself even deeper into what I would later learn was a sensitive section of skin called the brood patch: a feather-free region, densely packed with surface blood vessels, where body heat is efficiently transferred to the hen's eggs

or to her chicks. As I watched, the hen reacted to the bat by fluffing her feathers, hunkering down—and closing her eyes.

My God, I thought, these bats have learned to mimic chicks!

What was most remarkable to me was that in all likelihood chick mimicry wasn't innate behavior written into the *D. youngi* DNA over millions of years. It had probably developed in less than a thousand years—since humans brought domesticated fowl to South America. Were vampire-bat mothers teaching this cuddle-up trick to their young?

So enthralled was I at this wonderfully diabolical maneuver and its implications that I didn't notice that the second vampire had disappeared under the hoodwinked hen's tail feathers—until several minutes later, that is, when a thin trickle of blood appeared on the floor behind the bird. Through the gloom of the darkened enclosure I could see a small puddle forming, glistening like red tinsel.

VAMPIRE BATS FEED SOLELY on blood, and their adaptations to the peculiar challenges of that diet make them among the most highly specialized of all living mammals. Only three bat species out of the 1,100 in the order *Chiroptera* qualify as vampires. As I began to take an interest in these creatures, I noticed that vampire-bat researchers (with a few notable Mexican and South American exceptions) hadn't done much with the two rarer vampire bat species—*Diaemus youngi*, described above, and the hairy-legged vampire, *Diphylla ecaudata*. Instead, most of their research and nearly everything that had been written about vampire bats dealt solely with the common vampire bat, *Desmodus rotundus*. I wondered why. The bat experts I consulted told me confidently that all vampire bats would act similarly, but how could that could be so? With overlapping ranges and a coveted resource (blood), wouldn't the species be competing with one another, and wouldn't it be likely that differences in behavior and anatomy had evolved to reduce that competition?

Perhaps the reason for the near-exclusive focus on *D.*

rotundus can be found simply in the name

"common." This species is numerous across a widespread range that includes Mexico

and Central and South America;

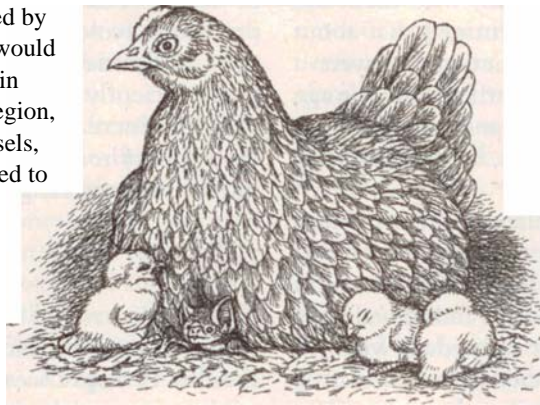
furthermore, it has been maintained successfully in captivity for more than seventy years, with some individuals surviving for as long as twenty years.

The hairy-legged and white-winged vampire bats, by contrast, are far more difficult to locate and capture within their more limited ranges, and they long had a reputation for being difficult to maintain in cap-

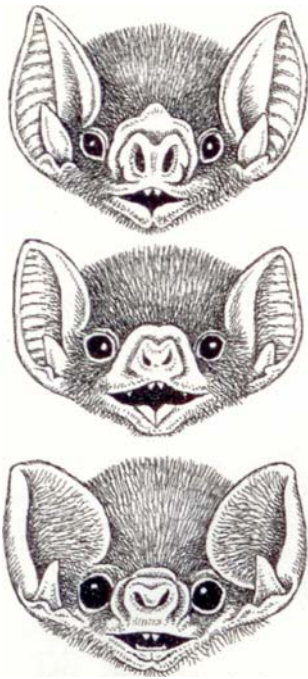
tivity. As a result, even though local scientists in places like Trinidad and Brazil, where the less common vampires live, had been aware of differences among the vampire species for years, it wasn't until the

very end of the twentieth century that the mainstream scientific community began looking at each of the three vampire bats as separate and distinct. Hence, the door was wide open for the comparative work I'd proposed to undertake, and for new discoveries like the one described above concerning chick mimicry.

