Chips, Infections, and National Security

THE RECENT OUTBREAKS OF ANTHRAX IN THE United States have brought a new urgency to the diagnosis of infectious disease resulting from bioterrorism. At the early stage of infection, pulmonary anthrax mimics viral upper respiratory infections; it is only later in the disease, often when the pathology of the disease has become life-threatening, that the bacteria can be directly detected.

In the 26 October issue of *Science*, a report appeared indicating that a bacterium, a virus, and a fungus induced unique patterns of gene expression in immune cells in vitro that could be detected by sophisticated DNA chip technology (*1*). In the accompanying Perspective written by us before the outbreaks of anthrax, we commented on the importance of this approach to understanding disease pathogenesis and future patient care (*2*).

However, the outbreaks of anthrax have added a new perspective to this work. It is now clear that this approach has additional potential for early diagnosis of microbial infections. It may be possible to refine this technology to allow the detection, perhaps from a few drops of blood, of unique molecular signatures of specific genes induced in host cells by individual pathogens, whether biowarfare agents or commonplace organisms. If so, this technology could provide a specific and sensitive system for establishing the presence of infection in people at risk long before clinical signs are evident or the microorganism can be directly identified—a system that reveals the nature of the pathogen, and who is infected and who is not.

Several steps would be required to develop and institute a gene chip test for the early diagnosis of infection from bioterrorism. (i) DNA chip analyses of a greater number of pathogens will clarify whether each pathogen triggers a unique signature of gene expression. (ii) Experimental animal models could be used to determine whether the gene chip test is specific and sensitive and what tissues are optimal for testing. (iii) It would be necessary to automate the test to screen large sectors of the population. Development would clearly be accelerated by a partnership among government, academia, and industry. A rapid molecular test such as this would have value not only for our defense against bioterrorism, but also for the early diagnosis of any infection.

ROBERT L. MODLIN,[1] BARRY R. BLOOM[2]
[1]Department of Microbiology and Immunology, Molecular Biology Institute, UCLA School of Medicine, Los Angeles, CA 90024–1750, USA; e-mail: rmodlin@mednet.ucla.edu. [2]Harvard School of Public Health, Boston, MA 02115, USA; e-mail: bbloom@hsph.harvard.edu

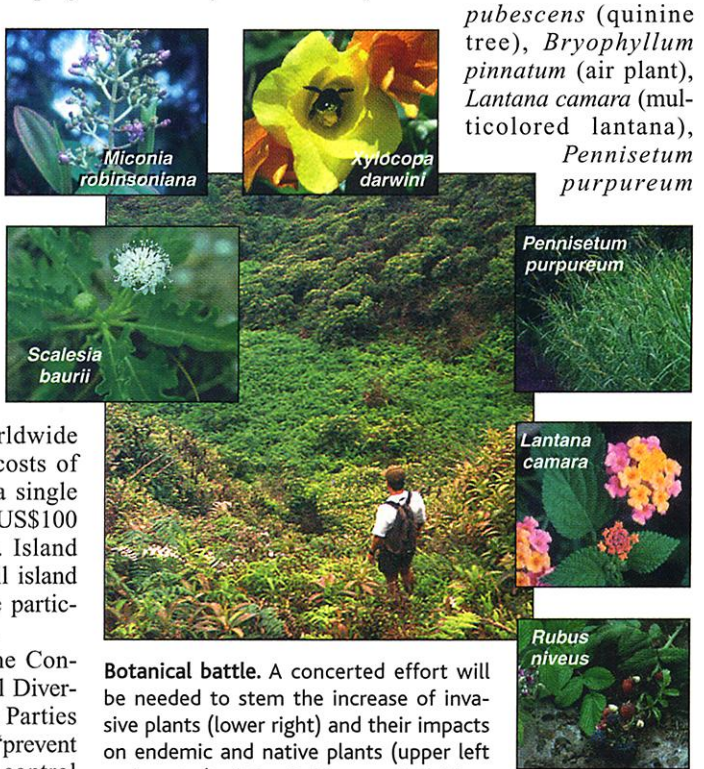
References and Notes
1. Q. Huang *et al.*, *Science* **294**, 870 (2001).
2. R. Modlin, B. R. Bloom, *Science* **294**, 799 (2001).

Green Invaders of the Galápagos Islands

THE CHARLES DARWIN RESEARCH STATION and the Galápagos National Park Service and their partners have a program under way to eradicate and control invasive species (*1*) in the Galápagos Islands (News Focus, "Galápagos takes aim at alien invaders," J. Kaiser, 27 Jul., p. 590). Invasive species are now among the top drivers of environmental change (*2*), causing social instability and economic hardship worldwide (*3*). The economic costs of invasive species to a single country can exceed US$100 billion annually (*4*). Island ecosystems and small island developing states are particularly vulnerable (*5*).

Article 8(h) of the Convention on Biological Diversity (CBD) calls on Parties and other bodies to "prevent the introduction of, control or eradicate those alien species which threaten ecosystems, habitats or species." Recent decisions under the CBD have emphasized the need to give priority attention to geographically and evolutionarily isolated ecosystems such as islands (see http://www.biodiv.org). The eradication and control efforts being undertaken in the Galápagos could well serve as a model and motivation for natural resource managers and policy-makers worldwide.

