Black Carp and Sick Cows

The tragedy befalling livestock and those who raise them in the United Kingdom and Europe is so gripping that it's hard to relate it to the News story on p. 203 in this issue, which reports that a new and potentially invasive fish, black carp, is now being cultured in the southern United States. Yet the two—infectious disease epidemics in agriculture and the invasion of ecosystems by alien species—are linked phenomena. Each is driven by social and economic forces that are almost certain to generate future crises.

As humans have grown in numbers and mobility, we have become the agents of a biogeographic diaspora. The early European navigators traveled with what Alfred Crosby has called the "portmanteau biota": livestock, grain seeds, Norway rats—and pathogens such as smallpox, which devastated indigenous populations in the "neo-Europes." More recent international translocations brought the chestnut blight to North America, rabbits to Australia, and zebra mussels to the Great Lakes. The contemporary explosion of economic globalization has brought us a new and even more troubling array of problems, exemplified by the 230 species of alien marine invertebrates established in San Francisco Bay through ballast water pumped out by ships from distant ports.

Black Carp

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It may seem odd to equate epidemics of infectious disease with the problem of invasive species. But in the complex distribution chains we humans have created, they become interdependent. Consider the following skein of circumstances. Rubber seedlings, brought in the 19th century from Brazil to Kew Gardens in England and then used to establish plantations in South Asia, came unaccompanied by the South American leaf blight fungus. Those plantations now supply most of the world's natural rubber and fuel several national economies. So if you arrive at Kuala Lumpur airport having visited South America on the same itinerary, you walk in on fungicide-soaked carpet and have your luggage irradiated. Meanwhile, the globalizing trade in radial auto tires, powered by natural rubber from Asia, brought the Asian tiger mosquito (*Aedes albopictus*) to the United States from Japan as a stowaway in used tire casings. It is well established as a nuisance in its new homeland, and because it is a competent vector for dengue fever, it worries public health officials as well.

The global economy of rubber has thus created an unusual ecosystem that includes the Amazonian rain forest, Malaysian plantations, Japanese tire factories, and New Jersey marshes. In East Africa, Tony Sinclair has described an equally complex linkage that began with the introduction of rinderpest virus in the late 1800s, probably from Asian cattle brought in to feed the Anglo-Egyptian army of the Sudan. In the Serengeti, it decimated the wildebeeste and other grazing herds, contributing to the conversion of grassland to dense acacia savanna. That provided new breeding grounds for tsetse flies, the vector responsible for nagana in cattle and, in the early 20th century, for epidemics of sleeping sickness in people. The costs have been heavy. Were a careless tourist or an agroterrorist to loose leaf blight fungal spores in Malaysia, the costs could be even heavier.

We know that international commerce and domestic economic forces were involved in the reemergence of foot-and-mouth disease in the United Kingdom—as they were, less directly, in the story of rubber above. We also know that the animals we tend and the plants we cultivate inhabit a world full of mobile pathogens, capable of unexpected emergence; sometimes, as in the Serengeti, through invasions that led to secondary ecological changes. The Law of Unintended Consequences is alive and well here, and we have amplified it by artificial selection regimes that favor yield, often at the expense of decreased resistance.

We doubt whether agencies such as the Animal and Plant Health Inspection Service in the United States have the capacity to prevent these epidemics, just as the Malaysian government may not be able to interdict every spore of the fungus it dreads. Are there policy solutions? Modest gestures have already been made, such as special laws regarding ballast pumping and used tire inspection. But there is neither a general strategy for dealing with these invaders nor a widespread awareness of our vulnerability. We have made the globe a biological Cuisinart, and we will either have to deal with the consequences or use our scientific capacity to improve forecasting and monitoring.

Donald Kennedy