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A Red-bellied Racer (*Alsophis rufiventris*) basking on the rim of The Quill, a dormant volcano on St. Eustatius. These snakes are abundant here, but have been extirpated elsewhere on the St. Christopher Bank, where the mongoose has become established.

Conservation Status of Lesser Antillean Reptiles

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Abstract.—Island populations of terrestrial animals often are vulnerable to human-mediated changes to their environments. Many insular endemics have become extinct, had populations extirpated, or are in various stages of decline. Herein we address the conservation status of terrestrial reptiles in the Lesser Antilles. Although many species in the region are ecological generalists and have adapted to the presence of humans, nearly half of the reptilian species native to the archipelago have suffered as a consequence of human alterations of their habitats or introductions of alien predators and competitors, often aggravated by catastrophic natural events such as hurricanes. Particularly vulnerable are species that are terrestrial and diurnally active. Although many of the listed factors have contributed to the decline or elimination of particular species from individual islands, we contend that the introduction of the mongoose is the single event most responsible for the extirpations and declines of many Lesser Antillean reptiles.

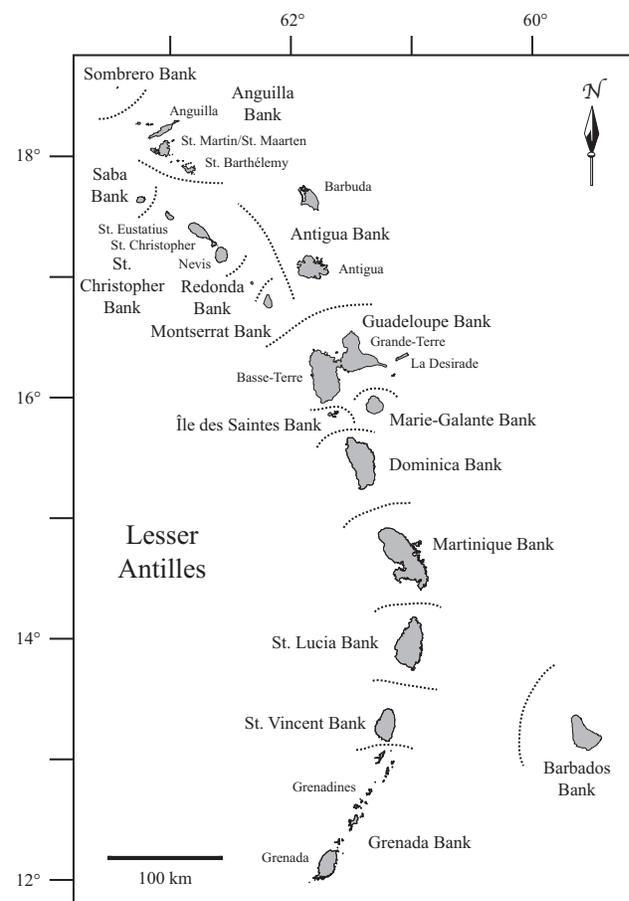
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Insular populations of terrestrial animals often suffer as a consequence of alterations to their habitats by human agency (e.g., Fosberg 1983, Case et al. 1992). Habitat specialists and endemic species that have evolved in the absence of efficient mainland predators and competitors are particularly vulnerable (e.g., Case et al. 1992). Faunas of isolated oceanic islands are represented disproportionately on lists of threatened or endangered species (e.g., 327 of 1264 or over 25% of species included on the list of U.S. endangered species are from Hawaii (http://ecos.fws.gov/tess_public/TESSUmap?status=listed)).

Declines in amphibian populations throughout the world have been documented in recent years (e.g., IUCN et al. 2004), but comparable surveys of reptilian species have yet to be implemented. Although a few species and even some genera (e.g., West Indian Rock Iguanas in the genus *Cyclura*; e.g., Alberts 2000, Alberts et al. 2004) have been the focus of intensive conservation efforts, populations of many more species, a large proportion of them found only on small islands, are in various stages of decline, and some are in imminent danger of extinction, often with little recognition by the public or even professional conservation biologists.

Herein we address these concerns for reptiles inhabiting the Lesser Antilles, an archipelago of oceanic islands on which reptiles are frequently the most abundant and obvious naturally occurring vertebrates. General surveys of the herpetofauna include Schwartz and Thomas (1975), Schwartz and Henderson (1988, 1991), and Censky and Kaiser (1999), but the only previous systematic overview of conservation needs is that of Corke (1992), and that was restricted to the Windward Islands. Although many Lesser Antillean species are ecological generalists and some thrive in altered habitats (e.g., Henderson and Powell 1999, 2001), populations of many others are declining at alarming rates. Some recent extirpations and even some extinctions have been documented, with a majority of both

attributable to human agency. Based on our own work in the region and surveys of the literature, we contend that at least 37 of 81 (45.7%) presumably native terrestrial reptilian species



Map of the Lesser Antilles, showing major islands and island banks.



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inhabiting these islands have been affected negatively in some substantive way by human activities (Table 1). These include species that have become extinct since European arrival and species (e.g., lizards in the genera *Ameiva* or *Iguana* and snakes in the genus *Alsophis*) with at least some populations that have been extirpated or drastically reduced in numbers.

Below is a summary of the terrestrial reptilian species found in the region, with particular emphasis on those that we believe warrant further attention by governmental and non-governmental, local and international conservation agencies. For those species that are most severely threatened, we provide an overview of the distribution, note any protective measures that currently exist, and provide tentative identification of the principal causative agents responsible for declining population numbers and preliminary recommendations for protection.

