

## Establishment of the Puerto Rican ground lizard (*Ameiva exsul*: Teiidae), on St. Croix, U.S. Virgin Islands: a threat to native fauna

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**ABSTRACT-** The Puerto Rican ground lizard (*Ameiva exsul*) was first documented on St. Croix, U.S. Virgin Islands in 2006. The species is native to Puerto Rico, the northern U.S. Virgin Islands, and the British Virgin Islands, and was purportedly transported to St. Croix with a shipment of goods. *Ameiva exsul* has since become established in a north-central neighborhood of St. Croix, from which we collected six specimens. Analyses of their gastrointestinal tracts demonstrated they had consumed vertebrates and invertebrates. In particular we documented a *Sphaerodactylus* sp. gecko, and eggs of the endemic anole, *Anolis acutus*, as prey of *A. exsul*. The potential for establishment of *A. exsul* on offshore cays where the only populations of the St. Croix ground lizard (*Ameiva polops*) exist is a serious conservation concern, as it may prey on and compete for resources with this critically endangered endemic species.

**KEYWORDS-** Caribbean, endemic, Greater Antilles, invasive.

Endemic reptiles of St. Croix include the St. Croix ground lizard, *Ameiva polops*, which is a U.S. endangered species, the St. Croix racer, *Alsophis sanctaecrucis*, which is extinct, the St. Croix dwarf gecko, *Sphaerodactylus beattyi*, and the St. Croix anole, *Anolis acutus* (Platenberg and Boulon 2006). As on many Caribbean islands, the biodiversity of St. Croix has been devastated by the mongoose (*Herpestes auro-punctatus*), an aggressive exotic predator introduced in the 1880s (Seaman and Randall 1962, Henderson 1992). Herein we report on establishment of another invader on St. Croix, the Puerto Rican ground lizard, *Ameiva exsul*. We document the predation of *A. exsul* on native lizards of St. Croix, and discuss the risk it poses to the critically endangered *A. polops* and other fauna.

*Ameiva exsul* is native to islands of the Puerto Rican Bank (Puerto Rico and its small offshore islands, Vieques, Anegada, Culebra, Mona, the British Virgin Islands, St. Thomas, St. John, and Water Island), which does not include St. Croix. St. Croix is politically part of the U.S. Virgin Islands, but it is geologically and biogeographically independent of St. Thomas and St. John. *Ameiva exsul* appears in older literature as native to St. Croix, apparently due to misiden-

tification of *A. polops* as *A. exsul*. Barbour and Noble (1915) and Schmidt (1928) presumed that *A. exsul* was native to St. Croix, and that both *A. polops* and *A. exsul* were extirpated due to mongoose predation. At the time, *A. polops* was only known from the type specimen. Chapman Grant (1937) pointed out that before 1930, Harry L. Beatty, an ornithologist, probably had misidentified *A. polops* as *A. exsul*. There are no specimens or any other evidence that *A. exsul* ever occurred on St. Croix, and Barbour and Noble (1915) gave no indication the species had ever been seen or collected there. Additionally, Barbour (1930, 1935) wrote "I have always doubted the St. Croix record." Because of the biogeographic improbability that *A. exsul* was native to St. Croix and the indications that specimens were misidentified, we follow other authorities on Caribbean herpetofauna (Schwartz and Henderson 1991, Henderson and Powell 2009) and are confident that *A. exsul* is not native to St. Croix. Platenberg and Boulon (2006) were the first to report that *A. exsul* had been sighted on St. Croix (year not given), and Platenberg (2007) pointed out that expansion of the species could pose a threat *A. polops* and *A. acutus*.

*Ameiva exsul* is a large lizard (maximum

snout-to-vent length [SVL]: males = 201mm; females = 103mm) in the family Teiidae (Henderson and Powell 2009; Platenberg and Boulon 2006). *Ameiva exsul* lays an average of 3.36 eggs up to three times per year (Henderson and Powell 2009). This species is a wide-foraging omnivore whose diet includes invertebrates, small vertebrates including lizards and tree-frogs, *Anolis* lizard eggs, plant material, and human food scraps (Henderson and Powell 2009). Additionally, *A. exsul* is a habitat generalist, and can be found in xeric coastal lowlands, island interiors, agricultural and urbanized areas, and forests, but generally not in areas with continuous canopy cover (Henderson and Powell 2009).

