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This male Green Iguana (Iguana iguana) from Fort Lauderdale (Broward Co.) is among the many species of exotic amphibians, reptiles, turtles and crocodilians that are established in Florida. (Photograph by Gary Busch).

A Runaway Train in the Making: The Exotic Amphibians, Reptiles, Turtles, and Crocodilians of Florida

Monograph 1.

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A RUNAWAY TRAIN IN THE MAKING:

THE EXOTIC AMPHIBIANS, REPTILES, TURTLES, AND CROCODILIANS OF FLORIDA

MONOGRAPH 1.

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DEDICATION

To the memory of Henry “Hank” T. Smith, a dear friend and co-investigator on many enjoyable projects, and a person who made a positive difference in my life and in those of many others.

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Herpetological Conservation and Biology 6(Monograph 1):1-101.
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INTRODUCTION

As of 2004, 40 exotic species of herpetofauna occurred in established populations in Florida (Meshaka et al. 2004a), and two years later, Meshaka (2006) reviewed the inclusion of six more species. Yet another species appeared as established in 2007. In light of a wealth of new published information since Meshaka et al. (2004a) went to press and a continuing accumulation of new exotic species and colonies of existing exotic species, it became apparent that an update of Meshaka et al. (2004a) was warranted. Thus, this new edition is both a snapshot in time and a progress report, providing a summary of Florida's exotic herpetofaunal phenomenon. Its goal remains unchanged: to convey to an audience of budding naturalists, land managers, professional biologists, and those at regulatory institutions what is currently known and unknown about the established ecology and colonization dynamics of each established species. This will better enable interested individuals to understand the colonization process and will provide them useful information with which to make wise management decisions. In a larger context, the geographic distributions of exotic herpetofauna in North America were determined to be so extensive that The Center for North American Herpetology maintains an active update of those species.

The taxonomic, ecological, and geographic patterns associated with the currently established 47 Floridian species deviates little from those patterns noted by Meshaka et al. (2004a). For example, most of the species are lizards, especially geckos and anoles (Table 1). Most of these species are small, early maturing, fecund, generally insectivorous, nocturnal, and excel in establishing themselves around humans even if they are not limited to human-disturbed situations. The native centers of geographic distribution for most of these species is the New World (n = 28), 15 of which are from

FIGURE 1. The 67 counties of Florida, U.S.A.

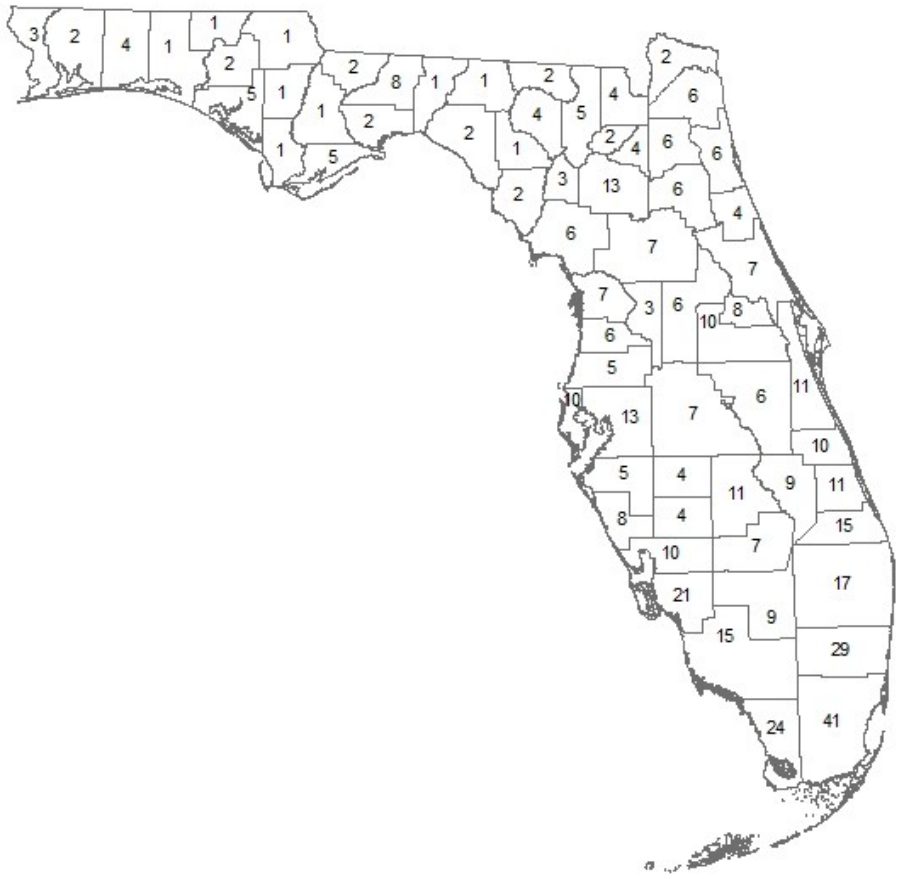

FIGURE 2. The number of exotic herpetofaunal species by county in Florida.

TABLE 1. Taxonomic breakdown of the established exotic species of herpetofauna in Florida.

Taxon	Number of species
Frogs and Toads	4
Turtles	1
Lizards	38
Snakes	3
Crocodilians	1
Total	**47**

the West Indies. Nineteen of the exotic species arrived from the Old World. The Florida distributions of most of these species are centered in the southern part of the state (Fig. 1 and 2). Exceptions to these patterns exist and sharply test the rule. For example, the Burmese Python (*Python bivittatus*) is a large carnivore that may require a few years of growth before egglyaying is possible (pers. obs.). The Texas Horned Lizard (*Phrynosoma cornutum*) is firmly established in northern Florida and apparently absent in southern Florida. Further, when compared to 2004, the geographic distributions for many of these species have exploded and the number of new species has yet to reach a plateau (Fig. 3); an exotic species runaway train, as it were.

Indeed, each new exotic population and each new exotic species is a barometer of human failure to be good stewards of a natural legacy for which we are responsible. For better or worse, these are also opportunities to more clearly understand why species succeed or fail and what can be done, if at all, to manage one of the most compelling Florida conservation issue of the new millennium (Meshaka and Babbitt 2005). I hope this current work has revealed these issues and has shed light on the value of understanding colonization processes and making good management decisions in this turbulent part of the world called "the Sunshine State."

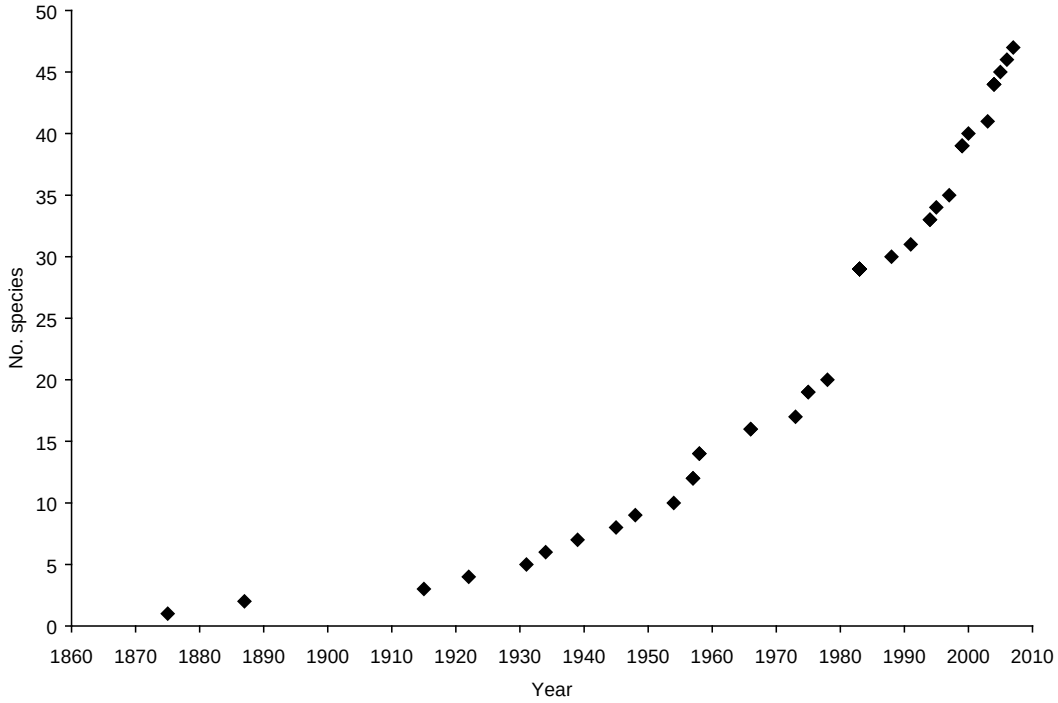

FIGURE 3. Accumulation curve of the number of exotic herpetofauna in Florida as measured by year of first record.

PROCEDURES AND ORGANIZATION

The species accounts are taxonomically organized by frogs and toads, turtles, lizards, snakes, and crocodilians. Within each of these groups, I present families and species in alphabetical order. I used the most current scientific names as proposed in peer-reviewed publications and the standardized common names of Collins and Taggart (2009). The literature search ended 30 June 2009. I have used a binomial nomenclature because of genetic mixing, both probable and known. This phenomenon was apparant in a number of these species (e.g., Lee 1985, 1987; Miyamoto et al. 1986; Lee 1992; Butterfield 1996) and seems likely in other species, such as the Green Iguana and the Cane Toad, imported from across their broad geographic ranges for the pet trade. Genetic mixing among closely related forms was a matter of concern in another taxon, the Red-eared Slider (*Trachemys scripta elegans*; Aresco and Jackson 2006). Indeed, these Florida populations may ultimately prove to have a greater heterozygosity than source populations, as in the case of the Brown Anole (Kolbe et al. 2004), and may perhaps deserve their own taxonomic names as distinct entities.

For each species, I provide a color photograph of an individual from Florida and begin with its name and description. I also provide a Florida distribution map for each species. Because, with rare exception, most of these species occur (for now) in one or a few counties and are widespread within those counties, and because narrative relating to their distributions accompanies each map, it seemed far more practical to denote distribution on maps at the county level. For each species, I discuss the geographic distribution, beginning with where the species is native and when and where it was first documented in Florida. For historical reference, I also include, if available, the age of the first colony. Meshaka et al. (2004a) discussed the history of introductions, and for information on that topic, I refer the reader to that source. Next, I discuss species occurrence in Florida. I begin with southern Florida and present data temporally and I present counties in alphabetical order. I present the same information for regions elsewhere in Florida. Within each region, I note presence as records (vouchered specimens or photographs) and sightings as reports. I pay special attention to presence along the chain of Florida Keys. Therefore, sites not noted in Meshaka et al. (2004a) are included with original citation. Sites previously summarized in Meshaka et al. (2004a) are cited as such. I include reports since those presented in Meshaka et al. (2004a) if they are noteworthy, such as those for previously undocumented counties or Florida Keys, or those in otherwise poorly documented counties. I include species as introduced and established exotic taxa in this update if they meet the criteria of Meshaka et al.

(2004a): presence of a record, evidence of breeding, and persistence having lasted at least one generation time. I note exotic status for each species if they occur elsewhere in the United States or in the West Indies. After distributional information, I follow with sections on *Body size* (of adults), *Habitat and abundance*, *Diet*, *Reproduction*, *Growth and survivorship*, *Activity* (seasonal then diel), *Predators* (native predator species followed by exotic species), and *Threats* (first impacts on or by native species, then impacts on or by other exotic species).

A section entitled Florida's Exotic Runaway Train follows the Species Accounts. This chapter clarifies the issue of the patterns and problems associated with the exotic herpetofauna of Florida. This chapter also discusses the human role in contributing to species colonization and, hopefully, its potential role in addressing this conservation issue.

Abbreviations used throughout the text are: ABS (Archbold Biological Station), BHSP (Barnacle Historic State Park), BIR (Buck Island Ranch), CFSP (Bill Baggs Cape Florida State Park), CNAH (The Center for North American Herpetology, ERCC (Everglades Regional Collection Center), ENP (Everglades National Park), FLMNH (Florida Museum of Natural History), FSP (Fakahatchee State preserve), HTBSP (Hugh Taylor Birch State Park), JULSP (John U. Loyd State Park), NMNH (National Museum of Natural History), SMP (State Museum of Pennsylvania), and SPSP (Savannah's Preserve State park).

SPECIES ACCOUNTS

RHINELLA MARINA FITZINGER 1826 — CANE TOAD

Description.—The dorsum color of the Cane Toad is variable shades of brown (Conant and Collins 1998; Bartlett and Bartlett 1999; Meshaka et al. 2004a; Fig. 4). In breeding males, the dorsum is cinnamon in color (Meshaka et al. 2004a) and spiny in texture (Bartlett and Bartlett 1999; Meshaka et al. 2004a). Parotid glands are large in size, and tadpoles are dark in color (Bartlett and Bartlett 1999; Meshaka et al. 2004a). The breeding call of a male is a low monotonal sustained guttural call.

Distribution.—The Cane Toad is a New World species, native to southern Texas (Conant and Collins 1998) whose first documentation in Florida is from Belle Glade and Canal Point, Palm Beach County, following intentional releases prior to 1936 (Riemer 1958). However, the species may not have established colonies until the accidental release of toads in Miami, Miami-Dade County, before 1955 (King and Krakauer 1966). In southern Florida, past records are from Broward (Meshaka et al. 2004a), Hendry (Meshaka et al. 2004a), Highlands (Meshaka et al. 2004a), Martin (Meshaka et al. 2004a), Miami-Dade (Meshaka et al. 2004a), Monroe (Key Largo; Meshaka et al. 2004a), Monroe (Key West;

FIGURE 4. A Cane Toad (*Rhinella marina*) from Lake Placid, Highlands Co., Florida. (Photographed by Suzanne L. Collins).

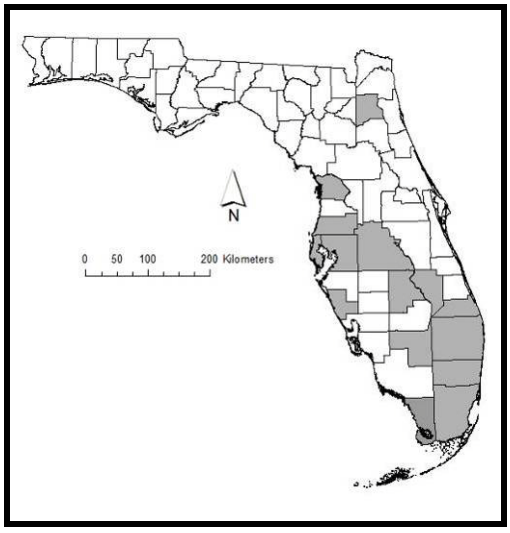

FIGURE 5. Geographic distribution of the Cane Toad (*Rhinella marina*) in Florida.

Lazell 1989; Meshaka et al. 2004a), Monroe (Stock Island; Meshaka et al. 2004a), Okeechobee (Meshaka et al. 2004a), Palm Beach (Meshaka et al. 2004a), and Sarasota counties (Meshaka et al. 2004a). More recent records are from Monroe (Key West; Krysko and Sheehy III 2005) and Okeechobee (Krysko et al. 2005) counties. Elsewhere in Florida, records of the Cane Toad exist from Citrus, Clay, Hillsborough, Pasco, Pinellas, and Polk counties (Meshaka et al. 2004a; Fig. 5). The Cane Toad also occurs as an established exotic species elsewhere in the United States (Hero and Stoneham 2005) and in the West Indies (Lever 2003).

Body size.—The Cane Toad is Florida's largest toad and the largest exotic anuran of Florida. The average body sizes of individuals from five sites in southern Florida were smaller in males (99.4 113.2 mm snout-vent length [SVL]) than in females (107.9 126.1 mm SVL) from their respective sites (Meshaka et al. 2004a). Anecdotal evidence suggested that average body size of the species in Miami-Dade County has decreased over time (Meshaka et al. 2004a).

Habitat and abundance.—In south Florida, the Cane Toad most often inhabited disturbed areas of two types: Around buildings and suburban backyards and around the shores of canals and ponds (Krakauer 1968). Wilson and Porras (1983) noted that this toad was common in urban and agricultural areas of southeastern Florida. In southern Florida, the Cane Toad usually inhabited disturbed habitats that were moist and open (Meshaka et al. 2004a). A good example of this could be seen in its abundance in the agricultural areas of Homestead and Florida City, Miami-Dade County, near Everglades National Park (ENP), whereas it was not established in the park itself (Meshaka et al. 2004a). The Cane Toad inhabited stands of Brazilian Pepper (*Schinus terebinthifolius*) and Australian Pine (*Casuarina equisetifolia*), but this was not a favored habitat (Rossi 1981). In Lake Placid, 92 males and 97 females were collected during one year in a residential area surrounded by otherwise uninhabitable sandy upland habitat (Meshaka et al. 2006a). In Highlands County, no record of it existed on either BIR (Meshaka 1997) or the ABS, but the former site was at risk of colonization by this species (Meshaka 1997).

Diet.—In Miami-Dade County, the Cane Toad ate mostly beetles (Coleoptera), earwigs (Dermaptera), and ants (Hymenoptera) (Krakauer 1968). Meshaka et al. (2004a) recovered remains of the Southern Ringneck Snake *(Diadophis punctatus punctatus)*, Eastern Ribbon Snake (*Thamnophis sauritus sackenii*), and Brahminy Blind Snake *(Ramphotyphlops braminus)* in scat of the Cane Toad. Its diet from Lake Placid included that of the syntopic Southern Toad (*Anaxyrus terrestris*; Meshaka and Powell 2010). Jack DeVane (pers. comm.) watched an individual eat a cooked pork rib bone that he tossed to it during the day. In Tampa, this amphibian primarily ate invertebrates, especially beetles and ants, but also ate vertebrates, feces, and vegetation (Rossi 1981). Olfactory cues were used by this toad to assist in finding stationary food (Rossi 1983). The species also hunted from positions above the ground (Rossi 1981).

Reproduction.—Lazell (1989) noted autumn breeding by the Cane Toad on Key West from what were "little more than puddles," including a brackish site. In southern Florida, males were capable of calling throughout the year (Meshaka et al. 2004a; Meshaka et al. 2006a); However, calling generally occurred during January-October in Miami (Krakauer 1968) and Lake Placid (Meshaka et al. 2006a). In Tampa, Rossi (1981) heard males call from March to August, and in Hillsborough and Pinellas counties, males called from March to July (Meshaka et al. 2006a). On 18 January 2007 in Miramar, I saw recently hatched tadpoles and heard calling that evening when air temperature was 23.9° C. Using minimal thresholds of monthly maximum (23.2 ± 0.3° C) and minimum air temperatures (7.1 ± 0.3° C), end of the month day length (10.9 hr), and monthly rainfall (0.69 ± 1.3 cm), predicted calling seasons for Key West are January-October, for Miami January-October, for Lake Placid January-October, for Okeechobee February-October, for Clearwater March-October, and for Tampa March-October (Meshaka et al. 2006a). Like Krakauer (1968), I have observed that calling occurred predominantly at night, and the species did not appear to have strict breeding site preferences. Breeding sites in southern Florida included puddles, canals, and borrow pits (Meshaka et al. 2004a), and in Lake Placid, canals leading into the lake and the shore of the lake itself were used as breeding sites by this species (Meshaka et al. 2006a).

In south Florida, gravid females were present throughout the year (Krakauer 1968). In Lake Placid, almost fully gravid females were collected in all nine months for which samples were possible, and females that were collected during March-August were ready to lay their eggs (Meshaka et al. 2006a). Egg deposition occurred during March-September in Homestead and March-August in Lake Placid (Meshaka et al. 2004a). Egg deposition quickly tapered off after a spike before mid-summer and by fall, females were yolking up for next year's clutch (Meshaka et al. 2006a). In Miami, the Cane Toad responded positively to Hurricane Andrew with increased breeding activity at monitored sites as well as at breeding sites newly created by the storm (Meshaka 1993).

Growth and survivorship.—In southern Florida, the larval period of the Cane Toad lasted about two months (Meshaka et al. 2004a). In Tampa, its larval period averaged < 50 d but was longer when in association with Southern Toads than when alone (Rossi 1981). The body sizes of metamorphs were small in southern Florida (10−13 mm SVL; Meshaka et al. 2004a) and in Tampa (10−11 mm SVL; Rossi 1981). Collections of metamorphoslings exist for Key West in October (Lazell 1989), Miami in September (Meshaka et al. 2006a), and south Florida in March (Krakauer 1968). The smallest sexually mature male was from Stock Island, Monroe County (75 mm SVL), and smallest gravid female from Florida City, Miami-Dade County (89 mm SVL; Meshaka et al. 2004a). In Lake Placid, minimum body size at sexual maturity was similar between males (90 mm SVL) and females (95 mm SVL), and both sexes reached sexual maturity approximately 10 months after metamorphosis (Meshaka et al. 2006a).

Activity.—In south Florida, individuals living near water were seasonally active over longer periods than those living away from water (Krakauer 1968). In Miami and Lake Placid, activity was pronounced during March-October although individuals were active at some level throughout the year (Meshaka et al. 2004a). In Tampa, surface activity of 1979−1980 ceased during November-February (Rossi 1981). In south Florida, adults were generally, but not exclusively, nocturnal, whereas newly emerged metamorphosed young were active at all times (Krakauer 1968). Meshaka et al. (2004a) noted that adults and sub-adults were generally nocturnal and noted diurnal activity in metamorphoslings.

Predators.—The Yellow Bullhead (*Ameiurus natalis*) and an unidentified species of Mosquitofish (*Gambusia* sp.) were predators of Cane Toad tadpoles (Rossi 1981). In Tampa, mortality rates from eating Cane Toad eggs varied among tadpoles of various anuran species as follows: The Southern Toad at 20%, Eastern Narrowmouth Toad (*Gastrophryne carolinensis*) at 0%, Green Treefrog *(Hyla cinerea)* at 100%, Cuban Treefrog at 30%, Southern Leopard Frog (*Lithobates sphenocephalus*) at 90%, and the Eastern Spadefoot (*Scaphiopus holbrookii*) at 60% (Punzo and Lindstrom 2001). In Miami, a Red-shouldered Hawk (*Buteo lineatus*) ate an adult Cane Toad through the venter of the toad (Meshaka 1994a). In Tampa, the species ate others of its own species (Rossi 1981). In captivity, Eastern Hognose Snakes (*Heterodon platirhinos*), Garter Snakes, Ribbon Snakes, Florida Water Snakes (*Nerodia fasciata pictiventris*), and Eastern Indigo Snakes (*Drymarchon couperi*) ate Cane Toads (Rossi 1981). The Blue Jay (*Cyanocitta cristata*) and Northern Mockingbird (*Mimus polyglottus*) were predators of toadlets of this species in Tampa (Rossi 1981).

Threats.—The ability of the Cane Toad to eat vertebrates is yet another negative impact to the ecologically fractured urban systems in southern Florida. The presence of larval Cane Toads did not affect survivorship, size at transformation, or larval period of the Green Treefrog or Southern Toad (Smith 2005). The tick, *Amblyomma rotundatum*, occurred on south Florida Cane Toads (Oliver et al. 1993; Meshaka et al. 2004a) but not on individuals from Lake Placid (Meshaka et al. 2004a). Other ticks, such as *A. americana* and *Dermacentor* species were present on Miami Cane Toads but not those from Tampa (Rossi 1981). Hookworm (*Aclyostoma caninum*) ova were present in fecal samples of the Cane Toad in Tampa (Rossi 1981). The Cane Toad is at some level a predatory threat to the Brahminy Blind Snake. Road mortality (Krakauer 1968) and absence of development are the only notable threats to the Cane Toad in southern Florida.

ELEUTHERODACTYLUS COQUI THOMAS 1966 – PUERTO RICAN COQUI

Description.—As described by Conant and Collins (1998) and Bartlett and Bartlett (1999), the dorsal color varies in shades of brown, including grayish brown, and the dorsum may be patterned obscurely or prominently (Fig. 6). Individuals may have a W-shaped marking above the forelimbs, a light dorsolateral stripe and/or a light interorbital bar. The breeding call of the male resembles a loud pronunciation of "Coqui".

Distribution.—The Puerto Rican Coqui is a West Indian species whose first documentation in Florida is from Fairchild Tropical Gardens, Miami, Miami-Dade County (Austin and Schwartz 1975); However, a freeze extirpated that population (Wilson and Porras 1983). In south Florida, it had colonized bromeliad nurseries in Homestead, Miami-Dade County (Loftus and Herndon 1984; Meshaka et al. 2004a). This is the least successful species among the established exotic amphibians in Florida (Fig. 7). However, the Puerto Rican Coqui also occurs as an established exotic species elsewhere in the United States (Lever 2003; Stewart and Lannoo 2005).

Body size.—Florida individuals measured 31.8–44.5 mm SVL (Bartlett and Bartlett 1999).

Habitat and abundance.—In southern Miami-Dade County, the Puerto Rican Coqui occurred only in association with greenhouses in southern Miami-Dade

FIGURE 6. A Puerto Rican Coqui (*Eleutherodactylus coqui*) from Miami, Dade Co., Florida. (Photographed by Suzanne L. Collins).

FIGURE 7. Geographic distribution of the Puerto Rican Coqui (*Eleutherodactylus coqui*) in Florida.

County (Meshaka et al. 2004a).

Diet.—The Puerto Rican Coqui feeds on small invertebrates (Meshaka et al. 2004a). The composition of its diet in Florida is uknown.

Reproduction.—In Homestead, Miami-Dade County, males called during May-October (Meshaka et al. 2004a).

Predators.—The Cuban Treefrog, an effective predator of small anurans, may have been its most likely predator in southern Florida greenhouses (Meshaka 2001).

Threats.—Predation by the Cuban Treefrog and the use of pesticides in greenhouses are the likeliest threats to the Puerto Rican Coqui in south Florida. Its ecological relationship with the Greenhouse Frog is unknown.

