TRAVEL AND TRADE: Hidden Threats - global ecological disruptions, spread of epidemics and infectious diseases - Statistical Data Included

By Hilary French for **USA Today Magazine**, March 2001

FOR MOST OF HISTORY, natural boundaries such as mountains, deserts, and ocean currents have served to isolate ecosystems and many of the species they contain. However, these physical barricades are now becoming permeable as people and organisms spread around the globe, leading to ecological disruptions with damaging and unpredictable consequences.

Ecological integration has accelerated dramatically in recent decades, as trade and travel have skyrocketed. More than 5,000,000,000 tons of goods are being shipped across the world's oceans and other waterways annually. International air travel is also soaring. More people are flying greater distances than ever before, with 2,000,000 crossing an international border every day. Since 1950, the number of passenger-miles flown has increased at an average of nine percent.

The rapid growth in the movement of human beings and their goods and services around the world has provided convenient transportation for thousands of other species of plants and animals that are taking root on foreign shores. This explosion in the movement of species and microbes across international borders poses a major threat to both the planet's biological diversity and the health of its human inhabitants.

The world community is just beginning to awaken to the pervasive danger posed by the spread of non-native "exotic" species, a process dubbed bioinvasion. Once exotics establish a beachhead in a given ecosystem, they often proliferate, suppressing native species, Invasive species are a major threat to the diversity of life on Earth. Nearly 20% of the world's endangered vertebrate species are threatened by exotics, and almost half of all species in danger of extinction in the U.S. are imperiled at least in part by non-native species.

Ballast water from international shipping is a major culprit in the spread of aquatic species. On any given day, some 3-10,000 of them are moving around the world in ship ballasts. When the ballast water is discharged, so are the organisms, after which they often cause incalculable damage. For example, a ballast water-induced invasion of the Black Sea by the Atlantic jellyfish in the early 1980s was instrumental in the collapse of the fisheries there by the end of that decade.

The U.S. Great Lakes have been hard hit by bioinvasions over the last several decades. One villain is the zebra mussel, which probably originated in the Caspian Sea and was likely first released into the Great Lakes from a ship's ballast water tank in the mid 1980s. Zebra mussels have spread widely throughout the lakes and other waterways of eastern North America, where they have wreaked havoc with delicate ecological systems by ingesting large quantities of algae--a fundamental component of aquatic food webs. Zebra mussels also multiply rapidly, clogging water intake pipes and encrusting aquatic infrastructure and boats. The associated economic losses are expected to add up to a cumulative figure of at least $3,000,000,000 within the next few years.

Terrestrial ecosystems are no less at risk. The damage wrought by the pesticide-resistant whitefly is a warning of the high stakes involved. The whitefly caused tens of billions of dollars of agricultural damage in California in the early 1990s before moving on to South America, where

it has helped spread crop viruses that led to the abandonment of more than 1,000,000 hectares of cropland. (A hectare equals 2.47 acres.)

In the U.S., the aggressive purple loose-strife plant has become a widely known symbol of the broader threat. It is thought to have first been accidentally introduced into North America in the late 18th century in wool imports and solid ship ballast, then deliberately imported for ornamental and likely for medicinal purposes during the 19th century. It has taken over more than 600,000 hectares of temperate and boreal wetland, crowding out native vegetation that is used by wildlife for food and shelter.

The bioinvasion problem cries out for an international response. Among the steps that could be taken are inspections, limits on ballast water discharges, and the adoption of a precautionary approach that prohibits the knowing introduction of exotic species unless they have been shown to be benign. Approximately 23 different international treaties make at least some mention of exotic species, including the 1951 International Plant Protection Convention, the 1982 Law of the Sea, and the 1992 Convention on Biological Diversity. Although many of these agreements are quite weak, some include important commitments. The 1959 Antarctic Treaty, for one, banishes all exotics from the region unless they are specifically listed on an annex of exceptions or the bearer is granted an import permit. Besides legally binding treaties, a range of "soft law" instruments such as codes of conduct and action plans are aimed at the bioinvasion threat.

Tougher international agreements are needed to address this situation adequately, yet any accord stringent enough to alter today's rising tide of biotic mixing could run into conflicts with world trade rules. In what may be a foreshadowing of controversies to come, the Chinese government (which is not yet a member of the World Trade Organization, although it hopes to join soon) has complained that a ban imposed by the U.S. in late 1998 on the import of goods in untreated wooden packing crates amounts to an unfair trade barrier. The U.S. government imposed the ban after determining that Chinese packing crates were a primary culprit in the introduction of the voracious Asian long-horned beetle, an invasive insect that poses a major threat to the health of American hardwood forests. The European Union has placed similar restrictions on Chinese packaging, while China, in turn, limited the use of U.S. and Japanese crates made from coniferous trees after discovering wood-eating worms in some of them.