Turtles (Testudines)

Tortoises (Testudinidae) in the Lesser Antilles are represented by an amalgam of populations that are apparently natural (e.g., fossil remains of *Geochelone sombreroensis* from Sombrero and *G. carbonaria* from Anguilla; Auffenberg 1967, Lazell 1993, respectively) and populations of *G. carbonaria* on several islands (e.g., Schwartz and Henderson 1991) or *G. denticulata* on Guadeloupe (Breuil 2002) that may be natural, introduced by Amerindians, established recently as a consequence of escaped pets, or combinations thereof (e.g., Censky 1988). Red-footed Tortoise (*Geochelone carbonaria*) populations occur on many islands ranging from Grenada north to Anguilla, but populations often are small and many are undoubtedly declining. To see tortoises on these islands, one frequently must find the person or persons who have taken an interest in them and who will accept donations of any individuals, often keeping them in enclosures on their property. At least some of these animals date to before the advent of the pet trade in the region and are descendants of either naturally dispersed ancestors or animals carried to the islands by Amerindians in pre-Columbian times or early European settlers. In either case, tortoise populations

were likely intended to serve as food resources on future visits or during hard times. Subsequent exploitation for food, efforts at extirpation of competitors for laboriously grown vegetable crops, collection for the pet trade, and habitat alteration and destruction have depleted essentially all populations. Protection is difficult to justify when the origins of the constituent animals is uncertain. Until genetic markers can be established to distinguish long-term residents and recently escaped or released pets, protective measures aimed at specific island populations are unrealistic expectations. However, efforts to develop the necessary tools and to monitor existing populations are undoubtedly warranted on at least those islands where individuals with ancestors that arrived there by natural means are suspected to occur. Both *G. carbonaria* and *G. denticulata* (known in the region only from Guadeloupe; Breuil 2002) are listed as CITES



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Red-footed Tortoise (*Geochelone carbonaria*) populations in the Lesser Antilles represent an amalgam of individuals that may have descended from ancestors that arrived naturally in the islands by over-water dispersal, been introduced by Amerindians or colonial Europeans (presumably as food stocks), or are recently released/escaped pets.

Table 1. Reptilian species of special concern in the Lesser Antilles. The following list includes those species that have already been recognized by CITES or the IUCN as being in need of some level of international protection. Additional annotations, many based on our observations, are listed in the last column.

Species	Island/Bank	CITES Appendix ¹	IUCN Category ²	Annotation
<i>Geochelone carbonaria</i>	Lesser Antilles	II		Systematic study
<i>denticulata</i>	Guadeloupe	II	Vulnerable ³	
<i>Cnemidophorus vanzoi</i>	Maria Major		Vulnerable ⁴	
<i>Kentropyx borckiana</i>	Barbados			Monitor
<i>Ameiva ameiva</i>	St. Vincent Bank			Monitor
	Grenada Bank			Monitor
<i>cineracea</i>	Guadeloupe Bank		Extinct ⁵	
<i>corax</i>	Little Scrub (Anguilla)			Monitor
<i>corvina</i>	Sombrero Bank			Monitor
<i>erythrocephala</i>	St. Christopher Bank			
<i>griswoldi</i>	Antigua Bank			Monitor
<i>major</i>	Îles de la Petite Terre		Extinct ⁶	
<i>plei</i>	Anguilla Bank			Monitor on St.-Martin/St. Maarten
<i>Diploglossus montiserrati</i>	Montserrat		Critically Endangered ⁷	
<i>Mabuya</i> spp.	Lesser Antilles			Monitor, systematic study
<i>Iguana delicatissima</i>	Lesser Antilles	II	Vulnerable ⁸	Upgrade status to "endangered"
<i>iguana</i>	Lesser Antilles	II		Monitor, systematic study
<i>Leiocephalus cuneus</i>	Anguilla, Barbuda, Antigua, Guadeloupe			Extinct ⁹
<i>berminieri</i>	Martinique		Extinct ¹⁰	
<i>Gonatodes</i> sp.	Union (Grenadines)			Monitor
<i>Sphaerodactylus kirbyi</i>	Bequia (Grenadines)			Monitor
<i>Alsophis antiguae</i>	Antigua Bank		Critically Endangered ¹¹	
<i>antillensis</i>	Montserrat			Monitor
	Guadeloupe		Possibly extirpated	
	Marie-Galante		Possibly extirpated	
<i>rijgersmaei</i>	Anguilla Bank		Endangered ¹²	Especially on St.-Martin/St. Maarten
<i>rufiventris</i>	Saba, St. Christopher Bank		Endangered ¹³	Extirpated on St. Kitts and Nevis
<i>sanctonum</i>	Les Saintes (Guadeloupe)			Monitor
<i>Clelia clelia</i>	Grenada	II		Possibly extirpated
<i>errabunda</i>	St. Lucia			Extinct ¹⁴
<i>Chironius vincenti</i>	St. Vincent		Critically Endangered ¹⁵	
<i>Liophis cursor</i>	Martinique Bank		Critically Endangered ¹⁶	Probably extirpated on Martinique
<i>juliae</i>	Guadeloupe, Dominica			Possibly extirpated on Guadeloupe, monitor on Dominica
<i>ornatus</i>	Maria Major		Endangered ¹⁷	Extirpated on St. Lucia
<i>perfuscus</i>	Barbados		Endangered ¹⁸	Probably extinct
<i>Mastigodryas bruesi</i>	St. Vincent, Grenada Bank			Monitor
<i>Boa constrictor</i>	Dominica, St. Lucia	II		Monitor
<i>Corallus cookii</i>	St. Vincent	II		Monitor
<i>grenadensis</i>	Grenada Bank	II		Monitor
<i>Typhlops annae</i>	St.-Barthélemy			Monitor
<i>tasyticris</i>	Grenada			Monitor

¹For criteria, see <http://www.cites.org/>, ²For IUCN Red List criteria, see http://www.redlist.org/info/categories_criteria.html, ³Tortoise & Freshwater Turtle Specialist Group 1996, ⁴Gibson 1996a, ⁵World Conservation Monitoring Centre 1996a, ⁶World Conservation Monitoring Centre 1996b, ⁷Day 1996d, ⁸Breuil and Day 1996, ⁹Breuil 2002, ¹⁰World Conservation Monitoring Centre 1996c, ¹¹Day 1996a, ¹²Day 1996b, ¹³Day 1996c, ¹⁴Underwood 1995, ¹⁵Henderson 1996, ¹⁶Breuil 1996, ¹⁷Gibson 1996b, ¹⁸Carrington et al. 1996

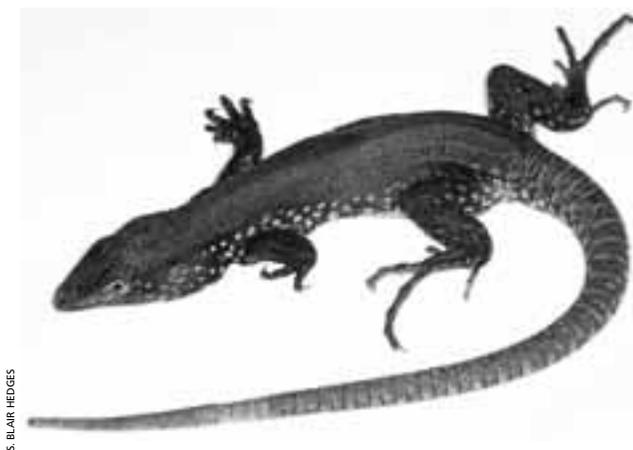
Appendix II (criteria for listing are given at: <http://www.cites.org/>), and *G. denticulata* is “vulnerable” according to IUCN Red List criteria (Tortoise & Freshwater Turtle Specialist Group 1996; for IUCN Red List criteria, see http://www.redlist.org/info/categories_criteria.html).