The first sightings of the species on St. Croix originate from the mid-1990s, when it was seen near the center of the island, in Estate LaGrande Princess (D. Yanez, personal communication). The introduction purportedly started at a tire shop (17.7519N, 64.7258W; WGS 84), perhaps with the incidental transport of *A. exsul* to St. Croix in a shipment of car tires from St. Thomas (Platenberg 2007). We have seen *A. exsul* there since 2007 and on 25 June 2008, collected six individuals from this area using a combination of baited Sherman traps and noosing. We captured two adult females at the tire shop (17.7519N, 64.7258W), one adult male from the St. Croix Rescue Training Center (17.7526N, 64.7271W), and two adult males and one juvenile male behind a supermarket (17.7528N, 64.7285W; specific locations and the core population area are illustrated in Figure 1). The specimens were catalogued into the Biodiversity Research and Teaching Collections, where they were measured and gastrointestinal tracts were removed for analyses. There is no definitive evidence for the mode of its dispersal to St. Croix, although individuals or eggs of *A. exsul* were almost certainly transported with cargo from another island, and the tire shipment is a likely candidate (Platenberg 2007). The neighborhood in which this *A. exsul* colony is established contains many businesses that depend on imported products, including a plant nursery, the tire shop, building suppliers, and supermarkets; thus, it is not conclusive in exactly what type

of cargo the lizards may have arrived. The epicenter of the *A. exsul* population is nonetheless this neighborhood, and the population is rapidly expanding. We have observed individuals as far as 1.5 km west of the core population area (17.7516N, 64.7401W), and they are spreading north, towards a nearby preserve owned by The Nature Conservancy (R. Gideon, personal communication). Additionally, in July 2009 one *A. exsul* was observed at the far west end of St. Croix, at the Good Hope condominium complex (17.6904N, 64.8640W; O. Davis, personal communication). This individual is believed to have been transported with plants from the nursery in Estate LaGrande Princess. One, presumably this individual, has since been removed by the Department of Planning of Natural Resources (W. Coles, personal communication). Although other *A. exsul* have not been seen in the area, lizards can be extremely difficult to detect (Smolensky and Fitzgerald 2010, Treglia 2010), and monitoring should be continued.

The specimens we collected ranged from 49 to 168 millimeters SVL, and one adult female contained six oviducal eggs. The gastrointestinal contents of the specimens were examined and prey items were identified to taxonomic order (or lower where possible). Body length (head to thorax) and width (at the widest centrally located section of body) of each prey item was measured with digital calipers to the nearest 0.01 mm. Volume for each prey item was then estimated using the formula for the prolate spheroid (Vitt et al. 1993). The contents within the specimens we collected included representatives from nine orders of invertebrates and two orders of vertebrates. The sizes of diet items ranged widely (prey volume range: 0.115–546.952 mm<sup>3</sup>; mean  $\pm$  1 SD: 53.99  $\pm$  102.38; data are presented in Table 1) and included eggs of the endemic anoline lizard, *Anolis acutus*, and a sphaerodactyline gecko which we were unable to identify to species, though one of the two present on St. Croix is endemic (*S. beattyi*; Henderson and Powell 2009). The three most important items in the gastrointestinal tract, calculated following Biavati et al (2004), were Coleoptera, Blattaria, and *Anolis acutus* eggs, respectively (Table 1).