Microbes across borders

In the first centuries of the Roman Empire, growing commerce between Mediterranean civilizations and Asia precipitated the great plague of 165 A.D. Believed to have been smallpox, this epidemic claimed the lives of a quarter of the population of the Roman Empire. In the 14th century, bubonic plague swept through Europe--the Black Death. This epidemic, which caused the deaths of a third of Europe's population, was introduced into China as the Mongol empire expanded across central Asia, and from there spread by caravan routes to the Crimea and the Mediterranean. Today, the process of globalization is dramatically accelerating the pace at which microbes travel the globe. As the late AIDS researcher Jonathan Mann of Harvard University explained, "The world has rapidly become much more vulnerable to the eruption and ... to the widespread and even global spread of both new and old infectious diseases. This new and heightened vulnerability isn't mysterious. The dramatic increase in worldwide movement of people, goods, and ideas is the driving force behind the globalization of disease." Only by looking out for the health of people everywhere is it possible to promote healthy societies anywhere.

The rapid growth in international air travel is a particularly potent force for global disease dissemination, as air travel makes it possible for people to reach the other side of the world far quicker than the incubation period for many ailments. At the same time, adventure tourism and other pursuits are drawing people to more-remote locations, increasing the chance that microbes will be introduced to vulnerable populations.

Environmental degradation is another powerful contributor to many of today's most pressing global health threats. The World Health Organization (WHO) estimates that nearly a quarter of the global burden of disease and injury is related to environmental disruption and decline. For certain diseases, the environmental contribution is far greater. About 90% of diarrheal diseases such as cholera, which kill 3,000,000 people a year, result from contaminated water. Moreover, 90% of the 1,500,000-2,700,000 deaths caused by malaria annually are linked with underlying environmental disruptions such as the colonization of rainforests and the construction of large open-water irrigation schemes, both of which increase human exposure to disease-carrying mosquitoes. A 1998 analysis by Cornell University ecologist David Pimentel and his colleagues reached an even starker conclusion--that around 40% of all deaths worldwide are attributable to environmental decline.

When globalization and environmental decline join forces, the health implications can be staggering. The power of this combination is demonstrated by the tragic history of the AIDS pandemic. As of 1999, the HIV virus had infected 50,000,000 people worldwide, killing more than 16,000,000. In particularly hard-hit countries in Africa, as much as a quarter of the population harbors the virus.

The epidemic initially came to light at roughly the same time in the early 1980s in Africa, the Caribbean, and North America. The question of where the virus had originated was politically charged, with WHO skirting the issue for many years by maintaining that the virus had emerged simultaneously on at least three continents. "Few scientists accepted that position, recognizing it for what it was--a political compromise" notes author Laurie Garrett in The Coming Plague. "If humanity hoped to prevent its next great plague, it was vital to understand the origins of this one." In the last few years, scientists have made important strides toward getting to the bottom of this controversial question.

It is now widely believed that HIV was originally harbored in chimpanzees inhabiting the West African rainforest, crossing over into human populations as early as the 1940s. Although exactly how this occurred will never be known, scientists speculate that it resulted from hunters cutting themselves while harvesting their kill, or perhaps through the direct consumption of raw meat. The epidemic thus may have had its origins in intermingling between humans and chimpanzees as a result of human incursion into previously remote forests. According to a theory put forth by Jaap Goudsmit of the University of Amsterdam, the decline in chimpanzee populations resulting from the human invasion might have created a biological imperative for the simian immunodeficiency viruses to seek out new hosts--humans.

Scientists believe that saving Africa's imperiled chimpanzees may be crucial for discovering a way to stave off the deadly HIV infection in humans, as the animals are immune from HIV's most lethal effects. Africa's primates are under siege, though, with many on the verge of extinction. One major threat is the thriving "bushmeat" trade. As logging roads penetrate remote forests, loggers and hunters snare chimpanzees, gorillas, monkeys, bush pigs, snakes, and other prey. They either eat the meat themselves or transport it to West African cities, where bushmeat

is considered a delicacy. "These chimps are information we need" maintains Beatrice Hahn of the University of Alabama, who led a team in 1999 that confirmed the link between AIDS and chimps. "Killing them for the pot is like burning a library full of books you haven't read yet" she argues.

Another major outstanding question related to the origins of the AIDS epidemic is how HIV, once it was transferred from chimps to humans, made the leap from being an isolated condition confined to Africa's remote hinterlands to its current status as a global pandemic. Although many links in this chain are unknown, a range of phenomena are thought to have contributed, including warfare near the region where the virus is believed to have first emerged; the paving of the TransAfrica highway, which provided an easy route for carrying HIV across the continent; population growth and urbanization; and, ultimately, burgeoning international travel and migration.

