Medfly and other fruit flies entrenched in California, study concludes

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A female Mediterranean fruit-fly (Ceratitis capitata). Credit: Alvesgaspar / Wikipedia.

Research to be published Aug. 7 in the highly respected international journal *Proceedings of the Royal Society B* clearly demonstrates that at least five and as many as nine species of tropical fruit flies, including the

infamous Medfly, are permanently established in California and inexorably spreading, despite more than 30 years of intervention and nearly 300 state-sponsored eradication programs aimed at the flies.

The new study by a trio of scientists affiliated with the University of California, Davis, has significant implications for how government agencies develop policies to successfully manage pests that pose a threat to California's $43.5 billion agricultural industry.

"Despite due diligence, quick responses, and massive expenditures to prevent entry and establishment of these insects, virtually all of the fruit-fly species targeted by eradication projects have been reappearing in the same locations—several of them annually—and gradually spreading in the state," said UC Davis entomology professor James Carey, an international authority on fruit-fly invasion biology and co-author of the study, which examined more than 60 years of state fruit-fly capture data.

"Regulatory policies as well as pest management and agricultural practices need to be revised to reflect the reality that these insects are here to stay. We need to develop long-term strategies to deal with these pests that are effective, safe for public and environmental health, and minimally burdensome to growers," Carey said. "Fortunately, the multiple small populations of fruit flies in the state and the long lag times in the growth of these populations will give policymakers and planners time to develop a robust, science-based response."

"This work is the most comprehensive analysis of populations of tropical fruit flies in California to date, and in any region worldwide," said insect population biologist George Roderick, the William Muriece Hoskins professor and chair of the Division of Organisms and Environment at UC Berkeley and an expert on biological invasions who is not affiliated with the new study.

"The strength of the study lies in the use of multiple lines of evidence—population modeling, molecular genetics, ecological trapping, border control/airport detections—and that it studies the same phenomenon in 17 species," Roderick said.

"The study has dramatic implications for California agriculture and the state's international trading partners, and speaks to the urgent need to alter current eradication policies aimed at invasive species," said horticultural entomologist Michael Parrella, professor and chair of the UC Davis Department of Entomology and Nematology.

Frank Zalom, incoming president of the Entomological Society of America and a UC Davis entomology professor, said the new study provides a "careful and systematic analysis of fruit-fly finds and presents a compelling argument that these detections represent continued reoccurrences of resident populations rather than re-invasions of California."

"This study deserves serious consideration, and I hope that it helps lead to new discussions on a long-term approach for dealing with fruit flies and similar exotic pests by the United States and international regulatory authorities," said Zalom, who is an expert on integrated pest management.

Carey notes that other U.S. states and European nations with conditions equally hospitable to fruit flies, as well as similar patterns of international travel and detections of fruit flies in cargo at ports of entry, do not have established fruit-fly populations.

"This combination of findings definitively rebuts the hypothesis that the multiple detections of many species of fruit flies in California each year are the result of repeated new introductions," he said. "What we are detecting here are low-level, established populations."

Carey collaborated with lead study author Nikos Papadopoulos, an entomologist at the University of Thessaly, Greece, and Richard Plant, a UC Davis professor emeritus of plant sciences and biological and agricultural engineering. Papadopoulos, the study's lead author and an internationally renowned expert on fruit-fly demography and invasion biology, was formerly a postdoctoral fellow and visiting scholar at UC Davis.

"These findings may have wider implications regarding management of fruit-fly invasions that may go well beyond California," Papadopoulos said. "This unique dataset can provide many fundamental answers regarding many aspects of invasion biology and related global policy."

"We're very confident that our results indicate that at least five and possibly several more fruit-fly species are established in California," said Plant, who provided mathematical modeling and statistical analysis for the study.

The researchers applied computerized data-mapping technology to analyze historical fruit-fly detection data. Using this analysis, they determined that besides the olive fly, which is confirmed as established, the Mediterranean, Mexican, oriental, melon, peach and guava fruit flies are now also established in California.