All other non-marine turtles found in the region are introduced semi-aquatic species in the genera *Trachemys* (Emydidae) and *Pelusios* (Pelomedusidae). The Common Slider (*T. scripta*), native to the American mainland from the southeastern United States at least into México and possibly into Central and South America, is established on St.-Martin/St. Maarten (RP, pers. obs.) and on Guadeloupe, Marie-Galante, and Martinique (Breuil 2002). The Central Antillean Slider (*T. stejnegeri*), native to Puerto Rico, parts of Hispaniola, and some Bahamian islands, has been introduced on Guadeloupe, Marie-Galante, and Les Saintes (Breuil 2002). Populations of both species are recent arrivals in the Lesser Antilles and probably originated as escaped or released pets or are descended from animals imported as food. Both have been evaluated according to IUCN Red List criteria and are considered to be at “lower risk” of becoming threatened or endangered. Schweigger’s Terrapin (*P. castaneus*) is native to West Africa and the origin of the West Indian populations on Guadeloupe and les Saintes is uncertain. Breuil (2002) noted that records of these turtles on Guadeloupe date to the early 19th Century. Consequently, since they are edible, they may have originally been introduced in association with the African slave trade. This species is listed as CITES Appendix III, based on exploitation of African turtles and with little or no consideration of the introduced West Indian populations.

Teiid and Microteiid Lizards

(Squamata: Teiidae and Gymnophthalmidae)

The St. Lucia Whiptail (*Cnemidophorus vanzoi*) is the only member of its genus in the Antilles (Presch 1971, Schwartz and Henderson 1991). Apparently endemic to two small islets, Maria Major and Maria Minor, off the coast of St. Lucia (Corke 1987), the entire population is estimated at fewer than 1000 individuals (Rowe et al. 2002). A third population has been established recently through translocation on nearby Praslin Island, from which exotic mammals (e.g., goats and rats) had



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The entire population of the St. Lucia Whiptail (*Cnemidophorus vanzoi*) is estimated at fewer than 1000 individuals.



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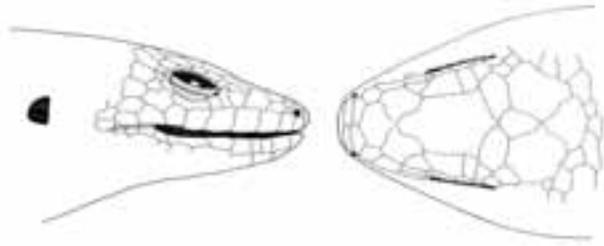
Ameiva erythrocephala appears to be doing well on mongoose-free St. Eustatius, but is essentially restricted to heavily trafficked “urban” areas on St. Christopher and Nevis.

been eradicated (Dickinson et al. 2001, John 1999). Gibson (1996a) listed the species as “vulnerable.” The relevant IUCN Red List criteria still apply, but the species is receiving the necessary attention that should keep its status from deteriorating.

Kentropyx borckiana is a unisexual species of hybrid origin that originated on the Guyana Shield and became established on Barbados following dispersal and colonization (Cole et al. 1995). Whether colonization was human-mediated is not known, nor have studies been implemented to evaluate the relationship between the Barbadian population and those on the South American mainland. The population on Barbados was once thought to be extinct (<http://users.sunbeach.net/rhinds/>), but is being encountered more frequently in recent years (Fraser et al. 1990), albeit in a very small portion of its historic range. Considering the extensive development of Barbados for agricultural purposes and, more recently, to accommodate the tourist trade, efforts to monitor this population should be encouraged.

Two Lesser Antillean species in the genus *Ameiva* are considered extinct (World Conservation Monitoring Centre 1996a,b). *Ameiva cineracea* apparently was restricted in recent times to Grand Îlet off Petit-Bourg on the eastern coast of Basse-Terre (Guadeloupe) (Schwartz and Henderson 1991), although fossil records suggest that it formerly ranged across Guadeloupe, La Désirade, Marie-Galante, and Les Saintes (Breuil 2002). *Ameiva major* was thought to occur on Martinique, but Breuil (2002) indicated instead that it was endemic to Les Îles de la Petite Terre near Guadeloupe. Breuil (2002) suggested that introduced predators and consumption by Amerindians played roles in the extinction of most populations, whereas a hurricane might have been largely responsible for the extinction of *A. major*.

The three melanistic populations of *Ameiva* from Redonda (*A. atrata*), Little Scrub Island off Anguilla (*A. corax*), and Sombrero (*A. corvina*) appear to be thriving in their respective island habitats. A documented capacity to survive potentially catastrophic natural events (e.g., hurricanes) and isolation on islands that discourage human access while offering little in the way of attractions seem to have served them well (e.g., Censky and Paulson 1992, Censky and Powell 2001). However, the very small size of these islands (Little Scrub 1.2 ha, Sombrero 38.4 ha, Redonda 130 ha) and the seasonal abundance and scarcity of food resources renders all three of these populations vulnera-



The critically endangered Montserrat Galliwasp (*Diploglossus montisserrati*) is known only from a single specimen and very few sightings. This drawing of the holotype is from Underwood (1964).

ble to unforeseen stochastic events. IUCN Red List criteria would qualify all three species for listing, although none are currently offered any formal protective status and all should be closely monitored.

