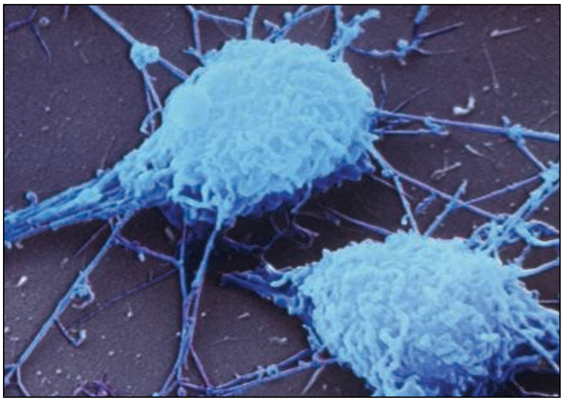

Partners in crime. Inflammatory cells such as the macrophages shown here are turning out to boost tumor growth and spread.

necrosis factor–α (TNF-α) that's made by macrophages. But when the researchers performed the same experiment with tumor cells bearing an NF-κB inhibitor, the tumors actually shrank following LPS injection due to increased apoptosis.

Although much evidence supports the idea that NF-κB promotes cancer by inhibiting apoptosis, it may contribute in numerous other ways as well. Some may be direct outgrowths of the protein's role in inflammation. The genes activated by NF-κB include the one that makes COX-2, an enzyme needed for the synthesis of a pro-inflammatory compound called PGE-2. This can bring in more immune cells to maintain the inflammation and further prod tumor growth. COX-2 also promotes blood vessel growth. Actions such as these may explain why COX-2 inhibitors have cancer-fighting effects.

Some NF-κB actions may be independent of inflammation, however. Although NF-κB activity is not necessary for cancerous transformation by Ras, Baldwin says, it does foster cancer growth, similar to what Karin's team found in their experiments. But when Ras activates NF-κB, the consequences may be different than when TNF-α or other inflammatory factors do. In work published in the 15 October issue of *Cancer Cell*, Baldwin and his colleagues analyzed the genes turned on by NF-κB following its activation by Ras. The genes affected included several that make growth-promoting proteins, but for reasons not yet understood, none of the inflammation-promoting genes typically activated in response to TNF-α. Although this fosters cancer growth, NF-κB activity in response to Ras apparently activates a different set of genes than when TNF-α is the activator.

However NF-κB works, it's looking more and more like a good target for anticancer drugs. "There are definitely ways to take advantage of this," Karin predicts. The pharmaceutical industry is currently working to develop NF-κB inhibitors, and even some low-tech compounds such as the active ingredients in green tea and red wine, which are thought to have anticancer properties, are turning out to act on the protein. "Almost every cancer preventive is an NF-κB inhibitor," Baldwin says.

–JEAN MARX

Invasive Species

Expanding Trade With China Creates Ecological Backlash

Scientists in the United States and China are scrambling to cope with an unintended consequence of increasing economic ties—a two-way flow of unwelcome plants and animals

To the unknowing eye, the reeds growing along the Yangtze River near Shanghai—a burst of green in the summer, with tips that turn golden brown in the fall—belong on picture postcards. But ecologists know them as a biological experiment run amok. The salt marsh grass *Spartina alterniflora*, a native of eastern North America introduced in 1979 to check erosion, has now spread across southeastern China, choking estuaries, crowding out native grasses, and reducing feed and habitat for fish and migratory birds.

Across the Pacific, the tiny holes in the bark of maples, willows, and elms in New York, New Jersey, and Illinois come from the Asian longhorned beetle. *Anoplophora glabripennis* is an unwelcome hitchhiker from China that most likely arrived in the United States a decade ago aboard wooden shipping crates. Unless checked, the beetle threatens to bore its way through billions of dollars' worth of valuable timber, shade, and maple syrup trees.