As the movement of people into remote parts of West Africa's forests continues to pick up speed thanks to logging and hunting, scientists warn that other dangerous viruses may make the jump from primates to people. An even broader issue is at stake as well. "AIDS is trying to teach us a lesson" Mann warned. "The lesson is that a health threat in any part of the world can rapidly become a health threat to many or all."

Numerous other urgent global health challenges loom. Over the past two decades, more than 30 infectious diseases have been identified in humans for the first time, including AIDS, Ebola, Hantavirus, and hepatitis C and E. In a case that aroused widespread concern in the U.S., health experts confirmed in October, 1999, that at least five people in New York City and surrounding areas died from a new strain of the African West Nile virus, a rare mosquito-borne disease never before seen in the Western Hemisphere. They attribute the emergence of the disease to the steady rise in international trade and travel, concluding that it was transmitted either by by an infected human who carried it into the country from abroad or via a smuggled exotic bird.

Environmental disruption is also a potent contributor to today's microbial migrations. According to WHO, "environmental changes have contributed in one way or another to the appearance of most if not all" of the newly emerging diseases. Changes in land use like deforestation or conversion of grasslands to agriculture that alter long-established equilibrium between microbes and their hosts are sometimes to blame. In other cases, changes in human behavior are the culprit, like careless disposal of food and beverage containers or car tires, which can create breeding sites for disease-carrying organisms such as mosquitoes. Movements of pathogens themselves or the organisms that carry them are sometimes the cause as well.

An added problem is the reemergence of microbes thought to have been vanquished in some parts of the world. Cholera's reappearance in Latin America is a case in point. Until 1991, there had been no epidemic outbreaks of this deadly disease in this region for nearly a century. However, the disease erupted with a vengeance in Peru that year, ultimately infecting some 322,000 people and killing at least 2,900 of them. The outbreak was catastrophic for the country's economy, causing importers to ban Peruvian fish and fruit from their markets and tourists to avoid the country. All told, the economic costs to Peru's economy added up to $770,000,000--almost one-fifth of the country's normal annual export earnings.

The outbreak quickly spread beyond Peru, contaminating the water supply of every country on the continent except Paraguay and Uruguay before it gradually wound down two years later.

Across the Americas, the disease infected more than 1,000,000 people and killed about 11,000 during the first half of the 1990s.

Scientists are trying to understand why cholera is reemerging with such force. A number of factors seem to be at work. One theory is that the cholera bacteria was discharged from the ballast water of ships arriving in Peruvian ports from South Asia. Poor sanitation undoubtedly played a major role, as cholera is often spread by contact with food or water that has been contaminated by human waste containing the bacteria. Another theory is that El Nino may have contributed to the outbreak by causing warmer ocean temperatures that encourage large blooms of plankton that can harbor the organism.

If El Nino was, in fact, a key piece of the puzzle, the cholera epidemic of the early 1990s was likely just a harbinger. Scientists project that climate change will lead to a surge in infectious ailments by increasing the range of disease-carrying organisms and inducing a growing number of extreme weather events such as floods and hurricanes, which tend to leave epidemics in their wake. "There are strong indications that a disturbing change in disease patterns has begun and that global warming is contributing to them" warns Paul Epstein, associate director of Harvard Medical School's Center for Health and the Global Environment.

Already, dengue fever and malaria appear to be expanding their reach northward into cooler climates. Locally contracted cases of malaria have been reported in recent years in Florida, Georgia, Texas, Virginia, New York, New Jersey, Michigan, and Ontario, Canada. The record number of extreme weather events experienced in 1998 exacted a heavy toll on human health. Epstein reports that major flooding in East Africa led to large increases in the incidence of malaria, Rift Valley fever, and cholera; delayed monsoons in Southeast Asia contributed to wildfires that caused widespread respiratory ailments; and Central American nations slammed by Hurricane Mitch experienced an increase in cholera, dengue fever, and malaria.

With the global interdependence of human and ecological health creating frightening vulnerabilities, it is generating an imperative for countries to work together to confront shared perils. Faced with raging transcontinental epidemics of cholera and plague during the mid 19th century, European governments held 12 International Sanitary Conferences between 1851 and World War I which forged international health agreements covering issues such as quarantines, trade restrictions, and procedures for disease notification and inspection. In 1946, these and later efforts culminated in the creation of the World Health Organization, which has had a number of important successes, perhaps most notably the eradication of smallpox in 1977.

This system provides a firm foundation on which to build the new biological controls that are needed to protect people and ecosystems from the introduction of disruptive exotic species and diseases. Although economic globalization dominated headlines at the close of the 20th century, ecological integration may wind up posing even greater challenges for international cooperation in the decades ahead.

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