
Sign of destruction. Brown swaths indicate the extent of rodent damage in rice terraces in the Philippines.

NEWS

Holding Back a Torrent of Rats

A "RAT FLOOD." THAT'S WHAT THE TRIBES IN BANGLADESH'S CHITTAGONG Hill Tracts call it. Every 48 years, the bamboo forests that dominate the uplands of Bangladesh, Northeast India, and Myanmar (formerly known as Burma) simultaneously produce a feast of pear-sized fruit that allows rat populations to explode. After consuming the fruit, the rodents attack nearby fields, devouring 50% to 100% of the rice crop. Rat floods caused famine in 1863, 1911, and 1959, when the misery touched off a rebellion in what is now India's Mizoram State.

Rat floods may be unusual, but rodent losses are a perennial problem worldwide. In Asia, for instance, rodents devour an estimated 6% of the annual rice harvest—roughly enough to feed Indonesia's 240 million people for a year. And they do damage in nearly every phase of farming, from munching on seedlings to eating stored grain.

Many farmers and agricultural officials, however, shrug. "Philippines farmers say, 'For every 10 rows of rice we plant, seven are for the family, two for the rats, and one for the birds,' " says Grant Singleton, a wildlife ecologist at the International Rice Research Institute in Los Baños, Philippines. Rat fatalism runs so deep that agricultural universities, which have courses in insect management, offer no training in defending against rodents. Thanks in part to growing concerns about food security, however, Singleton says rats are now "getting on the radar."

Rat race

In the wake of that recognition, agriculture agencies across Asia have started spreading the word about some relatively simple rat countermeasures. Small-scale farmers, for instance, often store grain in open bins in their homes and "don't appreciate what [rats] are taking," says Singleton. Steps such as raising the bin off the floor and installing metal flashing around bin legs can cut losses.

Rat fighters are also urging all farmers within a community to plant their crops within 2 weeks of each other. If fields ripen together, grain is available for a shorter time and rodents curtail breeding. Communities can also maximize efforts to flush out, trap, and kill rats by launching campaigns before planting begins. When paddies and fields are fallow, rodents tend to congregate in the thickets between fields and along roads and irrigation channels. "While they are aggregated, they are much easier to control," says Singleton. Most important, he says, communities need to work together: "If you do everything we think should be done to manage rodents and your neighbor does not, you will inherit those rodents."

Some of the 200-plus species of rats that pester farmers, however, require carefully timed control strategies that reflect unique habits. For instance, Indonesia's rice field rat, *Rattus argentiventer*, does its worst damage just as grains start to form, because the rats must eat huge quantities of immature grain to get sufficient nutrition; as the grain ripens, they eat less. In contrast, Myanmar's *Bandicota bengalensis* rats cause little damage until just before harvest, when they grab all the grain they can to horde in burrows. "The dynamics of the damage differs by species," Singleton says.

Rodents also respond to unusual patterns of food availability. In May 2008, Cyclone Nargis devastated the rice crop in Myanmar's Ayeyarwady delta (*Science*, 8 May 2009, p. 715). To recover, farmers planted rice when and where they could. As a result, the rice ripened at different times in neighboring paddies—providing a steady food supply for rats. The rodents bred for longer than usual, leading to a surprise outbreak this year that further dented precarious food supplies.

All together now

Even recognized events such as bamboo fruiting, however, can be difficult to prepare for. One problem is that agricultural agencies are reluctant to fund the long-term studies needed to understand the connection between bamboo "masting," where an entire population produces fruit simultaneously, and rodent explosions. Masting can occur at intervals ranging from several years to more than 100 years, depending on the species, so "there are few opportunities to study this," says Steven Belmain, an ecologist at the Natural Resources Institute of the University of Greenwich in Chatham Maritime, U.K. Only over the last several years, for instance, have scientists unraveled what happens to rat populations when masting occurs in *Melocanna baccifera*, which makes up more than 80% of the bamboo in Bangladesh, India's Mizoram State, and Myanmar.

Typically, rodents in that region start breeding in April or May, after the dry season when the first monsoon rains allow food in the form of insects and plants to proliferate. Upland farmers plant their rain-fed crops at the same time. Rodent populations build through the summer and damage the harvest, but losses are usually manageable. Once every 48 years, however, the *Melocanna* bamboo starts dropping fruit in February. With food abundant, the rodents start breeding 2 to 3 months earlier than usual. This head start means that "multiple generations of rats are breeding, [producing] exponential growth in the population," says Ken Aplin, a wildlife biologist at Australia's Commonwealth Scientific and Industrial Research Organisation in Canberra. By autumn, just as crops are ripening, the food in the bamboo forest is gone, leading to "a mass movement [of rodents] from the

CREDIT: GRANT SINGLETON

forest into the fields," says Aplin, who advised the Mizoram state government on dealing with masting. But "there is no way to stop the ecological phenomenon," says Belmain. "You can only manage the damage."

