

# Ripple Marks

## The Story Behind the Story

BY CHERYL LYN DYBAS

### MUSIC OF THE SPHERES

"It is said that Music is a universal bridge, crossing the barriers of culture, age, and language. Perhaps, eventually, we will learn that it also spans those of time...and space."

— "Music of the Spheres" episode, *The Outer Limits* television series (1995–2002)

JOHN LUTHER ADAMS BLENDS SCIENCE, ART, AND MUSIC. In the "Music of the Spheres" episode of *The Outer Limits*, aliens transmit an audiotape to Earth to save humans from lethal solar radiation. The tape, carrying sounds of the universe, is so entrancing that anyone who hears it falls under its spell.

The music of Alaska artist and scientist John Luther Adams is no less enchanting. Adams expresses the sounds of Earth, sea, and sky, as well as the moon and Sun: the music of the spheres. His innovative exhibition, *The Place Where You Go to Listen*, at the University of Alaska's Museum of the North in Fairbanks, echoes the ancient concept of the movements of celestial bodies—the Sun, moon, and planets—as a form of music. Pythagoras, the Greek "father of numbers" who lived from about 582–507 B.C.E., first used the term "music of the spheres." He thought of the cosmos as a lyre, with crystal spheres instead of strings.

In *The Place*, John Luther Adams has built a sonic installation that taps into natural forces and turns the daily workings of inner and outer space into sound. Through real-time readings of natural wavelengths, visitors hear the chords of day and night. One chord tracks daylight as experienced at Fairbanks' latitude and longitude. The other follows day as it turns into night, growing louder and higher until it eventually decreases and descends with the setting of the Sun.

Through *The Place*, Adams lets us hear inaudible forces and "see" invisible things: the Sun as it arcs through autumnal equinox, winter solstice, spring equinox, summer solstice; the moon on a

cloudy night; the northern lights during the day. "Residents of the city of Kiruna in northern Sweden claim that the aurora can be heard as a kind of crackling," said Larry Zanetti, a space physicist at Johns Hopkins University's Applied Physics Lab. "Researchers have tried to record the sounds made by active auroral displays in Kiruna, but none has been successful." John Luther Adams' work is the closest scientists have come.

From the formation of ice to the ebb and flow of the tides, sounds of Earth and beyond reverberate through *The Place*. "The spectrum of these frequencies is inaudible to us," said climate scientist Arthur Miller of the Scripps Institution of Oceanography in La Jolla, California. "Through Adams' interpretations, swells moving across the ocean surface are right in the room with us."

Adams conceived *The Place Where You Go to Listen* as "a contemplative space for tuning our ears to the unheard resonances of Earth, sea, and sky." He's known for arrangements like "Strange and Sacred Noise," "Winter Music," and "Mathematics of Resonant Bodies," which let listeners plug into pure Earth-sound. In *The Place*, streams of data tracking natural phenomena (the traverse of Sun and moon, geomagnetism, cloud cover, and visibility) are transformed into musical notes through a process called sonification.

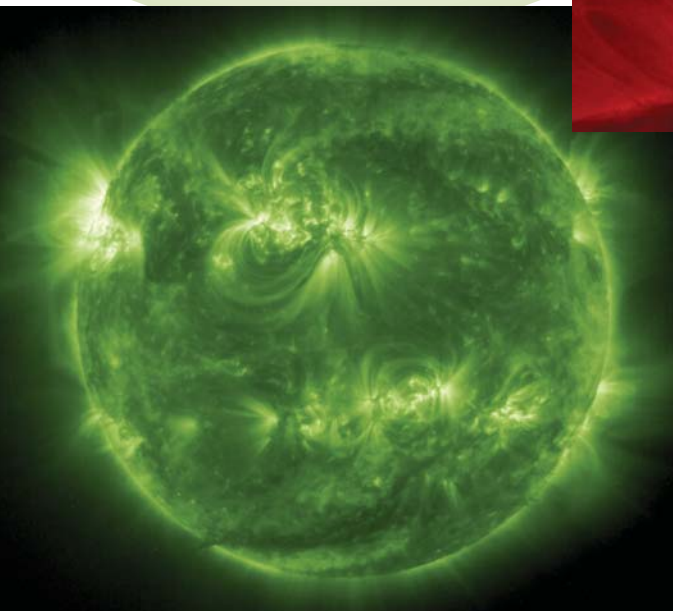
"The data streams are numerical maps of natural forces," Adams said. "Using these maps as points of departure, I devised new ways of translating the data into sound. It was a process I came to think of as 'tuning the world.'" Programs called SunAngles and MoonAngles, for example, calculate the positions of Sun and moon and turn their rotations into music we can hear.