Different continents, different species, different routes of introduction—but a common problem. Since China opened its doors to the West in the early 1980s, its burgeoning trade with the United States (see graph) has meant more marine organisms in ballast water and insects in packing crates accidentally transported across the Pacific in both directions. The influx has been supplemented by intentional introductions by commercial U.S. nurseries and horticultural collectors looking for exotic Chinese specimens. Many of these species flourish thanks to similar habitats and climates in the two countries. The result, says Li Bo, a plant ecologist at Shanghai's Fudan University, is that "American species can easily get established in China, and Chinese species can easily get established in America."

Many introduced species never expand beyond a beachhead, and most horticultural species are well behaved. But for reasons that are still being debated, some introductions lead to ecological disaster. This summer Chinese and U.S. scientists held two meetings* in hopes of sharing information and developing strategies that might help avert dire consequences from this two-way traffic. "There is a chance we could stop this wave of invasive species exchange between China and the United States" through stricter inspections and stiffer regulations, believes Peter Alpert, a plant ecologist at the University of Massachusetts, Amherst. But he says "there

Invaders. Arkansas rivers are filling with carp from China originally imported for aquafarming.

CREDITS (TOP TO BOTTOM): MANFRED KAGE/PETER ARNOLD INC.; USGS

*Beijing International Symposium on Biological Invasions, 8–15 June 2004. Biological Invasions: Species Exchanges between Eastern Asia and North America, Portland, Oregon, 2 August 2004, held in conjunction with the Ecological Society of America meeting.

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are as yet no effective policies to control species exchanges."

Proceed with caution

Controlling invasives is already a major headache for both countries. David Pimentel, an entomologist and systems ecologist at Cornell University in Ithaca, New York, concluded in 2000 that invasive species cost the United States more than $137 billion per year. A similar study presented this summer at the Beijing symposium by Xu Haigen of the Nanjing Institute of Environmental Sciences, working with colleagues there and at the Nanjing Forestry University, concluded that invasives had caused $2.4 billion in damages to eight major Chinese industries alone. Many researchers on both sides say these numbers are probably low and certain to rise.

The first bilateral efforts to control invasive species in Asia and North America occurred in the 1980s, when U.S. scientists visited China in search of natural predators for species imported as horticultural ornamentals in the late 19th and early 20th centuries. Many of these, such as Chinese privet, are now widespread in North America. Those initial surveys led to the creation of a Sino-American Biological Control Laboratory in Beijing in 1989 to identify and exchange insects that eat invasive plant species.

One apparent success story is a leaf beetle (*Diorhabda elongata*) native to Xianjiang Province. It attacks tamarisks (*Tamarix ramosissima*), an invasive Eurasian species that has displaced native plants along rivers and in arid regions of the American west. The beetle was released 7 years ago, and it "looks like it will be a terrific success" in reducing the spread of tamarisk, says Robert Pemberton, an entomologist at the U.S. Department of Agriculture's (USDA's) Agricultural Research Service in Fort Lauderdale, Florida. So too does the 1980 introduction into China of two beetles, originally from South America, to control the spread of water hyacinth.

Introducing insects to eat invasive plants is a laborious and risky process. The insects must be carefully screened to ensure that they don't attack native plant species, as happened with the weevil *Rhinocyllus conicus*, brought into Canada and the United States from Europe in the late 1960s to battle exotic thistles. It turned out to have a taste for native thistles as well. Ding Jianqing, an entomology postdoc at Cornell University who previously headed a biocontrol lab at the Chinese Academy of Agricultural Sciences, says that concerns about unintended consequences have limited the number of introductions in the past 15 years to just four predatory insects from the United States to China, and only three in the opposite direction.

In situations in which eradication is difficult or impossible, scientists would settle for preventing further spread of the invasive plant. But they are hoping that early intervention may actually stem the infestation of the Asian longhorned beetle. USDA researchers have been cooperating with their Chinese counterparts to develop better methods to detect tree infestation early as well as to identify possible lures to attract and kill the beetles. But this is still a work in progress.

Similarly, Duane Chapman, a fisheries biologist at the U.S. Geological Survey's Columbia Environmental Research Center in Missouri, is struggling to reduce damage from bighead and silver carp imported from Taiwan in the 1970s for aquaculture farms in Arkansas. The carp escaped and are now crowding out native species. Chapman and Chinese counterparts are summarizing and translating Chinese studies of the carp in their native habitat, information which may lead to more effective control strategies.

