The shadow. In fact, other astronomers have actually seen a planet around another star — though not as an image but as a shadow. Marcy, Butler, and Steve Vogt of UC–Santa Cruz had detected the planet indirectly, from the wobbles of its parent star. Then other astronomers saw the star dimming like clockwork every three and a half days as the close-orbiting planet swung past it.

When Charbonneau and others analyzed the dimmed starlight with the Hubble telescope last year, they saw something else: a subtle color change. The starlight was shining through the planet's atmosphere, picking up the tint of sodium vapor, a trace constituent. It was astronomers' first glimpse of what an alien world is made of.

In the next year, Charbonneau and his colleagues plan to study this planet's atmosphere with the Hubble and the Keck, looking for hints of water vapor, methane, and other gases. He and others will also be searching for more planetary shadows with small, wide-angle telescopes, able to watch tens of thousands of stars at once. Already, astronomers have seen a handful of dimmings that might be planets — though it will take follow-up observations on bigger telescopes to be sure.

If they are planets, the shadows should hold clues to their size and makeup. And worlds unimaginably far away will seem a little more comprehensible, and perhaps a little more like our own.

ALAN BURDICK

# *Four Ears to the Ground*

FROM *Natural History*

FROM TIME TO TIME, leaving the American Museum of Natural History after hours, I pass the elephants in the Akeley Hall of African Mammals. They occupy the center of the room: a cluster of them, on a wide dais, milling eternally in the state of taxidermy. Aside from them and me and a savanna of glass-eyed ungulates, the hall is empty. My footsteps produce the only sound, which seems somehow amplified by the elephants' great mass.

We share a regular, wordless dialogue, the elephants and I, but only lately have I come to understand what they have to say. For years now, scientists have understood that elephants communicate at a frequency typically too low for the human ear to perceive — about twenty hertz. Propagating through the air, these vocal calls can reach an elephant five miles away. For better reception, the listening elephant spreads its earflaps forward, effectively transforming its head into a satellite dish.

As it turns out, that is only half the story. Recently a Stanford University researcher, Caitlin O'Connell-Rodwell, discovered that an elephant's vocal call actually generates two separate sounds: the airborne one and another that travels through the ground as a seismic wave. Moreover, the seismic version travels at least twice as far, and seismic waves generated by an elephant stomping its feet in alarm travel farther still, up to twenty miles. What's most remarkable, however, is how elephants presumably perceive these signals: they listen, it seems, with their feet.

Seismic communication is widespread. Creatures from scorpions to crocodiles rely on ground vibrations to locate potential mates and to detect (and avoid becoming) prey. The male fiddler crab bangs territorial warnings into the sand with its oversized claw. A blind mole rat pounds its head against the walls of its underground tunnels, thus declaring its dominance over the blind mole rat two tunnels over, which may or may not be listening with its own head pressed to the wall.

O'Connell-Rodwell was first inspired by the seismic songs of planthoppers, tiny insects she studied early in her career. The planthopper sings by vibrating its abdomen; this causes the underlying leaf, and ideally all nearby planthoppers, to tremble. She observed that planthoppers in the peanut gallery would lift a foot or two, presumably for better hearing: the other feet, bearing more weight, thus became more sensitive to vibration. Years later, O'Connell-Rodwell saw similar behavior among elephants at a water hole in Namibia. Minutes before a second herd of elephants arrived, members of the first group would lean forward on their toes and raise a hind leg, as if in anticipation. "It was the same thing the planthoppers were doing," she says.

Was it? Several elegant experiments by O'Connell-Rodwell demonstrate that elephants do indeed generate long-range seismic signals. But can other elephants hear them? Early evidence from northern California's Oakland Zoo, where an elephant named Donna is being trained to respond exclusively to seismic cues, strongly suggests that the answer is yes. "We haven't sealed the deal," says O'Connell-Rodwell, "but it looks promising."

As a communication medium, she notes, seismic waves would offer the elephant several advantages. They dissipate less quickly than airborne waves, they aren't disrupted by changes in weather or temperature, and they aren't swallowed by dense jungle foliage. Complex vocal harmonics don't translate well into seismic waves. But even the simplest long-range message — "I'm here" or "Danger!" — beats a fancy one that can't be heard at all.

Air is the faster medium: an airborne elephant call will reach a distant listener before the seismic version does. The delay between signals may confer its own advantage, however, O'Connell-Rodwell proposes. The delay increases with distance; an astute listener would soon learn to gauge distance from the delay. Combined with its airborne counterpart, a seismic signal would enable the animal to coordinate its movements with faraway colleagues, to forage more effectively, and to detect unseen danger. It is compass, yardstick, and e-mail in one — an elephantine Palm Pilot.



