THE CHRISTMAS INVASION

The cheerful leaves of the poinsettia could be hiding an unwelcome visitor this festive season. Rex Dalton goes in search of the whitefly, a potentially devastating pest.

For many Americans, the festive season is hardly seasonal without a centrepiece of poinsettias. But for some entomologists the annual flood of red foliage is not such a welcome sight. When Timothy Dennehy lifts up a potted plant in a store or a nursery to inspect it — as he will be doing more and more over the next couple of months — he's not admiring the shape or the colour with an eye to how it might look sitting in his home. He's looking for little greenish-white harbingers of agricultural chaos.

Every autumn, Dennehy, an entomologist at the University of Arizona, Tucson, hits the state's flower stalls searching for whitefly (*Bemisia tabaci*) on the poinsettias shipped in for the festive holidays. In December 2004, his horticultural gumshoe work paid off in a Tucson market with the first US identification of the whitefly variant in question — the pesticide-resistant Q-biotype¹. The following year, the Q-biotype was found in stores across Arizona, spurring a nationwide survey that found the superfly in 22 states.

In the 1990s, the B-biotype whitefly swept through North American crops, inflicting more than a billion dollars' worth of damage on farmers in the United States and Mexico; it had hitch-hiked from Israel to Florida to California, and from there it seems likely to have been spread nationwide via the imported poinsettias. Cotton crops were devastated, melons withered on stunted vines, lettuces wilted. US farmers scrambled for scientific assistance, successfully beating the pest with a new class of insect-growth regulators — such as buprofezin

and pyriproxyfen, which were rushed through the approval process — and other pest management measures.

Now the spreading of whitefly by poinsettia is at risk of repeating itself in an even more devastating way. The Q-biotype, originally observed in Spain in 1997 (ref. 2), "is resistant to every pesticide we've tested", says Dennehy, who co-chairs a scientific panel on the pest convened by the US Department of Agriculture (USDA)³. So far, the superfly has been found only in retail shops or nurseries. But the fear that it will one day find its way into the fields is growing. "It scares me to death; it is one pest that could completely bury us," says Larry Antilla, an entomologist with the Arizona Cotton Research and Protection Council in Phoenix.

Festive pests

America is not the only country concerned about whitefly. Some scientists rank it as one of the world's most destructive pests to crops. Robert Gilbertson, a plant pathologist from the University of California, Davis, says damage caused by whitefly makes it "the worst [agricultural pest] problem in regions of Africa, Asia and South America". The flies' increased resistance to pesticides and indifference to drought — many actually prefer things hot and dry — make them a grave threat to crops in parts of the developing world. Elsewhere, international trade has put tomatoes in Japan, cassava in Africa and soya beans in Australia at increased risk.

In the worst infestations, the flies can form visible clouds, coating windscreens and clogging the mouths and nostrils of field workers. Not only does the fly kill flowers, vegetables and cotton, it spreads viruses that are equally deadly in plants (see 'At the sharp end', overleaf). The high doses of pesticides used in attempts to control them can do more collateral damage to the insects that feed on whitefly — such as ladybirds — than to the whitefly themselves.

The best way for a country to fight the whitefly is to stop them entering in the first place. But with today's one-world agriculture, there are enormous economic and political pressures that can hamper effective inspection and regulation. In the United States, for instance, there has been a heated behind-the-scenes battle over the invasion of the Q-biotype.

The cotton industry, fearing for its fields, has fought for more aggressive control methods; the ornamental flower trade, dependent on imports that could be quarantined at borders, has opposed them. The former is a \$6-billion industry, the latter is worth \$19 billion. After Dennehy and his colleagues found the Q-biotype in Arizona — a state where the B-biotype cost cotton growers \$180 million in the first half of the 1990s — representatives of the flower industry fought against plans for a nationwide survey to check for the new variant.

Dennehy, who receives some funding from cotton growers, was displeased. As he wrote to the task force on the subject at the USDA:

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M. CASTILLO/AP

"Holding off on surveys is tantamount to promoting ignorance over enlightenment regarding the biotype issue." Meanwhile, Joe Chamberlin, a North Carolina-based entomologist representing ornamental flower growers, told the USDA task-force members that his clients were concerned that the survey's "primary purpose is not to help manage the whitefly, but instead to justify imposition of regulatory action and to generate research dollars or publications for university scientists". As in the B-biotype outbreak, there has been pressure from poinsettia growers to play down their product's links to the fly. Pressure from one flower grower led to a researcher at the University of California, Riverside, having to refer to "silverleaf whitefly" rather than "poinsettia whitefly" in public statements.