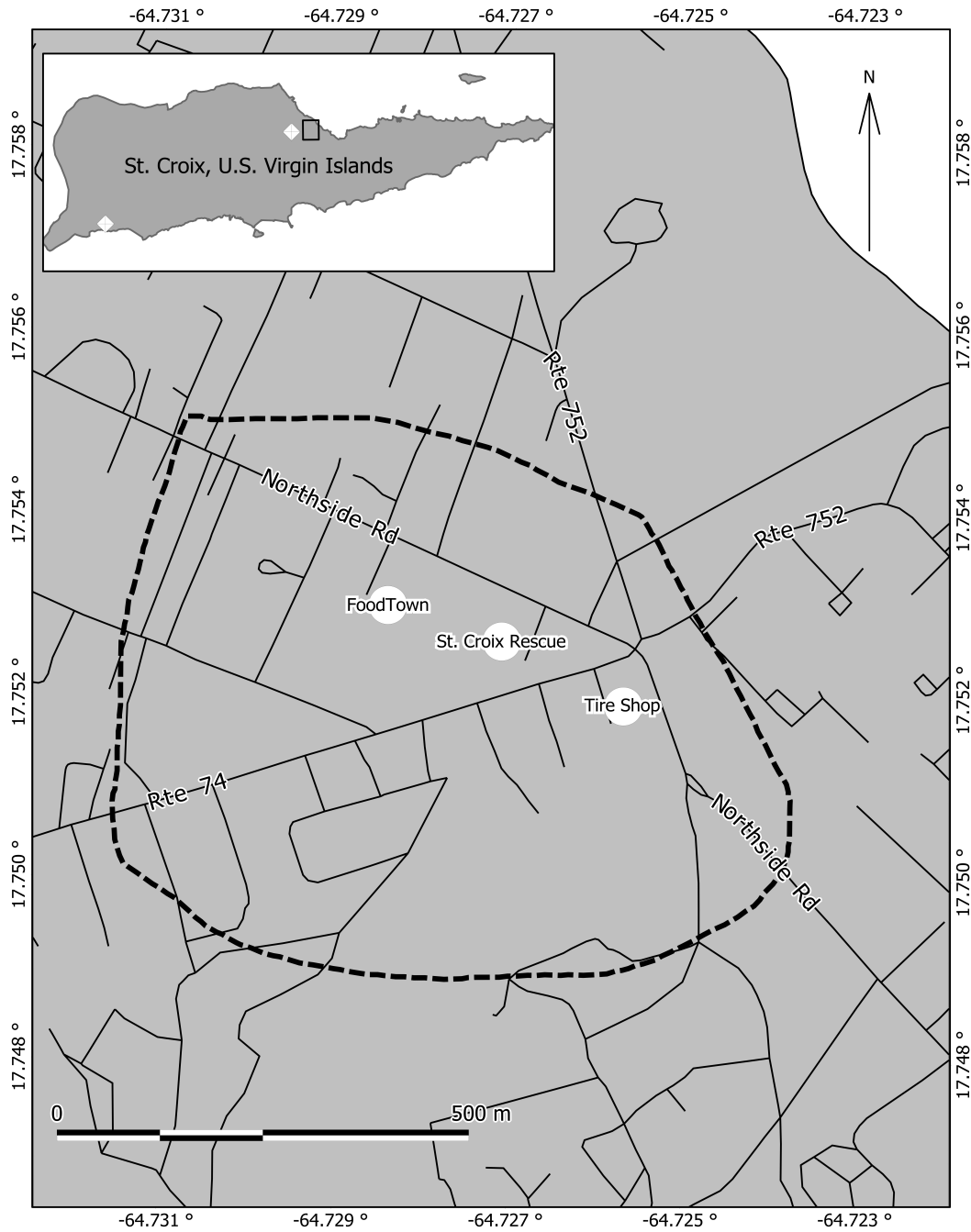


FIG 1 Map illustrating the core area occupied by *Ameiva exsul* (bounded by a dashed black line), and sites from which specimens were collected on St. Croix, U.S. Virgin Islands. White, labeled circles on the main map represent collection localities and white diamonds on the inset represent locations of other confirmed *A. exsul* sightings.

*Ameiva exsul* poses a potentially serious threat to the endangered, endemic St. Croix ground lizard, *A. polops*. *Ameiva polops* has been extirpated from St. Croix proper, with the last published sighting in 1968 (Philibosian and Ruibal 1971; Philibosian and Yntema 1976). There are currently only four populations of *A. polops*, exclusively on the small cays surrounding St. Croix: natural populations on Protestant Cay and Green Cay (each <10 ha); an introduced population on Ruth Cay, a dredge-spoil island; and another recently introduced population on Buck Island associated with a translocation project in 2008 (Treglia 2010). In light of the documented omnivory of *A. exsul*, our findings of a lizard and lizard eggs in stomach contents from St. Croix, and the small body size of *A. polops* (neonates and juveniles: 30–50 mm SVL; Henderson and Powell 2009; max. adult SVL: 88 mm; unpublished data), little doubt exists that *A. exsul* would prey on *A. polops*. We see this as a particular concern given that *A. exsul* is a dietary generalist and an aggressive active forager, that moves through habitat investigating

