

## **Out of Eden: An Odyssey of Ecological Invasion**

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**Out of Eden: An Odyssey of Ecological Invasion.** Alan Burdick, Farrar, Straus, and Giroux, New York. 324 pp. ISBN 978-0-37421-973-4. US \$24.00 (cloth cover).

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*Review by Thierry Work*

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Picture this: You are stationed on a military base somewhere in a Western Pacific island. It is early morning, and you are awakened by the baby screaming. You grudgingly stumble to the restroom, and as you settle in to heed nature's call, you feel a large snake slithering between your feet. You leap up in alarm and flip on the lights, but as luck would have it, electric power to the entire city is out because a snake shorted out the transformers at the local power plant. You go to the baby's room to see what the howling is all about, and to your horror the light of early dawn reveals a four-foot snake wrapped around your child's arm. The animal is in the process of ingesting the baby's thumb. After your tour of duty ends, you eventually relocate to Texas, and your personal effects arrive by ship after five months in transit. As the family unpacks the cargo, your wife belts out a shriek. You run across the room to witness, at the bottom of a crate, a live snake that hitched a ride from the island in your personal effects.

This unfortunate series of events, albeit compressed for dramatic effect, are all true incidents—the type of incidents that the residents of Guam, a U.S. territory in the Pacific and the southernmost island of the Marianas, have had to endure since the mid 1980s, when the brown tree snake, *Boiga irregularis*, made its presence widely known there through those events described in the first paragraph, some of which are included in *Out of Eden: An Odyssey of Ecological Invasion*. Alan Burdick explains that the brown tree snake most likely arrived in Guam from the Solomon Islands via military materiel at the end of World War II, during massive demobilization efforts that followed the surrender of Japan in 1945. Once in Guam, *B. irregularis* basically went amok and consumed the entire native avifauna of the island, so that by the 1990s only *two species* of native birds remained. Guam now hosts a density of several hundred snakes per square kilometer; its forests have been decimated of native birds, and conservation scientists there have been reduced to maintaining the Guam rail in cages

ad infinitum and wrapping tree trunks with electrical wire to save the last remaining nests of the native Mariana crow.

The saga of the brown tree snake—an extreme example of the ravages an invasive animal can impose on a naïve ecosystem—is how Burdick introduces us to a sweeping overview of invasive species ecology. The list of invasive species across the globe is overwhelming: varroa mites in honey bees, West Nile virus in North America, the large-leafed tree *Miconia* in Tahiti, and fire ants in Texas are just a few examples. Condensing a topic that has had gallons of ink expressed onto reams of paper in the form of thousands of scholarly articles, books, and journals into a volume of 324 pages would seem a daunting task; however, Burdick successfully manages to introduce the reader to the salient issues that surround the scientific and societal implications of invasive species by carefully presenting a few examples from both the terrestrial and marine realms. In doing so, he illustrates the current state of knowledge in this rapidly evolving discipline.

We begin our journey by meeting the scientists on the frontlines of brown tree snake research efforts in Guam, where they are working feverishly to not only to understand the biology of *B. irregularis* but also to devise myriad ways of trapping the snake, detecting it, and preventing its movement out of Guam to Hawaii. The singular success of the brown tree snake in Guam is attributed to its catholic feeding habits and the biomass of introduced skinks and lizards that have supported snake populations in spite of the decline and extirpation of its primary food source, native birds. By relating this web of factors, Burdick introduces the reader to the concept of invasive species abetting more invasive species. He also introduces us to biologists from several of the numerous agencies involved in efforts to interdict movement of this displaced snake. We meet biologists from USDA wildlife services who are tasked with managing dogs that detect snakes in military cargo and who have the onerous task of patrolling fence lines that isolate outbound cargos from snakes in the surrounding forests. We learn about extensive experiments to design exclusion barriers for the brown tree snake—not an easy task for an animal that can climb smooth surfaces along the smallest of hairline cracks. One inevitably senses that in spite of all these efforts, the snake will eventually make it to other Pacific islands.