ELEUTHERODACTYLUS PLANIROSTRIS (COPE 1862) – GREENHOUSE FROG

Description.—In southern Florida individuals are striped or mottled in appearance (Duellman and Schwartz 1958; Fig. 8). Most individuals are mottled, especially in Miami (Duellman and Schwartz 1958). Exceptionally, in Gainesville, individuals are overwhelmingly striped in pattern (Goin 1947). Both

FIGURE 8. A Greenhouse Frog, *Eleutherodactylus planirostris*, from Franklin Co., Florida (left) and an egg clutch of the Greenhouse Frog (right). (Both photographed by Suzanne L. Collins).

FIGURE 9. Geographic distribution of the Greenhouse Frog (*Eleutherodactylus planirostris*) in Florida.

morphs are present in the West Indies (Schwartz and Henderson 1991). The breeding call of a male resembles soft chirping.

Distribution.—The Greenhouse Frog is a West Indian species whose first documentation in Florida is from southern Florida (Cope 1875) and from Key West, Monroe County (Cope 1889). In southern Florida, past records are from Broward (Meshaka et al. 2004a), Collier (Meshaka et al. 2004a), Hardee (Meshaka et al. 2004a), Highlands (Meshaka et al. 2004a), Lee (Meshaka et al. 2004a), Martin (Meshaka et al. 2004a), Miami-Dade (Meshaka et al. 2004a), Miami-Dade (Key Biscayne; Duellman and Schwartz 1958), Monroe (Carr 1940), Monroe (Big Pine Key; Duellman and Schwartz 1958; Lazell 1989; Meshaka et al. 2004a), Monroe (Cape Sable; Carr 1940; Duellman and Schwartz 1958), Monroe (Cudjoe Key; Duellman and Schwartz 1958; Lazell 1989: Meshaka et al. 2004a), Monroe (Islamorada; Duellman and Schwartz 1958), Monroe (Key Largo; Duellman and Schwartz 1958; Lazell 1989: Meshaka et al. 2004a), Monroe (Key West; Carr 1940; Allen and Slatten 1945; Duellman and Schwartz 1958; Lazell 1989: Meshaka et al. 2004a), Monroe (Little Torch Key; Duellman and Schwartz 1958; Lazell 1989; Meshaka et al. 2004a), Monroe (Middle Torch Key; Lazell 1989: Meshaka et al. 2004a), Monroe (No Name Key; Lazell 1989: Meshaka et al. 2004a), Monroe (Stock Island; Duellman and Schwartz 1958; Lazell 1989: Meshaka et al. 2004a), Monroe (Sugarloaf Key; Duellman and Schwartz 1958; Meshaka et al. 2004a), Monroe (Summerland Key; Duellman and Schwartz 1958; Lazell 1989: Meshaka et al. 2004a), Monroe (Upper Matecumbe Key; Duellman and Schwartz 1958; Lazell 1989: Meshaka et al. 2004a), Okeechobee (Meshaka et al. 2004a), Palm Beach (Meshaka et al. 2004a), Sarasota (Meshaka et al. 2004a) counties. Reports of this species are from Charlotte, DeSoto, Glades, Hendry, Highlands, Manatee, and St. Lucie counties where it is widespread (Meshaka et al. 2004a). Individuals occur and call in the mangrove fringe of ENP, Monroe County (Meshaka et al. 2000). This species is continuous in its geographic distribution throughout southern Florida (Meshaka et al. 2004a).

Elsewhere in Florida, records of the Greenhouse Frog exist from Alachua, Bay, Brevard, Columbia, Duval, Flagler, Franklin, Gadsden, Hernando, Hillsborough, Indian River, Leon, Marion, Nassau, Okaloosa, Pinellas, Polk, St. Johns, and Volusia counties, and reports are widespread in the remaining counties (Meshaka et al 2004a). Schwartz (1974) had considered this species to be continuous in its geographic distribution south of Leon, Alachua, and Duval counties. After Meshaka et al. (2004a) went to press, a subsequent record appeared for the Greenhouse Frog in Wakulla County (Johnson et al. 2003a). Although Levy County was within the geographic range denoted by Schwartz (1974), a recent record is from Sea Horse Key (Lillywhite and Sheehy III 2004), and a more recent record of the Greenhouse Frog is from Clay County (Butler and Atkinson 2008; Fig. 9). An interesting county report stemmed from the dispersal of the species from a Gilchrist County mulch packing plant to the Detroit Zoo in the middle of winter (Zippel et al. 2005). The Greenhouse Frog also occurs as an established exotic species elsewhere in the United States (Meshaka 2005a 2008a) and in the West Indies (Lever 2003).

Body size.—The Greenhouse Frog is the smallest of Florida's exotic anurans. From the vicinity of Miami, males (mean = 16.6 mm SVL) were smaller in body size than females (mean = 22.6 mm SVL; Duellman and Schwartz 1958).

Habitat and abundance.—On the eastern rim of the mainland and upper keys, the Greenhouse Frog was abundant in mesophytic hammocks (Duellman and Schwartz 1958). It inhabited humid and edificarian sites on the lower Keys (Duellman and Schwartz 1958). In ENP, capture rates were highest (Dalrymple 1988) and I have heard it calling most often in tropical hardwood hammocks. In ENP, it also inhabited pineland, prairie, disturbed, and mangrove habitats (Dalrymple 1988; Meshaka et al. 2000). On the ABS, the Greenhouse Frog was much more abundant in long-unburned than burned sand pine scrub (Meshaka and Layne 2001) and was also the most numerous vertebrate inhabitant of Gopher Tortoise (*Gopherus polyphemus*) burrows (Lips 1991). On the ABS, James N. Layne (pers. comm..) found an

individual in an underground nest box with a tunnel entrance opening at the surface. On BIR, it occurred in Live Oak-Sabal Palm hammocks (Meshaka 1997). This diminutive frog was common around residences in southern Florida (Duellman and Schwartz 1958; Meshaka et al. 2004a) and in Gainesville (Goin 1947). Within its Florida habitats, the Greenhouse Frog sought various forms of moist cover (Deckert 1921; Carr 1940; Goin 1947; Van Hyning 1933; Duellman and Schwartz 1958). Likewise, in the West Indies, the Greenhouse Frog used cover in more or less mesic situations (Barbour and Ramsden 1919; Schwartz and Henderson 1991). It was primarily terrestrial in southern Florida (Carr 1940; Duellman and Schwartz 1958), but not entirely so (Harper 1935; Neill 1951; Lee 1969; Meshaka et al. 2004a), and terrestrial in north-central Florida (Goin 1947) and Cuba (Barbour and Ramsden 1919).

Diet.—Ants, beetles, and spiders (Areneae) were found in individuals in a southern Florida sample (Duellman and Schwartz 1958). Mostly ants were recovered from a small sample from Key West (Goin 1947). In north-central Florida, this small frog primarily ate ants, followed by beetles and roaches (Blattodea) (Goin 1947). Goin (1947) noted that his samples were comprised of primarily small-bodied, ground-dwelling, and likely nocturnal prey. Ants were recovered from a small sample in Cuba (Goin 1947).

Reproduction.—In southern Florida, males called during warm rainy summer nights (Duellman and Schwartz 1958). Carr (1940) noted breeding during December in Miami-Dade County, and in the same county, Deckert (1921) found eggs in May. In ENP, calling occurred during March-October (Meshaka et al. 2004a) but typically during April-September with May-June and September peaks (Meshaka and Layne 2005). Males called during February-November in Homestead (Meshaka et al. 2004a). On the ABS, calling occurred during April-September, with most calling records during June-September (Meshaka and Layne 2005). In Gainesville, calling occurred occurred April-September (Goin 1947). Carr (1940) noted breeding by this species in April in Alachua County.

In southern Florida, males called when monthly volume of rainfall was at least 6.9 cm (Meshaka and Layne 2005) and the mean monthly minimum air temperature was at least 15.8° C (Meshaka and Layne 2005). Those two thresholds were from Gainesville and were associated with Goin's (1947) calling dates, which were similar to, but lower than, those of ENP (Meshaka and Layne 2005). To this, I add the mean monthly maximum air temperature of at least 26.6° C as determined from weather data in Gainesville associated with dates of calling provided by Goin (1947), which, likewise, was lower than that of ENP. When the former two thresholds were applied to long-term climate data, predicted calling seasons were longest in the West Indies and southern Florida (7−10 mo), intermediate in south-central, central, and much of northern Florida (5 mo). Predicted calling seasons were shortest in extreme northern Florida and in Mobile, where the species could colonize (5 mo; Meshaka and Layne 2005). Applying the latter threshold corroborated Meshaka and Layne's (2005) findings and tightened estimates for Havana to eight months (April-November). Calling at an urban Miami site was stimulated by the advance of Hurricane Andrew, and calling males took up residence under newly created piles of debris (Meshaka 1993).

In ENP, males called when daily air temperatures were warm (Mean = 25.2 ^{0}C), humidity was high (mean = 96.8%), and usually in association with rain (mean = 1.8 cm; Meshaka and Layne 2005). In this regard, the Greenhouse Frog responded strongly to Hurricane Andrew (Meshaka 1993). In southern Florida, Duellman and Schwartz (1958) noted nocturnal calling, although it will call day and night (Meshaka et al. 2004a). Likewise, Goin (1947) noted calling day and night in Gainesville.

Deckert (1921) found two clutches in May in Miami-Dade County, females laid eggs during May-September in north-central Florida (Goin 1947). Two 12-egg clutches were found by Deckert (1921) in Miami-Dade County. Clutch size averaged 16.1 eggs in north-central Florida (Goin 1947), and a clutch of eight eggs was discovered by Goin (1044) in Jacksonville. Females deposited their eggs under cover throughout Florida and the West Indies (Deckert 1921; Grant 1940; Goin 1944; Ashton and Ashton 1988; Meshaka et al. 2004a). For Cuba, Dunn (1926) reported on captive females that laid two clutches (25 eggs in July and 19 eggs in July or August) and a clutch of 21 eggs that was found in a fallen bromeliad in August.

Growth and survivorship.—Lazell (198) found neonates on Key West in May and June. In north-central Florida, hatchling Greenhouse Frogs appeared during June-September (Goin 1947). In Cuba, hatchlings appeared in August (Dunn 1926). Individuals reached sexual maturity in six to eight months in south-central Florida (Meshaka and Layne 2005) and within one year in north-central Florida (Goin 1947).

Activity.—The Greenhouse Frog was essentially active throughout the year in south-central Florida (Meshaka and Layne 2005), with most movements having occurred September-December (Meshaka and Layne 2005) and October and November (Meshaka et al. 2004a). It was apparently active throughout the year in north-central Florida (Goin 1947). This species was primarily, but not

exclusively, nocturnal in its activity throughout Florida (Goin 1947; Meshaka et al. 2004a).

Predators.—In southern Florida, the Southern Ringneck Snake was a predator of the Greenhouse Frog (Meshaka et al. 2004a). The Cuban Treefrog, a predator of frogs generally and a predator of this species in the West Indies (Meshaka 2001), is a probable predator of the Greenhouse Frog in Florida.

Threats.—Lazell (1989) cast doubt on its status as an exotic species and natural dispersal seems more likely to the Florida Keys than to the mainland. However, as an exotic species, even if only for the mainland, this species is syntopic with a wide range of other small-bodied, insectivorous, semi-fossorial or fossorial indigenous amphibian and reptile species. In particular, the status of the Reef Gecko *(Sphaerodactylus notatus)* warrants concern as it is strongly associated with tropical hardwood hammocks in extreme south Florida (Duellman and Schwartz 1958; Meshaka et al. 2002) and at least superficially seems ecologically analogous to the Greenhouse Frog. A major threat to the Greenhouse Frog in southern Florida is in the maintenance of fire-regulated communities. The Southern Ringneck Snake and the Cuban Treefrog are threats to this frog. Its ecological relationship with the Puerto Rican Coqui is unknown.

OSTEOPILUS SEPTENTRIONALIS (DUMÉRIL AND BIBRON 1841) — CUBAN TREEFROG

Description.—The dorsum of the Cuban Treefrog is highly variable in pattern and changes from light green to ashy gray to light brown, sometimes to reddish brown (Duellman and Schwartz 1958; Meshaka 2001; Fig. 10). The dorsal markings are dark gray to dark olive green or deep brown (Duellman and Schwartz 1958; Conant and Collins1998; Meshaka 2001). The hard sandpaper feel of the co-ossified skull, diagnostic of this species, occurs in no other hylid treefrog in southern Florida. Its bones are greenish in color and can easily be seen on the undersides of its leg bones. The breeding call of a male is variable but generally sounds like a grating squawk. Occasionally the call ends with a series of clicks.

Distribution.—The Cuban Treefrog is a West Indian species whose first documentation in Florida is from Key West, Monroe County (Barbour 1931). In southern Florida, past records are from all counties: Broward (Meshaka et al. 2004a), Charlotte (Meshaka et al. 2004a), Collier (Meshaka et al. 2004a), DeSoto (Meshaka et al. 2004a), Glades (Meshaka et al. 2004a), Hardee (Meshaka et al. 2004a), Hendry (Meshaka et al. 2004a), Highlands (Meshaka et al. 2004a), Lee (Meshaka et al. 2004a), Manatee (Meshaka et al. 2004a), Martin (Meshaka et al. 2004a), Miami-Dade (Meshaka et al. 2004a), Monroe (Big Pine Key; Allen and Neill 1953; Duellman and Schwartz 1958), Monroe (Cudjoe Key; Lazell 1989), Monroe (Key Largo; Allen and Neill 1953; Duellman and Schwartz 1958), Monroe (Key Vaca; Peterson et al. 1952; Duellman and Schwartz 1958), Monroe (Key West; Barbour 1931; Carr 1940; Wright and Wright 1949; Allen and Slatten 1945; Mittleman 1950; Duellman and Schwartz 1958), Monroe (Little Torch Key; Lazell 1989), Monroe (Matecumbe Key; Wright and Wright 1949; Duellman and Schwartz 1958), Monroe (Stock Island; Wright and Wright 1949; Duellman and Schwartz 1958), Monroe (Upper Matecumbe Key; Wright and Wright 1949; Allen and Neill 1953; Duellman and Schwartz 1958), Okeechobee

FIGURE 10. A Cuban Treefrog (*Osteopilus septentrionalis*) eating a Wood Slave, *Hemidactylus mabouia*, in Palm Beach Co., Florida (left, Photographed by Jon A. Moore) and inside a building in Fort Lauderdale, Broward Co., Florida (right, Photographed by Gary Busch).

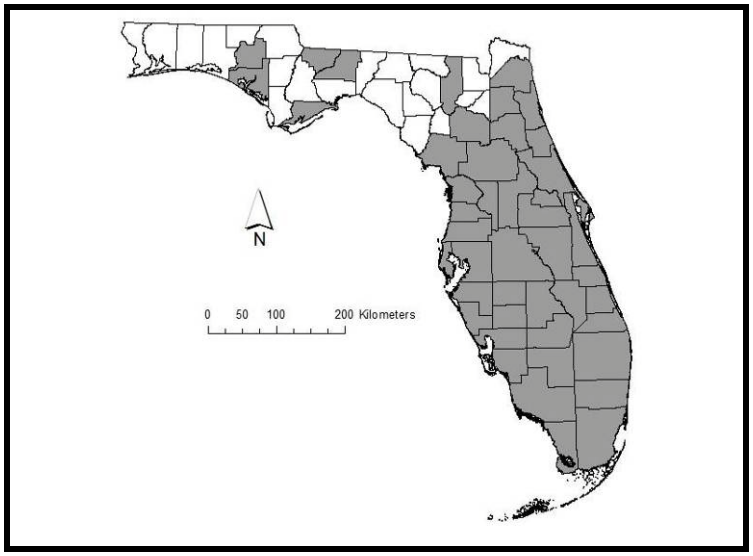

FIGURE 11. Geographic distribution of the Cuban Treefrog (*Osteopilus septentrionalis*) in Florida.

(Meshaka et al. 2004a), Palm Beach (Meshaka et al. 2004a), Sarasota (Meshaka et al. 2004a), and St. Lucie (Meshaka et al. 2004a) counties, and reports are from Monroe (Garden Key, Middle Torch Key; Lazell 1989) and Monroe (Upper Matecumbe Key; Trapido 1947) County. I include here records for Monroe (Cudjoe Key, Middle Torch Key, Plantation Key, Stock Island) County from animals collected during 1990–1991 the specimens of which are deposited in the NMNH. This species could potentially occur continuously in southern Florida with the exception of Cape Sable in Monroe County (Meshaka et al. 2004a).

Elsewhere in Florida, records of the Cuban Treefrog exist from Brevard (Meshaka et al. 2004a), Citrus (Meshaka et al. 2004a), Clay (Meshaka et al. 2004a), Gadsden (Johnson 2004), Hillsborough (Meshaka et al. 2004a), Indian River (Meshaka et al. 2004a), Leon (Meshaka et al. 2004a), Marion (Johnson 2004), Orange (Meshaka et al. 2004a), Osceola (Meshaka et al. 2004a), Pinellas (Meshaka et al. 2004a), Polk (Meshaka et al. 2004a), Seminole (Meshaka et al. 2004a; Welker 2004), St. Johns (Meshaka et al. 2004a), Volusia (Meshaka et al. 2004a), and Washington (Meshaka et al. 2004a) counties. The Holmes County record (Meshaka et al. 2004a) was apparently in error (Johnson 2004). In central Florida, the species occurred continuously throughout Brevard, Hillsborough, Indian River, and Pinellas counties (Meshaka et al. 2004a). After Meshaka et al. (2004a) was in press, the following records were published for central and northern Florida: Hernando (Townsend et al. 2002), Hillsborough (Egmont Key) (Dodd and Griffey 2002), and Levy (Johnson et al. 2003b) counties. More recent records of the species are from Alachua (Krysko et al. 2005), Bay (Krysko et al. 2005), Columbia (Krysko et al. 2005), Clay (Enge et al. 2009), Duval (Krysko et al. 2005), Flagler (Krysko et al. 2005), Franklin (Enge et al. 2009), Hillsborough (McGarrity and Johnson 2008), Lake (Enge et al. 2009), Orange (McGarrity and Johnson 2008), Osceola (McGarrity and Johnson 2008), Pasco (Enge et al. 2009), Putnam (Enge et al. 2009), and Sumter (Enge et al. 2009) counties. The Cuban Treefrog has been a highly vagile species in the agency of humans, and this trait has in turn been responsible for its rapid scattershot dispersal pattern in Florida (Meshaka 1996a). It was widespread throughout much of southern Florida and parts of central Florida (Meshaka et al. 2004a). As the species has back-filled, as it were, areas between colonies, its geographic range in Florida became continuous from southern Florida through north-central Florida, extending northward along the coasts with isolated colonies in extreme northerly sites (Meshaka 2001; Meshaka et al. 2004a). Its northward expansion has continued in this pattern (citations above), and human-mediated dispersal has continued to play an important role, as on Egmont Key (Dodd and Griffey 2002; Fig. 11). Meshaka (2001) felt that it was but a matter of time before the Cuban Treefrog dispersed to Central and South America by way of coastal states. The Cuban Treefrog also occurs as an established exotic species elsewhere in the United States (Meshaka 2005b, 2008a) and in the West Indies (Lever 2003). A geographic range extension of this species around the Gulf of Mexico has been predicted to occur as a natural phenomenon by Meshaka (2001) and as a consequence of global warming by Rodder and Weinsheimer (2009).

Body size.—The Cuban Treefrog is Florida's largest treefrog. Body sizes of males were smaller than females across their geographic range and generally averaged about 46 mm SVL, with females having averaged about 65 mm SVL (Meshaka 2001). Mean adult body size varied among sites much more so in females than in males (Meshaka 2001). McGarrity and Johnson (2008) noted a northward geographic trend towards reduction in body size dimorphism that was largely explained by reduction in female body size.

Habitat and abundance.—On the Florida Keys the species was especially numerous around cisterns (Carr 1940; Duellman and Schwartz 1958). In southern Florida the Cuban Treefrog inhabited mesophytic and edificarian situations (Duellman and Schwartz 1958), and had a tolerance for brackish systems (Peterson et al. 1952). In Everglades National Park (ENP), the species occurred in prairie, pineland, hammock, and disturbed habitats (Dalrymple 1988) as well as slough, canal, pond, lake, buildings, and mangroves (Meshaka et al. 2000). Number of refuges exerted a strong effect on the abundance of the Cuban Treefrog in nature and on buildings (Meshaka 2001). Meshaka (2001) noted that the Cuban Treefrog was filling an underexploited terrestrial-arboreal structural niche in Florida, whose ideal habitats were mesophytic forest and artificial analogs of that habitat. One failed attempt at colonization took place at BIR (Meshaka 1997). In light of increased human traffic to and habitat suitability of the ranch, and an increasing presence of this species in Lake Placid, Meshaka (1997) thought that successful colonization of the Cuban Treefrog to BIR was inevitable. The ABS presented a different situation, whereby despite reports of occasional waifs appearing on the main building, no evidence has existed for its establishment, nor do I expect establishment of the Cuban Treefrog on the majority of the station's holdings, which were subject to burn programs. Exceptionally, the cabins situated under heavy canopy and adjacent to a nearly continuously wet ditch could provide a precarious existence for the species.

Diet.—In ENP, the Cuban Treefrog ate wide range of invertebrate prey, especially beetles and roaches, isopods, and lepidopterans (Meshaka 2001; Meshaka and Mayer 2005). It also ate vertebrate conspecifics such as the Green Treefrog, Squirrel Treefrog *(Hyla squirella)*, Eastern Narrowmouth Toad, Southern Leopard Frog, Southern Toad, Brown Anole, Indo-Pacific Gecko, and Wood Slave (Meshaka 2001). A female Cuban Treefrog in Big Cypress National Preserve, Collier County, in south Florida, had captured and began swallowing a Florida Brown Snake (*Storeria dekayi victa*; Maskell et al. 2003), and also in Collier County a female ate a Green Darner (*Anax junius*) that was 122% of the predator's SVL (Bartareau and Meshaka 2007). In Plant City, Hillsboroough County, a 35 mm SVL Cuban Treefrog ate a 33 mm SVL Green Anole (*Anolis carolinensis*; Campbell 2007), and in Apopka, Seminole County, a 40 mm SVL Cuban Treefrog ate a 39 mm SVL Green Anole (Hoffmann and Johnson 2008). The diet of the Cuban Treefrog in ENP subsumed that of its potential competitors; however, potential for competition for food tended to be greater intraspecifically than it was interspecifically with native *Hyla* and the exotic Indo-Pacific Gecko and the exotic Wood Slave (Meshaka 2001; Meshaka and Mayer 2005). In Tampa, the Mediterranean Gecko was part of the Cuban Treefrog's diet (Punzo 2001a). The diet of the Cuban Treefrog from building sites in Brevard County, northeast Florida, was comprised mainly of beetles, lepidopterans, and Green Treefrogs (Heflick 2001). When adjusted by weight, the dominant prey taxa were beetles, roaches, and Green Treefrogs (Heflick 2001). The only vertebrate eaten in the Brevard County study was the Green Treefrog, which was eaten nearly exclusively by gravid female Cuban Treefrogs (Heflick 2001). Foraging on hylid treefrogs provided a nutritious meal for yolking females and secondarily removed a potential competitor (Meshaka 2001).

The effect of Cuban Treefrog predation on native hylid treefrogs can be profound. The appearance of the Cuban Treefrog in Mahogany Hammock in ENP was concomitant with the loss of both the Green Treefrog and Squirrel Treefrog (Meshaka 2001). An opposite pattern occurred following structural alterations to the Daniel Beard Center, Long Pine Key, ENP (Meshaka 2001). Repairs to the building following Hurricane Andrew resulted in replacement of two of the seven lights and the removal of all awnings and the 52 air condition units. The reduction in light-attracted prey and the severe reduction in the number of refuges from two sources resulted in a marked decline in Cuban Treefrog abundance (Meshaka 2001). Associated with this decline, was a significant increase in the number of Squirrel Treefrogs (Meshaka 2001). The Cuban Treefrog was a potential predator of Cope's Gray Treefrog (*Hyla chrysoscelis*), Barking Treefrog (*H. gratiosa*), Pine Woods Treefrog (*H. femoralis*), the Puerto Rican Coqui, and the Greenhouse Frog; the former two of which were thought to be potential competitors (Meshaka 2001). In light of its depredation on hemidactyline geckos, other geckos of Florida, native and exotic, are potentially at risk.

In an experimental setting, large Cuban Treefrogs tended to eat crickets (Orthoptera) first, but also ate Green Treefrogs and conspecifics (Wyatt and Forys 2004). This finding is logical if Cuban Treefrogs were attracted to movement and crickets move more than the anuran prey. Wyatt and Forys (2004) noted that the Cuban Treefrog would consume what was abundant and

easily eaten, and consequently raised the concern that cohabitation of Green Treefrogs and Cuban Treefrogs in high numbers in artificial refuges like polyvinyl chloride (PVC) pipes would increase the likelihood of predation by the Cuban Treefrog. In west-central Florida, the Cuban Treefrog was host to *Basidiobolus*, a saprophytic fungus in the gut of post-metamorphic individuals (Nelson et al. 2002). Cane Toad eggs were lethal to 30% of the larval Cuban Treefrogs that eat them (Punzo and Lindstrom 2001).

***Reproduction.*—**Calling records exist for June-September on Key West (Carr 1940) and March-September in southern Florida (Duellman and Schwartz 1958). Calling occurred throughout the year in the southern Everglades (Meshaka 2001); however, nocturnal calling in ENP occurred during March-October and especially from June through October (Meshaka 2001).

Seasonal calling was significantly correlated with rainfall in ENP ($r = 0.88$, $P < 0.001$; Meshaka 2001). In southern Florida, males called when monthly volume of rainfall was at least 1.8 cm (Meshaka 2001) and the mean monthly minimum air temperature was at least 12.1° C (Meshaka 2001). When these thresholds were applied to long-term climate data, predicted calling seasons were throughout the year in West Indian sites and south Florida and eight to nine months in south-central and central Florida (Meshaka 2001). To these data, I add mean monthly maximum air temperature from ENP of 25.1° C. When these three thresholds were applied to long-term climate data, predicted calling seasons adhered to the pattern of Meshaka (2001), exceptionally tightening the predicted calling season of Tampa by two months (April-November).