Populations of other species of *Ameiva* also have declined dramatically, but they remain common in at least some portion of their historic range. *Ameiva plei* is common on Anguilla and some of its satellites (e.g., Hodge et al. 2003) and on St.-Barthélemy (Breuil 2002), but populations on mongoose-infested St.-Martin/St. Maarten are localized, and the species is absent from many areas that apparently provide suitable habitat and adequate resources (Breuil 2002). Similarly, *A. erythrocephala* appears to be doing quite well on mongoose-free St. Eustatius (Kerr et al. 2005, Rojer 1997a), but is essentially restricted to heavily trafficked “urban” areas on St. Christopher and Nevis (Barbour 1930a, Malhotra and Thorpe 1999, Westermann 1953). *Ameiva griswoldi* is rarely encountered on Antigua (RP, pers. obs.), but remains abundant on several offshore islets and is common on Barbuda, despite the potential for extensive predation by feral cats (RWH, pers. obs.). Populations of *A. ameiva* on Grenada and The Grenadines also appear to be largely restricted to areas where high levels of human activity may moderate mongoose predation (Germano et al. 2003, Simmons et al. 2005), but many populations on St. Vincent are extirpated (Corke 1992). No recent surveys have addressed the status of *A. pluvianotata* on Montserrat. However, because of its largely lowland distribution (Schwartz and Henderson 1991), most populations probably were not affected dramatically by the ongoing eruptions of the Soufrière Volcano.

Lesser Antillean microteiid (Family Gymnophthalmidae) are comprised of insular populations of species with broad South American distributions (e.g., Williamson and Powell 2004). *Bachia heteropa* is a burrowing/litter-dwelling form that appears to be holding its own on Grenada (Germano et al. 2003) and The Grenadines. Parthenogenic populations of cryptozoic species in the genus *Gymnophthalmus* are either expanding their ranges to new islands or are merely being discovered on islands where these small, inconspicuous lizards may have been present for some time. No populations appear to be threatened by current levels of human activity.

Lizards: Galliwasp and Skinks (Squamata: Anguillidae and Scincidae)

In his description of the Montserrat Galliwasp, *Diploglossus montisserrati*, Underwood (1964) quoted the collector of the holo-

type as saying that he had seen this lizard only once before, and that was twenty-five years previously. Stevens and Waldman (2001) listed several more recent sightings (through 2001), but no successful efforts at collecting additional animals. Day (1996) considered the species to be “critically endangered.” Although recent records suggest that the population is extant, the rarity of encounters and the unknown effects of recent volcanic activity on moist woodland habitats seemingly preferred by these lizards warrant extensive efforts to determine the current population size and distribution of this species, which may very well be one of the most endangered lizards in the world.

Although *D. montisserrati* is the only anguillid native to the region, skinks in the genus *Mabuya* occupy similar niches on many islands (Breuil 2002, Schwartz and Henderson 1991). Although widespread, they are nowhere abundant, and populations on St.-Martin/St. Maarten, Basse-Terre (Guadeloupe), Marie-Galante, and Martinique have apparently been extirpated (Breuil 2002). Predation by mongooses, cats, and other exotic predators and deforestation with a resultant loss of surface litter on which these animals depend appear to be primarily responsible for these lizards’ extirpations, rarity, and possible population declines. Much of the lack of concern may be attributable to the assumption that these are relatively recent introductions of one or two species that are widely distributed on the American mainland. However, no detailed systematic studies exist and, since potentially threatened endemic taxa could be hidden among populations currently assigned to *M. mabouya* or *M. sloanii*, establishing the identity and relationships of Antillean populations and those in South America (see comments in Mayer and Lazell 2000, Miralles 2005, and Powell and Henderson 2003) should be high priorities for researchers in the region.

Iguanian Lizards

(Squamata: Iguanidae, Leiocephalidae, Polychrotidae)

Unlike its more familiar relative, the Common or Green Iguana (*Iguana iguana*; see below), which has an extensive range throughout much of the Neotropics, the Lesser Antillean Iguana (*I. delicatissima*) is endemic to this region. The species’ original range extended from Martinique in the south to Anguilla in the north. However, populations have been extirpated on Barbuda, Saint Kitts, Nevis, Antigua, Les Îles des Saintes, Marie-Galante, and St.-Martin/St. Maarten (Fogarty et al. 2004, Powell 2004).



Skinks in the genus *Mabuya* are widely distributed in the Lesser Antilles, but are nowhere abundant, and several populations have apparently been extirpated.



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The Red List status of Lesser Antillean Iguanas (*Iguana delicatissima*) should be reevaluated and almost certainly upgraded to “endangered.” This male was foraging in the Boven Hills of St. Eustatius.

Breuil (2002) recently listed the populations on Dominica, Îles de la Petite Terre, and La Désirade as vulnerable. Apparently only that on Petite Terre is stable and only that on Dominica is of even moderate size (Anonymous 2004). However, even the “stable” population on Petite Terre suffered greatly during a prolonged drought in 2001 (Breuil 2002 and references therein). Breuil (2002) listed populations on Basse-Terre, Îlet Chancel (Martinique), and St.-Barthélemy as endangered, and those on Antigua, Anguilla, Barbuda, Île Fourchue and satellites (St.-Barthélemy), Grande-Terre, Martinique, St.-Martin/St. Maarten, and St. Eustatius as critically endangered — and those on Antigua, Barbuda, and St.-Martin/St. Maarten have already disappeared (Fogarty et al. 2004, Powell 2004), along with populations on St. Christopher, Nevis, and Marie-Galante. Along with all iguanas, the species is listed in CITES Appendix II and as “vulnerable” in the most current IUCN Red List (Breuil and Day 1996). All populations are protected by local regulations from hunting, although enforcement ranges from non-existent to sporadic.

Two additional, separate threats face populations of *I. delicatissima* on St. Eustatius and on Martinique, Guadeloupe, and possibly Anguilla. Mexican Creeper (*Antigonon* sp.) was intro-

duced onto St. Eustatius as an ornamental garden plant, but has escaped and covers entire regions of the island, where it actively threatens native vegetation (Fogarty et al. 2004). No effective means of control has been identified. Even goats find the Creeper unpalatable and will eat it only in the absence of alternatives. The impact on plants consumed by iguanas has not been assessed, but the danger is obvious.

