



SOME LIKE IT HOT

Iran's Lut Desert—Earth's hottest—is devoid of plants but somehow sustains a vibrant ecosystem

By **Richard Stone**; *Photography by Bahman Izadi*

During the 1920s and 1930s, Viennese physician and adventurer Alfons Gabriel fell under the spell of Iran's Lut Desert. Gabriel had crisscrossed arid parts of the Middle East, Pakistan, and Afghanistan by camel, observing and mapping areas into which few dared venture—lands with names such as Dasht-i-Naumid (the Desert without Hope) and Dasht-i-Margo (the Desert of Death). But a “confused mass of impassable tangled dunes” stymied his efforts to probe the interior of the Lut Desert, a tract of sand and fantastical rock formations in southeastern Iran that was said to be the hottest place on Earth.

In March 1937, Gabriel finally conquered the central Lut—and barely made it out alive. He described his experiences a year later in a spellbinding talk to the Royal Geographical

Society in London. Late one afternoon, Gabriel recounted, “the landscape darkened under red clouds ... and a noise like the roaring of the sea began.” The dust storm raged into the night. “For several anxious hours we lay, motionless and helpless, outstretched on the ground.” Later, the voyagers were disoriented by mirages that were most vivid when the air was coolest, just before sunrise. Near the end of the 3-week journey, even their parched camels had had enough: “Their legs trembled; they panted, knelt down, and sometimes crept along on their knees.”

The allure of the Lut persists. Last month, a convoy of five SUVs carried 10 researchers and their guides, along with cameras, instruments, and hundreds of liters of water and fuel, into the heart of the desert. These modern explorers from Iran, the United States, and Europe were drawn not so much by the exotic landscape as by the puzzle of its un-

usual ecosystem. Many researchers had assumed that the Lut Desert is too hostile to sustain life, says Hossein Akhiani, a plant biologist at the University of Tehran. The interior of the desert, an area nearly as big as West Virginia, is mostly devoid of plant life. But adventurers and the occasional scientist who traveled into the Lut had spotted diverse animal life, including insects, reptiles, and desert foxes. How that food web holds together without plants has been a mystery.

A morbid, and possibly unique, phenomenon may be the answer. Dead birds are a frequent sighting in the desert. A few years ago, scientists in Iran began wondering whether migratory birds stray into the Lut and, overcome by the intense heat, fall from the sky like manna, forming the base of a food web. The expedition, organized by Akhiani and Bahman Izadi, head of an environmental nonprofit in Shiraz, Iran, and a Lut explorer,

The Lut Desert's fantastical landscape harbors creatures that eke out a living from hidden water and the occasional windfall.



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set out to test the idea. Colleagues warned that in the fall, right after the heat of summer, the team might not find enough living things to tell. Creatures that burrowed or migrated to escape the heat would not have had time to venture back into the desert.

Instead, the team confirmed the existence of a vibrant ecosystem and saw compelling signs that migratory birds do help nourish it. They also found that the bone-dry landscape conceals what they are calling a “hidden sea”: a surprisingly shallow layer of salty groundwater that may also help sustain life.

The Lut Desert also offers a less uplifting lesson—at least for people living on the knife edge of sustainability in arid regions. Climate change models predict that as temperatures rise, tracts of the Middle East that are naturally uninhabitable—not survivable without air conditioning—will expand. Those areas may come to resemble the transition zone between settlements on the Lut’s edges and its supremely hostile core.

AFTER GABRIEL'S PIONEERING VENTURE, the scientific literature on the Lut Desert remained sparse. One point was settled, though: Gabriel had noted that a contemporary, the German geographer Gustav Stratil-Sauer, “was of the opinion that the hottest region of the earth was not, as hitherto supposed, to be found in Sind, or Abyssinia, or in the Death Valley of California, but in the southern Lut.” In 2005, an infrared radiometer on NASA’s Aqua satellite measured a ground temperature of 70.7°C (159.3°F) at one spot in the Lut—the hottest satellite

reading of ground temperature ever. And in April 2014, Morteza Djamali, a paleoecologist at the Mediterranean Institute of Marine and Terrestrial Biodiversity and Ecology in Marseilles, France, and his colleagues ventured into the central Lut to install a temperature logger at the same spot. In an experience worthy of Alfred Hitchcock, a swarm of locusts descended, picking nearby bird carcasses clean, cannibalizing each other, and biting the researchers. “I can imagine that a lonely traveler could be killed by these small creatures” in a few days, Djamali says.

The hardship paid off, Djamali says. In July, the thermometer, planted 30 centimeters above the surface in the shade of a wooden cylinder, registered 61°C—some 5°C higher than the official shade record

set in Death Valley in 1913. Bands of heat-absorbing black sand, primarily magnetite, together with topography that limits air movement help explain the blazing temperatures, Djamali says.

That same year Akhani paid his first visit to the Lut, a quick scouting trip. A specialist in salt-loving plants, which grow in salty seeps in a few spots in the desert, he also had noticed the birds’ carcasses and wondered what role they might play in the ecosystem. Cobbling together backing from the Iranian National Science Foundation, the Saeedi Institute for Advanced Studies at Kashan University in Iran, and other sources, he assembled a team of specialists from Iran and abroad that will spend the next 5 years prizing scientific secrets from the desert.

Empty quarter

Few scientists had probed the heart of the Lut Desert.