The high volume of rainfall (mean = 3.0 cm) associated with nightly calling in ENP was in keeping with the short three to four week larval period (Meshaka 2001) and a strong association with open, shallow, temporary, and preferably vegetated sites across Florida and in the West Indies (Meshaka 2001). Diurnal calling occurred in association with high rainfall (mean = 3.3 cm) the night before (Meshaka 2001). Breeding occurred most often in temporary, fishless, shallow, grassy sites exposed to sun (Meshaka 2001). Nocturnal calling occurred when daily air temperatures were warm (mean = 25.7° C), relative humidity was high (mean = 97.8%), and often in association with rain (mean = 3.0 cm; Meshaka 2001). Cuban Treefrogs of both sexes moved *en masse* in warm air temperatures (mean = 26.4° C) and in the cover of rain (mean = 4.2 cm; Meshaka 2001). As was the case in southern Florida (Meshaka 2001), Cuban Treefrogs in Havana, Cuba, also called during the day (pers. observ.). In the southern Everglades, males were fertile throughout the year with a testicular cycle associated with day length (Meshaka 2001). In Miami, males responded to Hurricane Andrew by explosively chorusing in advance of and during the storm (Meshaka 1993). At one site, calling was intense during and a few days after the storm and continued to decline over the next ten or so days (Meshaka 1993). During Hurricane Andrew, the male fat cycle was contrary to the testicular cycle, peaking during the dry season (Meshaka 2001).

In southern Florida, females laid eggs when monthly volume of rainfall was at least 2.3 cm (Meshaka 2001), the mean monthly minimum air temperature was at least 17.6° C (Meshaka 2001). When these thresholds were applied to long-term climate data, predicted egg laying seasons were seven months to throughout the year in West Indian sites and south Florida, five or six months in south-central (May-October in Okeechobee, June-September in Lake Placid) and May-October in central Florida (Tampa and Orlando; Meshaka 2001). To these data, I add a mean monthly maximum air temperature from Homestead of 27.7° C. When these thresholds were applied to long-term climate data, egg laying seasons adhered to the pattern of Meshaka (2001) tightening the egg laying seasons of five sites from one to four months: Honolulu (April-November), Havana (March-November), Nassau (May-November), Freeport (April-October), Key West (April-October). These adjustments evermore refine the pattern of short breeding seasons in small insular sites and in south-central and central Florida and long seasons in mainland south Florida and Havana (Meshaka 2001). Minimum nightly air temperatures associated with oviposition were warm (mean = 23.8° C) and in association with rain (mean = 4.8 cm; Meshaka 2001). In this regard, the Cuban Treefrog responded positively to Hurricane Andrew with respect to clutch productions, especially among the smaller females (Meshaka 1993, 2001).

This species was hurricane-adapted in its reproductive patterns (Meshaka 1993). A fierce reproductive response by the Cuban Treefrog in south Florida followed Hurricane Andrew, the success of which was enhanced by the many newly created breeding sites (Meshaka 1993; Meshaka 2001). More specifically, Meshaka (2001) noticed that small females, usually at a competitive disadvantage to larger females with respect to clutch size and frequency, took advantage of the storm to produce another clutch by directly converting food into eggs. With body size removed in the analysis, the post-Hurricane Andrew clutch sizes and egg sizes were larger than previous clutches. The momentary superior competitiveness of small females that replaced later reproduction by larger females by producing larger clutches and eggs could provide smaller females with a competitive edge in the initial colonization process associated with storms (Meshaka 1993, 2001).

In ENP, male Cuban Treefrogs amplected with female Southern Leopard Frogs, male and female Green

Treefrogs, and dead female Southern Toads (Meshaka 1996b). In Brandon, Hillsborough County, and in west-central Florida, male Cuban Treefrogs likewise amplected with female Southern Leopard Frogs (Smith 2004). In the southern Everglades females were gravid throughout the year, clutches (mean = 3,961.0 eggs) and ova size (mean = 1.2 mm) covaried positively with female body size (Meshaka 2001). In south-central Florida, clutch size (mean = 4,831.1) but not ova size (mean = 1.2 mm) was explained by female body size (Meshaka 2001). In the southern Everglades, female body fat peaked in mass in the dry season and was depleted early in the wet season in association with clutch production (Meshaka 2001).

Growth and survivorship.—In southern Florida, tadpoles transformed less than one month (Meshaka 1993), possibly less during the summer, and in two months or more during the cooler times of the year (Meshaka 2001). Cuban Treefrog tadpoles were shown to be facultative carnivores, having developed faster and at a larger body size when the background resource was of low quality (Babbitt and Meshaka 2000). Field-captured metamorphoslings from southern Florida were small (mean = 12.6 mm SVL; Duellman and Schwartz 1958) and similar in size in ENP (mean = 16.0 mm SVL) and Havana (mean = 15.3 mm SVL; Meshaka 2001). Duellman and Schwartz (1958) captured metamorphosing young in southern Florida in July. In the southern Everglades, larval transformation occurred throughout the year, but was most evident during June-September or in October (Meshaka 2001). Metamorphosing young were evident in October in Lake Placid and in June in Havana (Meshaka 2001).

Males reached sexual maturity within three months after transformation in the southern Everglades, in four months after transformation in Okeechobee and Tampa, and potentially one month earlier in Cuban males than in Everglades males (Meshaka 2001). Females reached sexual maturity within seven or eight months after transformation in the southern Everglades, in eight or nine months after transformation in Okeechobee and Tampa, and potentially one month earlier than Everglades females in Cuba (Meshaka 2001). Body size at sexual maturity in Florida and Cuba was approximately 27 mm SVL in males and 44 mm SVL in females (Meshaka 2001). In the southern Everglades, males were dead by the end of their first year of post-transformation life or shortly thereafter (Meshaka 2001). In Okeechobee and Tampa most males were likewise dead in about one year but some may have survived to two years of post-transformation life (Meshaka 2001). In Cuba, male survivorship was similar to that of the Everglades (Meshaka 2001). Most females in the southern Everglades, Okeechobee, and Tampa were dead by the second year of post-transformation life although some could have survived one more year (Meshaka 2001). Female survivorship in Cuba was unknown (Meshaka 2001).

Activity.—In the southern Everglades, the Cuban Treefrog was active throughout the year, but especially so during the wet season of May-October (Meshaka 2001). Elsewhere in Florida, activity also occurred throughout the year but was even more depressed in the winter (Meshaka 2001). The seasonal activity of the species in Cuba mirrored that of the southern Everglades (Meshaka 2001); however, this did not specify potentially xeric sites such as Guantanamo Bay, where dry season activity would be even more curtailed as in small insular sites.

The Cuban Treefrog was primarily nocturnal, beginning its foraging activity often at dusk (Meshaka 2001). On sultry days or after a rain shower in the southern Everglades and in Havana, individuals would peek out from their hiding places and occasionally large females would bask (Meshaka 2001). Lantz (1952) observed captives burrowing to varying depths under the substrate, and I have found individuals hiding under old carpets on the ground. Differential temperatures of buildings and building interiors provided building-dwelling Cuban Treefrogs with the opportunity for greater activity during cold dry weather than those in natural areas, which in turn provided the species with an advantage to the colonization of otherwise inhospitable or less than optimal regions (Meshaka 2001).

Predators.—The following amphibians and reptiles were predators of the Cuban Treefrog in ENP (Meshaka 2001): Conspecifics, Florida Snapping Turtle (*Chelydra serpentina osceola*), Eastern Corn Snake (*Pantherophis guttatus*), Florida Water Snake, Peninsular Ribbon Snake, Eastern Garter Snake (*Thamnophis sirtalis sirtalis*), and Florida Cottonmouth (*Agkistrodon piscivorus conanti*). The Southern Black Racer (*Coluber constrictor priapus*; Meshaka and Ferster 1995), Eastern Rat Snake (*Scotophis alleghaniensis*; Meshaka and Ferster 1995), Peninsular Ribbon Snake (Love 1995), and Eastern Garter Snake (Meshaka and Jansen 1997) were predators of this species in southern Florida. The following birds ate the Cuban Treefrog in ENP: The Little Blue Heron (*Egretta coerulea*; Meshaka 2001), American Crow (*Corvus brachyrhynchus*; Meshaka 2001), Barn Owl (*Tyto alba*; Meshaka 2001), and Barred Owl (*Strix varia*; Meshaka 1996c). Among the exotic herpetofauna, the Knight Anole was as a predator of the Cuban Treefrog (Meshaka et al. 2004a). The highly toxic skin secretion of the Cuban Treefrog may have evolved in response to mammalian predators (Meshaka 2001).

Threats.—Duellman and Schwartz (1958) and Lazell (1989) cast doubt on its status as an exotic species. Meshaka (1996a, 2001) considered the species exotic to the mainland but did not discount the possibility of both human-mediated and natural dispersal to the Florida Keys. As this species has invaded new habitat, abundances of the Green Treefrog and Squirrel Treefrog have crashed (Meshaka 2001). The negative impact was especially notable in disturbed and forested habitat, both of which were secondary in preference to the two native hylids (Meshaka 2001). The reason for their demise has been more so the cause of predation than the potential for competition (Meshaka 2001). Thus, it is also a threat to native species such as the Cope's Gray Treefrog, Barking Treefrog, and Pine Woods Treefrog, all of which would have the opportunity to encounter the Cuban Treefrog. Related to this issue is the use of PVC pipes for anuran monitoring. The Cuban Treefrog differentially used refuge types based on body size (Meshaka 1996d) and its abundances were strongly affected by number of refuges available to it (Meshaka 2001). PVC pipes, in turn, represent artificial analogues to refuges. The diameter of the PVC pipes influenced both the body size and the species of the frogs using them (Bartareau 2004). The effect of prolonged PVC pipe use (i.e., exceeding one generation) was one of habitat enhancement, which would result in accelerating a colonization event or increase the population size of an existing population (Meshaka 2008b). In light of its demonstrably negative predatory impacts on native hylid treefrogs (Meshaka 2001) and its willingness to eat what was available (Meshaka 2001; Wyatt and Forys 2004), a logical concern exists that the prolonged use of PVC pipes creates the additional threat of providing artificially inflated populations of Cuban Treefrogs with an artificially concentrated anuran prey source or food trough. Also related to the impacts of the Cuban Treefrog to native anurans is the northward geographic trend towards reduced female body size which (McGarrity and Johnson 2008). The authors noted that the smaller body sizes could reduce the potential predation on native anurans by northern populations of the Cuban Treefrog (McGarrity and Johnson 2008). Among other exotic species, the Cuban Treefrog negatively impacts geckos and represents a threat as well to the Puerto Rican Coqui and Greenhouse Frog. The Cuban is subject to the depredations of the Knight Anole and was a paratenic host to *Skrjabinoptera scelopori*, both of which had followed it into Florida (Meshaka 1996e).

At the larval level, the presence of the Cuban Treefrog negatively impacted the transformation time of the Green Treefrog and Southern Toad and also the body size at transformation of the Southern Toad (Smith 2005). The body size at transformation of the Green Treefrog was larger when individuals were reared with the Cuban Treefrog (Smith 2005). Survivorship of the native tadpoles was not affected by the presence of the Cuban Treefrog (Smith 2005). On the other hand, Knight et al. (2008) found intense competition among tadpoles of the Cuban Treefrog, Squirrel Treefrog, and Southern Toad. Much more so than pond location, priority effects negatively impacted the performance and the survival of the two native species. Thus, timing played a major role in the competitive advantage of the Cuban Treefrog over these two native species with which it commonly co-occurred at the larval stage in Florida (Knight et al. 2008).

Overlap in habitat and diet between the Cuban Treefrog and the Tokay Gecko presented a high likelihood of potential for competition for this species (Meshaka 2001); however, hydrological restoration of the southern Everglades presented the greatest threat to the Cuban Treefrog in southern Florida (Meshaka 2001). To control building-dwelling populations of this anuran that benefit from light-attracted insect prey, Cress et al. (2007) suggested the use of lights that do not attract invertebrates. Its exotic status and demonstrable negative impacts on native fauna warrant concern with respect to its projected range expansion noted by Meshaka (2001) and Rodder and Weinsheimer (2009).

TRACHEMYS SCRIPTA (SCHOEPFF 1792) — SLIDER

Description.—As described by Conant and Collins (1998), Bartlett and Bartlett (1999), and Meshaka et al. (2004a), the carapace of juveniles is green and overlaid with light and dark lines, and a prominent red spot is found behind the eye (Fig. 12). The colors and patterns darken with age, especially in males. Meshaka et al. (2004a) noted that even the skin darkens, such that males in particular are melanistic and often have obscured red marks.

Distribution.—The Slider is a species native to North America (and the panhandle of northern Florida) whose first documentation (as the subspecies *T. s. elegans*) in southern Florida is from Miami-Dade County (Wilson and Porras 1983). It was established in Miami-Dade County by 1958 (Wilson and Porras 1983). This form is not to be confused with the Yellowbelly Slider, *T. s. scripta* (Schoepff 1792), which is native to the Florida panhandle. In southern Florida, past records are from Miami-Dade and Monroe (Stock Island) counties, and reports are from Collier, Miami-Dade, and Monroe (Big Pine Key) counties (Meshaka et al. 2004a). In Monroe County, the Slider was abundant in a large solution hole on Big Pine Key (Meshaka et al. 2004a) and a record

FIGURE 12. A Slider (*Trachemys scripta*) from Lee Co., Florida. (Photographed by Richard D. Bartlett).

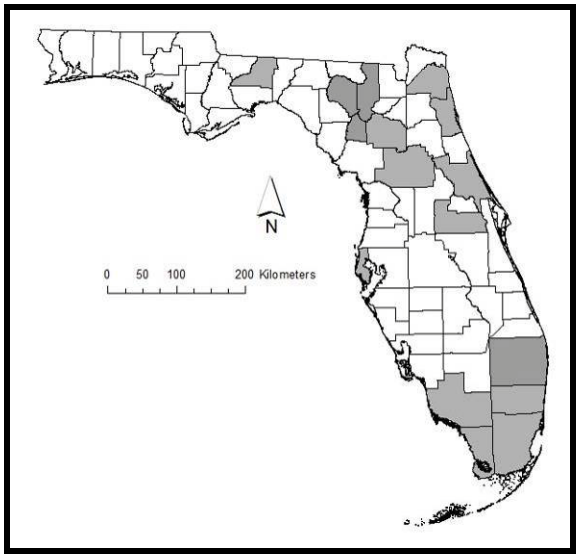

FIGURE 13. Geographic distribution of the Slider (*Trachemys scripta*) in Florida.

exists for an individual from a pond on Stock Island (Butterfield et al. 1994a). After Meshaka et al. (2004a) went to press, a subsequent record appeared for southern Florida: Broward County (Johnston and Johnston 2003a). More recent records of the Slider are from Monroe (Stock Island; Krysko and Sheehy III 2005) and Palm Beach (Enge et al. 2007) counties, and reports are from Broward County just north of the Miami-Dade County line (Meshaka et al. 2008a).

Elsewhere in Florida, records of the Slider exist from Orange and Pinellas counties, and reports exist from Alachua, Duval, and Marion counties (Meshaka et al. 2004a). After Meshaka et al. (2004a) subsequent record appeared for northern Florida: Volusia County (Townsend et al. 2002). More recent records for this turtle are from Columbia (Lau et al. 2008), Gilchrist (Thomas and Johnston 2009), Leon (Aresco and Jackson 2006), St. Johns (Ehret and Parker 2005), and Suwannee (Lau and Johnston 2009) counties (Fig. 13). The Slider also occurs as an established exotic species elsewhere in the United States and in the West Indies (Lever 2003).

Body size.—In Florida, body sizes of the Slider differed between the sexes. For example, in Miami canals males (mean = 148 mm CL) were smaller than females (mean = 237 mm CL; Meshaka et al. 2004a) and the same was true for males (mean = 167 mm CL) and females (mean = 220 mm CL) in a Miami pond (Witzell 1999). In Broward County, a female measured 223 mm CL (Johnston and Johnston 2003b). Farther north in a Pinellas County pond in west-central Florida, males (mean = 162 mm PL) were also smaller than females (mean = 183 mm PL; Emer 2004).

Habitat and abundance.—In south Florida, the Slider was a successful colonizer of canals and ponds of wayside parks, where individuals could become tame (Meshaka et al. 2004a). In a Miami pond, the Slider was similar in abundance to the Florida Redbelly Turtle (Witzel 1999). Johnston and Johnston (2003b) and Johnston et al. (2008) found this species to be abundant in Broward County canals. In the latter study, the Slider (n = 316) was the dominant aquatic turtle of that assemblage: Florida Snapping Turtle (n = 52), Florida Redbelly Turtle (*Pseudemys nelson*; n = 49), Striped Mud Turtle (*Kinosternon baurii*; n = 34), Florida Softshell (*Apalone ferox*; n = 30), Florida Cooter (*P. floridana*; n = 11), Common Musk Turtle (*Sternotherus odoratus*; n = 4). The accuracy of abundance estimates provided for the Florida Redbelly Turtle and the Florida Cooter is difficult to assess in light of overwhelming herbivory in adults of those species. It is nonetheless clear that the Slider was a dominant component to the omnivorous and carnivorous segments of those south Florida canals. Farther north and west, the Slider became abundant in a Pinellas County pond in a short period of time, in part by recruitment and also by immigration from nearby ponds (Emer 2004). In the Florida panhandle, the Slider was the predominant emydid in many lentic bodies of water (Aresco and Jackson 2006).

Diet.—In Broward County, individuals were seen eating fruit from Pond Apple (*Annona glabra*; Johnston and Johnston 2003b). Ease associated with trapping the species in traps baited with sardines in Pinellas County attested to some level of carnivory (Emer 2004). The same may be said for individuals in a Broward County

FIGURE 14. A male Agama, *Agama agama africanus* (left), in breeding condition, and an *Agama agama* from Broward Co., Florida. (Photographed by Jake Scott [left] and Richard D. Bartlett [right).

study captured in abundance using cut fish and beef liver (Johnston et al. 2008). In Louisiana, the Slider ontogenetically shifted its diet from carnivory to herbivory (Hart 1983).

Reproduction.—From turtles collected during June-August in Miami canals, clutch sizes ranged 9−12 eggs, and three clutches were produced by one female (Meshaka et al. 2004a). Egg dimensions of a 12-egg clutch laid by a 241 mm CL female from Miami averaged 37.6 X 24.4 mm (Meshaka et al. 2004a). These reproductive data do not conflict with data from northerly populations of the Slider (Ernst et al. 1994).

Growth and survivorship.—On Stock Island, two small individuals (30 and 70 mm CL) were collected in March (Krysko and Sheehy III 2005).

Activity.—I have found individuals active throughout the year in south Florida; however, in northern sites, such as Kentucky, individuals hibernate (Ernst et al. 1994).

Predators.—The American Alligator (*Alligator mississippiensis*) and the Spectacled Caiman are potential predators of this species.

Threats.—Aresco and Jackson (2006) raised the concern of intergradation of the Slider with the native subspecies in the Florida panhandle. Its reliance on canals and wayside park ponds increases the likelihood of road mortality by dispersing or nesting individuals. Its ecological relationships with other freshwater emydid turtles in Florida has been little studied but is a potentially fruitful (e.g., Witzell 1999; Johnston et al. 2008) topic. Road mortality associated with nesting females crossing roadside canals and borrow pits is a possible threat to the species.

AGAMA AGAMA (LINNAEUS 1753) — COMMON AGAMA

Description.—As described by Bartlett and Bartlett (1999) and Meshaka et al. (2004a), males are bluish or black in body color and have a yellow or orange head. Body colors of females and juveniles are shades of brown (Fig. 14).

Distribution.—The Common Agama is an Old World species whose first documentation in Florida is from Miami, Miami-Dade County, but the colony apparently did not survive (Wilson and Porras 1983). Since the 1980s, the species has existed in Davie, Broward County (Bartlett and Bartlett 1999). In southern Florida, past records are from Broward (Enge et al. 2004a; Meshaka et al. 2004a), Charlotte (Enge et al. 2004a), Martin (Enge et al. 2004a), Miami-Dade (Bartlett and Bartlett 1999; Enge et al. 2004a; Meshaka et al. 2004a), and Monroe (Key Largo; Enge et al. 2004a) counties, and reports are from Miami-Dade County (Meshaka et al. 2004a). With respect to the Monroe County record, Enge et al. (2004a) did not believe that it was established there. More recent records of the Common Agama are from Charlotte (Krysko et al. 2005), Lee (Sanibel Island) (Lechowicz 2006), and Miami-Dade (Krysko et al. 2005) counties.

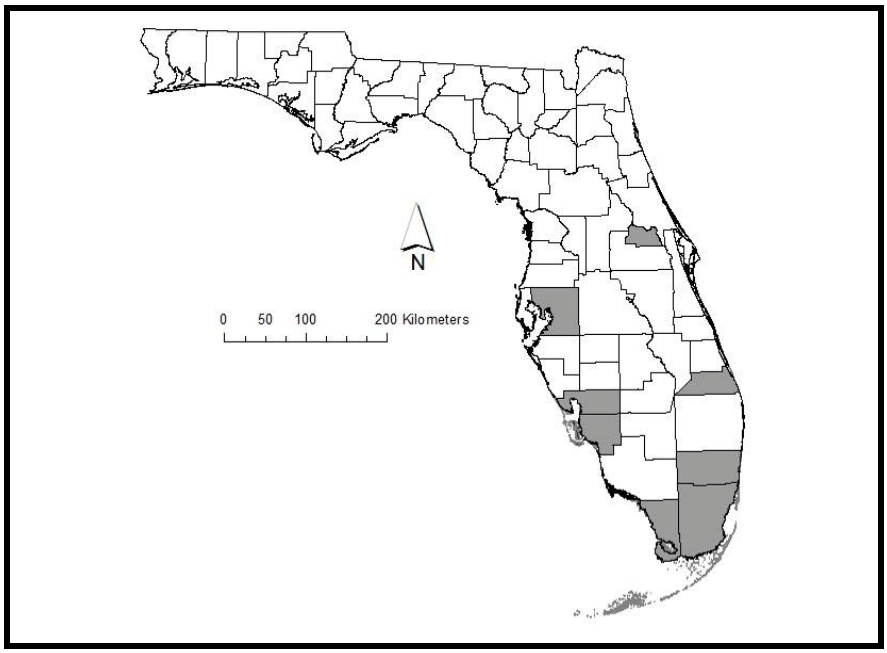

FIGURE 15. Geographic distribution of the Common Agama (*Agama agama*) in Florida.

Elsewhere in Florida, records of the Common Agama exist from Hillsborough (Campbell et al. 2009) and Seminole (Enge et al. 2004a; Krysko et al. 2005) counties (Fig. 15). (It should be noted that subsequent to the transferal of the ERCC herpetological collection to the FNHM, specimens of this species were incorrectly retagged with each others' ERCC tags by FNHM. Likewise, the FNHM tags also assigned to them did not match their respective collection data.)

Body size.—An adult male measuring 115 mm SVL was from Homestead (Meshaka et al. 2004a). Four adult males measured 122154 mm SVL, and mean adult body size of females measured 111 mm SVL (Enge et al. 2004a).

Habitat and abundance.—In south Florida, the Common Agama was strongly associated with the trappings of disturbed areas, such as rock piles, buildings, and adjacent trees (Bartlett and Bartlett 1999; Enge et al. 2004a; Meshaka et al. 2004a). Many individuals could be seen on single visits. For example, 25 individuals were seen during a visit to a site in Homestead in March, and at least 25 individuals were seen at a site in Punta Gorda, Charlotte County, in June (Enge et al. 2004a). Thirteen individuals were seen in May at a site farther north in Florida, in Sanford, Seminole County (Enge et al. 2004a).

Diet.—In south Florida, the Brown Anole was uncommon in suitable habitat occupied by the Common Agama, an observation thought to suggest some level of carnivory (Meshaka et al. 2004a). Individuals were caught by Enge et al. (2004a) on hook and line baited with crickets.

Reproduction.—Females captured from northern and southern Florida during May-August were gravid, and a Homestead female captured in September was not gravid (Enge et al. 2004a). Clutch sizes were estimated using follicles (mean = 9.7) and oviductal eggs (mean = 9.0), and were positively correlated with female body size (Enge et al. 2004a). A Punta Gorda, Charlotte County, female may have been able to produce two or three clutches (Enge et al. 2004a). Blunden and Krysko (2007) stated that there were errors in the work of Enge et al. (2004a) and recalculated the values with additional data to estimate a mean for clutch size (mean = 8.7 eggs) and length (mean = 14.1 mm). Three clutches were thought to be possible for this species in Florida (Blunden and Krysko 2007).

Growth and survivorship.—Two hatchlings captured in June from Punta Gorda, Charlotte County, measured 42 mm SVL (Enge et al. 2004a).

FIGURE 16. Indochinese Bloodsucker, *Calotes mystaceus*. (Photographed by Richard D. Bartlett).

FIGURE 17. Geographic distribution of the Indochinese Bloodsucker (*Calotes mystaceus*) in Florida.

***Activity*.—**The Common Agama is very much a heliothermic lizard (Bartlett and Bartlett 1999) and wary of human approach (Meshaka et al. 2004a).

***Threats*.—**The Common Agama was a potential threat to the Green Anole (Meshaka 2008a) and presumably the Brown Anole and probably other species of *Anolis*.

CALOTES MYSTACEUS (DUMÉRIL AND BIBRON 1837) — INDOCHINESE BLOODSUCKER

***Description*.—**As described by Bartlett and Bartlett (1999), males are gray with blue heads, and during breeding, their throats may turn orange. Females are brown with darker crossbars and longitudinal dorsolateral stripes. A dorsal crest is present in this species (Fig. 16).

***Distribution*.—**The Indochinese Bloodsucker is an Old World species whose first documentation in Florida is from Okeechobee, Okeechobee County (Bartlett and Bartlett 1999). The colony had been in existence since the early 1980s (Bartlett and Bartlett 1999). In southern Florida, past records are from Glades and Okeechobee counties (Meshaka et al. 2004a; Fig. 17).

***Body size*.—**Adult Indochinese Bloodsuckers reached up to 381 mm TL (Bartlett and Bartlett 1999).

FIGURE 18. Variable Bloodsucker, *Calotes versicolor*. (Photographed by Richard D. Bartlett).

FIGURE 19. Geographic distribution of the Variable Bloodsucker (*Calotes versicolor*) in Florida.

