

INVASIVE SPECIES

Island Invaders: Introduced Amphibians and Reptiles in the Turks and Caicos Islands

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The term “invasive” usually refers to non-native species that are having at least some negative impact on local floral or faunal communities. Invasive species are among the top three causes of global biodiversity decline (Lockwood et al. 2007), and understanding their distributions and avenues of introduction is important for regional conservation and management. Moreover, an understanding of the biology and natural history of invaders might help to suggest methods for their control and also predict effects on native wildlife.

Recently, much attention has been paid to invasive reptiles and amphibians (Kraus 2009). Reptiles and amphibians may be especially good colonizers, as evidenced by the nearly circumtropical distribution of certain species, such as the Brahminy Blind Snake (*Ramphotyphlops braminus*) and the Cane Toad (*Rhinella marina*).

Islands seem to be particularly vulnerable to invasive species, as these species often are freed from the pressures of natural enemies (predators and parasites) and competition (Whittaker and Fernández-Palacios 2007). Many tropical and subtropical islands contain unique herpetofaunal assemblages that are vulnerable to disruption by the introduction of non-native predators and competitors. The West Indies is considered one of the world’s most important biodiversity hotspots and the region’s native reptiles and amphibians are of particular conservation concern (Myers et al. 2000, Smith et al. 2005). Centuries of habitat modification and the introduction of damaging mammalian predators such as feral cats (*Felis catus*), Indian Mongoose (*Urva auropunctata*), and Black Rats (*Rattus rattus*) have negatively affected many reptilian and amphibian populations (e.g., Iverson 1978, Corke 1992, Smith et al. 2005, Tolson and Henderson 2006). As such, documenting and reporting the spread and impact of introduced herpetofauna remains an important task.



Fig. 1. The Turks and Caicos Islands are located at the southern terminus of the Bahamian Archipelago ~130 km from Hispaniola. Major islands and islands mentioned in the text are labeled.



Fig. 2. Native reptiles of the Turks and Caicos: (A) Turks and Caicos Rock Iguana (*Cyclura carinata*), (B) Turks and Caicos Curly-tailed Lizard (*Leiocephalus psammotromus*), (C) Caicos Blind Snake (*Typhlops platycephalus*), (D) Caicos Dwarf Boa (*Tropidophis greenwayi*), (E) Antillean Skink (*Mabuya* sp.), (F) Turks Dwarf Gecko (*Sphaerodactylus underwoodi*; female, left; male, right), (G) Caicos Dwarf Gecko (*Sphaerodactylus caicosensis*; male, bottom; female, top), (H) Caicos (Hecht's) Barking Gecko (*Aristelliger hechti*), (I) Turks Island Boa (*Epicrates chrysogaster chrysogaster*), (J) Southern Bahamas Anole (*Anolis scriptus scriptus*).

We have spent the last four years working in the Turks and Caicos Islands (Fig. 1) and have made an effort to document the presence and distribution of non-native species of this archipelago. The Turks and Caicos Islands, located at the southern terminus of the Bahamian Archipelago, contain ten species of native reptiles, eight of which are endemic at the species or subspecies level (Fig. 2). The remaining two species (*Anolis scriptus* and *Mabuya* sp.) are widely distributed in the southern Bahamas and throughout the West Indies. No amphibian species is native to the Turks and Caicos. As of October 2009, seven non-native reptilian and two amphibian species have been discovered in the Turks and Caicos, nearly doubling the number of reptiles and adding amphibians in a region where previously they had not been documented. Tourism and large international investments have resulted in explosive development of these islands and a surge in the number of immigrants filling jobs in the construction and service industries. Combined with the rapid increase in imports, the list of invaders might continue to grow. Below we discuss the distribution and abundance of the known invasive reptiles and amphibians in the Turks and Caicos, and encourage other researchers to document similar invasions in other regions that support a unique native herpetofauna.

Cuban Treefrog, *Osteopilus septentrionalis*. Established.

