"Italian Immigrants" Flourish on Long Island

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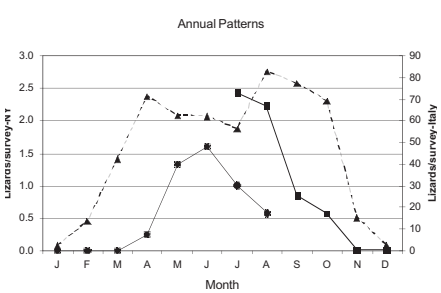
Italians have made many important contributions to the culture and accomplishments of the United States, and some of these are not generally appreciated. Two of the more underappreciated contributions are the Italian wall lizards, *Podarcis sicula* and *Podarcis muralis*. In the 1960s and 1970s, Italian wall lizards were imported to the United States in large numbers for the pet trade. These hardy, colorful little lizards are common in their home country, and are easily captured in large numbers. Enterprising animal dealers bought them at a cut rate in Italy and sold them to pet dealers all over the United States. Not all of these lizards made it to home terrariums, however — in at least four cities in North America, lizards escaped and survived in suburban neighborhoods. One of these populations began in Garden City, just a few miles west of Hofstra University. This population has spread in all directions, and recently the Italian lizards have been seen on the Hofstra campus.

The scientific community's view of the release (deliberate or accidental) of animals and plants into new places has changed over the years. In the past, amateur and professional scientists often actively promoted the introduction of foreign species into new habitats. For example, professional wildlife biologists brought ringneck pheasants (*Phasianus colchicus*) to North America for sport hunting, and pheasants have survived so well (for example, on Hofstra's North Campus) that many people are unaware that the species originated in China. Of course most of our common agricultural species — except for corn, pumpkins, and some beans — are non-native. The two most common bird species in the United States — starlings (*Sturnus vulgaris*) and English sparrows (*Passer domesticus*) — were both introduced here from Europe. Starlings got their beginning in Central Park in 1890, when someone decided that New York should be home to all the bird species mentioned by Shakespeare. Also in the late 1800s naturalists introduced the small Indian mongoose (*Herpestes javanicus*) to the islands of Mauritius, Fiji, Hawai'i, and much of the West Indies, supposedly to control the rat population. Rats were crop pests, and in most cases the rats were introduced from Europe. Instead of eating lots of rats, the mongooses ate numerous native animals, endangering many species and causing plenty of extinctions. They also became carriers of rabies. There are many more cases of introductions like these, and at the time the scientific community has either supported or ignored them.



Number of *Podarcis sicula* observed in surveys by month. Italian data from Foà et al. (1992b); New York data from Burke and Ner (2005). Triangles represent average number of lizards at Italian site in 1988 (Foà et al., 1992b); circles and squares represent average number of lizards at New York site in 1999 and 2000, respectively.

In more recent years, as the list of introductions with disastrous results has grown, many scientists have vigorously opposed further species introductions. Invasive species are now recognized as one of the most important causes of native species endangerment and extinction, and a considerable portion of conservation resources worldwide are devoted to combating the spread of invasive species. Invasive species hit us in the wallets as well. For example, zebra mussels (*Dreissena polymorpha*), a species originally from Europe, were carried to the Great Lakes in the ballast water of large ships. They have spread rapidly throughout lakes of the Midwest

and eastern United States, now causing billions of dollars of damage annually to factory and power plant water intake systems. Australian melaleuca (*Melaleuca quinquenervia*) trees were brought to southern Florida in the early 1900s to help dry up swamps, but have spread out of control, forming thick forests that exclude all native trees. Melaleuca forests are so successful at absorbing ground water that they alter local water flow patterns and regional climate. Because melaleuca bark is highly flammable yet the trunk is fire resistant, lightning fires in melaleuca forests quickly become extremely hot crown fires that spread into natural forests, clearing them of all vegetation and preparing them for further invasion by the surviving melaleucas. Gypsy moths (*Porthetria dispar*), originally brought to the United States for silk production, failed entirely in that regard, but escaped from laboratories in 1868. Since then they have become one of the most devastating forest pests in our country, stripping the leaves of trees across millions of acres in the northeast and heading south through the Appalachian Mountains. As a result of these three species and many others, U.S. taxpayers now spend $100-200 billion annually to monitor, contain, and control invasive species. Scientists today pay close attention to the spread of species, and work hard to limit further introductions. Invasive species ecology is perhaps the most rapidly growing subfield of ecology.