***Habitat and abundance*.—**The Okeechobee colony of this species inhabited a citrus grove (Meshaka et al. 2004a).

***Diet*.—**The Indochinese Bloodsucker is primarily insectivorous (Meshaka 2006); however, its diet in Florida has not been examined.

***Activity*.—**The Indochinese Bloodsucker, although an arboreal species (Bartlett and Bartlett 1999; Meshaka et al. 2004a), would also forage near the ground (Bartlett and Bartlett 1999).

***Threats*.—**Meshaka (2008a) noted that the impacts of this arboreal predator on Florida's fauna were as yet unknown.

CALOTES VERSICOLOR (DAUDIN 1802) — VARIABLE BLOODSUCKER

***Description*.—**Richard D. Bartlett (pers. comm.) noted that the Variable Bloodsucker is generally brown in color. The dorsum is darker than the lower sides, which

are, in turn, darker than the venter. Males have black throats. Adults have a vertebral crest of spines that are longest on the neck (Fig. 18).

Distribution.—The Variable Bloodsucker is an Old World species whose first documentation in Florida is from a site west of Port St. Lucy, St. Lucie County (Enge and Krysko 2004). The age of this colony dated back to 1978 (Enge and Krysko 2004). Meshaka (2006) noted the presence of this species in the pet trade. In southern Florida, the Variable Bloodsucker has been recorded in St. Lucie County (Enge and Krysko 2004) (Fig. 19).

Body size.—Enge and Krysko (2004) captured an adult female measuring 108 mm SVL in August.

Habitat and abundance.—The Variable Bloodsucker in south Florida occurred in disturbed habitat that bordered a canal (Enge and Krysko 2004).

Diet.—The Variable Bloodsucker was primarily, but not exclusively, insectivorous (Meshaka 2006); however, the diet of this species in Florida is unknown.

Reproduction.—An adult female lizard, captured on 15 August, died in captivity on 31 August, and contained 19 oviductal eggs (mean = 15.2 X 8.0 mm; Enge and Krysko 2004).

Growth and survivorship.—Body size data were available for 10 juveniles (mean = 31.0 mm SVL) in August (Enge and Krysko 2004).

Activity.—Individuals of this species were diurnal and slept in vegetation 1–9 m above the ground (Enge and Krysko 2004).

Threats.—The St. Lucie colony of this lizard may have been expanding northward (Enge and Krysko 2004). Because of its diet, the Variable Bloodsucker may have presented a threat to segments of the small vertebrate fauna (Meshaka 2008a).

LEIOLEPIS BELLIANA (HARDWICKE AND GRAY 1827) — BUTTERFLY LIZARD

Description.—As described by Bartlett and Bartlett (2006), the dorsum of males is olive-brown in color with a broken tan vertebral stripe. There is a broken olive-tan stripe along each upper side. Light spots and alternating bright orange and black vertical bars are present on the sides. The thighs are spotted and the forearms are banded in black and pale orange. The lower forearms are spotted. Females are not as brightly colored as are the males (Fig. 20). More recently, the parthenogenetic congener (Thai Butterfly Lizard, *L.triploidea*) has entered the pet market (Richard D. Bartlett, pers. comm.). Lacking the orange markings, it is otherwise

FIGURE 20. Butterfly Lizard, *Leiolepis belliana*. (Photographed by Richard D. Bartlett).

FIGURE 21. Geographic distribution of the Butterfly Lizard (*Leiolepis belliana*) in Florida.

similar in appearance to the Butterfly Lizard.

Distribution.—The Butterfly Lizard is an Old World species whose first documentation in Florida is from Miami, Miami-Dade County (Krysko and Enge 2005). The colony was localized and present since at least 1992 (Krysko and Enge 2005). The species was commonly offered in the pet trade (Meshaka 2006). In southern Florida, past records are from Miami-Dade County (Krysko and Enge 2005; Fig. 21).

Habitat and abundance.—In the Miami colony, individuals were seen actively foraging on open lawns (Krysko and Enge 2005). Individuals were thought to forage no farther than 30 m from their burrows (Krysko and Enge 2005).

Diet.—Lizards were captured by Krysko and Enge (2005) using live crickets attached to hook and line. Meshaka (2006) noted omnivory in this species, with a preference for insects.

Reproduction.—A large dead female contained five developing ova (Meshaka 2006).

Activity.—Krysko and Enge (2005) found this species to be diurnally active in Miami, preferring hot air temperatures. Frightened individuals quickly retreated into their burrows, re-emerging within approximately five minutes (Krysko and Enge 2005).

Threats.—Krysko and Enge (2005) noted the importance of eradication of the Butterfly Lizard, if desired, while the population was still localized.

FIGURE 22. Veiled Chameleon (*Chameleo calyptratus*) from La Belle, Glades Co., Florida. (Photographed by Richard D. Bartlett).

CHAMELEO CALYPTRATUS DUMÉRIL AND BIBRON 1851 — VEILED CHAMELEON

Description.—The Veiled Chameleon is a strikingly colorful animal with a laterally compressed and colorfully patterned body (Fig. 22). Only males have tarsal spurs, which are evident from birth.

Distribution.—The Veiled Chameleon is an Old World species whose first documentation in Florida is from Fort Myers, Lee County (Krysko et al. 2004). This colony has been in existence since 2001 and probably derived from the pet trade (Krysko et al. 2004). Reports of other colonies are from Lehigh Acres and Alva, both in Lee County, and a photograph exists of an adult from Naples, Collier County (Krysko et al. 2004). The status of the species in that latter county was not mentioned by Krysko et al. (2004). In southern Florida, records of this

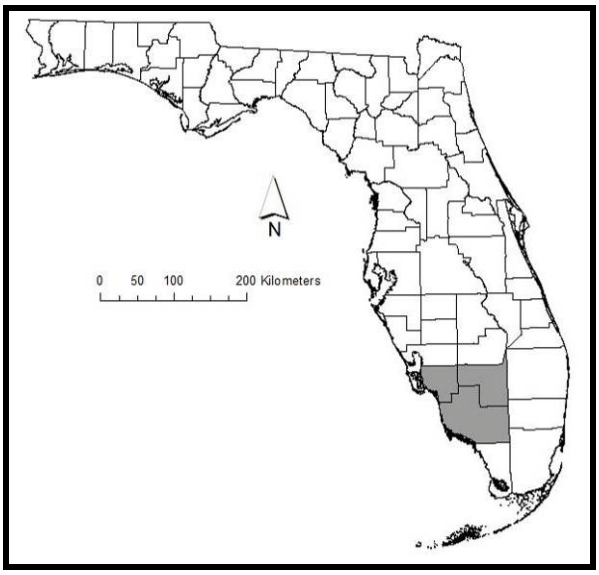

FIGURE 23. Geographic distribution of the Veiled Chameleon (*Chameleo calyptratus*) in Florida.

species are from Collier (Krysko et al. 2004), Hendry (Enge 2008), and Lee (Krysko et al. 2004; Fig. 23) counties. The Veiled Chameleon also occurs as an established exotic species elsewhere in the United States (Meshaka 2008a).

Habitat and abundance.—Individuals were present amid vegetation in a vacant lot (Krysko et al. 2004).

Diet.—Meshaka (2006) noted omnivory in the Veiled Chameleon, the diet of which included insects, small vertebrates, and vegetation.

Reproduction.—In captivity, females laid eggs several times each year in clutches of 20–50 eggs (Meshaka 2006).

Growth and survivorship.—Neonates were present in June and August (Krysko et al. 2004). In captivity, females were sexually mature within three months of age (Meshaka 2006).

Activity.—The species was diurnally active, and Krysko et al. (2004) noted the ease with which nocturnally sleeping individuals could be captured.

Threats.—Capable of eating small vertebrates, the Veiled Chameleon was a threat to some segments of the small vertebrate fauna (Meshaka 2008a). Its foothold in Florida is limited to the extent that eradication seems feasible.

BASILISCUS VITTATUS WEIGMANN 1828 — BROWN BASILISK

Description.—As described by Conant and Collins (1998) and Meshaka et al. (2004a), the body color of males is olive brown with yellow dorsolateral stripes. Females and juveniles are brown with cream or yellow dorsolateral stripes and dark crossbands. Both sexes have a crest on the back of the head and a dorsal crest on the body; however, those of the males are more prominent (Fig. 24).

Distribution.—The Brown Basilisk is a New World species whose first documentation in Florida is from Miami-Dade County and Davie, Broward County (Wilson and Porras 1983). This species had been present in Miami-Dade County since 1976 (Wilson and Porras 1983). In southern Florida, past records are from Broward and Miami-Dade counties, and reports are from Broward, Miami-Dade, and Palm Beach counties (Meshaka et al. 2004a). More recent records of the Brown Basilisk in southern Florida are from Broward (Krysko et al. 2006), Collier (Krysko et al. 2005, 2006), Hendry (Crutchfield and Enge 2009), Miami-Dade (Krysko et al. 2006), Palm Beach (Krysko et al. 2005, 2006), and St. Lucie (Krysko et al. 2005, 2006) counties. Elsewhere, a record of the Brown Basilisk exists from Indian River County (Rand et al. 2008). This is an increasingly common species and in many places within the counties from which it has been documented (Fig. 25).

Body size.—Both the largest male (160 mm SVL) and female (110 mm SVL) Brown Basilisk were from Miami-Dade County (Meshaka et al. 2004a).

Habitat and abundance.—In southern Florida, this lizard occurred around the dense vegetation of borrow pits and canals (Meshaka et al. 2004a). Its use of canals has conferred a distinct advantage in its rapid dispersal in south Florida. In Naples, Collier County, individuals were observed on mangrove trees and the edge of a canal (Krysko et al. 2005). Adults were active on or above the ground, whereas juveniles tended to be seen along the shoreline (Meshaka et al. 2004a).

Diet.—In southern Florida, the Brown Basilisk was an omnivore, eating ficus fruit and insects, especially beetles (Meshaka et al. 2004a). Lizards were also eaten, and two males were observed fighting over a captured Brown Anole (Krysko et al. 2006).

Reproduction.—In southern Florida, gravid females were present in March, June, and July (Meshaka et al.

FIGURE 24. Brown Basilisk (*Basiliscus vittatus*) from Miami-Dade Co., Florida. (Photographed by Richard D. Bartlettt).

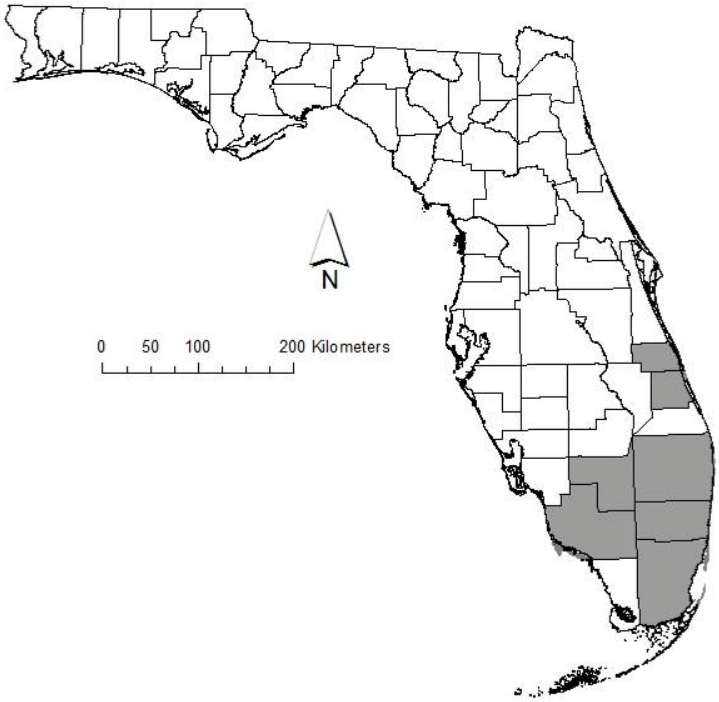

FIGURE 25. Geographic distribution of the Brown Basilisk (*Basiliscus vittatus*) in Florida.

2004a). Clutch sizes were of four and six eggs for the species in southern Florida (Meshaka et al. 2004a).

***Growth and survivorship*.—**In southern Florida, hatchlings measured 35–36 mm SVL, and were apparant in June and July (Meshaka et al. 2004a).

***Activity*.—**In southern Florida, individuals were active throughout the year. Individuals were most active on hot sunny days but would bask on cool and overcast days (Meshaka et al. 2004a).

***Predators*.—**The Brown Basilisk was eaten by the Eastern Corn Snake, Southern Black Racer, and Eastern Indigo Snake (Meshaka et al. 2004a).

***Threats*.—**The ecological impacts on the native vertebrate fauna in Florida by this exotic predator were not known (Meshaka 2008a). In light of its easy colonization of canals, the Brown Basilisk could appear in, even if not colonize, ENP (Meshaka et al. 2000). The Brown Basilisk is threatened by the Eastern Corn Snake, Southern Black Racer, and Eastern Indigo Snake and is a threat to anoles generally.

CHONDRODACTYLUS BIBRONII (SMITH 1845) — BIBRON'S COMB-TOED GECKO

***Description*.—**The body of this lizard is mottled in brown and black, and a dark eye stripe is present (Meshaka et al. 2004a). Its body surface is tuberculate (Bartlett and Bartlett 1999; Fig. 26).

FIGURE 26. Bibron's Comb-toed Gecko (*Chondrodactylus bibronii*) from Manatee Co., Florida. (Photographed by Richard D. Bartlett).

***Distribution*.—**Bibron's Thick-toed Gecko is an Old World species whose first documentation in Florida is from Bradenton, Manatee County (Bartlett and Bartlett 1999). This species had been in Manatee County since the 1970s (Bartlett and Bartlett 1999). In southern Florida, past records are from Manatee County (Meshaka et al. 2004a; Fig. 27).

***Body size*.—**Bibron's Thick-toed Gecko is a large-bodied gecko. Florida individuals can reach approximately 140 mm SVL (Bartlett and Bartlett 1999).

***Habitat and abundance*.—**In southern Florida, individuals were associated with buildings (Meshaka et al. 2004a), and Bartlett and Bartlett (1999) noted that individuals would venture to nearby power poles and trees.

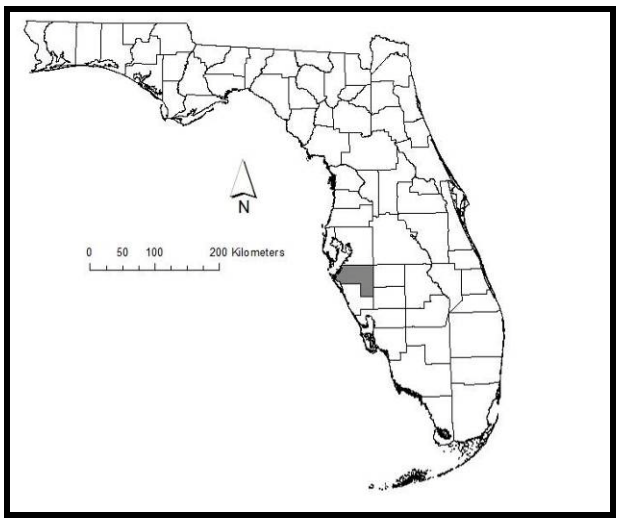

FIGURE 27. Geographic distribution of the Bibron's Comb-toed Gecko (*Chondrodactylus bibronii*) in Florida.

FIGURE 28. Asian House Gecko (*Cosymbotus platyurus*) from Lee Co., Florida. (Photographed by Suzanne L. Collins).

Diet.—Bartlett and Bartlett (1999) noted that Bibron's Thick-toed Gecko was able to eat small vertebrates and invertebrates.

Reproduction.—Florida captives laid eggs during the summer (Bartlett and Bartlett 1999). Clutch size numbered two eggs and several clutches were laid annually by this gecko (Bartlett and Bartlett 1999).

Activity.—Individuals were most often active after dark and could be seen perched face-down on walls near eaves (Bartlett and Bartlett 1999).

Threats.—Bibron's Thick-toed Gecko is also a likely threat to other building-dwelling geckos. Known only from Bradenton, this species is easily at risk of being extirpated from Florida. To control building-dwelling populations of this lizard that benefit from light-attracted insect prey, Cress et al. (2007) suggested the use of lights that do not attract invertebrates.

COSYMBOTUS PLATYURUS (SCHNEIDER 1792) — ASIAN HOUSE GECKO

Description.—Meshaka et al. (2004a) noted a brownish-gray dorsal color with a faint pattern. Toes are webbed, and a fold of skin is present on either side of the body (Fig. 28).

Distribution.—The Asian House Gecko is an Old World species whose first documentation in Florida is from Clearwater, Pinellas County (Meshaka and Lewis 1994). This colony had been in existence since the mid 1980s (Meshaka and Lewis 1994). In southern Florida, past records are from Lee and Miami-Dade counties (Meshaka et al. 2004a).

Elsewhere in Florida, records of the Asian House Gecko exist from Alachua and Pinellas counties, and reports exist from Hillsborough County (Meshaka et al. 2004a). This species is among the least successful exotic geckos in Florida (Fig. 29).

Body size.—The Asian House Gecko is not a large lizard. The largest male (61.2 mm SVL) was from Homestead, Miami-Dade County, and the largest female (48.6 mm SVL) was from Clearwater, Pinellas County (Meshaka et al. 2004a).

Habitat and abundance.—The Asian House Gecko inhabited buildings and other human structures, and on buildings it could be numerous (Meshaka and Lewis 1994). However, the species did not occupy the vegetation near buildings (Meshaka et al. 2004a).

Diet.—The stomach of a male from Homestead contained a single fly (Diptera) (Meshaka et al. 2004a).

Reproduction.—Meshaka et al. (2004a) collected a fertile male Asian House Gecko in July in Homestead and saw gravid females in April in southern Florida (Meshaka et al. 2004a).

Growth and survivorship.—In Clearwater, hatchlings were observed in November (Meshaka and Lewis 1994).

Activity.—The Asian House Gecko is primarily, if not exclusively, nocturnal. Hatchlings wagged their tails in

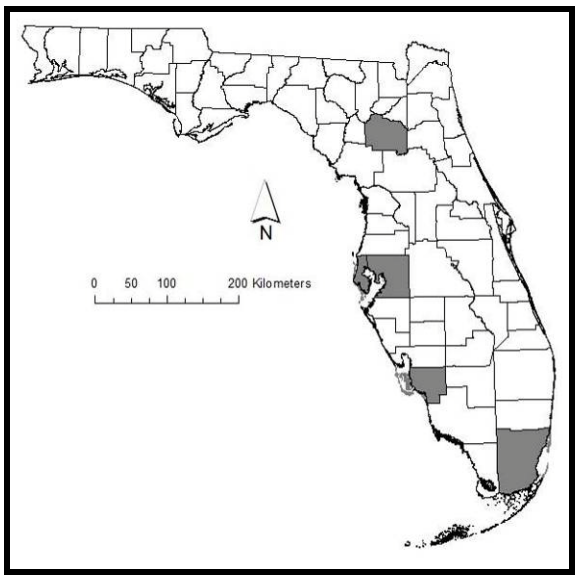

FIGURE 29. Geographic distribution of the Asian House Gecko (*Cosymbotus platyurus*) in Florida.

response to being dazzled by a flashlight (Meshaka and Lewis 1994). The largest individuals, thought to be males, were seen at the highest parts of the buildings (Meshaka and Lewis 1994). The species appeared to have been negatively impacted by other exotic geckos. A site in Ft. Myers, Lee County, was inhabited by the Asian House Gecko, Indo-Pacific Gecko, Common House Gecko, and Ringed Wall Gecko. When visited two years later, no Asian House Geckos were seen, and the Common House Gecko was more abundant (Meshaka et al. 2004a).

***Predators*.—**In southern Florida, the Ringed Wall Gecko was a predator of the Asian House Gecko, and the Cuban Treefrog and Tokay Gecko were thought to be potential predators of this species (Meshaka et al. 2004a).

***Threats*.—**In southern Florida, the Asian House Gecko is replaced by hemidactyline geckos and is threatened by the Ringed Wall Gecko. The ecological impact of the Asian House Gecko in Florida was unknown and could remain so if the species were to be eventually displaced to extinction in Florida (Meshaka 2008a). To control building-dwelling populations of this lizard that benefit from light-attracted insect prey, Cress et al. (2007) suggested the use of lights that do not attract invertebrates.

GEKKO GECKO (LINNAEUS 1758) — TOKAY GECKO

***Description*.—**The body is blue-mauve in color and marked throughout with small red and orange spots (Meshaka et al. 2004a). The skin is warty in texture (Meshaka et al. 2004a; Fig. 30). Krysko and Daniels (2005) provided a key to most of the geckos in Florida.

***Distribution*.—**The Tokay Gecko is an Old World species whose first documentation in Florida is from Miami-Dade and Broward counties (Wilson and Porras1983). The species may have been in southern Florida since the 1960s (Wilson and Porras 1983). In southern Florida, past records are from Broward, Highlands, Miami-Dade, and Monroe (Key West) counties (Meshaka et al. 2004a), and reports are from Broward, Collier, Lee, Martin, Monroe (Big Pine Key, Geiger Key), and Palm Beach counties (Meshaka et al. 2004a). More recent records of the Tokay Gecko are from Lee and Monroe (Key Largo, Little Torch Key, Plantation Key) counties (Krysko et al. 2005), and I report it from Sarasota County.

Elsewhere in Florida, records of the Tokay Gecko exist from Alachua, Hillsborough, Leon, and Pinellas counties, and reports are from Hillsborough and Leon counties (Meshaka et al. 2004a; Fig. 31). An eventual statewide distribution in Florida seems likely for this species. The Tokay Gecko also occurs as an established exotic species elsewhere in the United States (Lever 2003; Meshaka 2008a).

***Body size*.—**The Tokay Gecko is Florida's largest gecko. In southern Florida, males (mean = 144.9 mm SVL) were larger than females (mean = 126.8 mm SVL) of this species (Meshaka et al. 2004a).

***Habitat and abundance*.—**In southern Florida, the Tokay Gecko inhabited buildings and other human-made structures and large shade trees, such as *Ficus*, in urban disturbed areas (Meshaka et al. 2004a). It also inhabited disturbed hardwood hammocks (Meshaka et al. 2004a). In ENP, this large gecko occurred on the Key Largo Ranger Station (Meshaka et al. 2000). In Tallahassee, Leon County, the Tokay Gecko occurred around residences (Means 1996). In Martinique, the species described as being edificarian (Henderson et al. 1993). Population sizes of this gecko could be large; up to 20 individuals were counted at a site in one hour (Meshaka et al. 2004a). However, even if not abundant, this lizard can be widespread in an area, seen scattered throughout a large neighborhood.

***Diet*.—**In southern Florida, the Tokay Gecko ate a

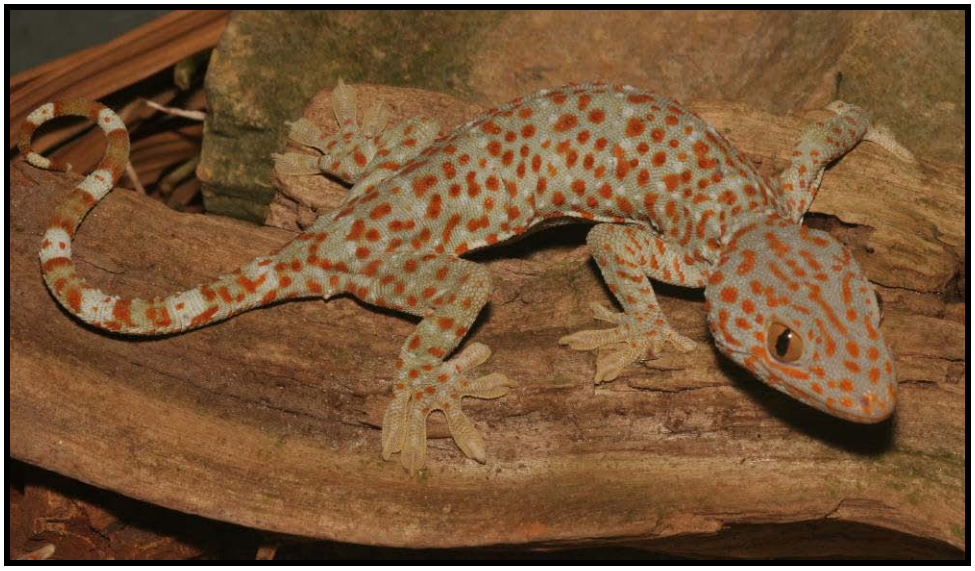

FIGURE 30. Tokay Gecko (*Gekko gecko*) from Miami-Dade Co., Florida. (Photographed by Richard D. Bartlett).

wide range of invertebrate taxa, especially beetles, roaches, and moths (Meshaka et al. 1997a, 2004a). In the study by Meshaka et al. (1997a), prey types were strongly associated with the trees and leaf litter where the geckos were caught rather than the nearby lighted buildings. Prey size was similar between males (Mean = 17. 3 mm), females (mean = 8.9 mm), and juveniles (mean = 12.7 mm; Meshaka et al. 1997a). The Tokay Gecko was also a predator of the Wood Slave (Meshaka et al. 2004a) and the Eastern Corn Snake (Love 2000). The Tokay Gecko is presumably a predator of other geckos.

Reproduction.—In south Florida, males had enlarged testes in July (Meshaka et al. 2004a). Females were gravid during May-September. Clutch sizes numbered two eggs, which measure 16–20 mm. Nests could be communal with up to 140 eggs observed and in some cases males were in attendance of them (Meshaka et al. 2004a).

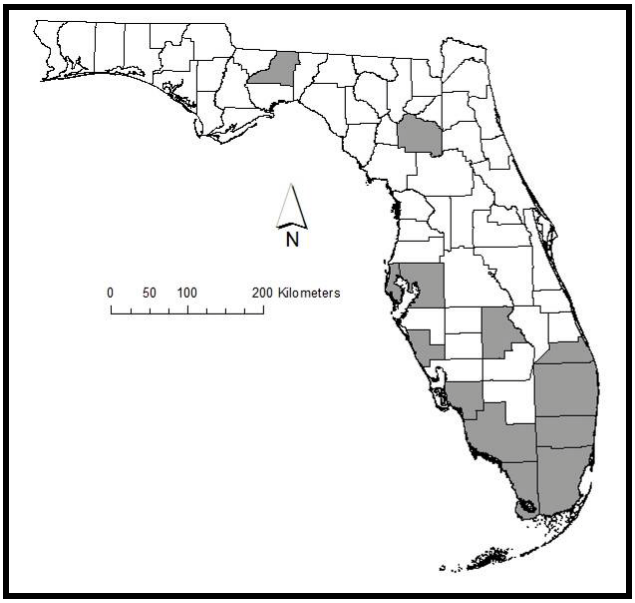

FIGURE 31. Geographic distribution of the Tokay Gecko (*Gekko gecko*) in Florida.