Adams' calculations are close to the scientific mark, if a discovery by solar physicist Craig DeForest of the Southwest Research Institute in Boulder, Colorado, is a guide. The Sun is far from silent. Ultrasound continuously plays there, with "notes" some 300 times deeper than the lowest pitch the human ear can hear. Sometimes the ultrasound is created by solar currents, and sometimes by solar waves that crash like ocean breakers as they flow



Above. Dramatic coronal loops of the Sun, which each span several Earths in size, are shown in false color. The corona is hundreds of times hotter than the solar surface; its loops emit ultraviolet light. Image credit: NASA/TRACE.

Left. The Sun's corona, or outer atmosphere, loops spaceward in this false color image from the Solar and Heliospheric Observatory (SOHO) spacecraft. John Luther Adams captures the sounds of our solar system's star, and turns them into music of the spheres we can hear. Image credit: NASA, SOHO/TRACE.



up and out from the surface of the Sun. The melody has a recognizable sonic signature, which DeForest uncovered. His results were published in the December 10, 2004, issue of *Astrophysical Journal Letters*.

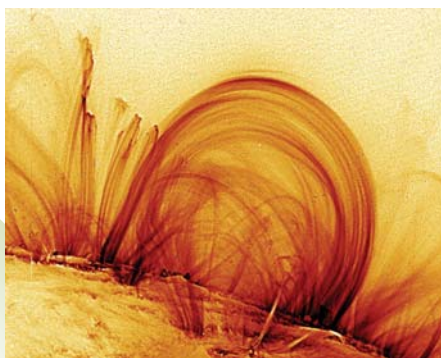
"Adams' musical efforts are like the search for new results in scientific data," said DeForest. "You're never sure what pattern might emerge, whole-formed, from a nebulous soundscape. His portrayal of the Sun is surprisingly evocative of the sounds that emerge from time-lapse data of the solar atmosphere."

Every ten seconds the Sun plays a new song.

"Whenever we listen carefully," said Adams, "we come to hear that music is around us all the time. By deepening the awareness of our connections to the universe, music can provide a model for the renewal of human culture."

According to legend, only Pythagoras could hear and understand celestial harmony. But the aliens in *The Outer Limits* conveyed that the music of the spheres "is there for those with the facility to hear it."

John Luther Adams has given us that gift.



*Winds flow through the solar atmosphere at nearly the speed of sound. The Place Where You Go to Listen brings the fleeting "music" of outer and inner space—sunlight and moonbeam, wind and wave—down to Earth. Image credit: NASA/TRACE.*

## RED RAIN

**RED RAIN OVER INDIA—ARE ALIENS IN OUR MIDST?** Red rain fell over Kerala, India, from July 25 to September 23, 2001, staining everything it touched blood-red.

Scientists Godfrey Louis and Santhosh Kumar of India's Mahatma Gandhi University initially suspected the rain was tinged with fallout from a meteor, then further study indicated that the rains had been colored by spores from a red alga. Recently, Kerala's red rains have garnered worldwide attention, with a theory that the colored particles are in fact extraterrestrial cells that hitched a ride to Earth on a comet.

In the online version of the journal *Astrophysics and Space Science*, Louis and Kumar discuss the possibility of an extraterrestrial origin of these particles. Their paper, "The Red Rain Phenomenon of Kerala and Its Possible Extraterrestrial Origin," (April 4, 2006) looks at this odd occurrence, and concludes that "conventional atmospheric transport processes like dust storms cannot explain it. Electron microscopic study of the red particles shows a fine cell structure, indicating their biological cell-like nature." Analysis shows that the major elements present in these particles are carbon and oxygen.

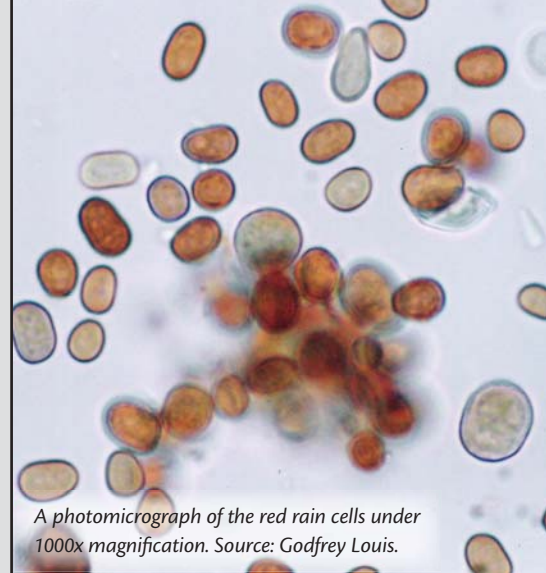
"Strangely," they write, "tests indicate the absence of DNA in these cells."

