

EVOLUTION

Darwinian Medicine's Drawn-Out Dawn

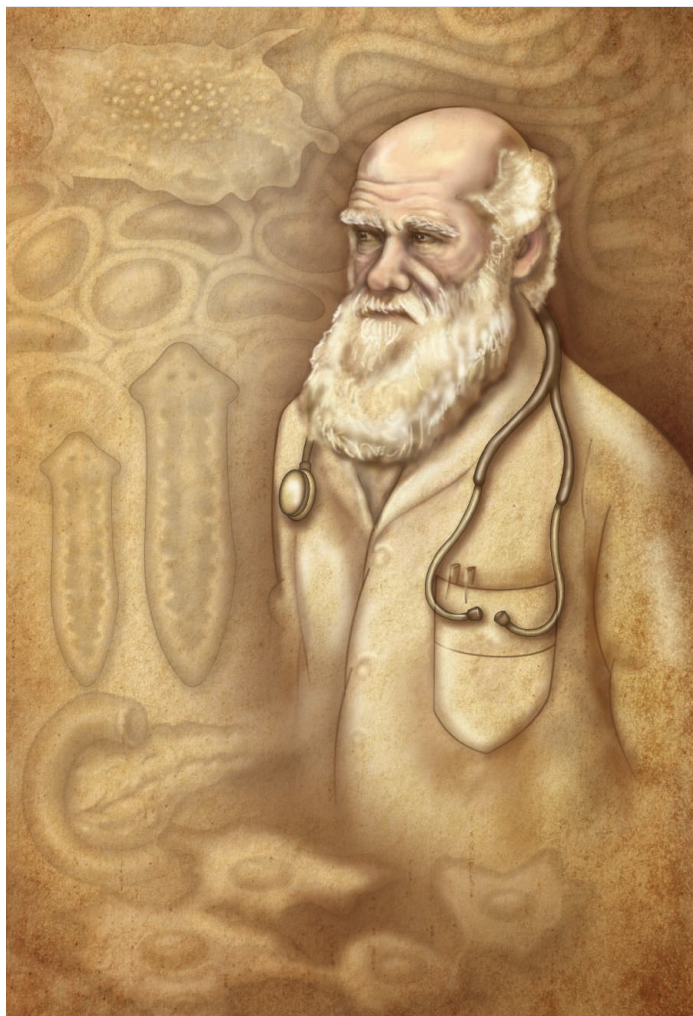
Ever since Darwin, physicians have wondered why humans haven't evolved to be healthier. Blame natural selection itself, says Randolph Nesse, a psychiatrist at the University of Michigan, Ann Arbor.

Twenty years ago, Nesse and evolutionary biologist George Williams attributed our vulnerability to disease to our evolutionary history. The most widely propagated versions of genes are those that made more babies possible, irrespective of their effect on health and well-being, they noted. Evolution, in other words, didn't always favor prolonged good health. Viewed through an evolutionary lens, disease symptoms such as fever and diarrhea were likely imperfect weapons in the body's defenses against infection, they argued. They also pointed out that our immune systems could not evolve fast enough to keep ahead of germs, and that other mismatches have developed between our bodies and modern environments.

In their 1991 paper in *The Quarterly Review of Biology*, Williams and Nesse urged medicine to embrace evolutionary thinking. Aptly titled "The Dawn of Darwinian Medicine," it called the dearth of evolutionary biology in medical schools "unfortunate" and asked physicians to be "as attuned to Darwin as they have been to Pasteur," as that would be the only way to truly understand why we get sick and could lead to changes in medical practice.

Twenty years later, there are signs that Williams and Nesse's ideas are getting traction. About 30 courses on evolutionary medicine, as the field is known, are being taught in universities; two journals are in the works; the U.S. National Institutes of Health (NIH) is about to unveil new high school curricula incorporating evolutionary medicine; and more parts of the medical community are recognizing its potential for providing a holistic framework for their increasingly specialized field. But it has been a long slog to get to this point, and proponents say there is still a long way to go.

Williams and Nesse made their plea at a



time when most physicians were focused on biochemical bases of diseases, not ultimate causes, and evolutionary biologists weren't tuned in to studying how human evolution might impact health. Nevertheless, the paper "really did have a big impact," says Stephen Stearns, an evolutionary biologist at Yale University. "It represented a considerable foray into new areas" and, according to some, gelled the field.

But even now, "there are some people who think it's just a series of 'just so' stories," says Peter Gluckman of the University of Auckland in New Zealand, who wrote the first medical textbook on evolutionary medicine. "Evolution has been resisted fiercely" by the medical profession, says Gilbert Omenn, a physician and human geneticist at the University of Michigan, Ann Arbor. Yet, he says, physicians could be on the front lines of educating the public about evolu-

tion: "Evolution is fundamental to understanding biology, and doctors are what people turn to to understand biology."

Evolutionary insights have certainly influenced medical research in the past 2 decades. Antibiotic resistance, for example, has driven home how the best medical technology can be outpaced by the capacity of bacteria to evade these drugs, and some immunologists are confident that understanding how parasitic worms co-evolved with the human immune system will lead to treatments for autoimmune diseases.

A growing body of researchers are studying the evolution of cancer to understand how tumors form, spread, and evade treatment. Earlier this year, Carlo Maley and C. Athena Aktipis established a center on the evolution of cancer within the cancer center at the University of California, San Francisco, and have built a worldwide network of researchers working on the topic. A second center is under way in France.