Against this backdrop of introductions causing ecological disaster, where do the scaly little Italian immigrants fit in? I am frequently asked whether the Italian wall lizards have a negative effect on their new environment, like so many other invasive species have. I'm asked this by gardeners who have them in their gardens, homeowners who have them in their basements, amateur herpetologists who want them in their backyards, and biologists who study invasive species generally. And another common question is, How do they survive the cold Long Island winters?

My students and I have been working on the answers to all of these questions. We know Italian wall lizards are doing very well on Long Island because there are many places where they are very abundant, and there must be thousands scattered throughout Long Island. This all started when a small number of lizards were released from a pet shop just off Hempstead Turnpike in Garden City in 1966. Six years later, according to a Cornell University undergraduate student doing a research project here,

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juvenile lizards were abundant, and the population was expanding. They had spread out in a semicircular pattern to about 1/4 mile from the original release site. Ten years later they had spread over 0.6 mile around the release site, and by the early 1990s they were seen as much as 1 1/2 miles from the original release site. Now they exist in some large, more or less continuous populations spread throughout entire neighborhoods in Nassau County, and a number of small isolated populations as far west as The New York Botanical Garden in the Bronx and as far east as Hampton Bays on the beach. They are still spreading, mostly through three methods. First, they disperse on their own, primarily along power lines and railroad right-of-ways. They make good use of Long Island Rail Road property as a safe corridor, and spread into neighborhoods that border the tracks. Second, there are people who deliberately release lizards in new places. That's almost certainly how lizards got to Leeds Pond Preserve on the north shore, The New York Botanical Garden, and Planting Fields Arboretum in Oyster Bay. Finally, lizards are moved accidentally by people. For example, people moving mulch from areas where lizards are common are probably also moving lizard eggs.

Why have they done so well in North America? Both species of wall lizards have lived in urban and suburban parts of Italy for thousands of years, and they really don't live in any habitats in Italy that could be called natural anymore. They have adapted to living near humans; in fact, one of the places they're most common here is a nursery school where people (especially children) pass right in front of them all day. The lizards carry on with their lives, hunting and socializing, undisturbed unless people get too close. Here on Long Island, they have spread through neighborhoods where they can find shelter in which to hide, but near open spaces where they can hunt for food. So far they have colonized suburban areas, gardens and parks here — they don't even seem to like more natural habitats on Long Island.

Two other reasons the lizards are spreading quickly and building up large populations in their new country are that they have no significant competitors or predators here. There are no other lizard species on Long Island — none of the native species that exist in nearby New Jersey made it here, and no other lizard species have been introduced. And perhaps because there are no other lizards here, there are really no predators that specialize on lizards. In Italy, lizards are commonly eaten by a variety of snakes and birds. On Long Island, we have one snake species that might occasionally eat lizards (milk snakes, *Lampropeltis triangulum*), but so far there is little overlap in the ranges of milk snakes and wall lizards. I've seen some of our common birds looking at lizards, but there's no evidence that

birds eat lizards here. The one predator of any consequence here is cats, which also eat wall lizards in Italy. One Long Island homeowner showed me her prize lizard catcher — and a collection of lizard tails. The cat was not always fast enough to get entire lizards, but managed to get the tails of its escaping prey. These lizards quickly drop their tails when that will help them get away, and the tails wiggle and squirm enticingly after detachment from the rest of the lizard. Those lizards can go on to lead long, healthy lives and regrow their tails.