The threat facing populations of *I. delicatissima* on Martinique and Guadeloupe is the possibility of hybridization with introduced populations of *I. iguana*. The possibility of previous, “natural” contact between the two species on various Lesser Antillean islands cannot be disregarded, despite the fact that the natural distribution of the two species appears to be allopatric. Fossil remains of *I. iguana* are known from Grande-Terre (Guadeloupe), where *I. delicatissima* presumably occurs naturally. Also, Breuil (2002) noted that the one figure in Seba (1734) that was not an illustration of *I. iguana* and on which Laurenti (1768) largely based his description of *I. delicatissima* was probably a hybrid, indicating that contact between the two species is not a recent phenomenon (see Pasachnik et al. 2005 for a complete list of pertinent references and an extensive discussion of the species’ nomenclatural history). Intermittent con-

tact, with the possibility of introgression into native populations of either species, quite possibly occurred on several islands (although the statement in Anonymous 2004 that “Dominica, La Désirade and La Petite Terre are the only islands where just *Iguana delicatissima* is thought to live” is not warranted or accurate, as no reason exists to doubt the “purity” of populations on Anguilla or St. Eustatius). Regardless, in recent years, human-mediated introductions of *I. iguana* onto islands inhabited by *I. delicatissima* and reductions in the extent of suitable habitat caused by human encroachment have dramatically magnified the frequencies of contact between the two species on Martinique and Guadeloupe, where populations of “pure” *I. delicatissima* have essentially disappeared.

In light of documented declines in many populations, ongoing habitat destruction and alterations, continuing competition with introduced mammalian herbivores, predation by

alien predators on many islands, and possible contamination of the gene pool as a consequence of interbreeding with introduced populations of Green Iguanas (Pasachnik et al. 2005), the Red List status of the species should be reevaluated and almost certainly upgraded to “endangered.” Only the fact that populations remain on multiple islands precludes assignment of “critically endangered” status.

Like Lesser Antillean populations of tortoises (see above), those of Green Iguanas (*Iguana iguana*) may be descendants of ancestors that arrived in the islands by natural (non-human-mediated) overwater dispersal, have been introduced by Amerindians (probably for food), established recently as a consequence of escaped pets, or combinations thereof (Powell 2004). Presumably native populations occur on Grenada, St. Vincent, The Grenadines, St. Lucia, Saba, and Montserrat. Populations of unknown or mixed origin are on Martinique,



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Priority should be given to better understanding the unique populations of *Iguana iguana* on Saba, Montserrat, and St. Lucia. This individual is from Saba.

Guadeloupe, Les Îles des Saintes, and Marie-Galante; and populations presumed or known to be introduced occur on Antigua, Barbuda, St.-Martin/St. Maarten, and Anguilla. A presumably natural population on Barbados is extirpated (Breuil 2002).

Because of the species' broad continental range, which extends from México through Central America and much of northern South America, and a general lack of recognition of genetic variability among populations, protective measures are considerably less stringent than for *I. delicatissima*. *Iguana iguana* is listed in CITES Appendix II, but export quotas exist for many countries, primarily for live animals (pet trade) or products (leather goods and meat). No distinction is made for native versus introduced or for continental versus insular populations. Hunting is usually prohibited, but enforcement of laws is lax at best. In Grenada, Green Iguanas are considered game animals (Powell 2004), with a "regulated" hunting season and bag limits. Both are routinely ignored by local hunters.

Basic surveys are necessary on Montserrat, where the status of the *I. iguana* population is unknown and on islands, such as St. Vincent, The Grenadines, and Grenada, from which we have no current data on the populations. Field research on the basic biology of populations are needed for all populations, but priority should be given to better understanding the genetically unique populations of *I. iguana* on Saba, Montserrat, and St. Lucia (Malone et al. 2004, Morton 2004), all of which might warrant recognition as distinct species (Powell 2004).



This woodcut of a "roquet" in Rochefort (1658) undoubtedly represents *Leiocephalus cuneus* and provides convincing evidence that the species was extant during the colonial period (from Breuil 2002).

Other iguanian lizards in the region include the ubiquitous and scansorial anoles (*Anolis*), which are found on essentially every island capable of supporting any vegetation. These lizards appear to adapt well to alterations of their habitats, functioning as human commensals in many instances (Henderson and Powell 1999, 2001). However, we cannot predict the effects on native species by introduced anoles. Documented instances in the Lesser Antilles (*A. carolinensis* on Anguilla, Eaton et al. 2001;



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Anoles, such as this *Anolis sabanus* from Saba, are found on essentially every island capable of supporting any vegetation and appear to adapt well to alterations of their habitats, functioning as human commensals in many instances.



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Alsophis rufiventris remains abundant on mongoose-free Saba and St. Eustatius, but has been extirpated on mongoose-infested St. Christopher and Nevis.

A. sagrei on Grenada, Greene et al. 2002; *A. cristatellus* on Dominica, Powell and Henderson 2003; and the apparently unsuccessful colony of *A. bimaculatus* on St.-Martin/St. Maarten, Powell et al. 1992) suggest that the introduced species are limited to areas of dramatically altered habitats, where they presumably pose little threat to native congeners. These are all relatively recent introductions, however, and longer-term effects are unknown.

In stark contrast to the anoles and more comparable to the fate of many populations of *Ameiva* is the apparent status of terrestrial Curly-tailed Lizards (*Leiocephalus*). Two species occurred in the Lesser Antilles, and both appear to have become extinct in historical times, albeit prior to the introduction of the mongoose (Breuil 2002, World Conservation Monitoring Centre 1996c). *Leiocephalus cuneus* may once have been widespread (fossil remains assigned to *L. cf. cuneus* are known from

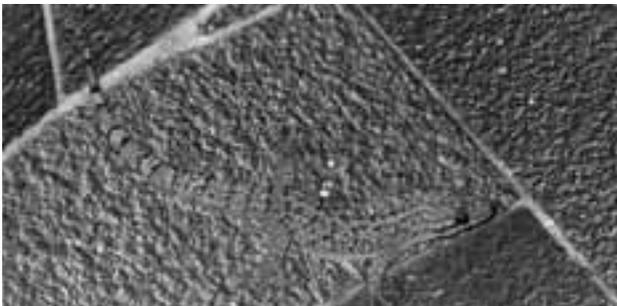
Anguilla, Barbuda, Antigua, and Guadeloupe; Breuil 2002, Schwartz and Henderson 1988), whereas *L. herminieri* is known only from Martinique. No specimens of the latter have been taken since the 1830s (World Conservation Monitoring Centre 1996c). The association of remains with archaeological sites suggests that pre-Columbian human activities may have contributed to these species' declines, although populations of both were apparently extant after European colonization.