THE TEAM SET OFF LAST MONTH on its maiden expedition, departing from Shahdad, an oasis on the Lut’s western edge, and heading

due north before arcing south in a path that bisected the desert (see map, left). In some areas, yardangs, wind-sculpted rock formations several meters tall, sprouted from the desert like mushrooms. Heftier formations called kaluts reminded Akhani of “the ruins of an old city.” Relics of what Djamali calls a “complex geoclimatic history,” some are made of sandstone, whereas others were eroded from the beds of saline and playa lakes that dotted the landscape some 10 million years ago. The topography, whimsical or majestic, is a major reason

CREDITS: (MAP) J. YOU/SCIENCE; (DATA) HOSSEIN AKHANI

the United Nations Educational, Scientific and Cultural Organization inscribed the Lut Desert on its World Heritage List last July. (Iran hopes it will beckon intrepid ecotourists.) Along their 700-kilometer journey, the researchers sampled soil and biota at 37 sites before emerging from the desert east of Bam, a city that suffered catastrophic damage from a 2003 earthquake.

One day, the team struck out on foot into a canyon called Zabone Mar, which means “snake’s tongue.” By satellite, the canyon,

ran, collected carcasses of several migratory species. Why the birds make a fatal detour into the desert is a puzzle, he says. Even outside the canyon dead migratory birds were plentiful, and they often bore signs of having been scavenged by foxes. “I think that’s their main food source,” AghaKouchak says.

Insects, too, are critical to the Lut’s food web. Many nibble on plants on the desert’s periphery and are in turn eaten by spiders, reptiles, and foxes in the Lut’s interior, supplementing the nutrients in the ill-fated birds, says expedition member Hossein

so dry that microwaves were radiating from deeper layers of soil or even rocks, falsely indicating shallow moisture.

Last month, in the heart of the desert, the team’s convoy entered “a flat landscape, as far as you can see,” the hydrologist says. A short distance onto the plain, one of the trucks broke through several centimeters of hard, crusty soil and sank, up to its axles—in mud. After another SUV pulled out the stricken vehicle, “you could actually see water” where the tires had been. “It was hard to believe,” AghaKouchak says, “but the area is really, really wet.”

He thinks the moisture comes from distant mountains that ring the table-flat playa. Occasional rainfalls in the spring and early fall drain into the flat basin, he says. According to the team’s guides, other areas of the Lut have similar features. Back at UC Irvine, AghaKouchak will attempt to correlate the local knowledge with satellite moisture data to map the extent of the hidden sea.

NO ONE LIVES in the heart of the Lut, and after a 6-year-long drought in Iran, settlements on the desert’s fringes are in retreat. That may foreshadow the fate of other parts of the Middle East as global warming pushes summer temperatures still higher, says Elfatih Eltahir, an environmental engineer at the Massachusetts Institute of Technology in Cambridge.

Last year, in *Nature Climate Change*, Eltahir and a colleague defined a naturally uninhabitable climate as one in which the heat index—temperature adjusted for humidity—exceeds 35°C for more than six straight hours. “What we are talking about are really extreme conditions,” Eltahir says. “If a human being is exposed to that, very likely that person would die.”

In summer, areas of the Persian Gulf already exceed that threshold and would be unbearable without air-conditioning. Barring “significant mitigation,” the uninhabitable areas near the Persian Gulf are likely to expand, including arid but still habitable regions of Iran. “Lut would be a good lab to study what an extreme environment would look like,” AghaKouchak says.

To probe such questions more deeply, Akhiani’s team plans to return in the spring. Among other things, they will bring more sophisticated instruments for measuring soil moisture and set up camera traps to study the ecology of the desert fox and other creatures in more detail. They also hope to decipher at a molecular level how the life forms adapt to broiling heat, Akhiani says. In 2018, they may even attempt a summer expedition.

“If we go then, we probably need to bring a physician,” says AghaKouchak, who has- tens to add, “I can’t wait to go back.” ■



The remains of birds that blundered into the desert (top) apparently help support an ecosystem of animals including Rüppell’s foxes (bottom left) and geckos (bottom right), along with numerous insects.

about 15 meters wide with walls reaching 30 meters high, looks like a bifurcated tongue. “I noticed a weird noise,” recalls expedition member Amir AghaKouchak, a hydrologist at the University of California (UC), Irvine. A continuous, soft crackling emanated from the walls. He speculates that the sound was the rock expanding as temperatures soared from nightly lows near 0°C up to fall daily maximums of about 40°C. “I just stopped and listened to this beautiful music.”

Or perhaps it was a siren call: The canyon is a death trap. Within its walls, the researchers found the remains of dozens of migratory birds. The birds may have sought shelter in the canyon’s shade, but without water they would have quickly perished, AghaKouchak says. Mahmoud Ghasempouri, an ornithologist at Tarbiat Modares University in Teh-

Rajaei, curator of Lepidoptera—moths and butterflies—at the Stuttgart State Museum of Natural History in Germany. Yet some live in the heart of the desert. When Rajaei set up light traps at night, he was surprised to count large numbers of moth species. “What do they do there? What do they eat there?” he asks. How the fly larvae he found in a pool of hypersaline water survive is another enigma, he says. And so is the question of how the Lut’s denizens stay hydrated.

The answer may lie just below the surface. Before the expedition began, AghaKouchak had scrutinized satellite sensor data from the Lut. To his surprise, microwaves emanating from the ground suggested that in some parts of the oven-hot desert, the soil is moist. Perplexed, AghaKouchak consulted a colleague, who proposed that the Lut’s soil is

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