Cuban Treefrogs (Fig. 3) are widely introduced in the Caribbean and southeastern United States, with populations on Puerto Rico, in the Virgin Islands, upper Lesser Antilles, Florida, and elsewhere (Henderson and Powell 2009). These frogs appear able to tolerate xeric conditions that would prevent most other amphibian colonists from becoming established. As long as they have access to ephemeral or permanent sources of freshwater, these frogs can breed prolifically and become abundant. Cuban



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Fig. 3. Cuban Treefrog (*Osteopilus septentrionalis*) from North Caicos.

Treefrogs are of particular concern because of their voracious appetites, high densities, and noxious skin secretions. Although this species is native to the Little and Great Bahama banks, it is generally considered a recent arrival to the Turks and Caicos, where it is firmly established on the islands of Providenciales, Grand Turk, North Caicos, and Middle Caicos, and will likely be found on several other islands with the expansion of irrigation for development. On North and Middle Caicos, these frogs reach exceptional densities, often covering the road after a heavy autumn rain. Endemic Caicos Dwarf Boas (*Tropidophis greenwayi*) have even shifted their behavior to feed on these frogs, occupying the interior walls of old stone water wells to capture metamorphs as they climb up the sides from the water below (RGR, C. Deal, and N. Manco, unpubl. data). Color photo vouchers, Austin Peay State University (APSU) 19024, 19027.

Greenhouse Frog, *Eleutherodactylus planirostris*. Established.

Greenhouse Frogs (Fig. 4) are small terrestrial frogs that stow away in soil and plants, and have been introduced to Jamaica, Florida, and the Turks and Caicos Islands from their native range in Cuba, the Caymans, and the Bahamas (Henderson and Powell 2009). This species is a direct-developer, meaning that the larval stage is completed in the egg. Eggs are laid in moist leaf litter, and hatchlings emerge as miniature adults. Greenhouse Frogs occur in the Turks and Caicos on the islands of Providenciales, Grand Turk, North Caicos, and Middle Caicos, and will likely be discovered on other islands. Color photo voucher, APSU 19023.



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Fig. 4. Greenhouse Frog (*Eleutherodactylus planirostris*) from North Caicos.

Red-Eared Slider, *Trachemys scripta elegans*. Not established.

Red-Eared Sliders (Fig. 5) are popular pets with long lifespans, and often are released when owners grow tired of them. Native to the eastern and mid-western United States, these freshwater aquatic turtles have been introduced to many islands in the West Indies, from Puerto Rico and Hispaniola to Guadeloupe and Martinique (Henderson and Powell 2009). They require a consistent source of freshwater and, although this type of habitat is rare in the Turks and Caicos, several ponds built for the Leeward golf course on Providenciales likely provide the main refuge for this species. Only a few adult Red-Eared Sliders have been captured and removed, although a few more probably occur in these manmade ponds. No hatchlings or juveniles have been observed; hence we do not consider this species to be reproducing. Color photo voucher, APSU 19021.

Antillean Slider, *Trachemys stejnegeri malonei*. Established?

A single Antillean Slider was collected in 1975 from Pine Cay on the Caicos Bank (W. Auffenberg, UF 49423), although several other individuals were reported in 1997 from a freshwater pond on the same island (Seidel 1986,



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Fig. 5. Red-Eared Slider (*Trachemys scripta elegans*) captured near the Provo Golf Club on Providenciales, Turks and Caicos Islands and being held at the National Environmental Centre.



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Fig. 7. Hatched nest of the Wood Slave (*Hemidactylus mabouia*) under a rock on Salt Cay, Turks and Caicos Islands.

1988; Lee and Ross 2001). This species is believed to be a human introduction to the Caicos Cays (Seidel 1988, 1996) from Great Inagua. We are unaware of any specimens reported since 1997, although persistence of this population from 1973 to 1997 would indicate that reproduction might be occurring, unless the species is being recurrently introduced, a situation that seems unlikely on this privately owned resort island.

Wood Slave, *Hemidactylus mabouia*. Established.