leaf litter and burrows, where prey, including *A. polops*, may hide (Henderson and Powell 2009). The apparent ecological similarity between *A. exsul* and *A. polops* could place *A. polops* at risk of displacement from refugia and competition for food resources should the two species come into contact. In Puerto Rico *A. exsul* is sympatric with the smaller *A. wetmorei* (Genet et al. 2001), but we cannot predict that there will not be adverse effects of *A. exsul* on *A. polops*, which does not naturally co-exist with congeners (Schwartz and Henderson 1991). Additionally, we note that *A. wetmorei* seems to occur at lower densities in the presence of *A. exsul* (Genet et al. 2001, Rivero 1998).

The proximity of the cays to St. Croix proper, and constant human use of these small islands, which includes cargo transport, increases the likelihood of human-mediated dispersal of *A. exsul* to the cays. Protestant Cay is at particular risk because it is also home to a major hotel that frequently receives a variety of materials from St. Croix proper. Protocols for prevention of, and rapid response to, introductions of *A.*

TABLE 1 Diet composition of the *Ameiva exsul* specimens from St. Croix, U.S. Virgin Islands (n = 6). Volume was measured as the prolate spheroid, Count is the total number of each prey item, and Frequency is the number of *A. exsul* specimens in which we found the prey item.

Prey Category	Volume (V)		Count (N)		Frequency (F)		Importance (I)
	No.	%	No.	%	No.	%	(%V + % N + %F) / 3
Phylum Arthropoda							
Araneae	22.13	0.45	2	2.17	2	6.90	3.17
Blattaria	2110.68	42.50	11	11.96	2	6.90	20.45
Coleoptera	249.16	5.02	5	5.43	3	10.34	6.93
Coleoptera larvae	339.41	6.83	39	42.39	5	17.24	22.16
Hemiptera	257.79	5.19	2	2.17	2	6.90	4.75
Hymenoptera	95.99	1.93	10	10.87	3	10.34	7.72
Formicidae	3.07	0.06	3	3.26	2	6.90	3.41
Ichneumonidae	12.91	0.26	4	4.35	1	3.45	2.69
Isopoda	20.51	0.41	1	1.09	1	3.45	1.65
Isoptera	4.26	0.09	1	1.09	1	3.45	1.54
Lepidoptera larvae	426.27	8.58	3	3.26	2	6.90	6.25
Scolopendromorpha	32.57	0.66	1	1.09	1	3.45	1.73
Phylum Chordata							
Aves embryo	546.95	11.01	1	1.09	1	3.45	5.18
Sphaerodactylus sp.	86.36	1.74	2	2.17	1	3.45	2.45
Anolis acutus eggs	758.74	15.28	7	7.61	2	6.90	9.93

*exsul* and mongooses to these cays warrant immediate development and implementation. We do not have a population estimate for *A. exsul* on St. Croix. However, based on even casual sightings of *A. exsul* and the time since its arrival to St. Croix, it is clear that the species is established and its range is expanding. Although mongooses are detrimental to *A. polops*, mongooses coexist with *A. exsul* on other islands (as on Puerto Rico, St. Thomas, and St. John). It is possible that *A. exsul* on St. Croix, combined with presence of mongoose, may result in an additive effect of invasive species predation on local fauna. Implementation of an eradication program of *A. exsul* will require political will and funding, and we recommend that such a program be developed and deployed while eradication is still feasible. Meanwhile immediate steps must be taken to impede the dispersal of *A. exsul*. We recommend capture and disposal of *A. exsul* whenever possible until a full eradication plan is implemented, inspection of materials before they are shipped to St. Croix, and most importantly a demonstration of willingness by natural resource agencies to address the problem. Most people are not aware of the native St. Croix ground lizard or the Puerto Rican ground lizard; thus, a well organized outreach campaign is needed to inform the public of the risks of the Puerto Rican ground lizard and the heritage value of the native St. Croix ground lizard. At the same time an eradication plan should be implemented immediately to eliminate *A. exsul* from St. Croix. Although *A. exsul* is clearly becoming established on St. Croix, we should not let this be another opportunity lost, in which we allow an introduced species to become a problematic invasive (Mack and Lonsdale 2002), and in this case at the potential expense of an endemic and geographically restricted congener.

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