

Three decades of biological work on Guana Island, British Virgin Islands: an overview

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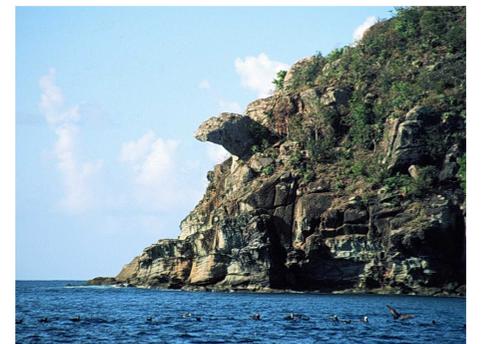
Abstract

Dry tropical forest, of the kind typical of Caribbean Islands, is severely threatened by human activities. On Guana Island, a small privately-owned island in the British Virgin Islands (BVI), decades of scientific research have provided an exceptionally broad understanding of island ecology. We highlight some of the most significant findings and successful conservation actions of the program, which has thus far produced over 200 peer-reviewed scientific papers and one book describing the island's biology.

Basic research on Guana has focused on understanding the island's ecology and evolutionary biology, defining patterns and processes of dispersal, speciation, adaptation, trophic relationships, and community structure. Conservation biology on Guana has focused on endangered species, invasive

species, and restoration ecology. Species reintroduced by the program include the Anegada Rock Iguana (*Cyclura pinguis*) restored to Guana, a reef of Elkhorn coral (*Acropora palmata*) restored to Guana's near-shore waters, and Caribbean flamingos (*Phoenicopterus ruber ruber*) restored to the BVI. For each species restoration, associated population and community changes are continuously studied, resulting in growing understanding of their biology and improved chances for long-term survival.

These and other individual studies, such as documenting the migratory birds that stop on Guana during the fall migration, have been ongoing for several decades. The resulting data allow interacting drivers of ecological change, such as those associated with climate change, to now be studied.



Guana Island and the Guana Project

Located just north of Tortola in the British Virgin Islands, Guana Island is a privately-owned exclusive hotel resort. At just about 3 km² and a maximum elevation of ~250 m, it is a typical medium-sized island for the BVI. Since the early 1980's, the owners of Guana Island have invited scientists to study the island's ecology.



Ecology

Ecology of species and communities has been the focus of many of the studies on Guana and has formed the basis for broader studies (summarized in Lazell 2005). For example, studies of fish ecology have elucidated the great importance of parasites in fish population dynamics (Forrester & Finley 2006) and the resilience of Elkhorn corals to bleaching has been linked to sun shading on Guana (Muller & van Woesik 2009). Many class projects conducted by Texas Tech students have addressed individual species such as soldier crabs or groups such as cacti. Others studies have focused on groups of species or on comparing single species among islands. For example, Ovaska *et al.* (2000) studied the rainfrogs of the BVI and their ecology, documenting certain calls for the first time.

Investigations on Guana have also incorporated whole ecosystems. For example, Jarecki (2004) described the ecology of the salt ponds found on many islands in the BVI. The salinity in these ponds varies from almost freshwater, after a large rainstorm, to hypersaline. As it changes, different species cycle through. Throughout the process, the ponds offer essential habitat for local and migratory birds, and such studies assist in the conservation throughout the region.



Guana's salt pond (left) is one of many hypersaline mangrove systems in the dry Caribbean. Dense fiddler crab (insert) populations along the shores may link microbial mat production within ponds to the shorebird bird community (Photos by Lianna Jarecki).

Restoration ecology

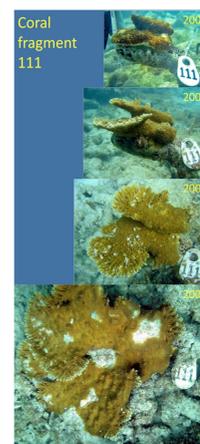
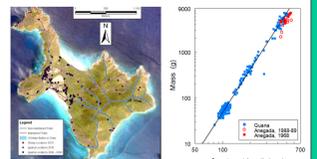
Several restoration projects have been the core of applied work on Guana. Two involve birds, are regional in scope, and involved bringing in bird species that have become locally extirpated: flamingoes (brought in to repopulate Anegada's salt ponds; Lazell, 2002) and the white-crowned pigeon.



In 1991, 20 adult Caribbean flamingos were released to their historical breeding ponds on Anegada in the BVI. Photo left (by Lianna Jarecki) shows the first (1995) of many successful breeding events. There are now over 200 flamingos on Anegada and they regularly visit other islands.

Perhaps the greatest applied success of the project is the restoration of the critically-endangered stout iguana (below) to Guana island, where it is thriving.