And the elephant's palm is the key, O'Connell-Rodwell believes. It may be that the seismic vibrations propagate from the elephant's feet to its inner ear — a process known as bone conduction. That would explain some of the odder features of elephant anatomy, including the fatty deposits in its cheeks, which may serve to amplify incoming vibrations. In marine mammals, similar deposits are called "acoustic fat."

But O'Connell-Rodwell thinks the elephant ear may be tuned even more acutely to the ground. "They do have nerves connected to their toenails, and they do lean on them. It could be a direct line to their head." A colleague is now exploring whether the fleshy pad of an elephant's foot contains Pacinian and Meissner corpuscles, specialized nerve endings that detect faint motion and vibration. The tip of an elephant's trunk has more of these structures per square inch than does any other animal organ, and it is supremely touch-sensitive. (In addition to lifting a foot to improve its hearing, an elephant sometimes holds its trunk to the ground, as if it were an amplifier, says the Stanford biologist.)

All of which raises the question, Which is doing the hearing here — the elephant foot or the elephant ear? The truth is, "hearing" is a semantic distinction, a construct of human language. To us, a "sound" is what happens when airborne acoustic waves vibrate tiny hairs inside our head. An "ear" is an acoustic organ that looks like ours.

Properly defined, however, sound is a series of compression waves in any medium: air, liquid, solid matter. Animals have evolved all manner of translating these mechanical waves into neural signals. A fish senses motion with a line of specialized receptors on both sides of its body. Walk toward a fish tank, and your footsteps startle the fish. Did it hear you or feel you? To the fish, there's no difference.

Perhaps, in our ear-o-centric view of the world, we have constrained our senses. "The animals have been paying attention to something that we haven't been noticing," O'Connell-Rodwell says. Lately she has begun exploring the possibility that other large mammals — bison, rhinoceroses, hippopotamuses, lions, giraffes — rely on seismic cues in their daily lives.

Paradoxically, the discovery that elephants and perhaps other large mammals may communicate seismically comes at a time when it is increasingly difficult for us to hear them. Just as the night sky is slowly becoming obscured by "light pollution" from countless streetlights and other artificial sources of illumination, so the sounding board of earth has become muddled with "bioseismic noise": rumbling trucks, electric generators, jet vibrations, the hum and trundle of civilization and commerce. Does this human static disrupt elephant conversations in the wild? Does it drive them nuts in captivity? The zoo environment is stressful enough without having to hear from every pothole within a twenty-mile radius. Then again, I manage to sleep through the most fearsome Manhattan traffic. "My guess is, elephants in urban environments have become desensitized to seismic signals, as people have," suggests O'Connell-Rodwell.

In the end, the primary casualty of bioseismic noise is us. The human foot happens to be a remarkably sensitive listening device. It is nearly as dense with pressure receptors as is the elephant's trunk. O'Connell-Rodwell suspects that once upon a quieter time, we paid closer attention to seismic signals than we do today. Vibrations from instruments such as the talking drum or the didgeridoo, or even from foot-stomping dances, may have spoken volumes to distant, unshod listeners. Then came telephones, automobiles, asphalt — and footwear. We hardened our soles to the world of sound.

The echo of my footsteps haunts me now. When last I strolled through the darkened Akeley Hall, it struck me that this is what it would be like to be entombed in a shoe. The silent elephants, the hushed lions, the stilled giraffes — a continent of primordial instincts urged me toward the exit: Loosen, unlace, enter the world barefoot.

CLARK R. CHAPMAN
AND
ALAN W. HARRIS

# *A Skeptical Look at September 11th*

## How We Can Defeat Terrorism by Reacting to It More Rationally

FROM *Skeptical Inquirer*

HUMAN BEINGS might be expected to value each life, and each death, equally. We each face numerous hazards — war, disease, homicide, accidents, natural disasters — before succumbing to "natural" death. Some premature deaths shock us far more than others. Contrasting with the 2,800 fatalities in the World Trade Center (WTC) on September 11, 2001 (9/11), we barely remember the 20,000 Indian earthquake victims earlier in 2001. Here, we argue that the disproportionate reaction to 9/11 was as damaging as the direct destruction of lives and property. Americans can mitigate future terrorism by learning to respond more objectively to future malicious acts. We do not question the visceral fears and responsible precautions taken during the hours and days following 9/11, when there might have been even worse attacks. But, as the first anniversary of 9/11 approaches, our nation's priorities remain radically torqued toward homeland defense and fighting terrorism at the expense of objectively greater societal needs. As we obsessively and excessively beef up internal security and try to dismantle terrorist groups worldwide, Americans actually feed the terrorists' purposes.

Every month, including September 2001, the U.S. highway death toll exceeds fatalities in the WTC, Pentagon, and four