Although the brown tree snake is an extreme example of ecological devastation that can be unambiguously attributed to one invasive creature, measuring the actual impact of invasive species is generally more complicated, as Burdick makes clear. (Technically, all organisms, particularly in island ecosystems, are invasive whether they arrive by natural means or by the help of humans with planes and ships.) However, Burdick points out that the fundamental problem is not so much biological invasion, but the rate of invasion, which has dramatically increased as humans introduce animals either intentionally, for a perceived benefit, or inadvertently, through their peripatetic activities. The author offers the example of the “acclimatization societies,” whose sole mission was to import animals and plants from one region to another so that newcomers could feel more at home in their newly adopted land. The English Sparrow was introduced into the United States by such means. In Hawaii, a local acclimatization society was responsible for releasing hundreds of nonnative birds into the islands, and good evidence exists that some of these birds probably introduced avian malaria, which routinely causes epizootics in native Hawaiian Honeycreepers.

Once established, invasive species are difficult to eradicate, and determining what to do about them is complicated by our uncertainty as to their effects on the ecosystem and our conflicting social imperatives. It does not help that what exactly makes one particular organism more invasive than another is still under discussion in the scientific community. Burdick points out that for many years, the dogma was that ecosystems developed into a stable state in which animals and plants filled all available niches. The thinking was that ecosystems that were “stable” were less susceptible to invasive species. However, Burdick describes elegant manipulative experiments using mites and oranges and microcosms showing that propagule pressure (how much and how often something is introduced) seems to be the more important determinant of successful establishment of invaders into new ecosystem. There is also a somewhat religious belief among some members of the conservation biology community that all invasive species are, by definition, a bad thing. Yet, the situation is not always that clear, and this can complicate management. For example, in Hawaii, feral pigs are blamed for the spread of alien weeds and destruction of habitat, and conservation agencies have fenced off areas of public land often to the outrage of local communities who strongly believe that having access to wild pig hunting is a cultural right.

Resolving these issues is not simplified by the fact that data on the effect of wild pigs in ecosystems are often not clear cut; there is ongoing debate even within the scientific community about exactly how detrimental are wild pigs to native ecosystems.

If the situation in terrestrial ecosystems is murky, Burdick, in the last portion of the book, reveals that for marine ecosystems the situation is a veritable bog. Unlike in terrestrial systems, in which there may be a traceable history of what constituted the more “pristine state,” virtually nothing is known about marine systems. Burdick introduces us to marine biologist Jim Carlton, who has studied invasions in marine ecosystems for more than 20 yr and reckons that many marine organisms that have historically been considered natives are actual introductions from abroad. How, then, do we deal with restoration of marine ecosystems when one has no real idea of the state before the advent of humans? Carlton speaks about the movement of fouling organisms that must have occurred regularly since humans started sailing to far-flung parts of the world and in the subsequent establishment of global commerce. Carlton reasons that at least 1,000 organisms in San Francisco Bay, California, USA, that have been considered native are actual introductions from elsewhere and has termed these cryptogenic species. *Out of Eden* also touches upon the European green crab, a voracious crustacean that has now been found in places as far flung as the United States and Tasmania.

Burdick points out that ballast water from ships have carried and disseminated aquatic plagues like zebra mussels, which are responsible for the extirpation of native mollusks in the Great Lakes, eastern North America, and which impose huge economic burdens by fouling power plant intakes, mooring buoys, and ship hulls. Addressing sociopolitical responses to the zebra mussel problem, the author offers a note of encouragement, noting that the movement of invasive marine species via ballast water has caught the attention of politicians and prompted regulation of ballast-water discharge in harbors. In keeping with the book's resistance to simplification of issues, Burdick allows that, for the shipping industry, developing mechanisms that allow for economical and safe exchange of ballast water poses significant challenges. He also introduces the reader to scientists working with the shipping industry to develop methods to mitigate the impact of ballast water in the spread of marine invasives. In the epilogue of the book, Burdick points out that our ability to move creatures far and wide extends to

sending organisms out into space via satellites (in spite of heroic efforts by satellite manufacturers to maintain clean assembly plants).

Given this overwhelming global onslaught of biological invaders, the reader may be left wondering what society and science can realistically do to address the situation. Economic imperatives and the movement of humanity dictate that invaders are here to stay. *Out of Eden* is an engrossing, thought-provoking narrative that may help society better determine the value it places on maintaining endemic diversity. When that decision is made, it will be up to scientists to figure out how to achieve the goals set. Although this book emphasizes mainly invasive

animals, plants, and marine organisms, the lessons are clearly applicable to invasive pathogens as well. A quick Google Scholar search of invasive animals (371,000 hits at this writing), plants (130,000 hits), and pathogens (73,000 hits) indicates that relatively little is known about the latter. Burdick's book provides important insight in to the general biology of invasive organisms that could just as easily be applied to invasive wildlife diseases. For that alone, it is worth reading.

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