Wood Slaves (Fig. 6) are rapidly expanding their range in the Western Hemisphere, and are firmly established in the Turks and Caicos Islands. These lizards are exceptionally good colonizers and, as human commensals, are afforded frequent opportunities to stow away in cargo, which is probably how they arrived in the Turks and Caicos. They are widely distributed in the Turks and Caicos and are currently known from six large islands: Providenciales, North and Middle Caicos, South Caicos, Grand Turk, and Salt Cay (Reynolds and Niemiller 2009), although they likely occur on many more. We have discovered nests on Salt Cay (Fig. 7) and have recorded juveniles and hatchlings on all six islands. These geckos probably do not represent a great threat to most of the local herpetofauna, except on the islands of North Caicos, French Cay, and Big Ambergris, where the endemic Hecht's (or Caicos) Barking Gecko (*Aristelliger hechti*) occurs. These native geckos are ecologically similar to the introduced Wood Slave,

occupying vertical surfaces of trees, rock walls, and buildings and feeding on small flying or climbing insects. Color photo vouchers, APSU 18047, 18945, 18946, and 18949.

Mayaguana Dwarf Gecko, *Sphaerodactylus mariguanae*. Established?

Mayaguana Dwarf Geckos are native to the Bahamian islands of Mayaguana and Booby Cay, located about 65 km to the northwest of the Turks and Caicos. Although small (SVL to 41 mm; Schwartz and Henderson 1991), they are much larger than the native *S. caicosensis* (SVL to 32 mm) and *S. underwoodi* (SVL to 32 mm). Dwarf geckos likely move between islands quite easily because of their small size, high fecundity, and proclivity for inhabiting stacks of building supplies, such as cinder blocks and lumber, as well as potted plants, soil, and mulch. Molecular data suggest that native *S. underwoodi* move between the islands of Grand Turk and Salt Cay on cargo (Reynolds and Koneczny, in review).

Schwartz (1968) and Schwartz and Henderson (1991) reported *S. mariguanae* from Grand Turk. To our knowledge, this species has not been seen there in quite some time, but the record stands in Henderson and Powell (2009). This record likely does not represent a misidentification, as 40 individuals were collected (Albert Schwartz Field Series [ASFS] 10766) and compared to other populations and to *S. underwoodi* (Schwartz 1968); however, whether these *S. mariguanae* individuals represent a human introduction or an extension of the species' native distribution is unclear. Also, that this species has apparently not been recorded since Schwartz (1968) and was never found on other islands on the Turks Bank is notable. Schwartz (1968) speculated that these Grand Turk *S. mariguanae* represented an introduced population, and evidence currently available certainly weighs in favor of this postulate, hence we include this species here as an introduced species. Grand Turk is a heavily developed island, yet endemic *S. underwoodi* appears to be fairly common, and thus *S. mariguanae* may yet persist there.

Green Iguana, *Iguana iguana*. Established?

As popular pets, Green Iguanas (Fig. 8) have become established in many areas outside of their native range in Central and South America, perhaps most notably in southern Florida, where they occur in very high densities near residential areas. In the Turks and Caicos, a few Green Iguanas have been found on Grand Turk and Providenciales. They likely represent released or escaped pets. Reproduction has not been documented, but this seems a likely possibility if several mature adults occur in the same area. Color photo voucher, APSU 19019.



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Fig 6. Wood Slave (*Hemidactylus mabouia*) from Salt Cay, Turks and Caicos Islands.



Fig. 8. Green Iguana (*Iguana iguana*) captured near Long Bay on Providenciales and being held at the National Environmental Centre.



Fig. 9. Eastern Corn Snake (*Pantherophis guttatus*) captured on Grand Turk, Turks and Caicos Islands, and being held at the National Environmental Centre.

Cuban Knight Anole, *Anolis equestris*. Not established.

Likely released pets, four Cuban Knight Anoles have been collected and several more sighted at a Grace Bay resort on Providenciales Island. Like Green Iguanas, these large arboreal lizards appear to thrive in appropriate habitat, as they also are quite common where they have been introduced in southern Florida (Meshaka et al. 2004). They apparently are not reproducing in the Turks and Caicos, although that cannot yet be ruled out, given the abundance of lush and irrigated vegetation in the Grace Bay resort complexes. Color photo vouchers, APSU 19025, 19026.

Brahminy Blind Snake, *Ramphotyphlops braminus*. Established.