Geckos

(Squamata: Gekkonidae)

Phyllodactylus pulcher is the only Leaf-toed Gecko known to occur in the Lesser Antilles. The species is endemic to Barbados, where it presumably is "nocturnal, arboreal, and insectivorous" (Dixon 1962, Schwartz and Henderson 1991). Although some references to edificarian habits exist (e.g., <http://users.sunbeach.net/rhhinds/>), known localities for the species are limited and its range has not been systematically investigated (Government of Barbados 2002). The species is considered rare (Ministry of Physical Development and Environment, Barbados 2001). Surveys seeking to establish the distribution and abundance of this Barbadian endemic should be encouraged, especially since insular populations of Leaf-toed Geckos elsewhere appear to be vulnerable to population declines when faced with competition from House Geckos in the genus *Hemidactylus* (G. Köhler, pers. comm.).

Other geckos known to occur on Lesser Antillean islands include two species of House Geckos (*Hemidactylus*), the Turnip-tailed Gecko (*Thecadactylus rapicauda*), various species of Dwarf Geckos (*Sphaerodactylus*), an undescribed species of Clawed Gecko (*Gonatodes*), and the introduced Tokay Gecko



R.H. HINDS

The Barbadian Leaf-toed Gecko (*Phyllodactylus pulcher*) is the only known member of its genus to occur in the Lesser Antilles. Essentially nothing is known about its natural history, distribution, or abundance (<http://users.sunbeach.net/rhhinds/Leaf%20Toed%20Gecko.html>).

Table 2. Presence or absence of species of *Ameiva*, *Alsophis*, *Liophis*, and the mongoose (*Herpestes javanicus*) on Lesser Antillean islands. A “+” indicates presence and a “–” indicates absence of the mongoose or absence of a species of *Ameiva*, *Alsophis*, and/or *Liophis* from an island where that species once occurred. An asterisk (*) indicates that, if the species still occurs on the island, it is very rare or restricted to isolated enclaves. The absence of either a “+” or a “–” denotes that no record of that taxon occurring on that island exists. Many small islands and cays not listed here may support *Ameiva* populations and have no mongooses. *Alsophis* also is known from Barbuda, but only as a fossil.

Island	Mongoose	<i>Ameiva</i>	<i>Alsophis</i>	<i>Liophis</i>
Sombrero	–	+		
Anguilla	–	+	+	
Scrub	–	+	+	
Little Scrub	–	+		
St.-Martin/				
St. Maarten	+	+	+	*
St.-Barthélemy	–	+	+	
Saba	–		+	
St. Eustatius	–	+	+	
St. Christopher	+	+	–	
Nevis	+	+	–	
Antigua	+	+	–	
Great Bird	–	+	+	
Barbuda	–	+		
Redonda	–	+		
Montserrat	–	+	+	
Guadeloupe	+		+	+
Terre-de-Haut	–		+	+
Terre-de-Bas	–		+	
Marie-Galante	+		–	+
Dominica	–	+	+	+
Martinique	+		–	
Rocher de				
Diamant	–			+
St. Lucia	+			–
María Major	–			+
Barbados	+			–
St. Vincent	+	+		
Grenada	+	+		

(*Gekko gekko*). House geckos are human commensals and are abundant nearly everywhere. Turnip-tailed Geckos are widely distributed, but appear to be less common than House Geckos, although that might be attributable largely to habitat preferences for forested areas rather than buildings (e.g., Howard et al. 2001). Many Dwarf Geckos are phenomenally abundant (e.g., *S. parvus* and *S. sputator* on Anguilla or *S. sabanus* and *S. sputator* on St. Eustatius; Nava et al. 2001, Hensley et al. 2004), but others, such as *S. elegantulus* on Antigua are rarely encountered, even in apparently suitable habitat (RP, pers. obs.). The first Dwarf Gecko to be found on the Grenada Bank, *S. kirbyi*, was described from six specimens in the mid-1990s (Lazell 1994). It has so far been recorded only from Bequia, one of the northernmost of The Grenadines. The population on Bequia should be monitored and other islands in The Grenadines should be surveyed for Dwarf Geckos, as should Grenada, the only major landmass in the Windward Islands that does not harbor a species of *Sphaerodactylus*. The undescribed Clawed Gecko (*Gonatodes*



Like populations of other diurnal, terrestrial reptiles, *Liophis*, like this *L. juliae* from Dominica, is extremely vulnerable to predation by introduced mongooses.

sp.) appears to be restricted to leaf litter in mature upland dry forest on Union Island in the Grenadines. Nothing is known about the distribution or natural history of this species, the habitat of which should be monitored closely.

Common Snakes (Squamata: Colubridae)

The ranks of the Colubridae, like the ground-dwelling *Ameiva* lizards, have suffered the greatest number of extirpations, extinctions, and/or dramatic reductions in geographic ranges in the West Indies in general and the Lesser Antilles in particular. West Indian Racers (*Alsophis*) are, essentially, snake counterparts of *Ameiva*. They are ground-dwelling, diurnal, fast-moving, oviparous, and apparently susceptible to predation by ground-dwelling, diurnal, fast-moving mongooses. Although some species on some islands harbor healthy racer populations (e.g., *Alsophis antillensis* on Dominica and Montserrat, *A. rijgersmaei* on Anguilla and St.-Barthélemy, and *A. rufiventris* on Saba and St. Eustatius; Breuil 2002, Heinz et al. 2004, Henderson 2004, Hodge et al. 2003, Maley et al. 2005, Malhotra and Thorpe 1999, Rojer 1997a,b, Savit et al. 2005, RWH and RP, pers. observ.), populations of the same species are restricted to small, isolated enclaves on St.-Martin/St. Maarten (*A. rijgersmaei*; Powell et al. 1992, Rojer 1997c, Breuil 2002) and extirpated on Antigua (*A. antiquae*), Marie-Galante (*A. antillensis*), St. Christopher and Nevis (*A. rufiventris*), and possibly Guadeloupe (*A. antillensis*) (Barbour 1930a, Henderson 1992, 2004, Maley et al. 2005, Sajdak and Henderson 1991, Sajdak 2004). In each instance, the mongoose appears to be primarily responsible.

If mongooses are present on an island, racers have usually been extirpated; if the mongoose is absent, racer populations are healthy (Table 2). A textbook example is illustrated by the situation on Antigua and one of its satellite islands. Mongooses were introduced onto Antigua in the late nineteenth century (Henderson 1989), and, in 1936, Parker declared *A. antiquae* extinct. Apparently unknown to Parker, however, a population of *A. antiquae* survived on the small (9.9 ha) mongoose-free satellite known as Great Bird Island, situated 2.5 km off the northeastern coast of Antigua. Valiant efforts are being made to insure that the Great Bird Island population of *A. antiquae* does not go the way of the main island populations (Daltry et al. 2001).

