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Puerto Rican Bank endemic species like this Saddle Anole (*Anolis stratulus*) are found on nearly all of the islands in the region. However, transporting even native species from island to island may dilute unique gene pools that have evolved on individual islands that have been separated for thousands of years.

# Keeping Invasive Species Off Guana Island, British Virgin Islands

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Only habitat loss is a bigger threat to native species than invasive species, which are found in increasing numbers in both terrestrial and aquatic habitats and cause over \$100 billion in estimated economic damage every year in the United States alone (Pimentel et al. 2000). Such species often arrive via the transportation network (reviewed in Ruiz and Carlton 2003), whether voluntarily (intentional introductions) or involuntarily (accidental immigrants). That has been the case of the Cuban Treefrog (CTF), *Osteopilus septentrionalis*, which has been spreading in the Caribbean, primarily as a stowaway in ornamental plants and construction materials (e.g., Townsend et al. 2000, Powell et al. 2005, Powell 2006). In recent years, one of us has documented its ongoing expansion in the British Virgin Islands (BVI), where it is now known from breeding populations on Tortola, Virgin Gorda, Beef Island, and Peter Island (Owen et al. 2005, 2006). Single individuals have been documented on Necker Island and Guana Island, but searches of both in 2006 revealed no breeding populations, adults, or tadpoles. This frog is of concern for several reasons: It appears to cause the decline of native frogs, at least partially by direct predation; it also feeds on lizards, snakes, birds, and — primarily — invertebrates. In addition, it invades the water cisterns that are the main source of drinking water for many BVI residents, raising human health concerns.

Even before the collection of a CTF on Guana Island, a private wildlife preserve, the owners and management have been committed to keeping these frogs off the island. Over the years, they have fumigated plants and construction materials with vehicle exhaust, but the frogs appear remarkably resistant to long exposures to the toxic fumes, and this practice has been stopped. Nursery staff is supposed to inspect all plants for frogs before loading. In addition, all arriving nursery and construction materials are individually inspected before they are allowed onto the island. So far, these searches have resulted in the capture and destruction of three CTFs, two in a single shipment in 2005 (S. Western, pers. comm.) and one in 2004 (H. Watson, unpublished). Here, we report on one such search.

On 12 October 2006, the barge Deriece-W, normally based on Beef Island, delivered over 220 potted plants to Guana Island: *Ficus microcarpa*, *Clusia guttifera*, *Bougainvillea* “Helen Johnson,” *Pandanus utilis*, *Jatropha integerrima*, *Suriana maritima* (Bay Cedar), and *Coccoloba wifera* (Seagrape). As with many ornamental plants used throughout the Caribbean, they originated in Florida, USA, which is inundated with invasive reptiles and amphibians (e.g., Meshaka et al. 2004). Prior to being loaded on the barge, plants were housed at Minine’s Plants, a nursery on Beef Island that is heavily infested with CTFs (Owen, 2005). Some of the material (*Clusia* and *Jatropha*) had arrived from Florida 10 days previously, while other plants had been on Beef Island for up to 18 months. In addition to the plants, the barge carried soil and several vehicles, including a truck loaded with additional plants. Thus, we were concerned about both frogs (either arriving directly from Florida or acquired at the nursery) and other organisms that might have arrived from either location. One species of particular concern was the Brown Anole, *Anolis sagrei*, which also has invaded Florida and is spreading in the Caribbean (e.g., Greene et al. 2002, Henderson and Powell 2005), often to the detriment of native species (Kolbe et al. 2004). So far, it has not been found in the BVI. The search was conducted by a team of eight, including the authors, and lasted approximately one hour. Each plant was individually searched, with both foliage and soil being sifted for invasive organisms. Those found were recorded and removed.

We removed from the plants inspected five juvenile anoles, later identified as the native Crested Anole (*Anolis cristatellus*),



BRIAN WHITE

A Cuban Treefrog (*Osteopilus septentrionalis*) on an ornamental plant at the Beef Island nursery.



BRIAN WHITE

A cistern on Beef Island, the source of water for a household, is teeming with dozens of Cuban Treefrogs (*Osteopilus septentrionalis*).



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Guana Island, like the many other islands of various sizes that comprise the British Virgin Islands, is separated from other islands only by short distances across intervening channels. As part of the Greater Puerto Rico Bank, these islands were once connected when sea levels were much lower than today. At least those populations of plants and animals with limited abilities to disperse across water have evolved separately on individual islands, and efforts should be made to avoid diluting potentially unique gene pools by transferring even common species from island to island.

and sighted at least one other that was not recovered. In the soil of the planters, we collected one dwarf gecko, later identified as a native *Sphaerodactylus macrolepis*. In addition, we recovered one immature spider (an unidentified member of the genus *Selenops*, catalog number TTU-Z 31,098) and three individual snails, *Zachrysis provisorio* (MCZ 356974). This species originates in Cuba, but has been reported in Florida and elsewhere in the Caribbean, including the U.S. Virgin Islands (A. Baldinger, pers. comm.; Kraus 2005). The soil in two pots contained nests of the imported Red Fire Ant (*Solenopsis invicta*), and had to be fumigated. This species is not listed among those



JOHN S. PARMERLEE, JR.