Do the introduced lizards have a negative effect on local species? Although I get many calls each spring and summer from frightened suburbanites with lizards in their basements, wall lizards are completely harmless to humans. They won't bite unless captured, and only the very largest males have the ability to even lightly break the skin if you let them bite. On the other hand, they are voracious predators of small insects and other arthropods. My students and I examined the diets of lizards throughout their active season, and we found they eat a wide variety of prey species, including familiar garden pests like aphids, grasshoppers, caterpillars, and snails. They also successfully tackled more formidable prey such as wasps, bees, and large beetles. Male lizards tend to reach slightly larger body sizes and have larger heads than females; not surprisingly they tended to eat the bigger, more challenging prey, while females specialized on aphids. One female we studied had eaten 50 aphids! The diversity of prey species eaten by Long Island wall lizards was quite close to that of their Italian counterparts, although, of course, the specific prey species were different. Because many of the species eaten by wall lizards are also non-native, and many of their prey are considered garden pests, we could conclude that the lizards have no negative effect on the suburban ecosystems they currently inhabit on Long Island.

There are more subtle ways that these new invaders could affect other organisms in their new home — if they

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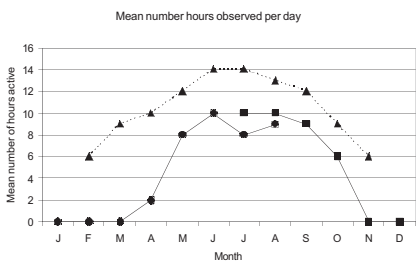
carried diseases or parasites with them, and these had spread to species here. There are a number of diseases known to spread between different reptiles (including birds) and mammals — some of the most common are bacteria in the genus *Salmonella*. *Salmonella* outbreaks are famous for popping up here and there in human populations and quickly disappearing, but they appear to be chronic in many turtle, lizard, and bird populations. They can be quite serious, causing severe illness and even death in humans, and occasional massive dieoffs in wild birds. Very little work has been done on diseases of wild reptiles in general, and no one has researched *Salmonella* or any other disease in wall lizards. The possibility exists that the lizards brought new species or new strains or have become a new reservoir for important diseases, but no evidence suggests this is so, and no disease problems have been linked in any way to these lizards. However, anyone who handles these or other reptiles should always wash carefully afterwards.

A bit more is known about both intestinal parasites and blood parasites of reptiles, and wall lizards in Italy are known to have both kinds of parasites. However, ecological theory suggests that we shouldn't expect the wall lizards in North America to be carrying many parasites, for three reasons. First, a small sample of lizards is likely to carry only a small sample of the total number of parasites found in the lizard populations in Italy, so whatever parasites they may have had in Italy, we should expect them to be carrying fewer parasites here. Second, many parasites depend on multiple hosts for their life cycle, and odds are low that any parasites the colonists brought with them would find good replacements for the other hosts they need. And finally, the "parasite release" hypothesis predicts



Average number of hours *Podarcis sicula* were observed in surveys per day each month. Triangles represent number of hours observed at Italian site in 1988 (Foà et al., 1992b); circles and squares represent number of hours observed at New York site in 1999 and 2000, respectively. Foà et al. did not report data for January and December.

that any species that does well as an invader does so in part because it is not held back by the parasites it faced in its native land. Wall lizards are certainly doing well in North America, so they probably aren't carrying many parasites, if the hypothesis applies.

Our lizards can be tests of these hypotheses, but not much is known about lizard parasites. Lizard blood parasites include the protozoans that cause malaria (genus *Plasmodium*); however, there are many kinds of *Plasmodium,* and each kind restricts itself to only a few host species. Lizard *Plasmodium* are not going to infect people, but they might infect some other lizards. Because there are no other lizards on Long Island, this is only a minor concern. *Plasmodium* also require time in a mosquito host as part of their life cycle. Given the fact that wall lizards are still not very abundant compared to other hosts that Long Island mosquitoes have available, the odds are low that a mosquito will pick up a *Plasmodium* infection from one wall lizard, and then later find another wall lizard to feed on, and infect. Thus it seems unlikely that a lizard *Plasmodium* infection could persist on Long Island, even if the original lizards were infected. My colleagues and I have examined hundreds of blood samples not only from Long Island wall lizards, but also from the three other North American populations of introduced wall lizards, and none have had any trace of blood parasites.