Ultimately, my colleagues and I found that not only did significant differences exist between the three vampire bat species, but that most of the variation—including unusual feeding methods and social interactions between



White-winged vampire bat (*Diaemus youngi*) snuggles up to a hen's brood patch, a region rich in surface blood vessels that functions to warm eggs or chicks. By mimicking chick behavior, the bat lulls the bird into a relaxed state, then feeds on the hen's blood. Opposite page: *Desmodus rotundus*.



Faces of the three species of vampire bats: *Desmodus rotundus* (top), *Diaemus youngi* (middle), and *Diphylla ecaudata* (bottom)

roost-mates-relates to the bats' preference for either mammalian or avian blood.

ASIDE FROM THE RELATIVE ease of studying the common vampire bat, its slew of fascinating behavioral, anatomical, and physiological features helped to sustain the exclusive interest in the species. And some of those "common" features do indeed seem likely to apply to all vampire bats. Take, for instance, one of the most fascinating of all vampire bat adaptations, which I

observed only once in the three years I kept a colony of *Diaemus* at Cornell: blood-meal sharing between bats.

In 1984, zoologist Gerald S.

Wilkinson, then of the University of California San Diego in La Jolla, first

reported that vampire bats in the wild commonly share food by regurgitating blood. Wilkinson, who made his initial observations on *Desmodus*, determined that about 70 percent of blood-sharing incidents occurred between a mother and her dependent offspring (until around the age of one). Blood sharing between mothers and newborn pups presumably transfers not only nutrients, but also bacteria necessary to an infant's digestive tract.

Blood sharing between both related and unrelated vampire bats also occurs on a reciprocal basis; that is, bats that Wilkinson had experimentally starved for one night and that then received blood from another individual were more likely to donate blood to that individual when it, in turn, was starved. That reciprocity almost certainly evolved in response to two basic realities: a bat that cannot find a blood meal will starve to death in less than three days, and yet on any given night, as Wilkinson found, about one in fourteen adult bats and fully a third of young vampires-in-training will fail to feed. And so there will be numerous occasions over a vampire bat's lifetime both to receive and to share food.

Therefore, it's remarkable but not surprising that *Desmodus* can remember past donors as well as recognize cheaters—those individuals who try to beat the system by not sharing blood. There's another way in which bats discriminate among recipients: adult males will share blood with females and young bats, but rarely with other adult males. That makes perfect sense. Why share food with someone who may be your rival for a mate?

There is anecdotal evidence that the white-winged and hairy-legged vampires also share blood, but in contrast to

Wilkinson's in-depth study of *Desmodus*, this behavior in *Diaemus* and *Diphylla* has yet to be studied in detail.

In other ways, *Desmodus* exhibits unique traits among the trio of vampire bat species. One of the reasons for the common vampire's success is its ability to feed from the ground—and thanks to humans, they have developed a partiality to cows' blood. This they often obtain while on the ground, from the region behind the cows' hooves, an area with relatively thin skin and an ample blood supply flowing close to the surface. Feeding also takes place with the bat riding its prey's back, where it's easy for the vampire to reach sensitive areas like the ears.

To feed on the ground, *Desmodus* has evolved the ability not only to walk and even run on all fours, but to make spectacular, acrobatic jumps in any direction. A

SHARE REGURGI

flight-initiating jump off the ground is powered by strong pectoral muscles and fine-tuned by elongated thumbs, which are the last things to leave the ground. The thumbs impart precise direction to jumps that can reach three feet in height. That enables the common vampire to escape predators, avoid being crushed by its relatively enormous prey, and initiate flight after a blood meal. This ability to feed efficiently and safely on large mammals, combined with the increasing supply of domesticated livestock, is the primary reason why *Desmodus* has been so successful in numbers and range.

