Advances in genetic, geospatial techniques aid efforts to fend off invasive insects

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The Mediterranean fruit fly (Ceratitis capitata, adult shown at left) and gypsy moth (Lymantria dispar, larva shown at right) are two invasive species among many for which new advances in genetic techniques and geospatial analysis are driving invasive-species management. Two new special collections in the Annals of the Entomological Society of America, published in a partnership between ESA and the National Invasive Species Council, feature more than a dozen research articles showcasing both cutting-edge technologies and practical implications for management of invasive insects and arthropods. Credit: Fruit fly: USDA ARS Photo Unit, USDA Agricultural Research Service, Bugwood.org. Gypsy moth: Karla Salp, Washington State Department of Agriculture, Bugwood.org.

In the fight to protect native ecosystems from invasive insects and related arthropod species, promising new tools are arising from rapid advances on a pair of research fronts: genetic analysis and geospatial technology.

At ports of entry in the United States, for instance, fruit flies hitchhiking in cargo can now be identified to species with DNA barcoding. And fine-scale environmental data combined with knowledge of insect lifecycles is putting simple maps that forecast pest emergence in the hands of forest managers across the country. These examples and more are showcased in a pair of new special collections in the *Annals of the Entomological Society of America*, published in a partnership between ESA and the National Invasive Species Council (NISC).

"We sought papers that exemplified both cutting-edge technologies and practical implications for improved management," says Stanley Burgiel, Ph.D., NISC executive director. "New and innovative solutions are needed to address the continued and growing challenges posed by invasive species."

The first of the two collections, "Geospatial Analysis of Invasive Insects," was published February 11, with seven articles showcasing applications of geographic tools for modeling movements and potential ranges of invasive insects such as wood-boring beetles, aphids, gypsy moth (*Lymantria dispar*), and the Mediterranean fruit fly (*Ceratitis capitata*). Included is a profile of the success of the USA National Phenology Network's "Pheno Forecasts" mapping tool, the result of "advanced work being done in a collaborative fashion across multiple federal agencies and academia," says Jeffrey Morisette, Ph.D., chief scientist at NISC and co-editor of the geospatial analysis collection with Kevin Macaluso, Ph.D., chair of the Department of Microbiology &

Immunology at the University of South Alabama.

"The paper also describes a consultative mode of engagement as a way to continuously improve these products so that they are more useful for the forest pest management community," says Morisette. "Both the incorporation of insect phenology for predictions and the consultative engagement provide insight on forest pest management strategies." (Also see "USA National Phenology Network Aids Management of Pest Insects With Life-Stage Forecast Maps" on ESA's *Entomology Today* blog.)

The second collection, "Advanced Genetic Analysis of Invasive Arthropods," is published today, with nine articles detailing new genetic techniques for detecting and tracking invasive species such as apple maggot fly (*Rhagoletis pomonella*), cattle fever tick (*Rhipicephalus microplus*), coconut rhinoceros beetle (*Oryctes rhinoceros*), and crazy ants (*Nylanderia* spp.). One article reports on research showing the potential for DNA testing using high-throughput sequencing to allow faster and more cost-effective species identification of fruit fly samples intercepted during baggage inspections at various airports and border crossings.

"Because fruit flies are often detected at an immature larval stage, identification can be extremely challenging," Burgiel says. "This work suggests that these technologies could be an important tool to support species-level identification from high-volume occurrences of visually ambiguous collections at points of entry."

Burgiel served as co-editor for the genetic analysis collection with Keith Gaddis, Ph.D., deputy program scientist for the Biological Diversity and Ecological Forecasting programs at NASA. "Genetic tools have streamlined the ability to detect invasive species presence across multiple possible sources, where we previously required months of

investigation to detect presence in a single sample," Gaddis says. "Using genetic tools, even a microscopic fragment of tissue from an invasive species can be used to identify the presence of that species."

Gaddis notes that scientists are only scratching the surface of what genetic and geospatial techniques may allow in the effort to fend off invasive arthropods. "This as a unique time where genetic and Earth observation data are advancing at an extremely rapid pace," he says. "These advances have made analyses that were feasibly or financially impossible a decade ago accessible to an increasingly broad scientific and societal audience."

Calling attention to these advances is exactly what brought NISC and ESA together to publish these research collections. "We hope that the collections enable greater adoption of these tools for better detection and more informed response actions by those working to prevent, eradicate, and control invasive species," Burgiel says. "At the same time, we hope the research community continues to build on these methodologies for more sophisticated, accurate, and easier methods."

More information: Jeffrey T Morisette et al. Overview of a Special Issue on Geospatial Analysis of Invasive Arthropod Alien Species, *Annals of the Entomological Society of America* (2020). DOI: 10.1093/aesa/saaa002

Jeffrey T Morisette et al. Overview of a Special Issue on Advanced Genetic Analysis of Invasive Arthropod Species, *Annals of the Entomological Society of America* (2020). DOI: 10.1093/aesa/saaa005

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