Is it raining alien life over India?

The jury is still out, said Louis.

Local residents reported that the first red rain was preceded by a loud thunderstorm and a flash of lightning, after which a grove of trees dropped shriveled, burned leaves. Spurred by public fears, the Government of India commissioned a report on the rains. Scientists at India's Centre for Earth Science Studies and Tropical Botanical Garden and Research Institute concluded that the red rain was made up of a type of algal spore from lichens.

The researchers' 2001 report, *Coloured Rain: A Report on the Phenomenon*, stated that no dust of meteoric, volcanic or desert origin was found in the red rain, and that its color was not a result of dissolved gases or pollutants. The researchers suggested that heavy "normal" rains in Kerala before the red rains' arrival could have caused a widespread growth of lichens, which might have led to a large quantity of red lichen spores swirling in the atmosphere. But the report found no clear mechanism for the uptake of the spores into clouds, nor of the spores' dispersal.



*A photomicrograph of the red rain cells under 1000x magnification. Source: Godfrey Louis.*

Other researchers thought the red downpour might have been rain contaminated with mammal blood from a flock of bats killed at high altitude, perhaps by a falling meteor. Some bat species live in India in large numbers. But no wing of bat was found in the red rain, and no known natural process would have separated red blood cells from white cells, platelets, and other blood components, biologists stated.

The search for an explanation continued. Scientists consulted history, hoping to find other such occurrences.

Unusual things have fallen in rain before. In 2000, for example, a waterspout in the North Sea scooped up a school of fish a mile offshore, then deposited its piscine cargo on Great Yarmouth. On that day in the U.K., it rained fishes.

But the red rain over Kerala remained a mystery.

Louis and Kumar proposed that the particles might be microbes of extraterrestrial origin. Could they have come from a comet? If so, they would be the first evidence of the panspermia theory, which holds that comet fragments carry life from one world to another.

Almost 85 percent of the red rain fell within 10 days of July 25, 2001. "That's consistent with the settling of red particles released into the upper atmosphere by a comet's break-up," Louis concludes. "Are these cell-like particles a kind of alternate life from space?"

Louis reports that the cells can reproduce in temperatures more than 300 degrees Centigrade, almost 200 degrees Centigrade above the highest known survivable temperature among hyperthermophiles living in such places as deep-sea hydrothermal vents.

If Louis is right, aliens indeed are in our midst.



## KELP HIGHWAY

"KELP HIGHWAY" MAY HAVE LED TO PEOPLING OF THE AMERICAS. Did humans migrate from Asia to the Americas along Pacific coastlines near the end of the Pleistocene era? If so, undersea forests of kelp may have aided their journey, according to maritime archaeologist Jon Erlandson of the University of Oregon.

Kelp forests are among the world's most productive ecosystems. They're found from Japan to Alaska to Oregon, from California to South America's west coast. "Kelp ecosystems would have provided an assortment of food resources, from shellfish to fish to sea mammals and seabirds, along thousands of miles of the Pacific coast," said Erlandson. "They also would have reduced wave energy, making it easier for early peoples to travel along this 'highway' in boats."

These peoples, he believes, would have had access to a variety of land resources, as well, when they came ashore in coastal regions. "In contrast," said Erlandson, "people migrating through interior lands would have had fewer options and would have had to pass through much more varied landscapes, including tundra, boreal and tropical forests, and deserts. That's a much harder way to go."

The "kelp highway hypothesis," as Erlandson calls it, first crystallized among an interdisciplinary group of scientists affiliated with the National Center for Ecological Analysis and Synthesis at the

University of California at Santa Barbara. Erlandson's kelp highway colleagues include marine ecologists Robert Steneck of the University of Maine and James Estes of the University of California at Santa Cruz.

Although the coastal migration theory has yet to be proved, researchers have been finding earlier and more widespread indications for coastal settlement around the Pacific Rim. "The fact that productive kelp forests are found adjacent to some of the earliest coastal archeological sites in the Americas supports the idea that such underwater forests may have facilitated human coastal migrations toward the end of the last glacial period," Erlandson believes. Kelp acted as a long-ago superhighway, it appears.