WHILE WORKING WITH white-winged vampire bats, I discovered that they move differently from the common vampire, and not only because they have shorter thumbs. Perhaps *Diaemus* bats once initiated flight similarly to their aggressive, spring-loaded cousins, but now their movements are more deliberately paced and show little sense of urgency. When placed on a force platform—which measures the forces generated by an animal as it moves across the surface—white-winged vampires would give a little hop or two, then scuttle off to find a dark corner to hide in.

Watching *Diaemus* feed in trees, rather than terrestrially like *Desmodus*, I learned why the former doesn't need to catapult into the air. Approaching a roosting bird from below its perch on a branch, a white-winged vampire will move slowly and stealthily, always keeping the branch between itself and the underside of its intended avian prey.

Once situated beneath the feathered lunch wagon, *Diaemus* picks a potential bite site, usually on the bird's backward-pointing big toe, the hallux. Feeding from that particular digit keeps the bat better hidden from above than if it were to feed on one "of the forward-facing toes. After licking the



Common vampire-bat mothers share food with their young by regurgitating blood.

chosen site for several minutes, the bat inflicts a painless bite with razor-sharp teeth, which characterize all three vampire bat species. The bite is never violent and very often occurs as the bird shifts position slightly. Anticoagulants in the bat's saliva will keep blood flowing from the tiny wound well after the bat has drunk its fill.

Still hanging below its completely oblivious prey, *Diaemus* begins feeding, and within five minutes it begins peeing. To meet its energy needs, the vampire must drink close to half its body weight in blood at each meal, and blood is about

80 percent water. So the bat's digestive and excretory systems have evolved to unload the

FOOD BY TASTING BLOOD

excess quickly: the stomach lining is rich in blood vessels that absorb water and shunt it straight to the kidneys. *Diaemus* deftly avoids soiling itself while it eats by extending one hind limb sideways and downward. After feeding for fifteen to twenty minutes, the bat releases its thumbs from the branch, hangs briefly by its hind limbs, then drops into flight. Initiating flight in this manner means that there is no need for *Diaemus* to jump in the manner of its terrestrially feeding cousin, *Desmodus*.

On numerous occasions, my colleagues and I have observed *Diaemus* feeding on birds from the ground. Supporting its body in a low crouch, as compared with the extreme upright stance of *Desmodus* feeding on a cow, the white-winged vampire is adept at hopping around, rather comically, in pursuit of a feathered blood meal. Although

ground locomotion has not been reported in the wild, we proposed on the basis of this behavior (and the possession of robust hindlimb bones) that white-winged vampires have made a relatively recent return to the trees, thus avoiding competition with their ground-feeding cousins.

During the terrestrial feeding bouts of our white-winged vampires, we also recorded a parasite-host interaction that rivaled chick mimicry on the "weird-o-meter." When a bat leaped or climbed onto a chicken's back to get a meal, a male chicken would quickly grow agitated and dislodge the bat with a shake and a peck. A hen mounted in this fashion, however, would immediately assume a crouching posture, giving the bat the opportunity to scuttle forward and bite the back of the bird's head or its fleshy comb. The hen would maintain this crouch until after the vampire bat had finished feeding and hopped off. With a little research into poultry behavior, we learned that this was the exact posture taken by a hen while being mounted by a male bird-for a completely different purpose.

Another way that *Diaemus* differs from *Desmodus*

and *Diphylla* is the presence of a pair of cup-shaped oral glands located at the rear of its mouth. When *Diaemus* gets upset or engages



in battles for dominance, these glands are projected forward and can be seen quite easily when the bat opens its mouth.

Diaemus simultaneously emits a strange hissing vocalization and a fine spray of musky-smelling liquid from the oral glands. Although a detailed study remains to be performed, the oral glands of *Diaemus* appear to be employed in self-defense, as well as in communicating infor-

White-winged vampire bat (*Diaemus*), above, climbs onto the back of a hen, which crouches as if mounted by a rooster. The bat will then feed, typically from the rear portion of the bird's fleshy comb. Below: The common vampire bat can run along the ground like a spider and make spectacular jumps, to initiate flight and to avoid being crushed by its mammal prey, such as cows.