Fruit-fly history in California

Tropical fruit flies have been a concern to California for nearly 60 years, with the first fruit fly discovered here in 1954. Since then, 11,386 individual flies, including adults and larvae representing 17 different fruit-fly species, have been detected in nearly all regions of the state.

Both adult and larval fruit flies pose a threat, with the larvae (maggots) actually burrowing into and damaging a wide range of fruits and

vegetables.

Because of the state's geographic location and climate, California is considered particularly vulnerable to introduction and establishment of tropical fruit-fly populations. The pests were thought to be arriving either on cargo shipments or on infested fruits carried in by travelers from regions of the world where fruit flies were native or had become established.

State and federal agencies have for many years coordinated efforts to prevent the invasive fruit flies from establishing breeding populations in California and other vulnerable states. Such activities include restricting commodity imports from regions with ongoing fruit-fly outbreaks, requiring post-harvest treatments for produce grown in areas with established fruit-fly populations, maintaining large-scale fruit-fly monitoring programs for early detection, and release of sterile fruit flies to slow or prevent reproduction of the invasive flies.

The potential costs associated with established fruit-fly populations are substantial. For example, a 1995 study estimated that a confirmed Medfly establishment alone in California would result in $493 million to $875 million in annual direct costs, and the imposition of a related embargo on shipping fruits and vegetables from the state would cause an additional loss of $564 million. The state economy could lose $1.2 billion in gross revenue and more than 14,000 jobs, the earlier study suggested.

New study findings

In the new published study, the researchers report that several lines of evidence now indicate that the fruit flies have become self-sustaining and thus established in California, including:

- abrupt initial appearance of fruit flies in the mid-1950s, followed by many repeat detections;
- seasonality of fruit-fly appearances;
- northward spread of fruit-fly detections in the state;
- lack of new detections or introductions of fruit-fly species in most other at-risk regions of the United States and the Mediterranean; and
- multiple detections of several fruit-fly species in nearly the same California locations 20 to 50 years after they were first detected.

"Collectively, the data suggest that, much like other invasive species, tropical fruit flies can be present in low numbers for decades," Carey said. "This 'lag time,' which is such a hallmark of invasion biology, explains why California can be harboring very small, established populations of these pests with only periodic captures that reveal their presence."

He noted that two aspects of the fruit-fly invasions are advantageous for policymakers and planners: all detected fruit-fly species are extremely small and may continue to exist for years below detectable levels, and the fairly long lag times provide opportunities for developing new management protocols and programs.

Suggested response

Carey said that an immediate assessment should be made of the economic impact of having each species established in the state, projecting the individual and collective effects of the fruit flies for all affected California fruit and vegetable crops.

He also suggests that government agencies might increase fruit-fly monitoring, particularly in the Central Valley and California's other agriculturally important areas; make contingency plans for future

outbreaks; establish "fruit-fly-free" zones in the state to assure trading partners; and enable farmers to purchase crop insurance that would provide protection against losses due to fruit-fly crop damage or marketing restrictions.

In addition, California farmers and packers should consider the presence of established fruit-fly populations when developing their cropping plans and production strategies, he said.

In the scientific arena, Carey recommends that genetic analyses be developed for all of the fruit-fly species identified in the state, to determine whether single or multiple invasions of each species are occurring and identify new strains that might be introduced in the future.

Invasion biology expert Roderick from UC Berkeley projects that the new study will have a sustaining impact on both science and policy.

"I predict this paper will be remembered as much for its future impact on how science is used in developing strategies for pest management worldwide as for the conclusions it draws about the state of tropical fruit-fly populations in California," he said.

More information: From trickle to flood: The large-scale, cryptic invasion of California, rspb.royalsocietypublishing.or … .1098/rspb.2013.1466

Provided by UC Davis

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