Reptiles are sometimes infected with intestinal parasites, including trematodes, nematodes, cestodes, and flagellates, and these are not nearly so host-specific. In fact, some of these can infect fish, turtles, birds, and mammals, so there is a possibility that the introduced lizards could have brought intestinal parasites that now infect local animals, or that local animals have intestinal parasites that now infect wall lizards. Unfortunately, very little is known about the intestinal parasites of Italian wall lizards in their home country, so we can't speculate on what the original released lizards might have had with them. Also, nothing is known about the parasites of Long Island reptiles, so we can't suggest what the wall lizards might have been exposed to here. However, my colleagues and I have examined the stomachs and intestines of more than 1,000 wall lizards, from all four North American populations, and found only two nematode parasites, and those had

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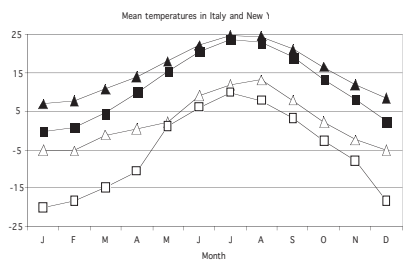
probably been ingested with insect prey. Both nematodes are members of North American species common in birds, so there's no evidence that the wall lizards brought anything from Italy, and it doesn't look like they've picked up much here either.

How do wall lizards survive our winters? Wall lizards range from the foothills of the Alps in extreme northern Italy all the way south to the island of Palermo off the southern tip of Italy, so different populations have certainly adapted to different climates. Our genetic work, however, shows that our Long Island population comes from the vicinity of Rome. This makes sense because pet wholesalers in the 1960s and 1970s were shipping animals out of Rome, and they probably obtained local animals. Rome's summer temperatures are actually quite similar to those of Long Island — matching our average temperatures in June, July, and August almost perfectly. However, our average winter temperatures are quite a bit colder, as it rarely gets much below freezing in Rome. The real differences are in extreme temperatures. Long Island often gets winter extremes of -4°F or even colder, whereas Rome's coldest nights, even in very cold years, bottom out around 23°F. So the Italian wall lizards survive much colder temperatures on Long Island than their recent ancestors experienced in Italy. How do they do it?

They don't do it by freezing. The European common lizard (*Lacerta vivipara*) is a close relative to the wall lizard, and it survives very cold winters by utilizing a series of physiological adapta-



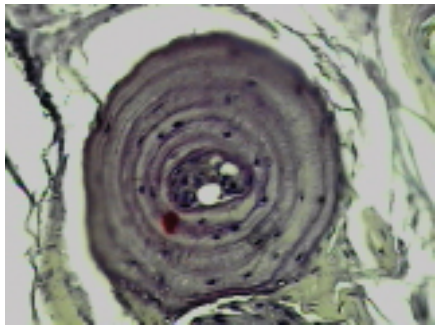
Filled triangles represent average monthly temperatures (°C) for Rome, Italy, 1901-1930; filled squares represent mean monthly temperatures for Mineola, NY, 1948-2001; empty triangles represent extreme minimum temperatures for Rome, Italy, 1901-1930; empty squares represent extreme minimum temperatures for Mineola, NY, 1948-2001.

tions that allow it to freeze solid without damaging its tissues. This is a neat trick; few other vertebrates can do it. For example, when our body parts freeze, we get frostbite and the frozen tissue dies, in part because the frozen cells burst. *Lacerta* changes its blood chemistry so cells don't burst. If wall

lizards could do the same, then they could easily survive cold Long Island winters. But our laboratory work shows that they don't, so they must avoid freezing.