***Growth and survivorship*.—**In south Florida, males were larger than females. For example, the smallest sexually mature male (126 mm SVL) was larger than the smallest sexually mature female (110 mm SVL; Meshaka et al. 2004a).

***Activity*.—**The Tokay Gecko was active primarily at night, but individuals could be seen out of their retreats on sultry days or just before hard rains (Meshaka et al. 2004a). Males called during winter and spring in Miami and Homestead (Meshaka et al. 2004a). In Tallahassee, individuals vocalized in April and May (Means 1996). Captives from Miami called most just before sunrise (Meshaka et al. 2004a).

***Predators*.—**The Cuban Treefrog, a predator of vertebrates, including geckos (Meshaka 2001), was a potential predator of hatchlings (Meshaka et al. 2004a).

***Threats*.—**The Tokay Gecko ate invertebrates and vertebrates and was potentially a threat to small native vertebrates living in disturbed mesophytic forests in Florida (Meshaka 2008a). The Tokay Gecko also overlapped with the Cuban Treefrog with respect to habitat and diet thereby increasing the potential for competition between these two species (Meshaka 2001) and the potential for depredation of small Tokay Geckos by this large anuran. The Cuban Treefrog is also a threat to other geckos, especially nocturnal species in Florida. To control building-dwelling populations of this lizard that benefit from light-attracted insect prey, Cress et al. (2007) suggested the use of lights that do not attract invertebrates.

GONATODES ALBOGULARIS (DUMÉRIL AND BIBRON 1836) — YELLOWHEAD GECKO

***Description*.—**Males are dark grayish blue in color with a bright yellow head, and females and juveniles are speckled brown (Conant and Collins1998; Meshaka et al. 2004a; Fig. 32). Krysko and Daniels (2005) provide a key to most of the geckos in Florida.

***Distribution*.—**The Yellowhead Gecko is a West Indian species whose first documentation in Florida is from Key West, Monroe County (Carr 1939). In southern Florida, past records are from Broward, Miami-Dade, and Monroe (Key West, Stock Island) counties; and reports are from Monroe (Key West; Lazell 1989; Meshaka et al. 2004a) County. More recent publications of old records of this species exist from southern Florida: Miami-Dade, Monroe (Boca Chica, Key Largo, Key West, Stock Island; Krysko 2005), Monroe (Bahia Honda; Krysko and Borgia 2008), and St. Lucie counties (Krysko 2005). On Key West, the Yellowhead Gecko was at one time considered to be abundant (Carr 1939 1940; Duellman and Schwartz 1958; King and Krakauer 1966). A series collection exists from 1971, but Wilson and Porras (1983) subsequently found none. Lawson et al. (1991) found the species on Key West. Based on their own field work and research and patterns revealed from literature, Meshaka et al. (2004a) concluded that the Yellowhead Gecko, once abundant, had now declined. A timed search by Krysko (2005) corroborated these conclusions. Krysko (2005) regarded the same conclusions of Meshaka et al. (2004a) as speculation because Meshaka et al. (2004a) did not specify time searched as did Krysko (2005). However, Krysko (2005) did not mention that the citations he and Meshaka et al. (2004a) used to build the case of erstwhile ubiquity and subsequent decline in the species likewise did not provide the amount of search time, yet Krysko (2005) accepted their conclusions but relegated those of Meshaka et al. (2004a) to speculation.

Landscaping activities resulted in the removal of trees used by the Stock Island colony (Meshaka et al. 2004a), and the Coconut Grove colony (King and Krakauer 1966) did not appear to be extant (Wilson and Porras 1983; Krysko 2005). Persistence of this little gecko in Florida seems tenuous (Fig. 33). The Yellowhead Gecko may be an exotic species elsewhere in the West Indies (Lever 2003).

***Body size*.—**A small gecko, the largest male (40.3 mm SVL) and female (37.8 mm SVL) Yellowhead Gecko were from Key West (Duellman and Schwartz 1958).

***Habitat and abundance*.—**The Yellowhead Gecko was a building-dwelling species on Key West (Carr 1940; Duellman and Schwartz 1958); however, it has also been observed on branches (Bartlett and Bartlett 1995) and trunks of trees (Meshaka et al. 2004a).

***Diet*.—**The Yellowhead Gecko is an insectivore whose diet in Florida has not yet been studied. An individual hunted for prey on a ficus tree on Key West, Monroe Co. (Meshaka et al. 2004a).

***Reproduction*.—**Lazell (1989) noted that the eggs of the Yellowhead Gecko did not stick to the substrate as in the hemidactyline geckoes.

***Activity*.—**Diurnal in activity (Carr 1940; Lazell 1989; Bartlett and Bartlett 1995; Meshaka et al. 2004a), this little gecko seemed to prefer shady places (Lazell 1989).

***Threats*.—**The Yellowhead Gecko has become rare in Florida, perhaps from replacement by other recently established geckos (Meshaka 2008a).

FIGURE 32. Juvenile (left) and male (center and right) Yellowhead Geckos (*Gonatodes albogularis*) from Key West, Monroe Co., Florida. (Right and left pictures photographed by Richard D. Bartlett, center photographed by Suzanne L. Collins).

FIGURE 33. Geographic distribution of the Yellowhead Gecko (*Gonatodes albogularis*) in Florida.

HEMIDACTYLUS FRENATUS DUMÉRIL AND BIBRON 1836 — COMMON HOUSE GECKO (A.K.A. CHIT CHAT)

***Description*.—**The dorsal color is gray with faint longitudinal dark stripes, the body is smooth in texture and femoral pores are present (Meshaka et al. 2004a; Fig. 34). Krysko and Daniels (2005) provided a key to most of the geckos in Florida.

***Distribution*.—**The Common House Gecko is an Old World species whose first documentation in Florida is from Key West and Stock Island, Monroe County (Meshaka et al. 1994a). In southern Florida, past records are from Lee, Miami-Dade, and Monroe (Key West, Stock Island) counties (Meshaka et al. 2004a). After Meshaka et al. (2004a) went to press, subsequent records appeared for southern Florida: Monroe (Key West) County (Krysko et al. 2003a). More recent records of this species are from Broward (Krysko et al. 2005) and Monroe (Big Pine Key; Krysko and Sheehy III 2005) counties. I include here record of this species in Broward County (JULSP) from specimens collected in 2004 and stored in the SMP (Fig. 35). Citing Townsend and Krysko (2003), Krysko and Sheehy III (2005) stated that the Common House Gecko had been present in Lee County since the 1990s; however, its presence in Lee County is stated in the Introduction of Townsend and Krysko (2003) with no other information. The Common House Gecko also occurs as an established exotic species elsewhere in the United States (Meshaka 2008a) and in the West Indies (Lever 2003).

***Body size*.—**Two large male (50.0, 53.0 mm SVL) and four female (mean = 49.9 mm SVL) Common House Geckos were from Key West, and two females (50.7, 52.5 mm SVL) were from Homestead (Meshaka et al. 2004a).

***Habitat and abundance*.—**In south Florida, the Common House Gecko has been found on buildings and *Ficus* trees (Meshaka et al. 2004a).

***Diet*.—**On Stock Island, Monroe County, this lizard ate invertebrates, especially flies and roaches (Meshaka et al. 2004a).

***Reproduction*.—**In south Florida, females were gravid during July-October (Meshaka et al. 2004a; unpubl. data) and were capable of producing four clutches annually (Meshaka et al. 1994a). The calcareous-shelled eggs of this species reduced water loss thereby providing the female with more acceptable sites to deposit her eggs and conferring an advantage in its colonization (Punzo 2005). On Key West, a communal nest comprised of eggs of the Common House Gecko, Wood Slave, and Ashy Gecko (Krysko et al. 2003a). Punzo (2005) noted the colonization advantage to communal nesting and absence of inter-female agonistic behavior for nesting sites among Florida's exotic hemidactyline geckos.

***Growth and survivorship*.—**A 23 mm SVL neonate Common House Gecko was collected from Key West, Monroe County, in September by Meshaka et al. (2004a).

***Activity*.—**The Common House Gecko is active throughout the year. Individuals were active primarily at night (Meshaka et al. 2004a). Punzo (2005) noted an advantage to the nocturnal activity of the introduced hemidactylines, such as the Common House Gecko, in colonizing Florida, whose indigenous lizard fauna was typically diurnal. The Common House Gecko replaced the Asian House Gecko and Indo-Pacific Gecko (Meshaka et al. 2004a), and was, in turn, replaced by the Wood Slave (Meshaka et al. 1994a, 2004a).

FIGURE 34. The Common House Gecko (aka Chit Chat), *Hemidactylus frenatus*, from Broward Co. (left, photographed by Suzanne L. Collins) and Key West, Monroe Co. (right, photographed by Richard D. Bartlett) in Florida.

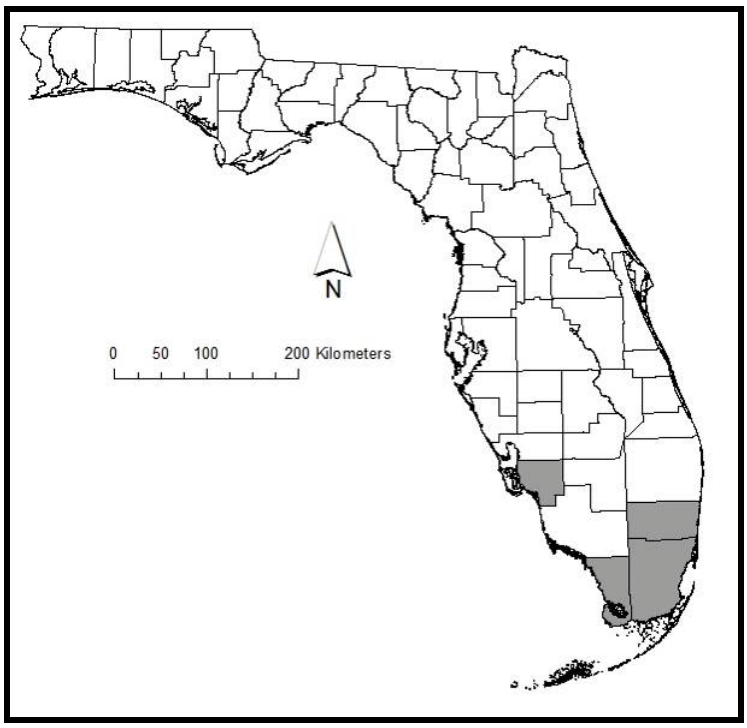

FIGURE 35. Geographic distribution of the Common House Gecko (a.k.a. Chit Chat), *Hemidactylus frenatus*, in Florida.

Predators.—In Homestead, the Ringed Wall Gecko was a predator of the Common House Gecko, and the Cuban Treefrog and Tokay Gecko were thought to be potential predators of the Common House Gecko (Meshaka et al. 2004a).

Threats.—In Florida, the hemidactyline geckos do not stably coexist with one another. In this connection, the Common House Gecko negatively impacts the Indo-Pacific Gecko and the Asian House Gecko through replacement and is negatively impacted through replacement by the Wood Slave. The Ringed Wall Gecko threatens the Common House Gecko. To control building-dwelling populations of this lizard that benefit from light-attracted insect prey, Cress et al. (2007) suggested the use of lights that do not attract invertebrates.

HEMIDACTYLUS GARNOTII DUMÉRIL AND BIBRON 1836 — INDO-PACIFIC GECKO

Description.—As described by Conant and Collins (1998) and Meshaka et al. (2004a), in this all-female species, individuals range from yellowish brown to black with white flecks above. The venter is yellow. The tail is dorsoventrally flat, saw-toothed, and yellowish orange underneath (Fig. 36). Krysko and Daniels (2005) provided a key to most of the geckos in Florida.

Distribution.—The Indo-Pacific Gecko is an Old World species whose first documentation in Florida is from Miami and Coconut Grove, Miami-Dade County (King and Krakauer 1966). The Miami-Dade County populations may have originated in the early 1960s. Its presence at two sites in Hialeah, Miami-Dade County, was known to Wilson and Porras (1983) a few years prior to King and Krakauer's (1966) Miami-Dade County records. In southern Florida, past records are from Collier (Meshaka et al. 2004a), Glades (Meshaka et al. 2004a), Hardee (Meshaka et al. 2004a), Hendry (Meshaka et al. 2004a), Highlands (Meshaka et al. 2004a), Lee (Sanibel Island; Meshaka et al. 2004a), Manatee (Meshaka et al. 2004a), Martin (mainland, Hutchinson Island; Meshaka et al. 2004a), Miami-Dade (mainland; Enge et al. 2004b; Meshaka et al. 2004a), Monroe (mainland of ENP; Meshaka et al. 2004a), Monroe (Garden Key and Loggerhead Key of the Dry Tortugas; Meshaka et al. 2004a), Monroe (Grassy Key;

FIGURE 36. Indo-Pacific Gecko, *Hemidactylus garnotii*. (Photographed by Suzanne L. Collins).

FIGURE 37. Geographic distribution of the Indo-Pacific Gecko (*Hemidactylus garnotii*) in Florida.

Meshaka et al. 2004a), Monroe (Key West; Meshaka et al. 2004a), Monroe (Summerland Key; Lazell 1989), Monroe (Upper Matecumbe Key; Meshaka et al. 2004a), Okeechobee (Meshaka et al. 2004a), Palm Beach (Meshaka et al. 2004a), Sarasota (Meshaka et al. 2004a), and St. Lucie (Meshaka et al. 2004a) counties. Reports of this species exist from Charlotte and DeSoto counties in southern Florida where it is widespread (Meshaka et al. 2004a). Reports of the Indo-Pacific Gecko exist from Miami-Dade (Key Biscayne; Frankenberg 1984), Monroe (Marathon; Frankenberg 1984), Monroe (Middle Torch Key; Lazell 1989), and Monroe (Summerland Key; Frankenberg 1984) counties. Frankenberg (1984) searched but did not find the species

on Big Pine Key, Monroe County. After Meshaka et al. (2004a) went to press, a subsequent record appeared for southern Florida: Charlotte (Townsend et al. 2002) and DeSoto (Klowden 2003) counties. Here I include records of this species from Broward (JULSP), Collier (FSP), and St. Lucie (SPSP) counties from specimens collected 2003–2005 and stored in SMP.

Elsewhere in Florida, records of the Indo-Pacific Gecko exist from Brevard (Meshaka et al. 2004a), Citrus (Meshaka et al. 2004a), Flagler (Meshaka et al. 2004a), Franklin (Meshaka et al. 2004a), Hillsborough (Meshaka et al. 2004a), Indian River (Meshaka et al. 2004a), Marion (Johnston and Johnston2004), Orange (Meshaka et al. 2004a), Osceola (Meshaka et al. 2004a), Pinellas (Meshaka et al. 2004a), St. Johns (Meshaka et al. 2004a), Suwannee (Townsend and Lindsay 2004), and Volusia (Meshaka et al. 2004a) counties. After Meshaka et al. (2004a) went to press, Dodd and Griffey (2002) noted an individual on Egmont Key, Hillsborough County, which they thought may have been dispersed through human-mediated transport of supplies. After Meshaka et al. (2004a) went to press, subsequent records appeared for central and northern Florida: Alachua, Baker, Bradford, Citrus, Flagler, Hernando, Levy (mainland, Cedar Key), Orange, Putnam, Seminole, St. Johns, and Volusia counties (Townsend and Krysko 2003). More recent records are from Bay (Himes and Enge 2007) Clay (Atkinson and Nifong 2009), and Lake (Krysko et al. 2005) counties (Fig. 37). This species is on the decline in response to the aggressive colonization of the Wood Slave. The Indo-Pacific Gecko also occurs as an established exotic species elsewhere in the United States (Meshaka 2008a) and in the West Indies (Lever 2003).

***Body size*.—**Adults from ENP averaged 55.0 mm SVL (Meshaka 1994b) and 56.2 mm SVL (Meshaka 2000). In Palmdale, Glades County, body size of the Indo-Pacific Gecko was larger (mean = 57.8 mm SVL) on buildings with the Cuban Treefrog than on those without its predator (mean = 55.3 mm SVL; Meshaka et al. 2004a). On BIR, 37 adults that I measured averaged 55.3 $\pm$ 3.0 mm SVL; range = 48–60).

***Habitat and abundance*.—**Although the Indo-Pacific Gecko has been seen ephemerally in a hammock and on a mangrove trail in ENP (Meshaka 2000, 2001), the species was associated with buildings in the park (Meshaka et al. 2000). In urban and disturbed areas, the Indo-Pacific Gecko inhabited buildings and on vegetation, diurnally hiding in palm boots (Meshaka 1996a), in pine bark in isolated Miami-Dade County pinelands, and in Australian Pine bark along Lake Okeechobee (Meshaka et al. 2004a). This species was the second most abundant of three gecko species found in six pine rockland parks in Miami-Dade County (Enge et al. 2004b). On BIR, individuals occurred on buildings and in cabbage palms and were abundant, in sharp contrast to only a single Mediterranean Gecko found on a building (Meshaka 1997). On the ABS, James N. Layne and I have found individuals on the main building and occasionally on cabins. The Indo-Pacific Gecko may have been in Lake Placid since the early to mid-1980s (Meshaka 1995).

***Diet*.—**In ENP, the Indo-Pacific Gecko was an insectivore, having eaten primarily flies and hymenopterans (Meshaka 2000, 2001; Meshaka and Mayer 2005). In syntopy at ENP, the diet of the Indo-Pacific Gecko and Wood Slave closely overlapped and more so than with any other potential competitors (Meshaka 2000, 2001; Meshaka and Mayer 2005). The rate of gastric evacuation and the digestive and assimilation efficiencies of the Indo-Pacific Gecko were lower than those of the Wood Slave and were considered to be at a competitive disadvantage to the Wood Slave with respect to its digestive functions (Punzo 2001b).

***Reproduction*.—**In ENP, the Indo-Pacific Gecko reproduced throughout the year with up to two eggs per clutch and at least three clutches annually (Meshaka 1994b). The diameters of the hard-shelled eggs have been measured by Meshaka (1994b; mean = 9.4 mm) and by Voss (1975; range = 7–10 mm). The calcareous-shelled eggs of this species reduced water loss thereby providing the female with more acceptable sites to deposit her eggs and conferring an advantage in its colonization (Punzo 2005).

***Growth and survivorship*.—**In ENP, hatchlings as small as 22 mm SVL were present in July, and individuals reached sexual maturity at 49 mm SVL before one year of life (Meshaka 1994b).

***Activity*.—**In southern Florida, the Indo-Pacific Gecko was active throughout the year (Meshaka 1994b, 2000, 2001). In ENP, individuals were be more active during the wet season (Meshaka 2000, 2001), and the species was primarily but not exclusively nocturnal (Meshaka et al. 2004a). On BIR, the Indo-Pacific Gecko and Green Anole foraged side by side on buildings for a brief time at dusk (Meshaka et al. 2004a). Nightly activity occurred 1700–0200 (Frankenberg 1984). Punzo (2005) noted an advantage to the nocturnal activity of the introduced hemidactylines, such as the Indo-Pacific Gecko, in colonizing Florida, whose indigenous lizard fauna was typically diurnal. Physical conditions associated with nightly activity at ENP were generally warm (mean = 25.1° C), humid (mean = 84% RH), and wet (mean = 1.1 cm) and overlapped closely with those of the Wood Slave (Meshaka 2000). The Indo-Pacific Gecko replaced the Mediterranean Gecko (Meshaka

1994b, 1995; Meshaka et al. 2004a), over which it was socially dominant (Frankenberg 1984). In this connection, in Frankenberg's (1984) study the Indo-Pacific Gecko greatly outnumbered the Mediterranean Gecko on Key Biscayne (Miami-Dade County), which is the county in which it had first been introduced; However, it was greatly outnumbered by the Mediterranean Gecko on Marathon Key and absent on Big Pine Key where the Mediterranean Gecko was numerous. On Summerland Key, Frankenberg (1984) found only four Indo-Pacific Geckos and no Mediterranean Geckos. In turn, the Indo-Pacific Gecko was replaced by the Common House Gecko (Meshaka et al. 2004a) and the Wood Slave (Meshaka 2000, 2001; Meshaka and Moody 1996; Meshaka et al. 2004a, 2005a, 2006b). With the latter species, this process occurred very quickly and results in a greater abundance of the Wood Slave than the previous abundances of the Indo-Pacific Gecko (Meshaka 2000, 2001; Meshaka et al. 2004a). In some cases, the Indo-Pacific Gecko was replaced entirely (Meshaka 2000, 2001). Camouflage on white buildings could confer an anti-predator advantage that could obstruct the turnover process (Meshaka et al. 2006b). Likewise, the presence of the Cuban Treefrog, a gecko predator, could suppress complete replacement (Meshaka 2000, 2001; Meshaka et al. 2005a). Like the Mediterranean Gecko, the Indo-Pacific Gecko did not allow as close an approach by a perceived threat as did the Wood Slave and, when frightened, would run farther away (Eifler et al. 2004). Its inclination to bite when restrained was less than that of the Wood Slave and the Mediterranean Gecko (Eifler et al. 2004). These behaviors were thought by Eifler et al. (2004) to place the Indo-Pacific Gecko at a competitive disadvantage to the Wood Slave.

***Predators*.—**The Indo-Pacific Gecko was eaten by the Cuban Treefrog, Knight Anole, and Eastern Corn Snake (Meshaka et al. 2004a).

***Threats*.—**The Indo-Pacific Gecko is negatively impacted by the Corn Snake. The ecological relationship between the Indo-Pacific Gecko and the Green Anole on BIR is unknown. This species negatively impacts the Mediterranean Gecko through replacement, and is in turn negatively impacted through replacement by the Common House Gecko and the Wood Slave. Assuming that the Wood Slave will eventually colonize BIR, the uncertainty of the ecological relationship between the Indo-Pacific Gecko and the Green Anole will become a moot point. The Indo-Pacific Gecko is threatened by the Cuban Treefrog, and Knight Anole and potentially by the larger species of exotic geckos in Florida. To control building-dwelling populations of this lizard that benefit from light-attracted insect prey, Cress et al. (2007) suggested the use of lights that do not attract invertebrates.

HEMIDACTYLUS MABOUIA (MOREAU DE JONNES 1818) — TROPICAL GECKO (A.K.A. WOOD SLAVE)

***Description*.—**As described by Meshaka et al. (2004a), the body color ranges in shades of brown with black dorsal chevrons; however, individuals can fade to nearly white. Bands are present on the tail. The body is moderately warty, and femoral pores are present (Fig. 38). Krysko and Daniels (2005) provided a key to most of the geckos in Florida.

***Distribution*.—**The Wood Slave is an Old World species whose first documentation in Florida is from Crawl Key, Monroe County (Lawson et al. 1991). Introduction of this species to Florida could have occurred in the early 1980s (Butterfield et al. 1993). In southern Florida, past records are from Broward (Meshaka et al. 2004a), Charlotte (Meshaka et al. 2004a), Collier (Meshaka et al. 2004a), Glades (Meshaka et al. 2004a), Lee (Meshaka et al. 2004a), Martin (Meshaka et al. 2004a), Miami-Dade (Enge et al. 2004b; Meshaka et al. 2004a), Monroe (mainland; Meshaka 2001), Monroe (mainland, Bahia Honda, Big Pine Key, Crawl Key, Fat Deer Key, Garden Key of the Dry Tortugas, Key Vaca, Key West, Lower Sugarloaf Key, Middle Torch Key, Plantation Key, Stock Island, Sunshine Key; Meshaka et al. 2004a), Okeechobee (Meshaka et al. 2004a), and Palm Beach (Meshaka et al. 2004a) counties, and reports are from Palm Beach County (Meshaka et al. 2004a). After Meshaka et al. (2004a) went to press, subsequent records appeared for southern Florida: Charlotte (Klowden 2002), Collier (Blihovde and Owen 2002), Lee (mainland; Klowden 2002), Lee (Gasparilla Island; Townsend et al. 2002), and Monroe (Key West, Lower Sugarloaf Key; Krysko et al. 2003a) counties. More recent records of this species are from Collier (Marco Island; Krysko et al. 2005), Hendry (Krysko et al. 2005), Martin (Krysko et al. 2005), Monroe (Big Pine Key, Fleming Key, Stock Island; Krysko and Sheehy III 2005), and Palm Beach (Krysko et al. 2005) counties. I include here records of this species from Broward (JULSP), Collier (FSP), and St. Lucie (SPSP) counties from specimens collected during 2003 and 2004 and stored in SMP. I also note two juvenile specimens I collected in Miami-Dade (Key Biscayne) County in 1993 and stored in NMNH.

FIGURE 38. Tropical Gecko (a.k.a. Wood Slave), *Hemidactylus mabouia*, from Highlands Co., Florida. (Photographed by Suzanne L. Collins).

Elsewhere in Florida, records of the Wood Slave exist from Brevard (Meshaka et al. 2004a), Indian River (Van Dyke 2004), and Orange (Meshaka et al. 2004a) counties. More recent records of this species are from Alachua (Krysko and Somma 2007), Hillsborough (Krysko and Camposano 2007), and Osceola (Krysko et al. 2005) counties (Fig. 39). The rate at which the Wood Slave has expanded its geographic range in Florida has been phenomenal such that it is but a short time before this species has a continuous Florida distribution and at the expense of other *Hemidactylus* species. The Wood Slave also occurs as an established exotic species in the West Indies (Lever 2003).

Body size.—On Garden Key of the Dry Tortugas, mean body size of adult males (57.3 mm SVL) was similar to that of females (59.4 mm SVL; Meshaka and Moody 1996). In ENP, mean body sizes of males (mean = 58.0 mm SVL) and females (mean = 58.9 mm SVL) were also similar, and in southern Florida generally, mean body sizes of males (mean = 58.1 mm SVL) and females (mean = 59.4 mm SVL) were similar (Meshaka et al. 1994b).