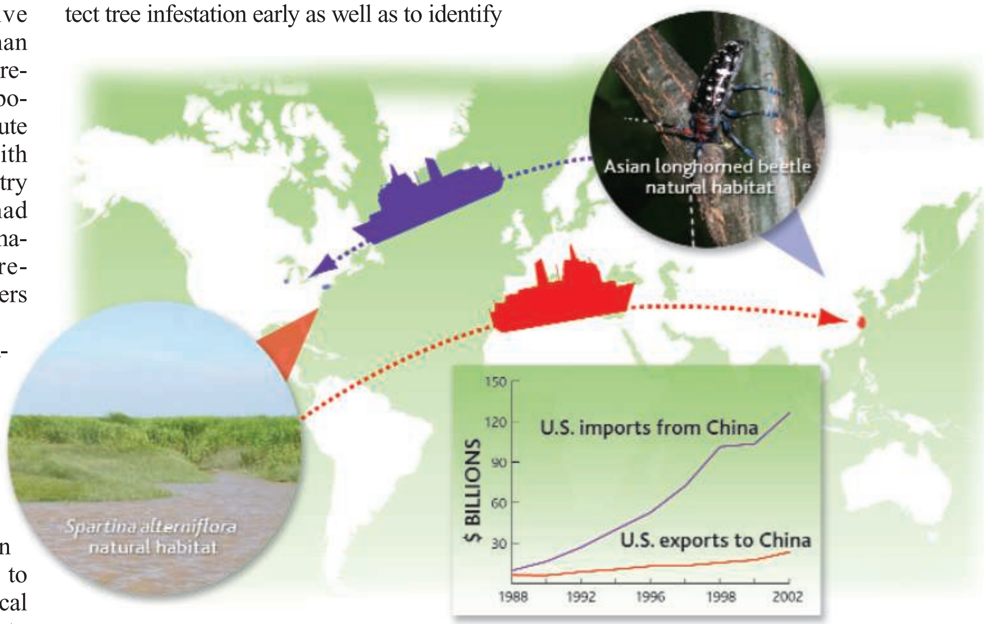
A closer look

Despite good working relationships between individual scientists, U.S. and Chinese researchers say that they won't make a serious dent in controlling invasive species until their governments make it a higher priority. The United States spent $1 billion this year on efforts such as inspections of cargo and baggage for accidental introductions and vetting deliberately imported species. A 2002 National Academy of Sciences (NAS) study says that USDA's Animal and Plant Health Inspection Service (APHIS) intercepts more than 53,000 arthropods, pathogens, and noxious plants each year. But that's only a tiny fraction of what needs to be done, say scientists. Only 2% of cargo shipments are checked, they note. And although packing crates infested with the Asian longhorned beetle have been stopped at ports in 17 states, according to USDA, enough slipped through to start an invasion.

There's also growing concern about deliberately introduced horticultural specimens. "We're going to have to take a much more aggressive position on evaluating whether a species can become a threat to any aspect of the U.S. biota prior to its release into the marketplace," says Richard Mack, an ecologist at Washington State University in Pullman. Mack chaired the panel that produced the 2002 NAS report *Predicting Invasions of Nonindigenous Plants and Plant Pests*. Its recommendations are being discussed by scientists and federal officials, he says, "but I don't see any strong movement yet" to implement them.

Fudan's Li says China has only recently begun to conduct inspections and implement quarantine requirements. Last year the government published a "black list" of species not to be brought into the country, but it simply covered known problems, such as *Spartina alterniflora*. This month, however, the Chinese Academy of Agricultural Sciences, with the support of the ministries of Science and Technology and of Agriculture, is holding a workshop to develop a national invasive species strategy that would cover prevention, early detection, and on-the-ground management. That strategy should give scientists on both sides of the Pacific more ammunition to battle an increasing onslaught of invasive species.

–DENNIS NORMILE



Along for the ride. These salt marsh grass and longhorned beetle species have expanded their habitats thanks to increased trade between the United States and China.

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