Diaemus possesses a unique feature among the three vampire bats, a pair of cup-shaped oral glands that project forward when the bat is agitated or during displays of dominance. The glands emit a fine spray of musky-smelling liquid.

mation such as status, mood, and territorial boundaries to others of its kind.

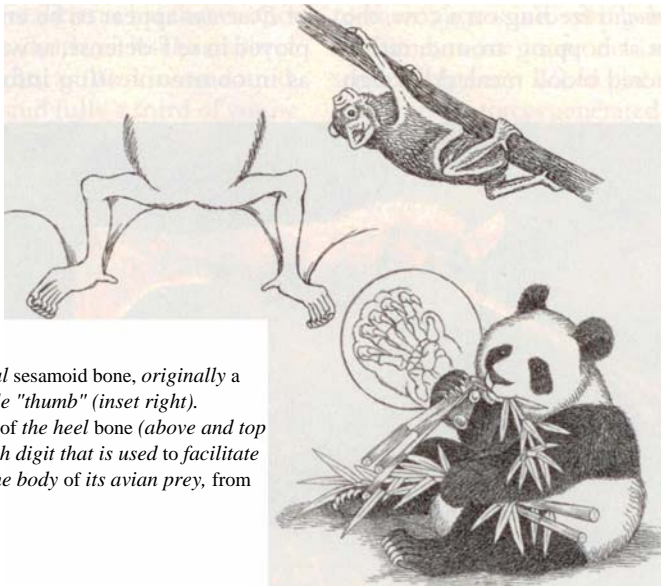
t CLOSER LOOK at the third genus, *Diphylla*, the hairy-legged vampire bat, so named for the fringe of hair that borders the back margin of its hind legs, also revealed unexpected morphological and behavioral adaptations related to feeding. *Diphylla* is thought to exhibit the most primitive anatomical characteristics of its group. In other words, scientists believe that *Diphylla* has undergone the least evolutionary change from ancestral vampire bats-whatever they were.

The hairy-legged vampire possesses an anatomical characteristic not seen in its blood-feeding cousins-or in any other animal. It is a unique variation in a structure found in many bats called the *calcar*, a bony or cartilaginous extension of the heel bone (the calcaneus).

Since bat hind limbs are rotated up to 180 degrees from the typical mammalian position-picture your knees facing backward-the *calcar* generally points toward the midline of the body. Its function is to strengthen and straighten the trailing edge of the tail membrane, or *uropatagium*, that spans the space between a bat's hind limbs. Basically, the *calcar* increases aerodynamic efficiency by preventing that extra lift surface from flapping around during flight.

As one would expect, the *calcar* varies in size and shape among the 1,100 bat species. It's also no surprise that the *calcar* is absent in bats that do not have a tail membrane. At least, that's what I thought until I started examining preserved specimens of *Diphylla* at the American Museum of Natural History, where I was working as a postdoctoral research fellow.

Having determined that differences in behavior existed between *Demodus* and *Diaemus*, such as jumping versus nonjumping, I started looking to see if those differences might be reflected in their anatomy. Comparing vampire-bat hindlimbs, I noticed that the *calcar* was absent in *Diaemus* and reduced to a flaplike tab in *Demodus*.



Evolution has co-opted the panda's radial sesamoid bone, originally a part of its wrist, into the role of opposable "thumb" (inset right). Similarly, Diphylla's calcar, an extension of the heel bone (above and top right), has evolved into an opposable sixth digit that is used to facilitate the bat's grip on branches as well as on the body of its avian prey, from which it hangs while feeding.



No big deal, when you consider that all three vampires lack a functional tail membrane.

The *calcar* of *Diphylla* was a completely different story. Not only was it present in the specimen I examined, but it protruded like a tiny finger. I immediately pulled out several additional specimens to make sure I wasn't simply looking at one extremely odd individual. But in each instance, I saw the same finger-shaped structure. Next, I hit the literature, looking for any mention of *Diphylla's* *calcar*. "Small but well developed," ran the typical description, but nothing more.