Habitat and abundance.—On Garden Key, individuals are found near and away from lights on the walls of Ft. Jefferson, as well as on nearby trees and on leaf litter (Meshaka and Moody 1996). In ENP, the Wood Slave was strongly associated with buildings (Meshaka 2000, 2001; Meshaka et al. 2000), whereas in urban situations it often inhabited trees (Meshaka et al. 2004a). I have found individuals in disturbed hammocks, and in southern Florida, it occurred in pinelands (Meshaka 2000; Enge et al. 2004b). In this connection, the Wood Slave was the second most abundant reptile and the most abundant of three gecko species found in six pine rockland parks in Miami-Dade County (Enge et al. 2004b). In ENP, this gecko was numerically superior to the Indo-Pacific Gecko, the partial or complete replacement of which occurred quickly (Meshaka 2000, 2001). The ability to achieve high population sizes conferred an advantage to the colonization ability of this species (Punzo 2005). Indeed, based on abundance and geographic range, the Wood Slave is the most highly successful species among the exotic geckos in Florida.

Diet.—The diet of the Wood Slave from the Dry Tortugas (Meshaka and Moody 1996), ENP (Meshaka 2000, 2001) and urban Miami-Dade County (Meshaka et al. 2004a) consisted of a wide range of invertebrate prey, especially spiders, flies, and moths. In syntopy at ENP, the diet of this lizard and the Indo-Pacific Gecko closely overlapped and more so than with any other potential competitor (Meshaka 2000, 2001; Meshaka and Mayer 2005). The rate of gastric evacuation and the digestive and assimilation efficiencies of the Wood Slave were higher than those of the Indo-Pacific Gecko and the species was potentially at a competitive advantage to the Indo-Pacific Gecko with respect to its digestive functions (Punzo 2001b). It remains unknown if predation of small geckos, such as hatchlings or small individuals of *Sphaerodactylus* species has been a mechanism in its replacement of other geckos in Florida.

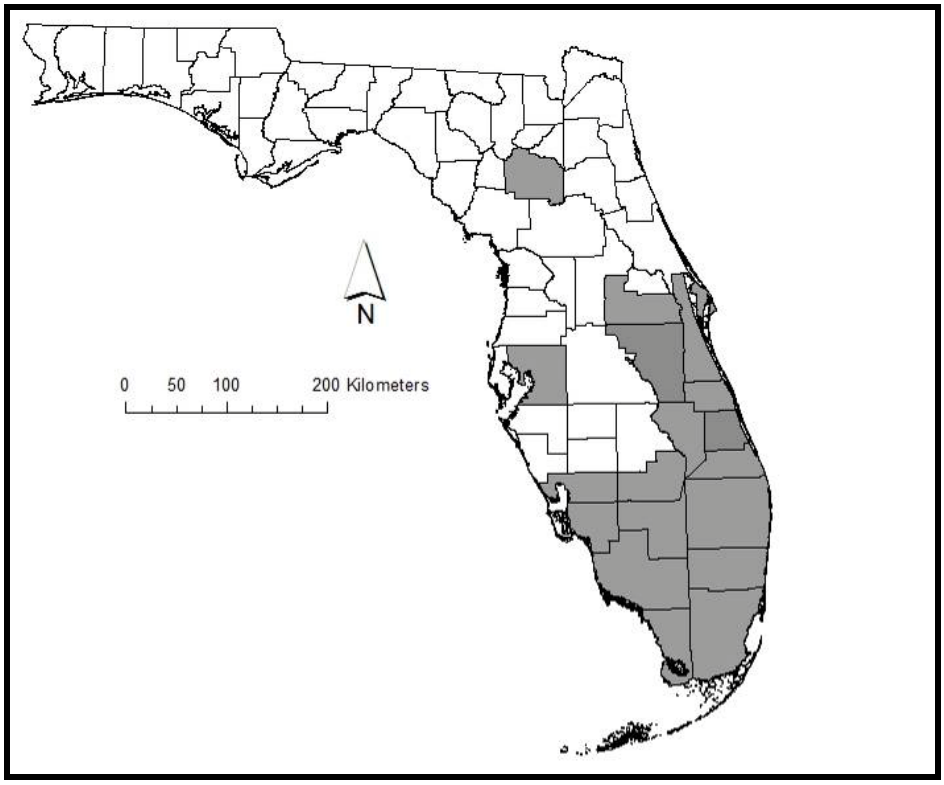

FIGURE 39. Geographic distribution of the Tropical Gecko (a.k.a. Wood Slave), *Hemidactylus mabouia,* in Florida.

Reproduction.—In Homestead, mating has been observed in December and March (Meshaka et al. 2004a). In southern Florida, the Wood Slave was gravid throughout the year (Meshaka 2000, 2001; Meshaka et al. 2004a). Using a southern Florida sample that subsumes the data of Meshaka et al. (1994b), I report mean clutch size (1.77 ± 0.43; range = 1–2; N = 17) and mean number of potential clutches produced annually (3.74 ± 1.42; range = 2–7; N = 23). I found no significant relationship ($P > 0.05$) between estimated clutch frequency and female body size. Using measurements of 19 shelled eggs, I found a significant difference (t = -3.681; df = 30; $P < 0.001$) between the means of length (9.1 ± 0.76 mm; range = 7.8–10.5 mm) and width (8.0 ± 1.2 mm; range = 6.0–10.0 mm). Also, a significant causal relationship ($r^2 = 0.39$; $P = 0.04$; Egg Size = 0.107 Body Size + 2.86; n = 11) existed between the largest shelled egg diameter (range = 8.5–10.5 mm) and female body size (range = 53–67 mm SVL). The calcareous-shelled eggs of this species reduce water loss, thereby providing the female with more acceptable sites to deposit her eggs and conferring an advantage in its colonization (Punzo 2005). In Miami, females used ficus trees and coconut palm trees as nest sites (Meshaka et al. 2004a). On Crawl Key, communal clutches of up to 30 eggs were found under carpet (Meshaka et al. 2004a). On Fleming Key, Krysko and Sheehy III (2005) found a communal nest of six eggs under the bark of an Australian Pine. In a disturbed hammock on Stock Island, a communal nest consisted of eggs of this lizard and the Ashy Gecko (Meshaka et al. 2004a). On Key West, a communal nest of eggs of this gecko, Common House Gecko, and Ashy Gecko was found (Krysko et al. 2003a). On Lower Sugarloaf Key, a communal nest was comprised of eggs of the Wood Slave, Ashy Gecko, and Reef Gecko (Krysko et al. 2003a). Punzo (2005) noted the colonization advantage to communal nesting and absence of inter-female agonistic behavior for nesting sites among Florida's exotic hemidactyline geckos.

Growth and survivorship.—In ENP, the smallest individuals of 15–17 mm SVL were present in the summer, and minimum body size at sexual maturity in males (46 mm SVL) and females (46 mm SVL) occurred within one year of life (Meshaka 2001).

Activity.—In southern Florida, the Wood Slave was active throughout the year (Meshaka 2000, 2001). In ENP, its seasonal activity was greater during the wet season than in the dry season (Meshaka 2000, 2001), and the species was primarily but not exclusively nocturnal (Meshaka et al. 2004a). Punzo (2005) noted an advantage to the nocturnal activity of the introduced hemidactylines, such as the Wood Slave, in colonizing

Florida, whose indigenous lizard fauna was typically diurnal. Physical conditions associated with nightly activity at ENP were generally warm (mean = 25.1° C), humid (mean = 84.5% RH), and wet (mean = 1.0 cm) and overlapped closely with those of the Indo-Pacific Gecko (Meshaka 2000). In Florida, this gecko replaced the Common House Gecko (Meshaka et al. 1994a; 2004a), the Indo-Pacific Gecko (Meshaka 2000, 2001; Meshaka and Moody 1996; Meshaka et al. 2004a, 2005a, 2006b), the Mediterranean Gecko (Meshaka et al. 1994c, 2004a), and the Ashy Gecko (Meshaka et al. 2004a). This phenomenon occurred quickly and with more individuals of the Wood Slave having replaced previous numbers of the Indo-Pacific Gecko (Meshaka 2000, 2001; Meshaka et al. 2004a). In some cases, the Indo-Pacific Gecko was replaced entirely (Meshaka 2000, 2001). A superior competitor and ubiquitous in southern Florida, this highly successful gecko could eventually colonize a building without first encountering the Indo-Pacific Gecko (Meshaka et al. 2006b), a phenomenon that appeared to have occurred in one Broward County development (Meshaka et al. 2008a). Camouflage by the Wood Slave on dark buildings may have conferred an anti-predator advantage that might accelerate the turnover process (Meshaka et al. 2006b). On the other hand, the presence of the Cuban Treefrog, a gecko predator, could suppress complete replacement (Meshaka 2000, 2001; Meshaka et al. 2005a). The Wood Slave allowed a much closer approach by a perceived threat than did the Mediterranean Gecko and the Indo-Pacific Gecko and when frightened, it would run the shortest distance away (Eifler et al. 2004). Its inclination to bite when restrained was greater than both the Indo-Pacific Gecko and the Mediterranean Gecko (Eifler et al. 2004). These behaviors were thought by Eifler et al. (2004) to place the Wood Slave at a competitive advantage over its two congeners.

Predators.—In southern Florida, the Wood Slave was eaten by the Cuban Treefrog and the Tokay Gecko (Meshaka et al. 2004a) and was scavenged upon by the Gray Squirrel (*Sciurus carolinensis*; Smith and Meshaka in press).

Threats.—The Wood Slave is a potential competitor for food with the Green Treefrog and Squirrel Treefrog in ENP. A superior competitor, it quickly replaces the Common House Gecko, Indo-Pacific Gecko, Mediterranean Gecko, and Ashy Gecko. In turn, the Wood Slave is threatened by the Cuban Treefrog and the Tokay Gecko, with which it has been found in syntopy. Bibron's Thick-toed Gecko and the Ringed Wall Gecko and may also be a threat to the Wood Slave. To control building-dwelling populations of this lizard that benefit from light-attracted insect prey, Cress et al. (2007) suggested the use of lights that do not attract invertebrates.

HEMIDACTYLUS TURCICUS (LINNAEUS 1758) — MEDITERRANEAN GECKO

Description.—The body ranges from pink to pale yellow in color and is covered in an irregular pattern of brown spots (Conant and Collins1998; Meshaka et al. 2004a; Fig. 40). Femoral pores are absent (Meshaka et al. 2004a). Krysko and Daniels (2005) provided a key to most of the geckos in Florida.

Distribution.—The Mediterranean Gecko is an Old World species whose first documentation in Florida is from Key West, Monroe County (Fowler 1915; Stejneger 1922). In southern Florida, past records are from Broward (Meshaka et al. 2004a), Glades (Meshaka et al. 2004a), Hendry (Meshaka et al. 2004a), Highlands (Meshaka et al. 2004a), Martin (Meshaka et al. 2004a), Miami-Dade (mainland; Meshaka et al. 2004a), Monroe (Big Pine Key; Duellman and Schwartz 1958; Meshaka et al. 2004a), Monroe (Key West; Carr 1940; Duellman and Schwartz 1958; Meshaka et al. 2004a), Monroe (Marathon; Frankenberg 1984), Monroe (Summerland Key; Lazell 1989), Okeechobee (Meshaka et al. 2004a), and St. Lucie (Meshaka et al. 2004a) counties, and reports are from Miami-Dade (Meshaka et al. 2004a), Miami-Dade (Key Biscayne; Meshaka et al. 2004a), Monroe (Key Largo, Sugarloaf Key; Meshaka et al. 2004a), Monroe (Big Pine Key, Marathon; Frankenberg 1984), and Okeechobee (Meshaka et al. 2004a) counties. Frankenberg (1984) searched but did not find this gecko

FIGURE 40. Mediterranean Gecko (*Hemidactylus turcicus*) from Lee Co., Florida. (Photographed by Suzanne L. Collins).

on Summerland Key, Monroe County. Searches for this species in Miami-Dade (Key Biscayne) and Monroe (Big Pine Key, Key Vaca, Summerland Key) counties were unsuccessful (Meshaka et al. 2004a). After Meshaka et al. (2004a) went to press, a subsequent record appeared for southern Florida: Charlotte County (McCoid 2002a).

Elsewhere in Florida, records of the Mediterranean Gecko exist from Alachua, Bay, Brevard, Columbia, Duval, Escambia, Franklin, Hillsborough, Indian River, Leon, Levy, Okaloosa, Osceola, Pinellas, and St. Johns counties, and reports are from Pinellas (St. Petersburg) and Volusia counties (Meshaka et al. 2004a). After Meshaka et al. (2004a) went to press, subsequent records appeared for northern Florida: Alachua (Townsend and Krysko 2003), Bradford (Townsend and Krysko 2003), Citrus (Townsend et al. 2002; Townsend and Krysko 2003), Clay (Townsend and Krysko 2003), Columbia (Townsend and Krysko 2003), Duval (Townsend and Krysko 2003), Hernando (Townsend and Krysko 2003), Levy (Townsend and Krysko 2003), Marion (Townsend and Krysko 2003), Orange (Townsend and Krysko 2003), Putnam (Townsend and Krysko 2003), Seminole (Townsend and Krysko 2003), St. Johns (Townsend and Krysko 2003), and Wakulla (Johnson et al. 2002) counties. More recent records of the Mediterranean Gecko are from Baker and Volusia counties (Krysko et al. 2005; Fig. 41). In Florida, it is the northern counties that have remained the strongholds for this species as it becomes evermore rare as one proceeds south in Florida, where more recently established and competitively superior geckos have become more ubiquitous. The Mediterranean Gecko also occurs as an established exotic species elsewhere in the United States (Meshaka 2008a) and in the West Indies (Lever 2003).

Body size.—In Lake Placid, Highlands County, body sizes of adult males (mean = 49.0 mm SVL) were similar to those of females (50.7 mm SVL; Meshaka 1995).

Habitat and abundance.—On Key West, the Mediterranean Gecko was associated with buildings (Carr 1940; Duellman and Schwartz 1958). On BIR, a single individual was on a building, the ranch otherwise dominated by the Indo-Pacific Gecko (Meshaka 1997). In Lake Placid, it occurred on buildings and may have been in Lake Placid by the 1960s (Meshaka 1995). An association with buildings by the Mediterranean Gecko also existed in populations of this lizard in Lake Placid (Meshaka 1995), Tampa, (Punzo 2001a), Gainesville, (King 1958; Gomez-Zlater and Moulton 2005), and Florida generally (Meshaka et al. 2004a). Its strong association with buildings in Florida was a trait that places this species at a disadvantage to other gecko species in Florida that use vegetation (Meshaka et al. 2004a). In the southeastern United States, the

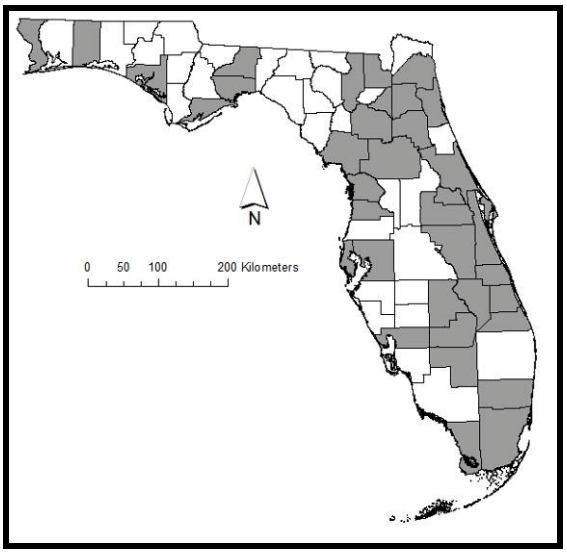

FIGURE 41. Geographic distribution of the Mediterranean Gecko (*Hemidactylus turcicus*) in Florida.

Mediterranean Gecko was very strongly associated with buildings, especially those of made of brick, concrete block or wood, although a few exceptions occur (Meshaka et al. 2006c). In Bowie County, Texas, a colony of Mediterranean Geckos inhabited a rock pile, some individuals of which appeared to also be using burrows under rocks that were flush with the ground (McCallum and McCallum 2006a). Individuals tended to avoid fluorescent and sodium vapor lights (Nelson and Carey 1993). Meshaka et al. (2006c) noticed individuals at a Louisiana site more often in dim and dark areas than lighted areas, which would have otherwise provided a superior source of light-attracted prey and suggested that this behavioral limitation would be a disadvantage in the face of more aggressive congeners. Elsewhere in the southeastern United States, the species avoided direct illumination (Paulissen and Buchanan 1991; Nelson and Carey 1993).

On buildings in Gainesville, adults perched at or higher than 1 m above the ground in exposed and unexposed locations, whereas sub-adults were active at or below 1 m above the ground more often in exposed locations (Gomez-Zlater and Moulton 2005). Most individuals observed by Paulissen and Buchanan (1991) in northwestern Arkansas were active 4.5 m or more above the ground. This gecko can be very abundant. For example, at Meshaka's (1995) study site in Lake Placid, the Mediterranean Gecko was abundant enough that 237 individuals comprised the annual sample, but very few Indo-Pacific Geckos were present at the time (pers. observ.). As of 20 June 2007, that same site was still dominated by the Mediterranean Gecko (Samuel D. Marshall, pers. comm.). Population estimates could be

as high as 1463 individuals/ha in Tampa (Punzo 2001a) and 2210 individuals/ha in southern Texas (Selcer 1986). Across the southeastern United States, relative abundances ranged in counts of 0.03 to 0.21 individuals/min (Meshaka et al. 2006c). The ability of this species to densely populate a site conferred an advantage to its colonization ability (Punzo 2005).

Diet.—In Florida, the Mediterranean Gecko ate hard and soft-bodied insects, especially flies and lepidopterans (Meshaka et al. 2004a). On one occasion I watched a 54 mm SVL female eat a large grasshopper in Moorehaven. In Tampa, this species ate a wide range of invertebrate prey, especially flies, spiders, and roaches (Punzo 2001a). In southern Louisiana, a wide range of invertebrates, especially insects, were eaten, the top three being caterpillars, beetles, and ants; Rose and Barbour 1968). In eastern Texas, the most important prey taxa were Orthoptera, Lepidoptera, and Isopoda, and dietary overlap was high among the sex and size-class comparisons (Saenz 1996). In Bowie County, Texas, a juvenile foraged on the Imported Red Fire Ant (*Solenopsis invicta*), having eaten 6−7 ants (McCallum and McCallum 2006b). The relationship between perch height and diet were evident in southern Texas, whereby males perched high and could capture more flying insects, and females perched low and could capture ground-dwelling prey such as spiders and isopods (Saenz 1996). Its generalist diet conferred a colonizing advantage to this species (Saenz 1996). The rate of gastric evacuation and the digestive and assimilation efficiencies of the Mediterranean Gecko were lower than those of the Wood Slave and were considered to be at a competitive disadvantage to the Wood Slave with respect to its digestive functions (Punzo 2001b).

Reproduction.—In Florida, reproduction in the Mediterranean Gecko was seasonal (Meshaka et al. 2004a). Mating has been observed in March in Lake Placid (Meshaka et al. 2004a), July in Gainesville (King 1958), and June in southern Louisiana (Rose and Barbour 1968). In Lake Placid, the seasonal distribution of testicular size was suggestive of spring mating (Meshaka 1995). Likewise, in southern Louisiana, spermatogenesis was at its peak during the spring (Rose and Barbour 1968). In southern Texas, testis mass was highest during April-July (Selcer 1986).

Eggs were laid during May-August in Lake Placid (Meshaka 1995) and Tampa (Punzo 2001a), and during April-August in Gainesville (King 1958). A four to five month egg laying season in Florida, compared to the continuous breeding throughout the year by its congeners was a disadvantage that may have played a role in its decline (Meshaka et al. 2004a). In southern Louisiana (Rose and Barbour 1968) and southern Texas (Selcer 1986) gravid females were present during May-August, and in the southeastern United States, the egg laying season was shortest at the northernmost reaches of its geographic range (Meshaka et al. 2006c). For example, in northwestern Arkansas eggs were laid in June (Paulissen and Buchanan 1991).

Two-egg clutches were the norm in Lake Placid (unpubl. data), Tampa (Punzo 2001a), and southern Texas (Selcer 1986). In Lake Placid, one to five (mean = 2.61) clutches can be laid annually of eggs, and up to three clutches could be laid in Tampa (Punzo 2001a) and southern Texas (Selcer 1986). In southern Louisiana, two or three clutches were produced each year (Rose and Barbour 1968). In Lake Placid, eggs averaged 9.54 mm in diameter (Meshaka 1995). In southern Louisiana, shelled egg dimensions (mean = 10.9 X 8.9 mm) were similar to those of Lake Placid. Punzo (2005) demonstrated that the calcareous-shelled eggs of this species reduced water loss, thereby providing the female with more acceptable sites to deposit their eggs and conferring an advantage in its colonization. The Mediterranean Gecko communally nested with conspecifics (Punzo 2001a) in nests of up to 14 eggs, and 62% of these nests were reused. Communal nesting, with an accompanying absence of inter-female agonistic behavior for nesting sites, was noted by Punzo (2005) to be a colonizing advantage among Florida's exotic hemidactyline geckos.

Growth and survivorship.—In Lake Placid, hatchlings were present in September (Meshaka 1995). In Lake Placid, the minimum body size at sexual maturity of males (39.4 mm SVL) and females (44.3 mm SVL) was small (Meshaka 1995). In Tampa, the smallest sexually mature males measured 42 mm SVL, and the smallest sexually mature females measured 41.5 mm SVL, with 43 mm SVL being used as the minimum body size at sexual maturity for the species (Punzo 2001a). In southern Texas, minimum body size at sexual maturity for both sexes was 44 mm SVL (Selcer 1986). In Lake Placid, individuals reached sexual maturity in less than one year of life (Meshaka 1995). Geckos reached sexual maturity at an age of 5.2–9.6 mo in Tampa (Punzo 2001a) and at 8.6 mo in southern Texas (Selcer 1986).

Activity.—In Lake Placid, individuals were active throughout the year, with a noticeable depression in during the coldest few months (Meshaka 1995). Individuals were active in each month in Tampa (Punzo 2001a), southern Louisiana (Rose and Barbour 1968), and southern Texas (Selcer 1986). In the southeastern United States, the Mediterranean Gecko was active for the shortest number of months at the northernmost parts of its geographic range (Meshaka et al. 2006c). In Florida, the Mediterranean Gecko was nocturnal in its activity (Meshaka et al. 2004a). In Tampa, most nocturnal activity occurred 2100−2359 and quickly

tapered off (Punzo 2001a). In Gainesville, peak nocturnal activity began 1−3 hr after sunset and decreased thereafter (King 1958). Punzo (2005) noted an advantage to the nocturnal activity of the introduced hemidactylines, such as the Common House Gecko, in colonizing Florida, whose indigenous lizard fauna was typically diurnal. Peak diel activity occurred just after dark in Louisiana (Rose and Barbour 1968) and bimodally at 2300 and 0300 in northwestern Arkansas (Paulissen and Buchanan 1991).

On buildings in Gainesville, the substrate temperatures associated with adults (mean = 23.2° C) were warmer and over a greater temperature range than those of subadults (22.7° C; Gomez-Zlater and Moulton 2005). In Louisiana, the Mediterranean Gecko was active at temperatures as low as the "40s F", which could have insured its continued presence in the southeastern United States if its thermal tolerance were to exceed that of its competitively superior congeners and the Roughtail Gecko (*Cyrtopodiun scabrum*; Meshaka et al. 2006c). The Mediterranean Gecko was replaced by the Indo-Pacific Gecko (Meshaka 1994b, 1995; Meshaka et al. 2004a) to which it was socially subordinate (Frankenberg 1984). In this connection, in Frankenberg's (1984) study, the Mediterranean Gecko was greatly outnumbered by the Indo-Pacific Gecko on Key Biscayne (Miami-Dade County), which is in the county that the latter species first colonized. However, on the Florida Keys, which is the region of Florida first colonized by the Mediterranean Gecko, this species either greatly outnumbered the Indo-Pacific Gecko (Marathon Key) or was numerous to the exclusion of the Indo-Pacific Gecko (Big Pine Key; Frankenberg 1984). On Summerland Key, no Mediterranean Geckos and four Indo-Pacific Geckos were found by Frankenberg (1984). The Mediterranean Gecko was also replaced by the Wood Slave (Meshaka et al. 1994c; 2004a). In Florida, the Mediterranean Gecko was territorial (Frankenberg 1982; Punzo 2001a). Like the Indo-Pacific Gecko, the Mediterranean Gecko did not allow as close an approach by a perceived threat as did the Wood Slave and, when frightened, would run farther away (Eifler et al. 2004). Its inclination to bite when restrained was intermediate between that of the Wood Slave and the Indo-Pacific Gecko (Eifler et al. 2004). These behaviors were thought by Eifler et al. (2004) to have placed the Mediterranean Gecko at a competitive disadvantage to the Wood Slave.

Predators.—In Tampa, the Mediterranean Gecko was eaten by the Cuban Treefrog, bats of unknown species, Crab Spider (*Heteropoda* sp.), Wolf Spider (*Hogna carolinensis*), Giant Whip Scorpion (*Mastigoproctuc giganteus*), and feral domestic cat (Punzo 2001a). In Bowie County, Texas, a juvenile Mediterranean Gecko first foraging on Imported Red Fire Ants was, on a visit 20 min later, engulfed by these ants, and by the next morning, it was reduced to a skeleton (McCallum and McCallum 2006b).

Threats.—The Mediterranean Gecko negatively impacts populations of wolf and crab spiders. This species is, in turn, negatively impacted by the Indo-Pacific Gecko and the Wood Slave by replacement such that its future in Florida should be considered in doubt. Its future in the Southeast generally may well hinge on its ability to tolerate lower temperatures than its competitively superior congeners and the Roughtail Gecko. The Cuban Treefrog, a potentially abundant inhabitant on buildings, threatens the Mediterranean Gecko as it does other geckos. Not withstanding its subjection to negative impacts by other hemidactyline geckos, this gecko may well be negatively impacted as well by the larger gecko species in Florida. To control building-dwelling populations of this lizard that benefit from light-attracted insect prey, Cress et al. (2007) suggested the use of lights that do not attract invertebrates.