Kaiser's article draws attention to the challenges of managing invasive animals in the Galápagos, but invasive plants require at least as much attention. About 600 species of alien plants have been detected in the Galápagos archipelago. These are primarily cultivated species (*6*) but also include plants brought in unintentionally. By 2001, 55% of the alien species did not appear to be establishing, but 45% had naturalized. Of the latter, 7% are invasive (aggressively outcompeting Galápagos endemic and native flora) and 20% are potential invasives. *Cinchona pubescens* (quinine tree), *Bryophyllum pinnatum* (air plant), *Lantana camara* (multicolored lantana), *Pennisetum purpureum*



Botanical battle. A concerted effort will be needed to stem the increase of invasive plants (lower right) and their impacts on endemic and native plants (upper left and center) of the Galápagos. A Galápagos National Park Service guard (center) surveys an island of endemic *Miconia* (dark green plants) and native fern in a volcanic crater on Media Luna. The invasive plant quinine (not visible) surrounds this area.

CREDIT: (CENTER PHOTO) J. MAGEE; (REMAINING PHOTOS) C. K. MCMULLEN

(elephant grass), *Psidium guajava* (guava), and *Rubus niveus* (hill raspberry) are among the worst invaders, and the four human-inhabited islands are the most significantly affected (*7*).

In the archipelago, the plant species introduced since the island's discovery in 1535 (600 species) now outnumber the native flora (500 species). This equates to a rate of more than one species per year, whereas the natural rate of arrival of new plant species on the islands is about one species every 10,000 years (*8*).

The Gardening for Galápagos Foundation, Inc. (GFG) was founded to encourage and assist botanical conservation and research efforts in the Galápagos Islands through fundraising, education, and community outreach programs. Our programs engage U.S. botanists, landscapers, gardeners, and other naturalists (see http://members.aol.com/aplectrum/GFG.htm). Prevention is the most cost-effective means of managing invasive species over the long run and is the Galápagos' first line of defense. Unless stringent measures are taken, the number of invasive species (plant and animal) will continue to rise. Ultimately, awareness campaigns, limits on human population, strong risk assessment and management procedures, and an effective quarantine program are required to minimize the arrival, spread, and impact of invasive species in the Galápagos (*5, 7*).

EXECUTIVE BOARD OF THE GFG: JOHN MAGEE,[1]* CONLEY K. MCMULLEN,[2] JAMIE K. REASER,[3] EMILY SPITZER,[4] SUSANA STRUVE,[5] CRAIG TUFTS,[6] ALAN TYE,[7] GARTH WOODRUFF[8]

[1]2716 West Ox Road, Herndon, VA 20171, USA. [2]Department of Biology, James Madison University, Harrisonburg, VA 22807, USA. [3]National Invasive Species Council, 1951 Constitution Avenue, NW, Washington, DC 20002, USA. [4]4807 Cumberland Avenue, Chevy Chase, MD 20815, USA. [5]CH2Mhill, 13921 Park Center Road, Herndon, VA 20171, USA. [6]National Wildlife Federation, 11100 Wildlife Center Drive, Reston, VA 20190–5362, USA. [7]Charles Darwin Research Station, Isla Santa Cruz, Galápagos, Ecuador. [8]Post Office Box 3601, Warrenton, VA 20188, USA

*To whom correspondence should be addressed. E-mail: euphorbia@aol.com

References and Notes

1. "Invasive species" means an alien (nonnative) species whose introduction does or is likely to cause economic or environmental harm or harm to human health. U.S. Executive Order 13112, 3 February 1999.
2. O. E. Sala *et al.*, *Science* **287**, 1770 (2000).
3. J. A. McNeely, Ed., *The Great Reshuffling: Human Dimensions of Invasive Alien Species* [World Conservation Union–International Union for Conservation of Nature and Natural Resources (IUCN), Cambridge, MA, 2001].
4. D. Pimentel *et al.*, *BioScience* **50**, 53 (2000); D. Pimentel *et al.*, *Agric. Ecosyst. Environ.* **84**, 1 (2001).
5. J. A. McNeely *et al.*, Eds., *Global Strategy on Invasive Alien Species* (IUCN, Cambridge, United Kingdom, in collaboration with the Global Invasive Species Program, 2001).
6. Cultivated alien species include food plants such as guava, banana, orange, and pineapple; ornamentals such as bougainvillea, hibiscus, Madagascar periwinkle, and oleander; forage plants such as elephant grass; timber trees, including West Indian cedar and balsa; and medicinal plants such as the quinine tree.
7. C. K. McMullen, *Flowering Plants of the Galápagos* (Cornell Univ. Press, Ithaca, NY, 1999).
8. D. M. Porter, in *Patterns of Evolution in Galápagos Organisms*, R. I. Bowman *et al.*, Eds. (American Association for the Advancement of Science, San Francisco, 1983), pp. 33–96.

Problem Pigs in a Poke: A Good Pool of Data

A MASSIVE EFFORT TO REMOVE INTRODUCED species, largely feral animals, from the Galápagos Islands is the topic of, as Jocelyn Kaiser's article "Galápagos takes aim at alien invaders" (News Focus, 27 Jul., p. 590). As with many other eradication programs of feral populations, the Galápagos project is missing an opportunity to collect basic demographic and ecological data from these populations, just the sort of data needed to