On the fly

Now a nationwide survey has been established, thanks in part to the diplomatic skills of Osama El-Lissy, an entomologist at the USDA's plant-inspection service in Riverdale, Maryland. "El-Lissy masterfully cajoled many key people," says Dennehy. For his part, El-Lissy stresses that the different affected industries — cotton, ornamental flowers and vegetables — "must work together to combat this pest." As a cautionary tale, he points to the spread of the B-biotype, introduced into Florida in 1986 (ref. 4). "Back then, it was a disaster," says El-Lissy, who was conducting research in Arizona at the time. "Why? Because the industries didn't work together."

The Arizona team's investigations suggest that the Q-biotype came into the country not through Florida but through California. Poinsettia cuttings taken in central America, mostly in Guatemala, Honduras and southern Mexico, are shipped north to be grown up into plants. The Q-biotype-infected poinsettias found in Arizona were traced to a grower near Salinas, California, then south to Ecke Ranch in Encinitas, California, which handles the cuttings for a massive 70% of the United States' seasonal poinsettias.

A family-owned operation run from an old, plantation-style California home, Ecke Ranch is spread over about two dozen hectares in foothills just inland from the Pacific, largely surrounded by newly built homes for San Diego commuters. To Paul Ecke, who has run the farm in recent years, worries about the Q-biotype are "overblown".

"These guys in Arizona went off the deep end, paranoid because of the cotton growers," says Ecke. To undertake a nationwide survey, Ecke says, "was a paranoid reaction that wasn't very effective". Ecke adds that integrated pest-management controls permitted his firm to

Plant watch: Timothy Dennehy scours poinsettias in Arizona for signs of whitefly (below) in a bid to arrest the spread of this highly destructive pest and so protect US crops.

ship poinsettia cuttings last spring into the United States "with zero whitefly problems", and that the clean-up operation after the Q-biotype was first reported at his Encinitas headquarters was successful. Although his company does not publish results of its internal tests in California or Central America, Ecke says he believes things are now under control. "The Q-biotype whitefly is a non-existent problem."

Farmers must hope he is right, as there are no restrictions on Ecke — or any plant grower from California to Florida — continuing to import plants from whitefly-affected regions, even those with the Q-biotype variant. The USDA takes no action to block the import or movement of plants infected with *B. tabaci* because it has determined that the insect meets the agency's standard for a pest that can't be

regulated — which is to say, one that can't be contained or eradicated. Other nations have taken a more proactive stance. In Australia, the authorities scrupulously watched for the B-biotype after it hit the United States, although it still sneaked into the country in 1994. Earlier this year, the European Union augmented its controls on whiteflies, which have been in effect since 1992. But some Mediterranean countries still have infestations.

US flower importers fear they will lose their crops if attempts are made to regulate whiteflies because of the Q-biotype. Because the genetic analysis needed to distinguish the Q from the B-biotype can take weeks⁵ — the two can't be distinguished visually, even under a microscope — individually packaged poinsettia cuttings being imported would die, because

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S. AUSMUS/USDA; A. & L. DETRICK/GRANTHELMAN PHOTOGRAPHY

AT THE SHARP END

Like a parent with a sick child, the rancher brought the stunted tomato plant to Jesús Méndez Lozano for help. "Why are my plants dying?" he asked.

With the equipment in his small lab, Méndez, who works for the National Polytechnic Institute in Guasave, Mexico, found that there was foreign DNA in the sick plant. This DNA had the same molecular weight as that of the dreaded tomato yellow leaf curl virus (TYLCV) — indigenous to Egypt⁶ and first found in the Western Hemisphere in 1994 in the Dominican Republic. Méndez sent the DNA to a larger lab for sequencing. Two weeks later, his fears were confirmed.

Thanks to the whitefly, a pest farmers on Mexico's Pacific coast have been struggling with for 15 years, TYLCV had been provided with a route up from Central America. Now it had invaded the largest winter tomato producing region in North America.

"I will never forget that day" last November, says Méndez. Neither will the ranchers of Sinaloa, the state in which Méndez is based and where the tomato is so important that its picture appears on vehicle number-plates.

