

MICROBIOLOGY

Global Spread of Leprosy Tied to Human Migration

Long before the Black Death or AIDS ravaged society, there was leprosy. But for a disease that has devastated humans for millennia, leprosy remains enigmatic. Where did it originate, and how has it followed people seemingly everywhere they've gone?

The first comprehensive genetic comparison of the bacterial strains that cause the disease is providing some answers. On page 1040, molecular microbiologist Stewart Cole of the Pasteur Institute in Paris and colleagues use rare DNA differences among leprosy strains culled from various corners of the world to infer an East African or Near East origin of the disease. Their findings also challenge popular theories of how leprosy spread and indicate that colonialism and the slave trade helped bring the sickness to West Africa and much of the New World.

"It's very interesting work that should help us fill in the picture of how human migration is tied to the dissemination of leprosy," says Daniel Hartl, a population geneticist at Harvard University in Cambridge, Massachusetts.

Confirmed reports of leprosy first appear around 600 B.C.E. in sacred Indian texts that describe a victim's loss of finger and toe sensation—a hallmark of the damage the bacterium *Mycobacterium leprae* inflicts on the nervous system. By medieval times, cultures around the globe were familiar with the deforming lesions



Worldwide toll. Leprosy persists among people in poor regions, such as these women in Afghanistan.

and decaying flesh that resulted in lepers being burned at the stake or carted off to die in remote colonies. Antibiotics helped bring the disease under control in the 1940s, but it persists in poor regions, and there are more than 500,000 new cases reported each year.

Scientists rely on genetic differences among strains to trace the history of a microbe,

but seven strains of the leprosy bacterium, collected by Cole's group from an array of countries, had practically identical genomes. "*M. leprae* has the lowest level of genetic diversity of any bacterium I'm aware of," says Cole. "One clone has infected the whole world."

The intense similarity between strains compelled the researchers to take a closer look at their samples. Eventually they found subtle DNA sequence mutations called single nucleotide polymorphisms that allowed them to break a total of 175 worldwide strains into four types. Most Central Asian strains were of the type-1 variety, whereas type 2 predominated in Ethiopia, type 3 in Europe, North Africa, and the Americas, and type 4 in West Africa and the Caribbean.

The mutation patterns among the strains suggest that leprosy originated in either Central Asia or East Africa, says Cole, who favors the latter location because type 2 is the rarest and, thus, likely the oldest. "India has been stigmatized as the cradle of leprosy," Cole says. "But the disease could have just as likely arisen in East Africa."

The data also challenge the theory that Alexander the Great's soldiers brought leprosy to Europe when returning from their Indian campaign. "That would have required a transition from type 1 to 2 to 3," says Cole. It's more likely, he argues, that the soldiers contracted the bug in the Near East.

Another striking finding is the apparent effect of European emigration and the West African slave trade on the spread of leprosy. *M. leprae* types 3 and 4 are more similar to each other than they are to type 1, indicating that ▶

DOE WEAPONS LAB

Los Alamos Appoints Interim Director

George "Pete" Nanos has stepped down as director of Los Alamos National Laboratory on the eve of a competition to manage the New Mexico weapons lab.

The University of California (UC), which operates Los Alamos for the Department of Energy (DOE), announced last week that nuclear weapons physicist Robert W. Kuckuck, 65, will become interim director on 16 May. Nanos, a retired Navy admiral, joined the laboratory in January 2003, pledging to right the ship after a series of security lapses. But tough reforms, a decision to shut the lab down last year after a laser accident, and his brash style—he called scientists "cowboys" during the shutdown—earned him harsh reviews from lab scientists. A series of suspensions following the disappear-

ance of classified disks—later found never to have existed—led to outrage in New Mexico and Washington, D.C., alike. Massachusetts Institute of Technology historian Hugh Gusterson calls Nanos "the most unpopular director the lab has ever had." Nanos is taking a job with the Pentagon's Defense Threat Reduction Agency.



Moving on. Nanos had a rocky tenure at Los Alamos.

"Nanos was between a rock and a hard place," says Pete Stockton, an investigator with the Project on Government Oversight, a Washington, D.C., watchdog group. Last week, Defense Nuclear Facilities Safety Board acting Chair A. J. Eggenberger told Congress that the shutdown—which is estimated to have cost more than \$120 million—"resulted in the identification of numerous corrective actions." But at the same hearing, DOE's

Inspector General Gregory Friedman reviewed a litany of lingering management problems.

Nanos's rocky tenure, insiders say, underscores the risk facing UC's Board of Regents. "Some think UC might walk away" from the competition, says Doug Roberts, the Los Alamos computer scientist who runs a Web site for anonymous comments from lab employees. Last month, Sandia National Laboratories operator Lockheed Martin recruited Sandia's former director, Paul Robinson, for its bid (*Science*, 15 April, p. 339). The National Nuclear Security Administration is expected to release final contract language shortly.

Oak Ridge National Laboratory Director Jeff Wadsworth calls Kuckuck (pronounced "cook-cook") a "terrific team builder." A physicist and former deputy director of Lawrence Livermore National Laboratory in California, he is not expected to be part of UC's management team if it competes for the Los Alamos contract. —ELI KINTISCH

these activities, rather than human passage from Asia via the Bering Strait, brought the disease to the New World. "Leprosy has clearly migrated with human populations in orderly patterns," says Cole. "And in places like the Americas, where the disease is relatively new, you're really seeing the negative side of colonialism."