Grove Snakes (*Liophis*) are, like racers, ground-dwelling, diurnal, oviparous, and have been extirpated on islands where mongooses have been introduced (Table 2). For the most part, they occur on islands south of the range of *Alsophis*, although Guadeloupe, Marie-Galante, and Dominica have or had representatives of both genera. Grove Snakes have been eliminated from Martinique (*L. cursor*), St. Lucia (*L. ornatus*), and Barbados (*L. perfuscus*). A satellite population of *L. cursor* occurs on Rocher de Diamant (0.06 km²) and, similarly, a satellite population of *L. ornatus* occurs on Maria Major (0.09 km²) off the coast of St. Lucia. The status of both of these populations is, at best, precarious. *Liophis juliae* occurs on Guadeloupe and Dominica. It is rare to possibly extirpated on mongoose-infested Guadeloupe and, conversely, it is widespread and common on mongoose-free Dominica.

Two species of *Clelia*, often called “cribo” in the West Indies, are somewhat of an enigma. *Clelia clelia* (CITES Appendix II) may reach 2.0 m and is a powerful snake that is capable of constriction and injecting venom via fangs situated in the rear of the upper jaws. The venom is effective for subduing vertebrate prey (mostly snakes and small mammals). Because it shares characteristics with *Alsophis* and *Liophis* (ground-dwelling, sometimes diurnal), it may be or may have been vulnerable to mongoose predation. It may never have been common in the West Indies (Henderson 2004). During fieldwork spanning 15 years on Grenada, RWH has never encountered this species, and Grenadians concur that it is a very rare snake. Most adults have not seen one since they were children. Although the species warrants protection on Grenada, we are uncertain how to effectively establish protection for a species that most people have never seen and therefore would not know it if they did see it. *Clelia errabunda* was endemic to St. Lucia. It is now extinct, and Underwood (1995) attributed its disappearance to human activity.

A single species of *Mastigodryas* (*M. bruesi*) occurs on St. Vincent and the Grenada Bank. It has been introduced to Barbados, possibly via banana shipments that originated in St. Vincent (Underwood et al. 1999). This slender, diurnal snake was often encountered sleeping in trees on St. Vincent in the late 1980s, but surveys in the early 1990s failed to produce any sightings. Barbour (1914) described this species as “... apparently, the most abundant ophidian on the island [of Grenada].” Whether or not that was an accurate statement in 1914 is impossible to say (see comments in Henderson and Powell 2005 regarding the accuracy of Barbour’s assessments of herpetofaunal abundance), but it doesn’t apply today. Barbour (1930a, 1930b, 1935, 1937) declared the species extinct on St. Vincent and “very rare” on Grenada. Corke (1992) noted that the species was “relatively common,” but might have been referring solely to St. Vincent. The species apparently is rare in Grenada (Greene et al. 2003). RWH has not observed a live individual over a 15-year span, but two field associates saw individuals at two different sites in 2003. The species may be more common on at least some of The Grenadines, but it has been over a decade since active fieldwork has been conducted there. Although its arboreal tendencies (Schwartz and Henderson 1991) might provide some protection from predation by terrestrial mongooses (Sajdak and Henderson 1991), the species’ uncertain status throughout its known range certainly calls for survey work and possible monitoring.



ROBERT POWELL

The largely arboreal habits of *Mastigodryas bruesi* appear to render this species somewhat less vulnerable to mongoose predation than more terrestrial colubrid snakes in the region.



ANITA MALHOTRA

Boa Constrictors (*Boa constrictor*), such as this individual from Dominica, are subject to persecution on the Lesser Antillean islands where they occur; although not in imminent danger of eradication, populations should be monitored.



ROBERT W. HENDERSON

Whether the apparent recent decline in the numbers of treeboas (*Corallus grenadensis*) is a natural phenomenon or not is uncertain.

Chironius, a geographically and ecologically widespread genus on the Neotropical mainland, is represented by a single species in the West Indies. *Chironius vincenti* is endemic to St. Vincent. Henderson et al. (1988) described the first specimen to reach a museum in over 100 years. This may be the most habitat-dependent snake species in the Lesser Antilles. Snakes are restricted to primary and secondary forests at elevations from 275–600 m, where they are active by day on the ground and in trees and where they feed on anurans (Henderson and Haas 1993). Radical modification of primary and secondary forests on St. Vincent would have serious consequences for *C. vincenti*; it is considered “critically endangered” on the IUCN Red List (Henderson 1996).

Boas (Squamata: Boidae)

The Boa Constrictor (*Boa constrictor*) is restricted to Dominica and St. Lucia in the Lesser Antilles, and each island supports an endemic subspecies (*B. c. nebulosus* and *B. c. orophias*, respectively). On Dominica, the species is exploited for its fat, which is rendered and the resultant oil is used to treat arthritis and other joint ailments (Malhotra and Thorpe 1999; M. Day, *in litt.*). Boa Constrictors are subject to persecution merely because they are snakes, and also because they may represent a potential danger to humans as a consequence of their size. To the best of our knowledge, *B. constrictor* populations in the Lesser Antilles are not in imminent danger of eradication, but they should be monitored.

The treeboas *Corallus cookii* and *C. grenadensis* are Lesser Antillean endemics on St. Vincent and the Grenada Bank, respectively. *Corallus cookii* was moderately common when last surveyed in the late 1980s and early 1990s (Henderson 2002). *Corallus grenadensis* occurs on ten islands (Grenada plus nine of The Grenadines). We have not surveyed populations on The Grenadines for over a decade, but we assume all populations are still extant. Population declines have been observed on Grenada (Henderson 2002, Henderson and Berg 2005), but we are unable to state with any certainty why they have occurred. We have seen declines at sites where treeboas were being captured, marked, and released; we have also witnessed them where no handling occurred. Although Henderson (2002) did not agree with



HANS E. A. BOOS

Pit-viper populations may have benefited from the introduction of the mongoose, as larger snakes readily consume them. This *Bothrops lanceolatus* is from Martinique.



S. BLAIR HEDGES

Because of the secretive habits of snakes in the genus *Typhlops*, assessing the status of these small ant- and termite-eating snakes can be difficult. This is *T. geotomus* from Nevis.