I immediately put together a proposal to examine the function of *Diphylla's* *calcar*, and I set my sights on a visit to central Brazil, where I would be working with Brazilian zoologist Wilson Uieda-a scientist who had been studying the hairy-legged vampire for years with his colleague Ivan Sazima.

What I'd hypothesized was similar to the story of the panda's

thumb, popularized in an essay by Stephen J. Gould in *Natural History* ["This View of Life," November 1978]. The giant panda feeds on bamboo leaves that it strips off branches, seemingly with the aid of its opposable thumb. But anatomists who examined the panda's forelimb found that things weren't quite as they seemed. The panda's thumb was actually a wrist bone-the radial sesamoid-that had become greatly enlarged, allowing the structure to take on a new function: grasping bamboo



Diaemus feeds from a wound it has inflicted on a chicken's backward-facing big toe, called the hallux. Feeding this way keeps the bat hidden from its sharp-beaked prey.

stalks. Gould cited the panda's "thumb" as a beautiful example of how evolution tinkers with what's already there, modifying structures for a new function rather than creating new structures from scratch. Would the same principle apply to the vampire bat's calcar?

At a ranch outside the capital city of Brasilia, Uieda and [set up my infrared video camera at sunset. We aimed the camera upward, into the branches of a fig tree, for it was there that the resident guinea fowl went to roost at dusk.

another site clearly showed that *Diphylla* was using its opposable calcar to get a grip on the body of its avian prey. Unlike the white-winged vampire, which generally hangs from a branch and feeds from the toes of perching birds, *Diphylla* made many of its bites around the cloaca—the common opening for the digestive, urinary, and genital tracts found in many non-mammalian vertebrates, such as birds.

Several days later, we visited a cave that was home to a small colony of *Diphylla*. Using the infrared camera again, we recorded three hairy-legged vampires as they moved across the stony ceiling. Not only were the bats walking upside down, they were moving backward (not really strange, since bat knees face backward). What was unique was the way they led with their hind limbs, carefully seeking a secure purchase before taking a step—and using their "sixth digits" much as a rock climber would use his thumbs.

After scrambling around the cave ceiling for a few minutes, the vampire bats disappeared into a narrow crevice. I left the cave elated that we'd been able to support my hypothesis with observations in the field. What had begun as a surprising observation back in New York City ended with the discovery that, just like the panda's radial sesamoid bone, the hairy-legged vampire bat's calcar had been co-opted for a new role as an opposable digit.

Several hours after nightfall, as I stared bleary-eyed through the camera's viewfinder, a pair of dark shapes flew past the sleeping birds.

"Wilson, check this out," I whispered.

My friend, who had been dozing on the chair next to mine, was instantly alert.

Less than a minute later, we performed the aerial reconnaissance a second time.

Uieda whispered a single word: "*Diphylla*."

After that we saw nothing for several minutes—until a tiny pair of glowing spots appeared beneath one of the roosting birds. I hit the zoom on the camera, focusing in on the twin points of reflected light. They were eyes!

Uieda traced a dark silhouette on the screen, and [could just make out *Diphylla's* upside-down head peeking out from the guinea fowl's feathery breast.

"Dinnertime," he said.

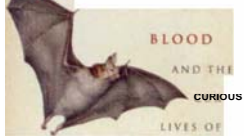
"This is different from *Diaemus*," [responded.

Rather than feeding from below the branch, *Diphylla* was actually hanging from the bird! Even more interesting, photographs taken by Wilson Uieda and his colleagues at

VAMPIRE BATS HAVE LONG been prime candidates for superstition and folklore-based fear. Only relatively recently have they gone from barely glimpsed creatures of the night to subjects of thoroughgoing scientific research and increasing open-mindedness. Rather than presuming that the three vampire bat genera are similar, researchers are currently studying these mammals with an eye toward variation. As a result, we are discovering intriguing adaptations and behaviors related to blood feeding. But we've also come to understand that two of the three vampire species (*Diaemus* and *Diphylla*) urgently need our help if they are to avoid extinction over the next few decades. The welcome shift in the vampire bat's public image may be coming just in the nick of time.

DARK

BANQUET



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