The Guana population is now estimated at 200 animals which are in better condition than those originally seen on Anegada and current head-started juveniles (below, right). However, the minimal overlap between iguanas and feral sheep (Skipper *et al* 2013; center) raises concerns about population stability.



Elkhorn coral (*Acropora palmata*), once a highly abundant shallow reef-builder, is now an endangered species. Forrester *et al.* 2013, describes cost effective methods developed on Guana for greatly increasing the survival of naturally-produced Elkhorn fragments by transplanting them to dead reef structures. Using methods simple enough for implementation by volunteers, we have restored Elkhorn corals shallow reefs on Guana.

Left: Composite photo showing three year's growth of a representative transplanted coral fragment that was transplanted in 2005 (photos by Graham Forrester)

α -taxonomy

Much of the early work conducted on Guana focused on identifying the species present in both terrestrial and marine environments.

Examples of new species described include *Saronebalia guanensis* (right), a new species of crustacean belonging to a new genus and named after the island (illustration from Haney and Martin, 2004) and *Psorthaspis gloria*

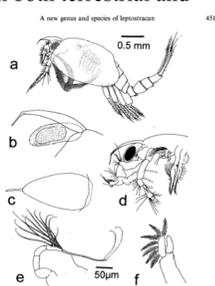


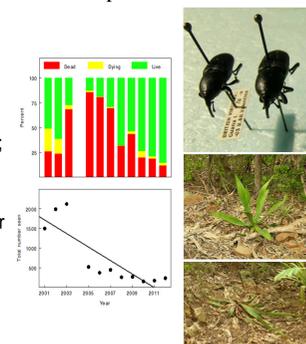
FIG. 1. *Saronebalia guanensis* n. gen., n. sp. - holotype male (a) whole specimen; paratype male (b) rostrum and mouthparts; (c) rostrum, dorsal view; (d) antenna; with antenna removed; (e) first maxilla (mesostyle); (f) second maxilla (50µm scale bar refers only to (e) and (f)).

(left, photo by Snelling, who described the species in 1995), named after one of Guana's owners.



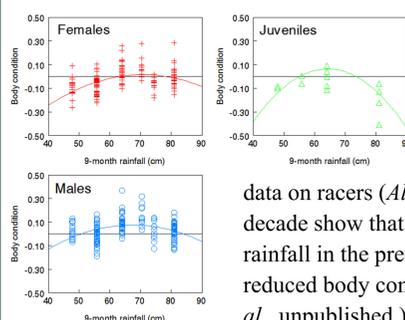
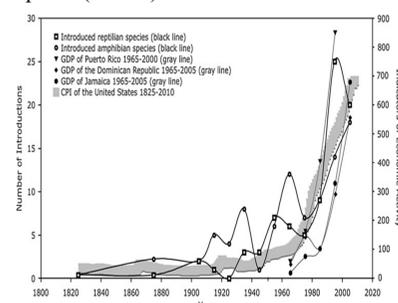
In addition, studies continue to document native species new to the island or region, such as mushrooms (Miller *et al.*, 2000) and even birds (Boal *et al.*, 2006). Unfortunately, new non-native arrivals, such as the Cuban Treefrog, are also being documented (Perry, 2009). The result is a far richer fauna and flora than would be expected based on the size of the island.

The Agave weevil (top right), first identified by B. Valentine over a decade ago, has devastated the endemic agave (healthy: middle right; dying, bottom) throughout the region. Annual boat based counts on Guana show an initial increase in the number of dying plants (top left) but little increase in numbers as infections declined (Photos and unpublished data by Gad Perry).



Some of the Guana studies have been broad enough geographically or of such long duration that they have become part of broader attempts to understand ecological phenomena. For example, Powell *et al.* (2011) were able to document 364 introductions of 130 amphibian and reptile species in the entire Caribbean basin: 25 amphibians (19.2%) and 105 reptiles (80.8%).

Increase in number of invasive herpetofauna in the Caribbean is related to regional economic indicators. GDP: Gross Domestic Product. CPI: Consumer Price Index. PR - Puerto Rico; DR: Dominican Republic; JA- Jamaica. Figure from Powell *et al.* (2011)



Long-term studies now allow assessment of the effects of climate change on native species. For example, unpublished

data on racers (*Alsophis portoricensis*) over a decade show that both high rainfall and low rainfall in the previous nine months result in reduced body condition. (Data from Perry *et al.*, unpublished.)

Perhaps the longest-lasting and widest-ranging project on Guana involves banding both local and migratory birds. Records for Guana begin in 1952 and annual banding has continued since 1993, currently by C. Boal of the USGS. Changes noted in migration patterns in recent years may be related to large-scale weather patterns.



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