PHELSUMA MADAGASCARIENSIS GRAY 1870 — MADAGASCAR DAY GECKO

Description.—As described by Bartlett and Bartlett (1999), dorsally and laterally, individuals are Kelly green in color often with dorsal blotches or spots of brilliant orange. An orange stripe runs from the nostril to the eye (Fig. 42). Frightened or cold individuals are darker. Hatchlings are a dull olive green. Adult males have prominent femoral pores. Krysko and Daniels (2005) provided a key to most of the geckos in Florida.

Distribution.—The Madagascar Day Gecko is an Old World species whose first documentation in Florida is from Broward and Lee counties, the former of which was a breeding colony (Bartlett and Bartlett 1999). Bartlett and Bartlett (1999) noted that reports of its establishment in Miami-Dade County had yet to be verified. Meshaka et al. (2004a) noted a failed colony in Homestead and noted the existence of 19 specimens from Monroe County in the FMNH. Meshaka et al. (2004a) did not feel that the aforementioned data were sufficient for them yet to confirm its establishment in Florida. Consequently, the species was listed in a section of uncertain status by the authors. After Meshaka et al. (2004a) went to press, subsequent records appeared for southern Florida: Monroe (Big Pine Key, Grassy Key, Little Torch Key, Plantation Key) County (Krysko et al. 2003b). Krysko et al. (2003b) confirmed

FIGURE 42. A Madagascar Day Gecko (*Phelsuma madagascariensis*) from Little Torch Key, Monroe Co., Florida. (Photographed by Richard D. Bartlett).

establishment of this species in Florida, several introductions of which were known to be intentional. In southern Florida, past records are from Broward, Lee, Miami-Dade (Meshaka et al. 2004a), and Monroe (Big Pine Key, Grassy Key, Little Torch Key, Plantation Key; Krysko et al. 2003b)
counties. More recent records are from Monroe (Big Pine Key; Krysko and Sheehy III 2005), Monroe (Key West; Krysko et al. 2008a), Monroe (Marathon; Krysko et al. 2007a), and Palm Beach (Krysko et al. 2008a; May and Krysko 2009) counties. Reports of this gecko are from Monroe (Sugarloaf Key) County (Krysko and Sheehy III 2005; Fig. 43). In Miami-Dade County, eggs of this species found in a palm tree were hatched, and photographs were taken of one hatchling (Meshaka 2006). The Madagascar Day Gecko also occurs as an established exotic species elsewhere in the United States (Meshaka 2008a).

Body size.—Most individuals were adult in body size at 216−228.6 mm TL, and males were larger than females (Bartlett and Bartlett 1999).

Habitat and abundance.—On the Florida Keys, in the vicinity of humans, individuals occurred on Coconut Palms (*Coco nucifera*; Krysko and Sheehy III 2005; Krysko and Hooper 2006), White Mangroves (*Laguncularia racemosa*; Krysko et al. 2003b), Buttonwoods (*Conocarpus erectus*; Krysko et al. 2003b), Gumbo Limbos (Krysko et al. 2003b), Slash Pines (*Pinus elliotii*; Krysko and Sheehy III 2005), and human-made structures (bird cages, buildings, phone poles, utility poles, wooden fences; Krysko et al. 2003b). In south Florida, the Madagascar Day Gecko inhabited palms and other trees near buildings, and on palm trees individuals used the palm boots for cover (Bartlett and Bartlett 1999). Individuals were also found on buildings, often near the eaves (Bartlett and Bartlett 1999).

Diet.—Bartlett and Bartlett (1999) noted its diet comprised insects, pollen, sap, and exudates from over-ripe fruit. On Little Torch Key, adults and a juvenile were observed eating nectar of Coconut Palms (Krysko and Hooper 2006). While feeding on the

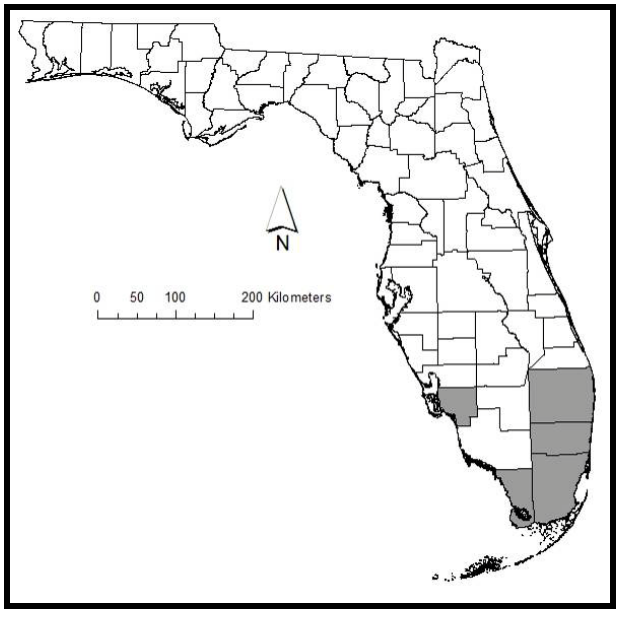

FIGURE 43. Geographic distribution of the Madagascar Day Gecko (*Phelsuma madagascariensis*) in Florida.

FIGURE 44. An adult (left) and hatchling (right) Ocellated Gecko (*Sphaerodactylus argus*) from Key West, Monroe Co., Florida. (Photographed by Suzanne L. Collins [left] and Richard D. Bartlett [right]).

nectar, some adults also snapped at approaching hymenopterans (Krysko and Hooper 2006). On the Lower Florida Keys, an adult fed on insects, until 30 min after dark at which time it retreated into a crack in a wooden building (Krysko et al. 2003b). In Lake Worth, an adult male fed on a juvenile Northern Curlytail Lizard (May and Krysko 2009).

Reproduction.—As captives, the Madagascar Day Gecko bred throughout the year laying two-egg clutches of adherent eggs. In southern Florida, females laid their eggs in palm tree axils (Bartlett and Bartlett 1999).

Growth and survivorship.—On Marathon, Monroe County, neonates were present in October (Krysko et al. 2007a). Captive individuals were noted to be sexually mature at one year or just over one year of life (Meshaka 2006).

Activity.—On the Florida Keys these geckos were observed to forage until 30 min after dark (Krysko et al. 2003b).

Predators.—The Knight Anole, a confirmed predator of lizards (Meshaka et al. 2004a), is a potential predator of the Madagascar Day Gecko.

Threats.—Its ecological relationship with native and exotic anoles is unknown but was a confirmed predator of geckos. In turn, this species could be negatively impacted by predation by the Knight Anole and the larger geckos.

SPHAERODACTYLUS ARGUS GOSSE 1850 — OCELLATED GECKO

Description.—As described by Conant and Collins (1998) and Meshaka et al. (2004a), the body is brown, and light-colored spots are present on the head and neck. Lateral and dorsal scales are keeled and the former are larger in size (Fig. 44). Krysko and Daniels (2005) provided a key to most of the geckos in Florida.

Distribution.—The Ocellated Gecko is a West Indian species whose first documentation in Florida is from Key West, Monroe County (Savage 1954). In southern Florida, past records are from Monroe County (Key West, Stock Island; Meshaka et al. 2004a). The recorded history of the Ocellated Gecko in Florida corroborates the notion of actual rarity of this species. Duellman and Schwartz (1958) suspected that it no longer occurred in Florida. Subsequent searches provided records on Key West (King and Krakauer 1966; Love 1978) and Stock Island (Wilson and Porras 1983). Lawson et al. (1991) could not find the species, and surveys during the 1990s failed to turn up any individuals for Meshaka et al. (2004a). After Meshaka et al. (2004a) went to press, the species was considered extirpated by Krysko and King (2002a). Subsequently, a juvenile was collected on Stock Island, and an adult was collected on Key West by Krysko and Sheehy III (2005). Thus, the status of this species is one of actual rarity with a tenuous hold on its colonization in Florida (Fig. 45). Introductions of the Ocellated Gecko exist elsewhere in the West Indies (Lever 2003).

Body size.—Adults of this little gecko were adult at 50.8−63.5 mm TL (Bartlett and Bartlett 1999). An

FIGURE 45. Geographic distribution of the Ocellated Gecko (*Sphaerodactylus argus*) in Florida.

adult from Key West measured 31.3 mm SVL (Krysko and Sheehy III 2005).

Habitat and abundance.—On Key West, the Ocellated Gecko has been found in a vacant lot (Love 1978) and under a cement slab (Krysko and Sheehy III 2005). On Stock Island, a record exists for a juvenile ca. 1.5 m above the ground and underneath the bark of an Australian Pine (Krysko and Sheehy III 2005).

Diet.—The Ocellated Gecko is probably an insectivore in Florida (Meshaka et al. 2004a).

Growth and survivorship.—On Stock Island, Krysko and Sheehy III (2005) collected a juvenile (18.1 mm SVL) in March

Threats.—The actual rarity of this species and its very small geographic range in Florida increases the risk of extinction from Florida. The role of competition with other sphaerodactylines, perhaps competition with juvenile hemidactylines, and predation by larger geckos and the Cuban Treefrog could also contribute to its precarious existence in the state.

SPHAERODACTYLUS ELEGANS MACCLEAY 1834 — ASHY GECKO

Description.—The body of the Ashy Gecko ranges from gray to light brown to gold in color (Conant and Collins1998; Meshaka et al. 2004a). Light stripes are present on the head, and the snout is pointed (Fig. 46). Juveniles are banded and their tails are red. Krysko and Daniels (2005) provided a key to most of the geckos in Florida.

Distribution.—The Ashy Gecko is a West Indian species whose first documentation in Florida is from Key West, Monroe County (Stejneger 1922). In southern Florida, past records are from Monroe (Big Coppit Key; Meshaka et al. 2004a), Monroe (Big Pine Key; Meshaka et al. 2004a), Monroe (Boca Chica Key; Meshaka et al. 2004a), Monroe (Boot Key; Meshaka et al. 2004a), Monroe (Cudjoe Key; Meshaka et al. 2004a), Monroe (Key West; Meshaka et al. 2004a), Monroe (Little Torch Key; Lazell 1989), Monroe (Middle Torch Key; Meshaka et al. 2004a), Monroe (Raccoon Key; Meshaka et al. 2004a), Monroe (Stock Island; Meshaka et al. 2004a), and Monroe (Summerland Key; Meshaka et al. 2004a) County, and reports are from Broward (Carr 1940), Miami-Dade (Carr 1940), Monroe (Big Pine

Figure 46. Ashy Geckos (*Sphaerodactylus elegans*) from Key West, Monroe Co., Florida. (Photographed by Richard D. Bartlett (left) and Suzanne L. Collins (right).

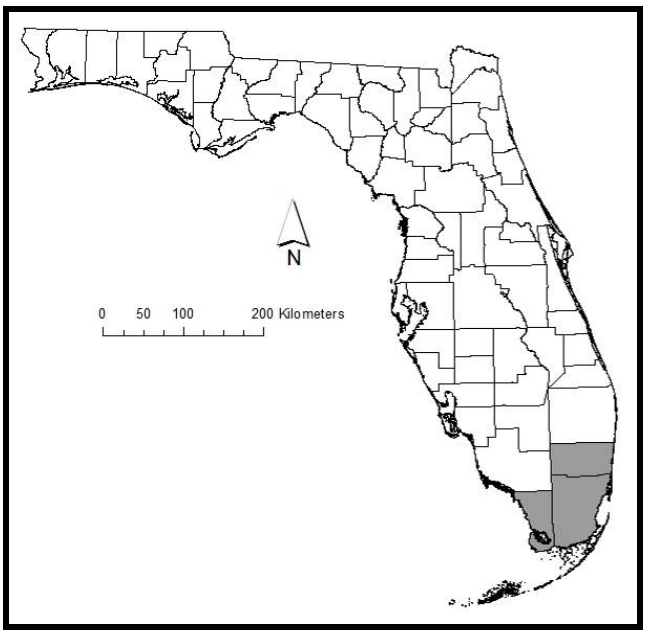

FIGURE 47. Geographic distribution of the Ashy Gecko (*Sphaerodactylus elegans*) in Florida.

Key, Cudjoe Key Spotswood Key; Lazell 1989), and Monroe (Sugarloaf Key) counties (Meshaka et al. 2004a). After Meshaka et al. (2004a) went to press, subsequent records appeared for southern Florida: Monroe (Key West, Lower Sugarloaf Key) County (Krysko et al. 2003a). More recent records of the Ashy Gecko are from Broward County (Somma and Krysko 2008), and reports are from Monroe (Fleming Key, Stock Island) County (Krysko and Sheehy III 2005; Fig. 47).

***Body size*.—**The Ashy Gecko is a very small species of gecko. A male and a female, both from Key West, each measured 35 mm SVL (Meshaka et al. 2004a).

***Habitat and abundance*.—**Duellman and Schwartz (1958) found these geckos at the cemetery and on buildings of Key West. Bartlett and Bartlett (1999) noted the presence of individuals on buildings and trees, under bark of Australian pines, and under moist ground debris. The Ashy Gecko occurred on lighted and unlighted human-made structures as well as under the bark of Australian pines and of rotting logs (Meshaka et al. 2004a). On the Florida Keys, the arrival of the Wood Slave was concomitant with the decrease in abundance of this diminutive lizard (Meshaka et al. 2004a).

***Diet*.—**On Key West, ants and a fly were eaten by a female Ashy Gecko (Meshaka et al. 2004a).

FIGURE 48. A Ringed Wall Gecko (*Tarentola annularis*) from Broward Co., Florida. (Photographed by Richard D. Bartlett).

***Reproduction*.—**Females contained one to two eggs in March and September (Meshaka et al. 2004a). On Key West, a communal nest was comprised of eggs of the Ashy Gecko, Common House Gecko, and Wood Slave (Krysko et al. 2003a). On Stock Island, a communal nest was comprised of eggs of the Ashy Gecko and the Wood Slave (Meshaka et al. 2004a). On lower Sugarloaf Key, a communal nest was comprised of eggs of the Ashy Gecko, Wood Slave, and Reef Gecko (Krysko et al. 2003a).

***Growth and survivorship*.—**A 22 mm SVL hatchling hatched from its egg in April, one day after the egg had been found on Stock Island (Meshaka et al. 2004a). Presumably, sexual maturity is achieved within one year of life, although this has yet to be confirmed.

***Activity*.—**I have found this species active throughout the year on the Florida Keys, and individuals foraged after dark (Bartlett and Bartlett 1999; Meshaka et al. 2004a). The Ashy Gecko has been collected from under bark at night and during the day (Meshaka et al. 2004a).

***Predators*.—**On the Florida Keys, the Cuban Treefrog and the Tokay Gecko are potential predators of the Ashy Gecko.

***Threats*.—**The potential for competition between the Ashy Gecko and the Ocellated Gecko (as a cause for the rarity of the latter species) has yet to be evaluated. The Ashy Gecko is negatively impacted by the Wood Slave through replacement, the mechanisms of which remain ripe for study. It seems likely prey of larger geckos. To control building-dwelling populations of this lizard that benefit from light-attracted insect prey, Cress et al. (2007) suggested the use of lights that do not attract invertebrates.

TARENTOLA ANNULARIS (GEOFFROY 1827) — RINGED WALL GECKO

***Description*.—**The body color is light or grayish brown with slightly darker crossbands, and two light-colored spots are present on each shoulder (Meshaka et al. 2004a). Bartlett and Bartlett (1999) noted the elongate toe pads (Fig. 48). Krysko and Daniels (2005) provided a key to most of the geckos in Florida.

***Distribution*.—**The Ringed Wall Gecko is an Old World species whose first documentation in Florida is from Homestead, Miami-Dade County, and Fort Myers, Lee County (Bartlett 1997). The Miami-Dade County colony had been in existence since 1990 (Bartlett 1997). In southern Florida, past records are from Lee and Miami-Dade counties (Meshaka et al. 2004a).

Elsewhere in Florida, reports of the Ringed Wall Gecko exist from Leon County as per a 1999−2002 report by the Florida Fish and Wildlife Conservation Commission (Meshaka et al. 2004a; Fig. 49).

***Body size*.—**Two males of this large species from Homestead, Miami-Dade County, measured 80 and 104 mm SVL, and females from the same site averaged 86.9 mm SVL (Meshaka et al. 2004a).

***Habitat and abundance*.—**In southern Florida, the Ringed Wall Gecko inhabited buildings (Bartlett and

FIGURE 49. Geographic distribution of the Ringed Wall Gecko (*Tarentola annularis*) in Florida.

Bartlett 1999; Meshaka et al. 2004a) and other human structures (Meshaka et al. 2004a).

Diet.—In Homestead, this large gecko ate invertebrates, especially insects, and also ate other geckos (Asian House Gecko, Common House Gecko; Meshaka et al. 2004a).

Reproduction.—In Homestead, Miami-Dade County, females with small ovarian follicles were present in June and July and during September-October (Meshaka et al. 2004a). Two eggs were laid at a time and up to five clutches were possible annually (Meshaka et al. 2004a).

Growth and survivorship.—In Homestead, two juveniles measuring 37 mm SVL and 39 mm SVL were collected in October (Meshaka et al. 2004a).

Activity.—Bartlett and Bartlett (1999) noted activity of the Ringed Wall gecko on warm evenings, and, in Homestead, the species appeared to be primarily nocturnal (Meshaka et al. 2004a).

Predators.—Meshaka et al. (2004a) considered the Tokay Gecko to be a potential predator of the Ringed Wall Gecko in Florida.

Threats.—The Ringed Wall Gecko is primarily an insectivore but also eats other geckos. Consequently, although the ecological impacts of the Ringed Wall Gecko in Florida are unknown, it may pose a predatory threat to small native nocturnal vertebrates in Florida. To control building-dwelling populations of this lizard that benefit from light-attracted insect prey, Cress et al. (2007) suggested the use of lights that do not attract invertebrates.

CTENOSAURA PECTINATA (WEIGMANN 1834) — MEXICAN SPINYTAIL IGUANA

Description.—Adults are black with white or yellow blotches. Females may have peach markings and often with a green hue. The juveniles are bright green with small black markings (Bailey 1928; Conant and Collins 1998; Meshaka et al. 2004a; Fig. 50). On the tail, three rows of flat scales are present between each of the first five or six whorls of large spiny scales and two rows of flat scales between each of the next five or six whorls of large scales (Bailey 1928).

Distribution.—The Mexican Spinytail Iguana is a New World species whose first documentation in Florida is from Miami, Miami-Dade County (Eggert 1978). In southern Florida, past records are from Miami-Dade County (Meshaka et al. 2004a). After Meshaka et al. (2004a) went to press, two distributional papers discussed the status of this species in southern Florida. The first paper provided a record of the species for the mainland of Charlotte County (McCoid 2002b). In this paper, McCoid (2002b) noted that Bartlett and Bartlett's (1999) Gasparilla Island, Charlotte County, record applied to the northern 1/3 of the island, below which was Lee County, thereby suggesting that if its occurrence were island-wide, the distribution of the species should also have included Lee County. The second paper confirmed that the Mexican Spinytail Iguana occurred only in Miami-Dade County (Townsend et al. 2003a; Fig. 51). I have reliably seen this species at the Miami-Dade County site.

More recent reports of this lizard are from Broward County (Krysko 2009). The Mexican Spinytail Iguana also occurs as an established exotic species elsewhere in the United States (Meshaka 2008a; Locey et al. 2008).

Body size.—A male (293 mm SVL) and female (253 mm SVL) were collected from Perrine, Miami-Dade County (Meshaka et al. 2004a).

Habitat and abundance.—The Miami-Dade County colony has been persistent in the disturbed hammocks and pineland and the residences that replace these habitats along Cutler Road (Wilson and Porras 1983; Meshaka et al. 2004a).

FIGURE 50. A Mexican Spinytail Iguana (*Ctenosaura pectinata*) from Miami-Dade Co., Florida. (Photographed by Suzanne L. Collins).

Diet.—In Miami-Dade County, the Mexican Spinytail Iguana ate vegetation and mamey fruit (Wilson and Porras 1983). Captives also eat meat (Meshaka et al. 2004a).

Reproduction.—Females were gravid in June (Wilson and Porras 1983), and Eggert (1978) reported a clutch of 13 eggs.

Activity.—The Mexican Spinytail Iguana inhabited rock walls, roofs, foundations of buildings, and trash piles (Wilson and Porras 1983). Strongly heliothermic, this lizard warily basks on rock walls and roofs on hot sunny days (Meshaka et al. 2004a).

Threats.—Isolated observations of the species exist for ENP; however, no colonies existed in the park (Butterfield et al. 1997; Meshaka et al. 2000). Wilson and Porras (1983) predicted that habitat alteration at the location of the single colony would reduce colony size as long as certain features of the habitat remain (Wilson and Porras 1983).

FIGURE 51. Geographic distribution of the Mexican Spinytail Iguana (*Ctenosaura pectinata*) in Florida.

CTENOSAURA SIMILIS (GRAY 1831) — BLACK SPINYTAIL IGUANA

Description.—Adult body color is variable with black crossbands that reach the venter, whereas juveniles have a green hue and are marked in black, brown, and white (Fig. 52). On the tail, two or three rows of flat scales are present between each of the first, second, and sometimes third whorls of large spiny scales and two rows of flat scales between each of the next six to eight whorls of large spiny scales (Bailey 1928).

Distribution.—The Black Spinytail Iguana is a New World species whose first documentation in Florida is from Miami-Dade County (Bartlett and Bartlett 1999). In southern Florida, past records are from Broward, Charlotte, Collier, Lee, and Miami-Dade (mainland, Key Biscayne) counties (Meshaka et al. 2004a). After Meshaka et al. (2004a) went to press, subsequent records

FIGURE 52. A Black Spinytail Iguana, *Ctenosaura similis*. (Photographed by Richard D. Bartlett).

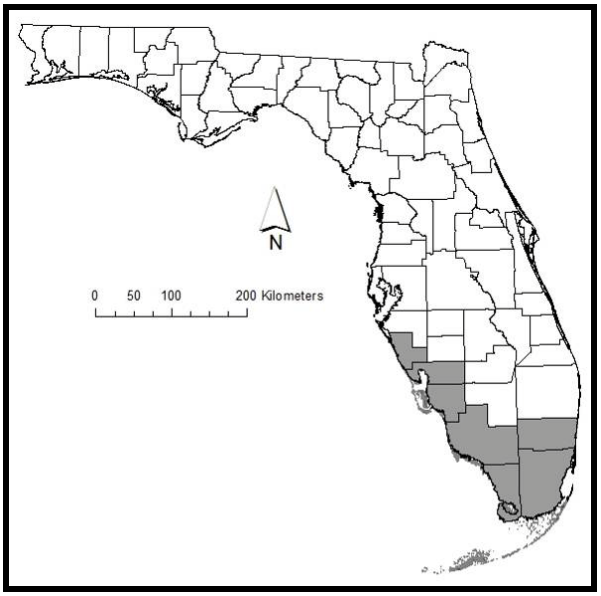

FIGURE 53. Geographic distribution of the Black Spinytail Iguana (*Ctenosaura similis*) in Florida.

appeared for southern Florida: Broward (Townsend et al. 2003a), Charlotte (Gasparilla Island) (Krysko et al. 2003c; Townsend et al. 2003a), Collier (mainland; Krysko et al. 2003c), Collier (Keywaylin Island; Krysko et al. 2003c; Townsend et al. 2003a), Lee (Gasparilla Island; Krysko et al. 2003c; Townsend et al. 2003a), and Miami-Dade (mainland, Key Biscayne; Townsend et al. 2003a) counties, and reports are from Charlotte (Cape Haze, Gulf Cove, Placida), Collier (Little Marco Island), and Lee (Cayo Costa) counties (Krysko et al. 2003c). McCoid's (2002b) record was for mainland Charlotte County as compared to Gasparilla Island (Charlotte and Lee counties). Townsend et al. (2003a) noted that the record was incorrectly ascribed to the Mexican Spinytail Iguana. More recent records of the Black Spinytail Iguana are from Monroe (No Name Key; Enge et al. unpubl. data) and Sarasota (Olson et al. 2007) counties (Fig. 53). This species is especially well-entrenched in the sandy, open topography of the coastal southwest portion of its geographic range in Florida.

Body size.—A large female (245 mm SVL) was from Key Biscayne, Miami-Dade County (Meshaka et al. 2004a).

Habitat and abundance.—Individuals of this iguana occurred in open areas of human-disturbed sites (Meshaka et al. 2004a). Common to the colonies around southern Florida were habitats associated with humans, relatively open soil in which individuals could dig burrows, and an abundance of edible vegetation. Attesting to its potential abundance, on Gasparilla Island approximately 12−15 burrows per 100 m were counted along a 10 m wide Brazilian Pepper corridor (Jackson and Jackson 2007). On Gasparilla Island Black Spinytail Iguanas readily entered active Gopher Tortoise burrows, occasionally crawling over Gopher Tortoises that were sitting at the entrance. Gopher tortoises used many but not all burrows that were occupied by this iguana. In one instance, a burrow occupied by 12 iguanas was re-occupied by Gopher Tortoises once researchers removed the lizards (Engeman et al. 2009a).

Diet.—In southern Florida, this species ate a lot of vegetation, including Brazilian Pepper berries, but also ate human garbage (Meshaka et al. 2004a). On Gasparilla Island, these iguanas ate Brazilian Pepper berries and flowers of the Beach Sunflower (*Helianthus debilus*) found on sand dunes (Jackson and Jackson 2007). At Crandon Park and Gasparilla Island, the diet of this species shifted ontogenetically from primarily insects to primarily plants (Krysko et al. 2009). This finding mirrored that of Van Devender (1982) for this species in Costa Rica.

Reproduction.—A female from Key Biscayne collected in March contained 82 eggs (Krysko et al. 2003c).

Growth and survivorship.—Hatchling iguanas appeared in late summer and early fall (Meshaka et al. 2004a).

Activity.—In southern Florida, the Black Spinytail Iguana was active throughout the year. When alarmed, individuals would enter burrows, although juveniles would also climb into bushes (Meshaka et al. 2004a).

Adult males sometimes confronted their attacker and turned sideways, gaping and hissing (Meshaka et al. 2004a).