Molecular anthropologist Connie Mulligan of the University of Florida, Gainesville, says the data tying colonialism to the spread

of leprosy are "really good," but she's not convinced there's enough evidence to favor type 2 over type 1 as the original leprosy strain. Still, Mark Achtman, a microbial population geneticist at the Max Planck Institute for Infection Biology in Berlin, says that this new study is bringing us closer to understanding leprosy's past. "As humans, we want to know where we came from," he notes. "The same goes for our diseases."
—DAVID GRIMM

ECOLOGY

Fish Moved by Warming Waters

Climate change has fish populations on the move. In Europe's intensively fished North Sea, the warming waters over the past quarter-century have driven fish populations northward and deeper, according to a study by conservation ecologist John D. Reynolds of the University of East Anglia in Norwich, U.K., and his colleagues. Such warming could hamper the revival of overfished species and disrupt ecosystems, they assert. The warming is expected to continue in the North Sea, and although fish species living to the south will likely move north and replace departing ones, the forecast for the region's fisheries will depend on whether the species that succeed are marketable.

"This is another clear indication that warming is playing a role" in ocean ecosystems, says physical oceanographer Ken Drinkwater of the Institute of Marine Research in Bergen, Norway. Although there have been many studies looking at the effects of climate change on marine species, "no one has looked in detail at changes in distributions of commercial and noncommercial species," says fish biologist Paul Hart of the University of Leicester in the United Kingdom. Similar climate-induced shifts in fish populations, he adds, might happen in other temperate seas, including those around Europe and much of the United States.

The study, published online this week by *Science* (www.sciencemag.org/cgi/content/abstract/1111322), used extensive records of fishing catches made by research vessels between 1977 and 2001, a period during which the North Sea's waters warmed by 1°C at the sea floor. Reynolds's team cast a wide net, compiling data on the sea's 36 most common bottom-dwelling fish. They found that two-thirds of the populations moved toward cooler waters—either going north or to deeper waters, or both. "We saw shifts in both commercial and noncommercial species, and across a broad set of species,"

says conservation ecologist Allison Perry of the University of East Anglia. The fish species whose distribution have shifted tend to be smaller and mature earlier, she and her colleagues noted.

"Those fish that didn't shift raise interesting questions," adds Perry. Such species might be more closely tied to particular habitats or might not spread as quickly because of longer generation times. Because species are redistributing at different rates or not at all, the shifts could rend ties within ecosystems. Species are often adapted to each other and have developed mechanisms for avoiding cer-



Gone fish. Warming waters in the North Sea may make it harder for commercial fishers to find their normal catch.

tain predators or catching specific prey, Hart says: "If suddenly faced with new predators or prey, this could change the balance." Moreover, if the timing of development shifts differently among various species, "this could affect the match or mismatch between the fishes' food and predators," Drinkwater says.

Heavy commercial fishing has already pushed some species in the North Sea to the edge of extinction, and some researchers worry that the changing climate will exacerbate those problems. "Fishing is undoubtedly the most important factor for all the commercial species," says fisheries biologist Niels Daan of the Netherlands Institute for Fisheries Research in IJmuiden. "But it is possible the warming could prevent the recovery of stocks."
—MASON INMAN

No Stemming the Tide

New York state legislators have so far failed to pass a stem cell research bill, but private donors are busy making sure the state stays abreast of California in the stem cell stakes.

Last week, Mount Sinai School of Medicine in New York City announced a \$10 million donation from financier Leon D. Black for the Black Family Stem Cell Institute. The new institute becomes the latest work outside the federal government's stem cell guidelines. Last year, Weill Medical College of Cornell University, also in New York City, was given \$15 million by Houston philanthropists Shahla and Hushang Ansary to establish the Ansary Center for Stem Cell Therapeutics.

The Black Institute will be led by stem cell biologist Gordon Keller, who plans to hire six more researchers. "Yes, the private gifts are flowing," says Keller. "There'll be a lot happening in New York." Keller acknowledges that he's had some nibbles from California but that the new gift "allows us to build a very strong stem cell program here at Mount Sinai."
—CONSTANCE HOLDEN

ALS-Vet Linkage Pursued

The ALS Association is pushing for more research into why U.S. military veterans seem more prone to amyotrophic lateral sclerosis (ALS), also known as Lou Gehrig's disease, than the general population.

The reasons aren't clear. Last year, a Department of Veterans Affairs (VA) report by an outside panel of veterans and scientists concluded that there was a "probable link" between neurotoxins and Gulf War illnesses, some of which resemble ALS symptoms. That finding was criticized by a number of researchers (*Science*, 1 October 2004, p. 26).

At least two studies have found that veterans of the 1990–91 Gulf War were roughly twice as likely to develop ALS. But because ALS usually strikes in the 40s and 50s, those samples were relatively small. A much broader study was published in January in *Neurology*: There, a team of Harvard epidemiologists reported that men in the military had a roughly 50% greater chance of contracting ALS—meaning their lifetime risk rose from 2 to 3 in 1600.

This week the association called for additional funding to tackle the apparent link between ALS and military service and also asked Congress to respond to the VA report's recommendations.
—JENNIFER COUZIN

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