Anticipating the 2008 *Melocanna* masting event, for instance, the Mizoram government launched the 5-year Bamboo Flowering and Famine Combat Scheme that included upgrading roads to carry aid to remote communities, rat-proofing warehouses, and encouraging farmers to plant early-yield rice varieties and alternative crops less attractive to rodents. When the inevitable rat flood hit, the government and relief organizations provided food assistance. "In a broad sense, it worked," says Aplin, though it will take several years for the area to completely recover.

Now, researchers are pondering how the lessons learned could help other regions. If researchers can pin down when and where masting events will occur, "it might allow us to understand which communities will be hit so limited resources can be better targeted," says Belmain. Rat flood control, it seems, is just getting started.

–DENNIS NORMILE

Cute but hungry. Researchers track rats fitted with transmitting collars to understand their movements and habits.

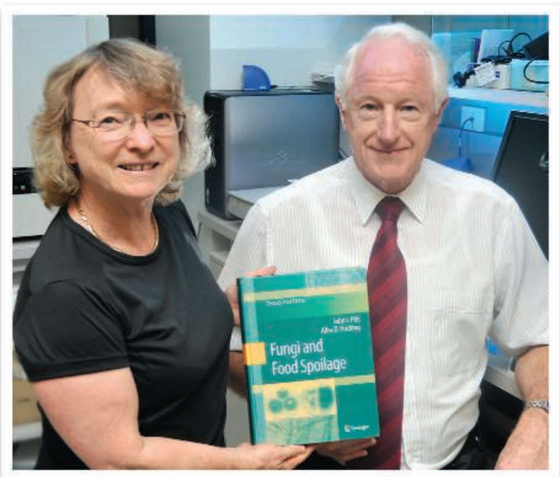
NEWS

Spoiling for a Fight With Mold

IT'S TOUGH GETTING PEOPLE TO WORRY ABOUT MOLD AND ITS ROLE IN food security. "Everyone has seen mold on things in refrigerators and says, 'It's just mold, it doesn't matter,' " says John Pitt, a fungus specialist at Australia's Commonwealth Scientific and Industrial Research Organisation (CSIRO) in Sydney. But mold spoils some 10% of the world's annual harvests, he notes. And perhaps more significantly, fungal toxins in food "are certainly having a major impact on life spans in developing countries. It's an area which doesn't get anything like the publicity it should."

That is certainly not for lack of Pitt's efforts. He has focused virtually his entire 45-year career on understanding fungi and trying to reduce the losses they cause—and gained renown in the process.

Pitt graduated from high school at 16 in 1953 and immediately got a job with CSIRO's Division of Food Preservation and Transport. He got hooked on fungi at a time when what he calls the "fascinating" organisms, which can leave crops putrid and inedible, got little attention from agricultural experts. Eventually, his work determining which fungi infected which crops, their origins, and developing techniques to measure infection levels practically established a new field. In 1985, along with longtime CSIRO colleague Ailsa Hocking, he distilled his findings into a thick tome—*Fungi and Food Spoilage*—"that was a milestone" in food safety, says Antonio Logrieco, a mycotoxicologist at the Institute of Sciences of Food Production in Bari, Italy. The third edition appeared last August.



Fungi fighters' bible. Ailsa Hocking (*left*) and John Pitt co-wrote the standard reference book on fungi that spoil and contaminate food.

CREDITS: (TOP) PETER BROWN; (BOTTOM) CHRIS TAYLOR

Pitt has also helped raise the alarm about insidious health effects. Many fungi produce mycotoxins, poisonous chemicals that can accumulate in human tissues. The most dangerous is aflatoxin, which Pitt calls "by far the worst liver carcinogen known to man." Two fungus species produce aflatoxin in peanuts, maize, and cotton seeds if the crop is stressed by drought or stored improperly. In advanced countries, inspection and testing weeds out infected material. But subsistence farmers in developing nations often aren't aware of the threat. The result, Pitt says, is that the toxin is elevating rates of liver cancer and likely stunting childhood growth in Africa, Southeast Asia, and China. Aflatoxin "probably has a much bigger effect on human health than has ever been fully documented," Pitt says. He's now working with the World Health Organization's Foodborne Disease Burden Epidemiology Reference Group to quantify the toll.

Pitt is also studying a possible solution. It's based on the concept of "competitive exclusion," which involves introducing spores of a benign fungus into the soil in hopes it will outcompete and drive out the aflatoxin-producing strain. But these days, he's doing it on his own. As an Honorary Research Fellow at CSIRO he has lab space but no longer draws a salary; he even pays his own way to international meetings. It's expensive, but Pitt says he's still just trying to get fungi the attention they deserve.

–DENNIS NORMILE

Published by AAAS