Essentially a circumtropical species, the Brahminy Blind Snake, which is native to the Indian Subcontinent, has proven to be an exceptional colonizer because of its habit of sequestering itself in potted plants and its parthenogenetic mode of reproduction. This species has been found on both Providenciales and Grand Turk and is likely to find its way to many of the other islands in the archipelago. We currently do not know whether Brahminy Blind Snakes compete with the ecologically similar native blind snakes (*Typhlops* sp., *sensu* S.B. Hedges, *in litt.*), which are more abundant on islands other than Grand Turk and Providenciales. Color photo voucher, APSU 19022.

Eastern Corn Snake, *Pantherophis [Elaphe] guttatus*. Not established.

The Corn Snake (Fig. 9) is native to the southeastern United States and has been introduced elsewhere in the Caribbean, although it is successfully established only on the islands of Grand Cayman (Schwartz and Henderson 1991) and St. Thomas (U.S.V.I., Henderson and Powell 2009). These snakes might have arrived on islands as eggs laid in the soil of large potted trees from Florida; however, escaped pets also are a possible means of conveyance. Thus far, three adults have been found on Grand Turk, one of which laid a clutch of non-viable eggs after capture (B.N. Manco and B. Riggs, pers. comm.). Color photo voucher, APSU 19020.

Conclusions

The Turks and Caicos contain a unique assemblage of native reptile species. Threats from habitat modification and direct persecution (i.e., killing snakes) are taking a toll on species such as the Turks Island Boa (*Epicrater chrysogaster*) and the Turks and Caicos Rock Iguana (*Cyclura carinata*) (G. Gerber, unpubl. data; Reynolds and Gerber, in review). Threats from invasive mammalian species, such as cats, are well established, and local reptilian populations have suffered tremendously from their introduction (Iverson 1978, Mitchell et al. 2000). The degree of threat to local wildlife posed

by introduced reptiles and amphibians is largely unknown at this time. However, the first step is to document successful invasions. We encourage fellow biologists and amateur herpetologists in the West Indies to take note of introduced species and report them to local authorities.

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Cuban Brown Anoles (*Anolis sagrei*) in St. Maarten

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Photographs by the author.

Cuban Brown Anoles (*Anolis sagrei*) are native to the Bahama Islands (Cay Sal, Conception, Crooked, Acklins, Grand Bahama, Little Bahama, Rum Cay, and San Salvador island banks), Cuba and associated cays, Isla de La Juventud, and Little Cayman, including most satellites and cays with even rudimentary vegetation. The species also has become established in Jamaica, either naturally or through human mediation. More recently introduced populations are known in Grand Cayman, Swan Island, Grenada, St. Vincent, the Grenadines (Canouan), Barbados, the Atlantic Coast of México as far as Belize, the Islas de la Bahía (off Honduras), Aruba, Hawaii (Oahu and Coconut Island, Kauai), Taiwan, the southeastern United States, and California (Orange County; Henderson and Powell 2009 and references therein). At least some introduced populations originated in the southeastern United States.

Within a 30-minute period on 2 March 2010, I observed three male and two female *Anolis sagrei* in and around the Philipsburg harbor in St. Maarten. St. Maarten is a major commercial center in the eastern Caribbean; a number of exotic species have been recorded there, and several (e.g., Cuban Treefrogs, *Osteopilus septentrionalis*, Green Iguanas, *Iguana iguana*) have become established (Powell et al. 2005).

Although I did not observe any juveniles, the abundance of observations in such a short period is suggestive of a breeding population. I did observe native Anguilla Bank Anoles (*Anolis gingivinus*) associated with ornamental vegetation in and around the harbor. I saw no evidence of competitive interactions, but the apparently restricted range of *A. sagrei* is suggestive of a recent arrival. Whether the newly established population remains largely restricted to severely altered habitats, as has been described on Grenada (Greene et al. 2002, Germano et al. 2003) and St. Vincent (Henderson and Powell 2005, Treglia 2006, Treglia et al. 2008) remains to be determined. The origin of the population on St. Maarten is unknown.

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Male (top) and female Cuban Brown Anoles (*Anolis sagrei*) from the Philipsburg harbor on St. Maarten. Photographic vouchers have been deposited in the Milwaukee Public Museum: MPM P745 (male) and MPM P746 (female). The identity of these lizards was confirmed from photographs by Robert W. Henderson.