

TURNING TO DARWIN: THE MYSTERY OF INVASIVE SPECIES

An invasive ice plant growing on and killing a native Coprosma shrub on the coast of New Zealand. Credit Jason Fridley

Invasive species are both a fact of life and a scientific puzzle. Humans transport animals and plants thousands of miles from where they first evolved — sometimes accidentally, sometimes intentionally. Many of those species die off in their new homes. Some barely eke out an existence.

But some become ecological nightmares. In the US Northeast, emerald ash borers are destroying ash trees, while Japanese barberry is blanketing forest floors, outcompeting native plants. Scientists aren't certain why species like these are proving superior so far from home.

“If natives are adapted to their environment and exotics are from somewhere else, why are they able to invade?” asked Dov F. Sax, an ecologist at Brown University.

A big part of the answer may be found in the habitats in which invasive species evolve. Many alien species in the northeastern United States, including the emerald ash borer and Japanese barberry, invaded from East Asia. But the opposite is not true. Few species from the northeastern United States have become problems in East Asia.

In a new study published in the journal **Global Ecology and Biogeography**, Dr. Sax and Jason D. Fridley, a biologist at Syracuse University, argue that this is not a



coincidence. They offer evidence that some parts of the world have been evolutionary incubators, producing superior competitors primed to thrive in other environments.

“I don’t believe that all species are created equally,” said Dr. Sax.

Until recently, ecologists trying to solve the mystery of invasive species paid relatively little attention to their origins, focusing instead on factors that might be helping them in their new homes. The invaders, for example, may benefit from leaving behind their enemies: without the parasites and predators adapted to killing them, they’re free to multiply with abandon.

Or a newly arrived species may thrive because humans have made the new ecosystems vulnerable to invasion. Cutting a forest into fragments or loading a lake with fertilizer tears apart the ecological web, making it easier for new species to slip into the gaps.

But as far back as the 19th century, some scientists saw a role for evolution. In “The Origin of Species,” Charles Darwin wrote that we shouldn’t be surprised by native species “being beaten and supplanted by the naturalised productions from another land.”

Darwin reasoned that these victories were inevitable. Different species might adapt to a particular ecological niche in different parts of the world. Put them in the same place, in the same niche, and one might well outcompete the other because it has evolved superior attributes.

Before Dr. Fridley and Dr. Sax met in 2007, each had become convinced that Darwin might be right. When they discovered they shared the same belief, they joined forces to test Darwin’s idea. Their approach was two-pronged.

First, they looked at the places where invasive plant species tend to originate, examining the number of plant families in various regions. Invasive plants, they found, were more likely to have evolved in habitats with a great diversity of competing species. Darwin was right: Some plants have evolved to be fighters.

“We were both kind of gobsmacked,” said Dr. Fridley.

In the second test, Dr. Fridley and Dr. Sax looked at the role that canals have played in helping some species become invasive. Sometimes, humans have dug canals that linked ecosystems with an equal diversity of species. But in other instances, canals have connected regions with low diversity to those with great variety of species.

The scientists predicted that invasive fish and mollusks would tend to come from places with high diversity and would have used canals to establish themselves in habitats with low diversity.



“It’s not a perfect experiment,” said Dr. Sax. “But it’s still a pretty good unplanned experiment.”

In 1825, the Erie Canal joined the Great Lakes to the Hudson River. The two ecosystems originally had about the same diversity of fish and mollusk species, the ecologists found, and species from each side became invasive on the opposite side in roughly the same proportions.

The story of the Suez Canal was very different. On one side was the Red Sea and the Indian Ocean, a huge, stable ecosystem with a deep diversity of fish and mollusks. On the other side was the Mediterranean, a relatively young habitat without nearly as much species diversity.

Dr. Fridley and Dr. Sax found the Mediterranean was overwhelmed with invasive species from the other side of the canal, while hardly any from the Mediterranean took up residence in the Red Sea.

Dr. Fridley speculated that a similar imbalance could explain why the Northeast gets so many invasive species from East Asia. Today both regions have a similar climate. But the United States was buried by glaciers during the Ice Ages, while East Asia was spared. Its species continued to grow more diverse, to evolve and eventually to become superior competitors — ready to invade, once humans started acting as their chauffeurs.

Jay Stachowicz, an ecologist at the University of California, Davis, who was not involved in the study, praised the researchers for finding a way to investigate Darwin’s idea. “They’re probably the first to test it in a meaningful way,” he said.

David Tilman, an ecologist the University of Minnesota, called the study “a wonderful extension of Darwin’s hypothesis.” But he cautioned that the work raises a paradox. While predators and pathogens can wipe out native species, it’s rare for an invasive competitor to do so.

“The most common outcome is coexistence,” said Dr. Tilman. The new hypothesis doesn’t explain why.

The evolutionary imbalance hypothesis, as Dr. Sax and Dr. Fridley call their hypothesis, could have a grim implication for conservation biologists trying to preserve native species: They may be fighting millions of years of evolution.

“If that’s true, the phrase, ‘Resistance is futile’ comes to mind,” said Dr. Stachowicz.

CARL ZIMMER
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