New discoveries have moved the coastal migration theory to the forefront of debate on the origins of the first Americans. Seafaring peoples living in Japan near the height of the last glacial period (some 35,000 to 15,000 years ago) adapted to cold waters comparable to those found today in the Gulf of Alaska. From there, they may have migrated northward to the coast of Beringia, the ancient land bridge between what is now Siberia and Alaska, and into the Americas.

"Most anthropologists believed that maritime adaptations and seafaring developed very late in human history," writes Erlandson in *The First*

*Giant kelp, an important fisheries habitat, can grow as much as two feet a day in depths at up to 150 feet. Photo credit: Wheeler North, NOAA Restoration Center.*

*Americans.* "Recently, there has been a veritable sea change in our perceptions of the Pleistocene colonization of the Americas."

We've long underestimated the sophistication of our distant ancestors, Erlandson thinks, as well as the importance of the sea in human history and the maritime capabilities of Late Pleistocene peoples. When did our ancestors first develop more complex technologies? When did they adapt to the sea and first use relatively sophisticated watercraft?

The answers to these questions, and the strongest evidence for the kelp highway theory, may lie hidden in the depths of the offshore ocean. There rising seas over the past 10,000 years have submerged the traces of our long-ago West Coast ancestors.

## KILLIFISH ADAPT TO TOXINS

FOR BETTER OR WORSE, KILLIFISH THRIVE IN TOXIC SUPERFUND SITE WATERS. The waters of New Bedford Harbor, Massachusetts, sparkle on sunny days. But beneath the bay's gleaming surface lies one of the most toxic environments in the nation.

"You'd think nothing, absolutely nothing, would be able to live in New Bedford Harbor," said Jim Kendall, fisherman and president of New Bedford Seafood Consulting. "But you'd be dead wrong. Something does live there, and in huge numbers: tiny fish called killifish."

How the fish do it is the big question, said toxicologist Mark Hahn of the Woods Hole Oceanographic Institution in Massachusetts. "It's what can happen when animals are exposed over generations to high levels of contaminants." The result

goes one way or the other, he said. "The population dies out, or it adapts through genetic changes to extreme pollution levels."

New Bedford Harbor is a U.S. Environmental Protection Agency (EPA) Superfund Site, its bottom sediments polluted with PCBs, or polychlorinated biphenyls, dumped there as a by-product of manufacturing processes that took place from the 1940s through the 1970s.

Luckily for New Bedford Harbor's killifish, said biologist Diane Nacci of EPA's National Health and Environmental Effects Research Laboratory in Narragansett, Rhode Island, "they've evolved a way of adapting. We're beginning to figure out how they succeeded, which has led to other questions, like: is this always a good thing?"

Nacci, Hahn and Gloria Callard of Boston Uni-

versity have studied New Bedford's killifish for the past decade.

Hahn and Callard are using genetic techniques to trace the evolution of genes through which response to PCBs is altered. "Fish have more receptor genes for chemicals like dioxins and PCBs than do mammals," said Hahn, "possibly explaining the extreme sensitivity of most fish to these pollutants. Small changes in these genes likely are involved in PCB resistance in New Bedford killifish."

Nacci wonders what will happen to New Bedford's killifish if the harbor is finally cleaned up. "Where will the actions of decades ago have led? Will these fish be so adapted to a polluted environment, that they won't be able to live in a clean one?"

# FUELING FISHING

GLOBAL FISHING FLEET CONSUMES MORE OIL ANNUALLY THAN MOST NATIONS. Global fishing fleets account for annual oil consumption equivalent to that of the Netherlands, the world's 18<sup>th</sup>-ranked oil consuming country. They also directly emit more than 130 million tons of carbon dioxide into the atmosphere every year, according to resource economist Peter Tyedmers of Dalhousie University in Nova Scotia, Canada.

Tyedmers and scientists Reg Watson and Daniel Pauly of the University of British Columbia published results of their study of global fishing fleets' fuel consumption in the December 2005 issue of the online journal *Ambio*.

"In 2000," said Tyedmers, "fishing vessels burned about 13 billion gallons of fuel to catch 80 million tons of fish. Although the fish-to-gallon of oil ratio varies from fish species to fish species, it's getting worse overall, because fishers have to go farther out to sea in search of productive fishing grounds."

In a process that began with the launch of the first coal-fired steam trawler in the late 1880s and accelerated through the latter half of the 20<sup>th</sup> century, fossil fuels have become the dominant energy input to the world's fisheries, the scientists say.

"Vessels powered by diesel, and to a lesser degree gasoline and kerosene, now account for the vast majority of global fisheries landings," said Tyedmers. Fishing may be the most energy-intensive food production method in the world today, he said.

