

Every time the small cabbage white butterfly flaps its wings it has us to thank

11 September 2019, by Patricia McDaniels



The geographic range and genetic diversity of the small cabbage white butterfly is detailed in a new study co-authored by Sean Ryan, formerly of the UT Department of Entomology and Plant Pathology within the UT Institute of Agriculture. Ryan worked under the supervision of DeWayne Shoemaker, professor and head of the UT Department of Entomology and Plant Pathology, who is also an author on the paper. Credit: Lauren Nichols, Department of Applied Ecology, North Carolina State University. Used by permission.

The caterpillar form of an unassuming, small, white butterfly is among the world's most invasive pests affecting agricultural crops, and a newly published paper by a consortium of scientists documents how humans have helped it spread for thousands of years.

Through close examination of genetic variation and similarities between existing populations, and comparisons of historical data regarding infestations of *Pieris rapae* in Brassicaceae crops—like cabbage, canola, bok choy and turnips—the researchers document how humans helped the small cabbage white butterfly spread from Europe across the world. Led by Sean Ryan, formerly a postdoctoral researcher in the Department of Entomology and Plant Pathology at the University of Tennessee Institute of Agriculture,

the team of scientists from eight institutions partnered with more than 150 volunteer citizen scientists from 32 countries to detail the pest's range and current genetic diversity.

Published online on September 10, 2019, in the *Proceedings of the National Academy of Sciences (PNAS)*, the paper correlates the pest's invasive spread across the world through human travel and trade beginning with the overland ancient Silk Road routes from Europe to Asia, followed by the tall ships that traveled the more modern Silk Trade Routes, to the "iron horses" that traversed North America beginning in the second half of the 19th century.

"The success of the small cabbage white butterfly is the consequences of human activities. Through trade and migration humans helped to inadvertently spread the pest beyond its natural range, and through the domestication and diversification of mustard crops, like cabbage, kale and broccoli, humans provided it with the food its caterpillars would need to flourish," says Ryan.

Prior to the study, historical records provided some indication of when this agricultural pest arrived in each new continent it invaded. However, the timing, sources, and routes remained unsolved. What's more, such detailed knowledge is crucial in developing an effective biological control program as well as for answering basic questions associated with the invasion process, such as genetic changes and how species adapt to new environments.



An unassuming, small, white butterfly is among the world's most invasive pests affecting crops like cabbage, kale and broccoli. A newly published study in the Proceedings of the National Academy of Sciences (PNAS) documents how humans have helped *Pieris rapae*, the small cabbage white butterfly, spread across the globe for thousands of years. Credit: Lauren Nichols, Department of Applied Ecology, North Carolina State University. Used by permission.

The research team took to [social media](#) to ask the public for help. The approach was similar to how researchers have been expanding our understanding of human ancestry through in-home DNA sampling kits. Instead of asking people to swab their cheek, the butterfly research team asked citizen scientists to grab a butterfly net, then catch and send small cabbage white [butterflies](#) to the team for genetic testing. Ryan, currently with Exponent, Inc., in Menlo Park, California, then used the DNA from the submitted specimens to analyze genetic data and determine how the small cabbage white spread across the world. More than 3,000 butterflies were submitted. The samples cover nearly the entire native and invaded ranges of the butterfly and comprise 293 localities.

The researchers found that the small cabbage white butterfly likely originated in eastern Europe and then spread into Asia and Siberia when trade was increasing along the Silk Road. The researchers also found that, as expected, Europe was responsible for the introduction of the small cabbage white to North America. Surprisingly, the introduction into New Zealand came from San Francisco, California. Also, the butterflies living in

central California and the surrounding area are genetically distinct from all other butterflies in North America and appear to be the consequence of a few butterflies hitching a train ride from the eastern U.S. to San Francisco. Although each invasion into a new area or country led to significant loss of genetic diversity, the invasions were successful, hence the abundance of small cabbage white butterflies today.

Citizen science—research in which members of the public play a role in project development, data collection or discovery—is subject to the same system of peer review as conventional science. Its power lies in its ability to help conventional studies overcome challenges involving large spatial and temporal scales. Social media and the internet are key tools that allow citizen scientists, who are often share similar interests through memberships in nature-based groups or professional societies, enhance the scale and scope of a particular project and its impact on society.

"Citizen science projects have been growing exponentially over the last decade, opening doors to new scientific frontiers and expanding the limits of what was once feasible," says DeWayne Shoemaker, professor and head of the UT Department of Entomology and Plant Pathology, and one of the paper's co-authors. "The relatively unique approach we took was asking the public to help collect—not just observe—these agricultural pests, and in so doing we were able to extract information recorded within the DNA of each individual butterfly. That information, when aggregated, told a story about the collective past of the small cabbage white butterfly."

"The international success of our citizen science project—the *Pieris* Project—demonstrates the power of the public to aid scientists in collection-based research addressing important questions in invasion biology, and ecology and evolutionary biology more broadly," says Ryan. He believes the use of collection-based citizen science projects will help society more accurately document ecological and evolutionary changes, which can lead to improvements in crop management and success as well as better environmental controls for invasive species.

More information: Sean F. Ryan et al. Global invasion history of the agricultural pest butterfly *Pieris rapae* revealed with genomics and citizen science, *Proceedings of the National Academy of Sciences* (2019). DOI: [10.1073/pnas.1907492116](https://doi.org/10.1073/pnas.1907492116)

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