Agricultural authorities estimate

Whitefly spread the dreaded tomato yellow leaf curl virus to Mexican plantations.

that last winter about 75% of the state's tomato crop was wiped out by the virus, with the effects getting worse as the season went on. Ranchers who had started off losing 30% of the first planting were losing 100% by the third. They didn't even try a fourth.

There is no cure for the virus, and the cost of pesticides to kill the whitefly — the B-biotype, in this case — is too much for many small farmers. Last winter's economic damage was so severe, a drive through the state shows ranchers often can't afford to plough over old plants or weeds, a failing that allows the virus and its whitefly host to get better established. In 2006, as part of an integrated management plan, the summer

planting season for soya beans in Sinaloa was largely halted, thereby denying the whiteflies sustenance. In 2005, federal subsidies for soya beans — provided despite the objections from tomato ranchers — is thought to have worsened the effects of the tomato virus.

To know how to treat this sort of viral infection, a farmer

has to distinguish between different types of gemini virus — the family to which TYLCV belongs⁷. Méndez's lab at Guasave, a prosperous community on Mexico's main north-south highway, is an example of how the necessary expertise can be provided. In the five years since he and his researcher wife Norma Leyva Lopez arrived, they have upgraded the facility to offer the most advanced analysis, such as DNA amplification while-you-wait.

Realizing the importance of such knowledge, nearly 500 ranchers and businessmen came to a scientific conference on the control of whitefly and viruses that was held in late August in

the nearby city of Mazatlan.

"Ranchers will come in with a scientific article and ask: 'Can you do this?'" says Méndez, who did postdoctoral studies at the Scripps Research Institute in La Jolla, California. "I say, 'Yes. But we need more facilities.'" To this end, Méndez is building support for a new agricultural biotechnology lab.

South America, Africa and Asia all face similar challenges as they seek to offer on a worldwide basis niche crops that will bring high prices when they are not available from traditional growing regions. Stations such as Méndez's are the outposts with which scientists from developed regions must work to defeat invasive pests.

One reason for such collaboration is that the pests, while limited by available food and climate, do not respect national borders. TYLCV has recently been identified in tomatoes in southern Texas, says Robert Gilbertson, a plant pathologist at the University of California, Davis. "I don't mean to be Chicken Little and say the sky is falling, but we are getting worried," he says. "There are no US controls on plant movements. It takes only one tomato transplant to get the virus started." **R.D.**

they need water and nourishment that couldn't readily be provided for quarantined products.

Under the strain

Meanwhile, the B-biotype still presents problems of its own. Lance Osborne, an entomologist at the University of Florida's research facility in Apopka and Dennehy's co-chair on the USDA science panel, points out that it is widespread in crops in the southeast, from cotton in Georgia to ornamental flowers and vegetables in Florida. It takes just two or three B-biotype whiteflies to do their damage to a plant, sucking out sap and leaving leaves with silver-coloured sooty mould; the Q-biotype seems to require hundreds of flies to do equivalent damage, Osborne says.

Osborne's worry is that farmers could promote resistance in the B-biotype by using more pesticides — as they may well do if the Q-biotype gets into fields. "I'm very concerned the B-biotype will become pesticide resistant," he says. "The B-biotype fly lays more eggs than the Q; it

could be more of a superfly than the Q-biotype." To avoid over-reliance on pesticides, Osborne and other scientists champion integrated pest-management programmes. Along with distinct applications of the pesticides, these also involve denying the flies food by not planting some crops in hot weather, and devoting significant amounts of land to crops the flies won't infect — they love melons, peppers and leafy vegetables, but not alfalfa, wheat or corn.

But these courses can cause economic strain. In the Mexican state of Sonora, where the Yaqui River Valley has produced bumper grain crops, farmers have largely halted the planting of soya beans that mature in late summer. With fields fallow, revenue and jobs disappear. Without summer crops with labour-intensive harvests, many of the poorest Mexicans lost their jobs, transforming rural cultures as people moved to cities looking for work. In lower Sonora alone, agricultural economists estimate the losses from not planting their 70,000 hectares of summer soya beans at about \$75 million.

Now entomologists are looking at the possible responses to the pesticide-resistant Q-biotype, such as management schemes that make use of new members of the neonicotinoid family of pesticides. Far better, though, if the whitefly could indeed be kept out in the first place, however pretty its Trojan horses.

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