In their study, the researchers looked at data for more than 250 distinct fisheries or fishing-fleet subsets, based in 20 countries. Most fisheries targeted species caught over large geographic ranges, such as tuna, billfish, and squid. "Hence, we believe our data set is broadly representative of world fisheries," said Tyedmers.

In 2000, global fisheries reported landings of 80.4 million tons of fish and shellfish from marine waters. In the process of acquiring this catch, the world's fishing fleets burned approximately 50 billion liters of fuel, yielding a global average fuel use of 620 liters per live weight ton of fish and shellfish landed. Global fisheries, said Tyedmers, therefore landed approximately 1.9 tons of fish and invertebrates for every ton of fuel directly consumed in their capture.

As a consequence of burning almost 42.4 million tons of fuel in 2000, representing approximately 1.2 percent of total global oil consumption,

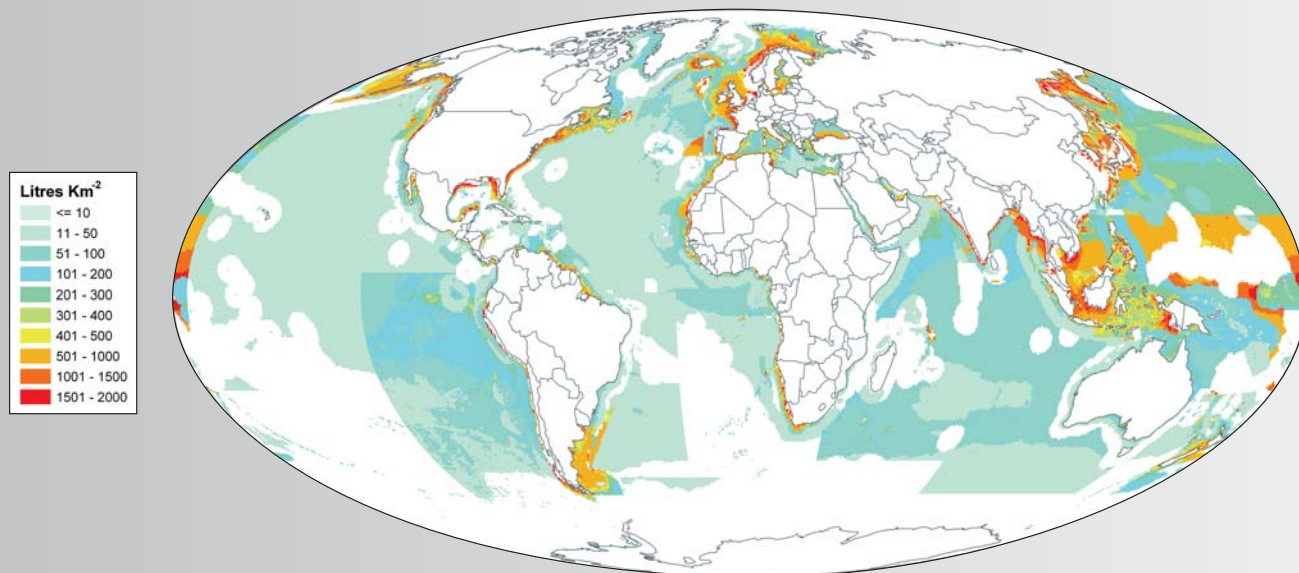
fishing boats released about 134 million tons of carbon dioxide into the atmosphere, at an average rate of 1.7 tons of carbon dioxide per ton of live-weight landed product.

"In terms of their energy efficiency," said Tyedmers, "fisheries globally dissipated 12.5 times the amount of fuel energy they provided in the form of edible-protein energy." Fishing grounds in which heavy fuel use is of particular note include the western Pacific Ocean, the Bering Sea and the coastal waters of the northeastern and southwestern Atlantic and northern Indian Oceans.

The scientists say they've likely underestimated total fuel consumption and carbon dioxide emissions as freshwater fisheries, and illegal, unreported, and unregulated fisheries, were not included in their study.

Perhaps the insights are more about fish than fuel, however. Researchers at Dalhousie University showed that 60 or 70 years ago, Nova Scotia fishing fleets used only a quarter of the fuel they use today.

"The more inshore stocks are depleted and the farther out the 'good' fish are," said Tyedmers, "the more and more fuel it will take to catch fewer and fewer fish."



*Modeled fishery fuel use distribution and intensity across the world's oceans in 2000. In the process of capturing just over 80 million tonnes of seafood, global fishing fleets burned approximately 50 billion liters of fuel with most expended in nearshore fishing grounds of the Northern Hemisphere. Source: Peter Tyedmers.*

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