There is also growing evidence for Williams and Nesse's point that natural selection can result in greater prevalence of

gene variants that are detrimental to health: Before 1930 and the arrival of better birth control methods, women with mutations in the *BRCA1* and *BRCA2* genes, which increase breast and ovarian cancer risk, gave birth to about two more children, on average, than women without these mutations, researchers reported in October in the *Proceedings of the Royal Society B*.

As far as medical education is concerned, Stearns, one the field's strongest proponents, thinks a turning point came 2 years ago. In 2009, an evolutionary medicine meeting at the National Academy of Sciences pulled in medical school deans and dozens of physicians (*Science*, 10 April 2009, p. 162). Also, that same year, a report by the Howard Hughes Medical Institute and the Association of American Medical Colleges called for medical students to have a more comprehensive understanding of evolution before they enter

medical schools. “Interest in and acceptance of evolutionary applications really seemed to get a big boost,” Stearns says.

Others have begun to view evolutionary medicine as an important element in general science education, as a way to get students interested in evolution. Eleven NIH institutes worked together to produce *Evolution and Medicine*, a free, 250-page high school curriculum supplement planned for release next month. It includes lesson plans and activities that cover antibiotic resistance, lactase persistence, flu vaccine selection, and other biomedical topics that reveal evolutionary principles.

More curriculum changes could be on the way. The National Evolutionary Synthe-

sis Center (NESCent), a National Science Foundation–funded organization in Durham, North Carolina, that promotes cross-disciplinary efforts in evolutionary biology, has sponsored a project that is surveying evolutionary medicine courses and analyzing medical school coursework to see where evolutionary medicine could be squeezed in. By the end of 2013, Mark Schwartz, a physician at New York University who co-coordinates this project, hopes to produce a series of online and in-class teaching modules that can help bring medical students up to speed on evolutionary medicine. “I would like to see evolutionary medicine sprinkled in,” he says.

Such materials may be critical, because it’s unlikely that medical schools will provide

entire courses in evolutionary medicine, given the already-intense course load students face. And the idea that students would get a strong grounding in evolutionary medicine as pre-meds has recently taken a hit: The proposed 2015 Medical College Admission Test actually contains much less evolution than the 2009 report recommended, Stearns says.

“Progress has been patchy,” NESCent Director Allen Rodrigo acknowledges. But Gluckman takes the long view. “You are seeing a growing interest and conviction that having this more holistic view is critical to understanding the human condition,” he says. “In 10 years, it will be a formal part of the training of health professionals.”

—ELIZABETH PENNISI

GENETICS

China Bets on the Variome to Uncover Hereditary Diseases

BEIJING—One in five people on the planet live in China, yet the prevalence of genetic diseases here is an enigma. Known cases of cystic fibrosis are rare, for example, but geneticists are unsure whether that’s because Chinese are less susceptible or because the disease is underdiagnosed. Genetic testing services are woeful, with “no quality control and no standards,” says Qi Ming, director of the Zhejiang University Center for Genetic & Genomic Medicine in Hangzhou.

China aims to change that with a 3 billion yuan (\$470 million) contribution to the Human Variome Project, an international effort to catalog gene variations affecting human health (*Science*, 7 November 2008, p. 861). The commitment—the largest from any country and over a quarter of the target budget—was made official at a ceremony here last week set to the *Star Wars* theme song. The windfall is intended to jumpstart China’s genetic services as much as fund global health work.

Under the agreement, China plans to set up a domestic research network, or “node,” overseen by Qi at Zhejiang University to gather data from hospitals and clinics. Internationally, China will provide support for 5000 to 8000 disease-specific databases. Sequencing of numerous samples will be done at Zhejiang University and BGI in Shenzhen, along with BGI branches in Copenhagen and Cambridge, Massachusetts.

The cash infusion is a boon for the

Human Variome Project, which has been on shaky footing ever since it began in 2006. Progress “has been at a suboptimal rate,” concedes the project’s scientific director, Richard Cotton, a geneticist at the University of Melbourne. “The contribution of China will accelerate this activity considerably,” he says. Since China signed on in January, the number of countries with established nodes has risen from five to 12.

technology,” boasts Li Xitao, director of the Chinese node.

China’s largesse also has a practical purpose: to build up genetic services and train professionals in an emerging field. “A major goal is translational medicine,” Qi says. Global funding for cataloging genetic variations lags because many of the corresponding diseases are rare. In China, Qi says, geneticists face an additional barrier: Three ministries

must approve new medical training programs. By signing on to the Human Variome Project, scientists will sidestep that bureaucratic obstacle.

Using that end run, China plans to establish genetic counseling programs at leading universities. Full master’s degree programs will be bolstered by short-term training courses for specialists. Ultimately, Qi hopes that an army of trained clinicians will help geneticists unravel the cystic fibrosis mystery—as well as uncover novel variations in China’s 56 ethnic groups.

That could be good news for doctors worldwide tasked with diagnosing—and eventually preventing via prenatal screening—genetic disorders in people of Chinese descent. With few clues to genetic variations common in certain ethnic groups, clinicians don’t know where in the genome to start looking for culprits. “You’re searching for a needle in a haystack,” Cotton says. With China coming on board, the search should get easier.

—MARA HVISTENDAHL



Genomic duo. Qi Ming (right) heads up China’s research on the Human Variome Project, launched in 2006 by scientific director Richard Cotton.

Behind China’s investment is a desire to become a powerhouse in genetic research. In the 1990s, the country supplied 1% of the Human Genome Project budget. It later chipped in 10% of funding for the International HapMap Project, an effort to log common genetic variations. The jump to 25% for the more extensive variome project better matches China’s portion of the world population, officials say—and shows that it has become a “powerful country in science and