Grenadians that *C. grenadensis* was not as common as they once were, he now concurs that, certainly at some sites, numbers have dwindled (Henderson 2003, Henderson and Berg 2005). The depression in numbers we are now seeing may be a natural phenomenon, and numbers might eventually increase again. Regardless, the situation on Grenada warrants monitoring.

Pit-vipers (Squamata: Viperidae)

Two species of Pit-vipers occur in the Lesser Antilles: *Bothrops caribbaeus* on St. Lucia and *B. lanceolatus* on Martinique. Both species survived years of having bounties on their heads. Although bounties are no longer offered, over a seven-year period in the 1960s, bounties on more than 50,000 *B. lanceolatus* were collected on Martinique (Pinchon 1967). These snakes undoubtedly are routinely killed when encountered by humans. Nevertheless, we are led to believe that both species remain common on their respective islands (Lazell 1964, Powell and Wittenberg 1998). Lazell (1964) even suggested that, unlike so many other West Indian endemic snakes and lizards, *Bothrops* may have benefited from the introduction of the mongoose, as larger individuals readily consume mongooses.

Blind Snakes and Thread Snakes (Squamata: Leptotyphlopidae and Typhlopidae)

Because of the secretive habits of these small ant- and termite-eating snakes, assessments of their status are difficult. *Leptotyphlops bilineatus* (Martinique, St. Lucia, Barbados) and *Typhlops geotomus* (St. Christopher Bank, Antigua Bank) have multi-island distributions and likely have healthy populations. Conversely, *T. annae* (St.-Barthélemy), *T. monastus* (Montserrat), *T. guadeloupensis* (Guadeloupe), *T. dominicanus* (Dominica), and *T. tasymicris* (Grenada) have single-island distributions and some species may deserve legislated protection. *Typhlops dominicanus* is widespread on Dominica (Malhotra and Thorpe 1999), and we have had no trouble finding *T. guadeloupensis*. *Typhlops annae* was only recently described (Breuil 1999) and it occurs on a small (22 km²) island; its status should be monitored. *Typhlops tasymicris* was discovered in 1968 (Thomas 1974) and, since then, only one additional specimen has been deposited in a scientific collection (Wallach 2000). We have made unsuccessful efforts to collect it (or even to find someone on Grenada who is

familiar with the species). We are unaware of the status of *T. monastus*. Its relatively extensive distribution on Montserrat (Schwartz and Henderson 1991) would suggest that the species is secure despite recent volcanic activity on that island. Possible effects resulting from the introduction of *Ramphotyphlops braminus* on Anguilla, St.-Martin/St. Maarten, and St.-Barthélemy (Breuil 2002, Censky and Hodge 1997) are unknown.

Summary

Many Lesser Antillean reptiles are habitat generalists, descendants of effective colonizers, and often adapt well to human-mediated alterations of their environments. The most obvious examples are the many anoles that probably were arboreal historically, but adapt readily to almost any vertical structure. Furthermore, they are heliothermic to varying degrees and seem to thrive in situations in which human activity has created habitat edges. Also apparently doing well are some of the nocturnally active species (e.g., *Hemidactylus* and *Thecadactylus*), those that are small and inconspicuous (e.g., *Gymnophthalmus* and some *Sphaerodactylus*), and species that spend most of their lives underground (e.g., *Bachia* and most *Typhlops*).

In sharp contrast, many other reptiles have seen populations decline precipitously and even disappear altogether. Particularly vulnerable are species that are associated primarily or solely with pristine habitats that no longer exist on most islands, are large and can serve as an economic commodity, inspire fear, or are diurnally active and terrestrial. Undoubtedly the most widely applicable effects on the majority of species are associated with habitat destruction or change. Species, such as *Diploglossus montisserrati* or *Chironius vincenti*, for example, that are adapted to either dry lowland forests or lush rainforests, usually at higher elevations, often suffer as trees are cleared to make way for agriculture, human housing and associated infrastructure, or the demands of the tourist industry. Iguanas often suffer when forced to compete for food with introduced mammalian herbivores, and Treeboas (*Corallus*) require a contiguous



ALAIN FOSSE

In the absence of mongoose (*Herpestes javanicus*) introductions, extirpations of terrestrial reptiles in the Lesser Antilles would be far less common.

Table 3. Factors that may contribute to extinctions, extirpations, range constrictions, and/or declining populations in Lesser Antillean reptiles.

Factor	Examples
Introduced predators	cats, dogs, mongooses, rats
Introduced competitors	<i>Gekko gekko</i> , <i>Elaphe gutatta</i> , herbivorous mammals
Habitat modification due to development	housing for growing human population; hotels and golf courses for tourism
Habitat modification to sustain human population	deforestation to create pastures or livestock; fields for crop production, charcoal production
Habitat modification due to free-ranging livestock	cropping of vegetation to dirt level by goats, sheep, burros, pigs, and cattle
Natural catastrophes	hurricanes

canopy that exists in increasingly fewer localities within their ranges. Some, such as the tortoises, the iguanas, and even *Boa constrictor*, are exploited directly for food or other marketable products. Others, such as nearly all of the snakes, are persecuted by residents who consider them all dangerous.

Factors that may contribute to declining populations (and, potentially, extirpation or extinction) are listed in Table 3. With the exception of natural catastrophes, the one variable that the rest of these factors have in common is the human element. The first four categories all require human involvement. With so many factors that are capable of contributing to the extinction, extirpation, or obvious decrease in population numbers or constricted geographic ranges, singling-out one factor to explain a geographically broad pattern of extirpations may seem irresponsible. However, the geographically broad scope of the extirpations points to a single factor and, more importantly, to a single species: *Herpestes javanicus*. The almost complete correlation between the presence of mongooses and the decline or absence of terrestrial lizards (e.g., *Ameiva*, possibly *Mabuya*) and snakes (e.g., *Alsophis*, *Liophis*) (Table 2) clearly indicates that this introduced predator has, in fact, directly contributed to the decline, extirpation, and even extinction of Lesser Antillean reptiles. This assertion differs with Corke (1992), who suggested that no conclusive evidence existed for the widely reported role of introduced mongooses in the decline of the islands' reptiles. Likewise, Baskin and Williams (1966) were, at best, ambivalent regarding the impact of *Herpestes* on *Ameiva*. Although we concede that other factors (e.g., overdevelopment; cats, dogs, and rats) have contributed to the decline or elimination of a particular species from an island, we contend that, in the absence of mongoose introductions, extirpations would be far less common in the Lesser Antilles.

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