They avoid freezing on Long Island by going deep underground, and not coming out until the danger of freezing is long past. We have monitored the activity of Long Island wall lizards, and we've found that they're quite different from their Italian relatives. In Rome, wall lizards may be active any month of the year, even on warm days in January. In contrast, our wall lizards spend November, December, January and February deep underground, quite safe from freezing. Therefore they're active for a much smaller fraction of each year, and we'd expect that they grow more slowly, reproduce less frequently, and reach maturity more slowly than in Italy. Unfortunately, there's no Italian data available to test that hypothesis. I'm hoping to spend some time in Italy next year gathering data on their lizards, so we can make better comparisons with ours.

Italian wall lizards might be an example of an invasive species with little impact on their new homes. That doesn't mean I advocate spreading them around deliberately — they're spreading



This is a cross section of a toe from an Italian wall lizard captured on Long Island. The image shows bone rings laid down with each winter the lizard survived, just as a tree lays down annual growth rings. This adult male has survived at least five winters.

just fine on their own and don't need any help. They have not yet spread into even moderately natural habitats in North America, and they may yet turn into a problem when they do. It is certainly hard to imagine how we could stop them even if we wanted to. In the meantime, it should be noted that the introduced wall lizard populations can have some value. First, they can provide useful data for evolutionary and ecological model testing, especially with regard to theories dealing with how species will respond to new environments. This is particularly important when the new environment differs from ancestral environments in only a few factors, such as day length or minimum temperature. Second, they can provide data useful for conservation. For example, concerns about the rare Aeolian wall lizard (*Podarcis raffonei)* have led to the suggestion that reintroductions may be needed in the future, and learning about the successful and failed introductions of its close relatives may be helpful. Finally, wall lizard introductions have occurred only in urban or suburban areas, and these ecosystems have few species of native reptiles. Therefore, introduced wall lizards can provide excellent opportunities for study by amateur biologists, because wall lizards often become abundantly common and they are easy to observe. For me, the opportunities to watch and handle wild animals in my neighborhood played a key role in my inclination to become a biologist. Wall lizards can provide the herpetological equivalent of watching birds at feeders, introducing students and other nonprofessionals to the basics of scientific research. As the lizards spread across the Hofstra campus, you can expect my students to be taking notes.

Russell Burke's longstanding interest in reptiles was a major influence in his decision to pursue a career in biology. As a child, he recalls collecting local snakes and keeping them in captivity. A major complaint growing up was that there were no lizards or venomous snakes nearby, and he seized the earliest opportunities to visit places in Florida where both were abundant. Today, he continues to focus his research efforts largely on reptiles.

Professor Burke earned a B.S. in zoology from Ohio State University, an M.S. in wildlife ecology from the University of Florida at Gainesville, and a Ph.D. in biology from the University of Michigan. He began teaching at Hofstra as an assistant professor in 1996, and was promoted to associate professor in 2002. Professor Burke teaches evolution, ecology, behavior and conservation biology.

He first began serious research on lizards while at the University of Michigan, when he recognized the advantages of lizards as study organisms: they are easy to observe both in the wild and captivity, they are short-lived, and often abundant. These characteristics make them excellent models for studies of natural selection. The abundance of Italian wall lizards near Hofstra University actually contributed to Professor Burke's desire to teach here.

Because wall lizards are common close to campus, they are an excellent species for introducing Hofstra undergraduates to scientific research in the lab and in the field. Since 1997, 10 undergraduates have completed research projects on wall lizards in Professor Burke's lab, resulting in several publications. Despite the fact that the lizards are quite active around people, many Hofstra students, even having grown up in neighborhoods where the lizards are common, are unaware of their presence. "One of the best things about taking students out in the field to study lizards is their surprise when they find that lizards have been around them all along and they never noticed," he explains. This trend is likely to continue as the lizards spread onto Hofstra campus — he's recently found them at the Hofstra University Model Bird Sanctuary. He predicts that the lizards will continue to spread over the Hofstra campus, startling students and visitors alike. "That awareness of the living world around us, often unexpected, makes everyone a biologist."