The Cuban Brown Anole (*Anolis sagrei*) is an aggressive invader originating in Cuba. These lizards thrive in habitats altered by human activity.



GAD PERRY

The barge, with its gate down, is ready to discharge its load of plants and soil on Guana Island.



GAD PERRY

James Lazell and Howard Watson inspecting the leaf axils of *Pandanus utilis* for stowaways.

located by Miller (1994), who searched a similar barge at the same location, but looked for invertebrates.

In addition to these cargo-related species, we recovered two juvenile ground lizards, later identified as the native *Ameiva*



GAD PERRY

A juvenile Crested Anole (*Anolis cristatellus*) on a nursery plant on top of a truck loaded on the barge. The animal escaped before it could be captured.

*exsul*, which appeared to have been resident on the barge. When chased, the lizards behaved in a manner we have never previously encountered or seen described. Both lizards used a drain hole on the edge of the deck to launch themselves into the sea, about 3 meters below. Once in the water, they swam as a crocodile or marine iguana would, tucking their limbs against their bodies and undulating the body and tail. Swimming occurred both under and on the surface of the water and lasted about 1 minute in each case. The lizards then swam back to the boat and climbed up its side. This ability may help explain why ground lizards are found on so many islands. We are happy to report that the owners of Guana Island, in keeping with their long-term policy of protecting the island, have now decided to suspend such shipments.

None of the reptiles collected were invasives, nor were CTFs found during our search, but some of the invertebrates collected were, similar to the findings of Miller (1994). Both the number of organisms discovered on this barge and their diversity is alarming for two reasons. First, they indicate that a broad range of organisms can and is transported in such shipments, which are not uncommon. In the last few years, Guana Island, which is not a major consumer of nursery plants, typically received 2–3 shipments of similar magnitude a year, as well as several smaller ones (H. Watson, unpublished). The potential for arrival of invasive species, such as the Fire Ants (already established on Guana) or CTF (which has not been noted this year, despite repeated surveys of all freshwater locations on the island) is alarmingly high. Second, transporting native species between



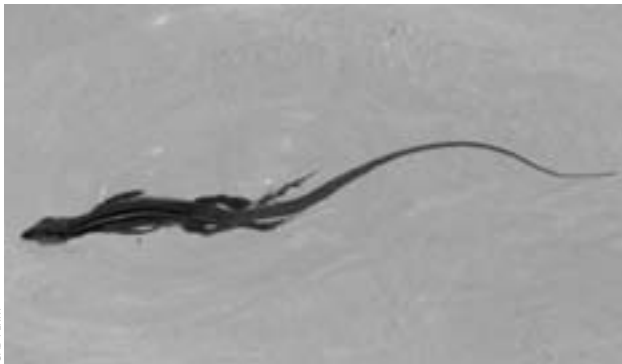
ROBERT POWELL

This dwarf gecko, *Sphaerodactylus macrolepis*, is common in the British Virgin Islands.



GAD PERRY

One of two juvenile ground lizards (*Ameiva exsul*) encountered on the barge.



GAD PERRY

*Ameiva exsul* swimming in the sea after leaping from the deck of the barge.

islands is not a benign activity. It swamps local genetic specializations that have evolved after the islands separated, leaving populations less well-adapted to local conditions. For example, water loss rates vary among islands in a manner related to their aridity (Dmi'el et al. 1997), and this variation has at least some genetic basis (Perry et al. 2000). Bringing in foreign genetic material could make an island population less capable of surviving a drought. In addition, such translocations make research into the biological history of the islands much more difficult. For example, an ongoing study of the genetic differences among Crested Anole populations and their relationship to other biogeographic patterns would be severely hampered if animals are regularly transported among islands.

BVI law offers little guidance about inspecting and sanitizing shipments arriving from other locations, such as Florida. We support the recommendation of Perry and Gerber (2006) that additional measures are needed to prevent the arrival of invasive species and eradicate those already in the BVI. In addition, however, we also recommend that internal biosecurity measures be established to reduce the risk of native species being accidentally moved among islands. Such measures are clearly needed to reduce the spread of invasives already found in the BVI, such as the Fire Ant or CTF, to new locations. We are not aware of such

regulations being in effect in any island-based nation. Attempts at quarantines of mainland invasives, such as the Fire Ant in the USA, often have failed because the volume of transport is high and inspection is lax, but the isolation provided by an island-based system offers some hope of success.

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