Predators.—Engeman et al. (2007) reported the remains of a Black Spinytail Iguana in the scat of a Bobcat (*Felis rufus*) from Gasparilla Island. The removal of its overabundant predator, the Raccoon (*Procyon lotor*), at CFSP in Miami-Dade County resulted shortly thereafter in an increase in population size of what had previously been an uncommon lizard (Meshaka et al. 2008b).

Threats.—Potential for negative impacts on the southern Florida ecosystem exists for this species. The species might pose a threat to the Least Tern (*Sterna antillarum*), the Wilson Plover (*Charadrius wilsonia*), Snowy Plover (*C. alaexandrinus*), and Florida Burrowing Owl (*Athene cunicularia floridana*; Krysko et al. 2003c). Its use of Gopher Tortoise burrows on Gasparilla Island also warranted attention (McKercher 2001). To that end, some level of burrow sharing existed in a Gasparilla population (Engeman et al. 2009a). This lizard was subject to the depredations of the Bobcat and Raccoon. An individual caught and killed a Racer, both having measured ca. 60 cm TL, and returned to attack as the body twitched. The lizard did not attempt to eat the snake, and the next day, the snake carcass was still uneaten (Engeman et al. 2009b). Regardless of the motivation for the attack, this species could likewise negatively impact other snakes, including sensitive species such as the Eastern Indigo Snake.

Individuals ate the berries of the exotic Brazilian Pepper (Meshaka et al. 2004a), and in turn could disperse these seeds in its scats. Providing winter food and cover, Brazilian Pepper stands were an important factor in the success of the Black Spinytail on Gasparilla Island (Jackson and Jackson 2007), such that the authors considered the removal of the corridor a potential tool in the management of the species as well as providing the benefit of removal of a highly invasive exotic plant. Feasibility of its eradication in Florida was discussed in detail (Engeman et al. 2009c).

IGUANA IGUANA (LINNAEUS 1758) — GREEN IGUANA

Description.—Adult body color is varying shades of green and that of juveniles in vibrant green (Conant and Collins1998; Meshaka et al. 2004a). The dewlap is conspicuous (Meshaka et al. 2004a). In southern Florida, breeding males vary in the intensity of orange that is generally found on the anterior part of the body but will often extend throughout the sides. Older females tend towards an olive or brown dorsal color. A spiny dorsal crest is present but varies in height. Dewlaps are present on both sexes, and jowls are well-developed on males (Fig. 54).

Distribution.—The Green Iguana is a New World species whose first documentation in Florida is from Miami, Miami-Dade County (King and Krakauer 1966) and populations were reproducing in Miami were 17 years later (Wilson and Porras 1983). In southern Florida, past records are from Broward, Lee, Miami-Dade (mainland), and Palm Beach counties, and reports exist from Broward, Highlands, Miami-Dade (mainland, Key Biscayne, Virginia Key), Monroe (Big Pine Key, Key Largo), and Palm Beach counties (Meshaka et al. 2004a). After Meshaka et al. (2004a) went to press, subsequent record appreared for southern Florida: Broward County (Townsend et al. 2002). More recent records of this species are from Broward (Krysko et al. 2007b), Collier (Krysko et al. 2005, 2007b), Lee (Krysko et al. 2005, 2007b), Miami-Dade (mainland, Key Biscayne; Krysko et al. 2007b), Monroe (Big Pine Key; Krysko et al. 2007b), Monroe (Key Largo; Krysko et al. 2007b), Monroe (Key West; Krysko et al. 2007b), Monroe (Little Torch Key; Krysko et al. 2005), Monroe (Vaca Key; Krysko et al. 2007b), Monroe (Stock Island; Krysko et al. 2005), Monroe (Upper Sugarloaf Key; Krysko et al. 2005), Monroe (Windley Key; Krysko et al. 2007b), and Palm Beach (Krysko et al. 2005, 2007b) counties, and reports are from Collier (mainland, Marco Island) and Monroe (Bahia Honda, Big Coppitt Key, Boca Chica, Cudjoe Key, Duck Key, Little Crawl Key, Lower Sugarloaf Key, Middle Torch Key, Plantation Key, Summerland Key) counties (Krysko et al. 2007b). This species has become well-established along the canals of Marco Island, such that a trapper hired by the City of Marco, as reported by the Naples News, captured 225 Green Iguanas (33−198 cm TL) within a six month period.

Elsewhere in Florida, records of the Green Iguana exist from Alachua County (Meshaka et al. 2004a). The Alachua County record, like that of the Highlands County report, was probably a waif (Meshaka et al. 2004b). Reports of the Green Iguana are from Hillsborough and Indian River counties (Meshaka et al. 2004b). A more recent record of this species is from Alachua County (Krysko et al. 2007b) (Fig. 55). This species is becoming evermore widespread in the state and within the counties from which it is known. The Green Iguana has also been documented as an established exotic species elsewhere in the United States (Meshaka 2008a) and in the West Indies (Lever 2003).

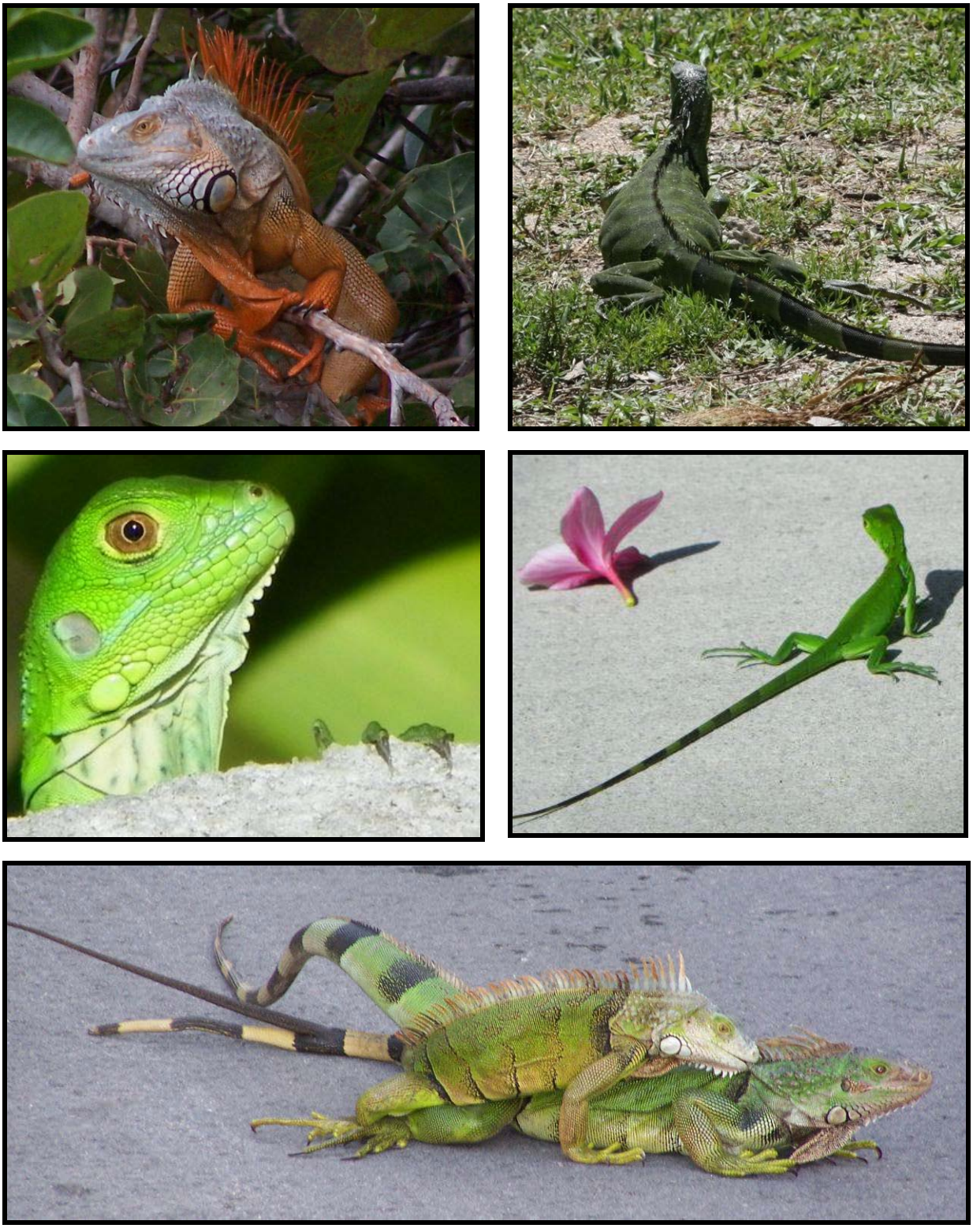

FIGURE 54. An adult male (upper left), gravid female (upper right), hatchling (middle left), juvenile (middle right), and copulating pair of Green Iguanas (*Iguana iguana*) from Broward Co., Florida. (Photographed by Gary Busch).

Body size.—The Green Iguana is a large species. A male (463 mm SVL) from Key Biscayne, and female (353 mm SVL) from Miami were reported by Meshaka et al. (2004a). At CFSP in Miami-Dade County, males (mean = 252 mm SVL) were smaller than females (mean = 328 mm TL), perhaps because of the recent population explosion, the smaller minimum body size of males, and the limited number of large dominant males at the park; however, the largest males were larger than the largest females at that site (Meshaka et al. 2007).

Habitat and abundance.—In southern Florida the Green Iguana generally occurred in habitat having both permanent bodies of water and trees (Meshaka et al. 2004a). For Florida, Townsend et al. (2003b) noted an association with water, where individuals could be found in trees or on embankments bordering canals and lakes. In North Miami, individuals inhabited mangrove stands (Meshaka et al. 2004b). At HTBSP, frightened individuals jumped into brackish water from the seawall (WEM). Although individuals have appeared in ENP, no colonies of this species existed in the park (Butterfield et al. 1997; Meshaka et al. 2000; Meshaka et al. 2004a,b). The species was, however, well-established along the canals near the park (Meshaka et al. 2004b).

Under optimal conditions, the Green Iguana could be astonishingly abundant. For example, during a five-year period 397 individuals were removed from CFSP (Meshaka et al. 2004b). Contrary to statements by Krysko et al. (2007b), values of Meshaka et al. (2004b) were accurate. So quickly and so large had the Green Iguana population become, a peak estimated population density was 626 Green Iguanas/ km^2 (Smith et al. 2007a); this occurred after the population was released from an overabundance of its limiting predator, the Raccoon (Meshaka et al. 2007). At CFSP, the Green Iguana and the Racer were the co-dominant roadkill over an 11 year period, its first appearance coinciding with the removal of Raccoons (Meshaka et al. 2007; Smith et al. 2007b). Since the removal of overabundant Raccoons (n = 263) from CFSP, the Green Iguana experienced a population explosion documented through the removal of a peak of 811 individuals in 2003 (Meshaka et al. 2007). The removal of Raccoons at HTBSP likewise resulted in a rapid increase in the number of young Green Iguanas (Meshaka et al. 2009). A density of 1,794 burrows/ ha was estimated along to occur along a canal levee in Broward County (Sementelli et al. 2008a). Elsewhere, at Fairchild Tropical Garden in Miami, the Hibiscus garden could no longer be maintained because of high population densities (Meshaka et al. 2004b). Driving along a two mile stretch of canal in Broward County during late afternoon, Henry T. Smith and I counted more than 40 individuals sunning and eating grass along the levy. As noted above, 225 individuals of mixed size-classes were trapped in a six month period on Marco Island.

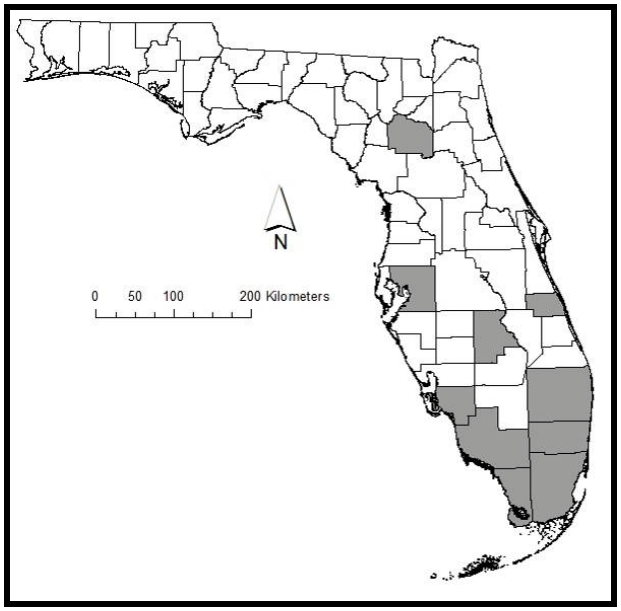

FIGURE 55. Geographic distribution of the Green Iguana (*Iguana iguana*) in Florida.

Diet.—Meshaka et al. (2004a) considered the species to be primarily herbivorous. In Homestead, a fecal sample from a male contained flowers, leaves, and fruit of the Night Blooming Jasmine and berries from the Washington Palm (*Washingtonia robusta*) (Meshaka et al. 2004a). On Key Biscayne, diet included a tree snail (*Drymaeus multilineatus*) (Townsend et al. 2005), Nicker Bean (*Caesalpinia bonduc*), cracked corn, a rat (*Rattus* sp), and mammal hair found in the mouth of a roadkilled individual (Krysko et al. 2007b). Elsewhere in Florida, Spanish Stopper (*Eugenia foetida*) was eaten by two individuals (Krysko et al. 2007b).

Reproduction.—In south Florida mating occurred during winter − spring (Meshaka et al. 2004a; Krysko et al. 2007b). A 353 mm SVL female from North Miami captured in March deposited 49 eggs the next day (Meshaka et al. 2004a), a Homestead female laid 17 eggs in April (Meshaka et al. 2004a) and a clutch of 41 eggs was laid in April (Krysko et al. 2007b). At CFSP, females were gravid and recently spent during March − July, with a peak in April (Meshaka et al. 2007). Many females nested in a sandy area on Key Biscayne (Townsend et al. 2003b).

Growth and survivorship.—Most hatchlings appeared during July− August (Townsend et al. 2003b) and late August (Meshaka et al. 2004a). On Little Torch Key, hatchlings were seen in July (Krysko et al. 2005). At

CFSP, hatchlings were observed during June September (Meshaka et al. 2007). On the southern Florida mainland and Florida Keys, neonates were present during May-August (Krysko et al. 2007b). At CFSP, males reached sexual maturity at a smaller body size (178 mm SVL) than females (240 mm SVL) (Meshaka et al. 2007). At the same site, sexual maturity was possible by 16− 17 months of age in males and by 24 − 25 months of age in females (Meshaka et al. 2007).

Activity.—The Green Iguana used trees and ground to forage and bask (Meshaka et al. 2004a). In areas of human persecution, individuals became very wary, and frightened individuals would dive into the water or ascend trees in efforts to escape (Meshaka et al. 2004a). McKie et al. (2005) observed tail tracks of the Green Iguana at burrow entrances of the Borrowing Owl. To escape cold weather, individuals remain under the water with only their snouts exposed (Townsend et al. 2003b).

Predators.—In southern Florida, eggs were eaten by the Gray Fox (*Urocyon cinereoargenteus*; Smith et al. 2007c). Domestic dogs (*Canis familiaris*) were predators of adult and young Green Iguanas in Florida (Meshaka et al. 2004a). A Yellow-crowned Night Heron (*Nyctanassa violacea*) ate a very young Green Iguana on Bahia Honda Key, Monroe County (Engeman et al. 2005). In Boca Raton, Palm Beach County, the Florida Burrowing Owl was a confirmed predator of young Green Iguanas (McKie et al. 2005), and in Broward County, a c.a. 20 cm SVL individual was eaten by a Raccoon (Smith et al. 2006a). At both CFSP and HTBSP, adult males were observed facing off with a Raccoon (Smith et al. 2006a; Meshaka et al. 2007).

Threats.—Through physical disturbance or, perhaps, nest predation, the interactions between the Green Iguana and the endangered Florida Burrowing Owl warrant concern. This large lizard alters the burrows of the Gopher Tortoise (Truglio et al. 2008). In turn, the Green Iguana is threatened by the Yellow-crowned Night Heron, Florida Burrowing Owl, and the Raccoon. With respect to the management of the Green Iguana, Meshaka (2009b) suggested that by initiating removal programs of the Green Iguana preceding and during nuisance Raccoon removal programs, the replacement of one limiting predator with another (= humans), would prevent a sudden population increase of this lizard. The authors also suggested targeting the colonial nest sites during the time between nesting and hatching as another method of control. Krysko et al. (2007b) advocated the use of artificial nest boxes to attract nesting females for population control. This control method could easily be counterproductive if, either by neglect or design, eggs are not removed, thereby enhancing population size instead of controlling it. Southern Florida was subjected to a severe frost in January 2008 to which the Green Iguana suffered mortality to the extent that the topic was covered in the local news. In this regard, on 4 January 2008 Rose A. Meshaka and I found a dead gravid female that appeared to have dropped from a Black Olive (*Bucida buceras*) near a burrow pit in Cooper City. On 5 January 2008, Ellen and Luke Duarte and I found a dead male and female Green Iguana along a canal in Pembroke Pines and a dead male (c.a. 5.4 kg) along a canal in Miramar. These last three iguanas appeared to have died where they had been basking.

Smith et al. (2007d) provided an update on research of the Green Iguana in Florida and underscored the importance of life history data in providing answers to reasons of success and failure of colonizing species as well as possible methods of control. Sementelli et al. (2008b) quantified economic costs to the negative impacts of the Green Iguana in Florida.

PHRYNOSOMA CORNUTUM (HARLAN 1825) — TEXAS HORNED LIZARD

Description.—As described by Conant and Collins (1998) and Meshaka et al. (2004a), the dorsum is grayish brown reddish or buff in color with darker spots along each side. The body is flat dorsoventrally. Four pairs of spines, two of which are enlarged, are present along the back edge of the head. The body is rough in texture (Fig. 56).

Distribution.—The Texas Horned Lizard is a native North American species whose first documentation in Florida is from Miami, Miami-Dade County (DeSola 1934). In southern Florida, past records are from Miami-Dade and Palm Beach counties (Meshaka et al. 2004a). More recently, Owens and Krysko (2007) discussed records from Miami-Dade and Palm Beach counties.

Elsewhere in Florida, records of the Texas Horned Lizard exist from Alachua, Duval, Escambia, Indian River, Lake, Marion, Okaloosa, Orange, Polk, Putnam, and Santa Rosa counties (Meshaka et al. 2004a). Owens and Krysko (2007) discussed records from those same counties, added Levy County to the list, but incorrectly stated that no published documentation existed for this species from Alachua, Okaloosa, and Santa Rosa counties. Whereas many records were not confirmed breeding populations, two established colonies were known from Duval and Santa Rosa counties (Meshaka et al. 2004a). The Duval County population was in existence since at least 1953 (King and Krakauer 1966), and the Escambia County population was reported in

FIGURE 56. A Texas Horned Lizard, *Phrynosoma cornutum*. (Photographed by Suzanne L. Collins).

1940 by Carr (1940; Fig. 57). To these two counties, Owens and Krysko (2007) added Okaloosa and Santa Rosa counties to the list of counties with extant populations. The Texas Horned Lizard also occurs as an established exotic species elsewhere in the United States (Conant and Collins1998).

Body size.—In northern Florida, body size of males (mean = 70.9 mm SVL) was smaller than females (mean = 83.7 mm SVL; Meshaka et al. 2004a).

Habitat and abundance.—Colonies of the Texas Horned Lizard were associated with coastal sandy areas (Meshaka et al. 2004a). Whereas the Duval County colony occurred in a residential area, the Santa Rosa County colony was in a natural area (Meshaka et al. 2004a).

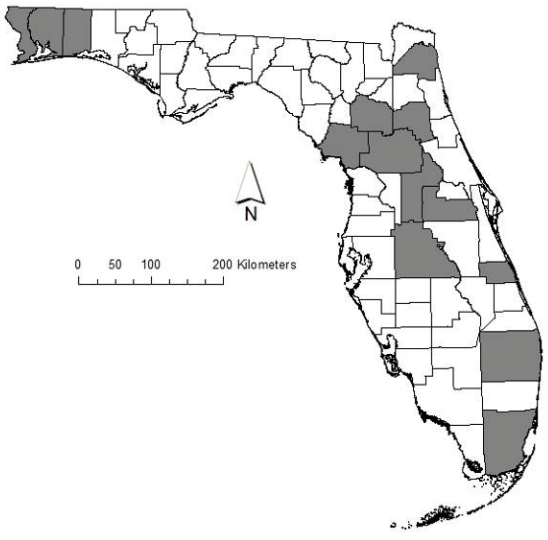

FIGURE 57. Geographic distribution of the Texas Horned Lizard (*Phrynosoma cornutum*) in Florida.

Diet.—The Texas Horned Lizard is a predator of ants (Collins et al. 2010); however, no study has been conducted of its diet in Florida.

Activity.—Individuals from the Duval County population were most often seen from June to August (Meshaka et al. 2004a).

Threats.—The Texas Horned Lizard inhabits natural and disturbed sandy open habitat, where it feeds on ants. The ecological impacts of this species on Florida ants, especially the single species of harvester ant in the Southeast, the Florida Harvester Ant (*Pogonomyrmex badius*), is unknown.

ANOLIS CHLOROCYANUS DUMÉRIL AND BIBRON 1837 — HISPANIOLAN GREEN ANOLE

Description.—The body color can change from green to black, and the dewlap is black and blue in males (Meshaka et al. 2004a). The female has a smaller blue dewlap (Bartlett and Bartlett 1999; Fig. 58).

Distribution.—The Hispaniolan Green Anole is a West Indian species whose first documentation in Florida is from Miami, Miami-Dade County (Bartlett 1988). This colony was apparently extirpated, and a

FIGURE 58. A Hispaniolan Green Anole (*Anolis chlorocyanus*). (Photographed by Suzanne L. Collins).

second colony was found in Broward County and had been in existence since 1987 (Butterfield et al. 1994b; Meshaka et al. 2004a). In southern Florida, past records are from Broward and Miami-Dade counties, and reports are from Martin County, which, according to a 1999−2002 Florida Fish and Wildlife Conservation Commission report, survived for only a time (Meshaka et al. 2004a; Fig. 59).

***Body size*.—**The largest male (70 mm SVL) and female (55 mm SVL) Hispaniolan Green Anole were from Broward County (Meshaka et al. 2004a).

***Habitat and abundance*.—**The Broward County population inhabited the buildings and trees of a disturbed site (Meshaka et al. 2004a), and the population size was small (Meshaka et al. 2004a). Butterfield et al. (1994b) noted that this species used fewer kinds of perches and occurred in lower abundances than Largehead Anoles with which it occurred.

***Diet*.—**In Florida, the diet of the Hispaniolan Green Anole probably includes a variety of arthropods (Meshaka et al. 2004a).

***Reproduction*.—**In September a female contained a shelled egg and an enlarged follicle (Meshaka et al. 2004a) indicative of multiple clutch production, and a male captured at the same time was fertile (Meshaka et al. 2004a).

***Activity*.—**Individuals were generally active at or above 2 m from the ground on buildings and trees (Meshaka et al. 2004a).

***Threats*.—**The Hispaniolan Green Anole was a potential competitor of the Green Anole (Meshaka 2008a). Removal of large trees from this otherwise small site has negatively impacted the species potentially jeopardizing its existence (Meshaka et al. 2004a).

FIGURE 59. Geographic distribution of the Hispaniolan Green Anole (*Anolis chlorocyanus*) in Florida.

FIGURE 60. A Puerto Rican Crested Anole (*Anolis cristatellus*) from Miami-Dade Co., Florida (Photographed Suzanne L. Collins).

ANOLIS CRISTATELLUS DUMÉRIL AND BIBRON 1837 — PUERTO RICAN CRESTED ANOLE

Description.—As described by Conant and Collins (1998) and Meshaka et al. (2004a), body color ranges from greenish gray to dark brown in metachrosis. The dewlap is reddish-orange with and greenish in the middle. Adult males often have a large dorsal crest that extends onto the tail (Fig. 60).

Distribution.—The Puerto Rican Crested Anole is a West Indian species whose first documentation in Florida is from Key Biscayne, Miami-Dade County (Schwartz and Thomas 1975). In southern Florida, past records are from Miami-Dade (mainland, Key Biscayne) County (Meshaka et al. 2004a) where it is becoming more widespread in its distribution. Elsewhere in Florida, records of the Puerto Rican Crested Anole exist from Brevard County; however, its establishment was in doubt (Meshaka et al. 2004a; Fig. 61). The Puerto Rican Crested Anole also occurs as an established exotic species elsewhere in the West Indies (Lever 2003).

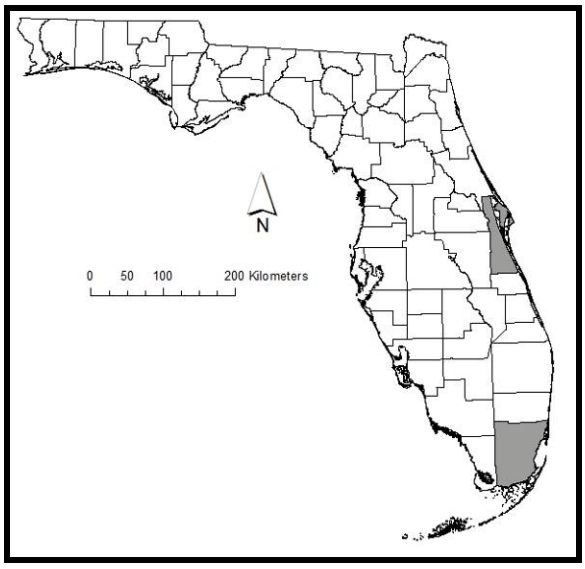

FIGURE 61. Geographic distribution of the Puerto Rican Crested Anole (*Anolis cristatellus*) in Florida.

Body size.—Adult males (mean = 61.4 mm SVL) were larger than adult females (mean = 44.9 mm SVL) in Miami-Dade County (Meshaka et al. 2004a). The same was true for males (mean = 68 mm SVL) and females (mean = 48 mm SVL) on Key Biscayne on Key Biscayne (Brach 1977).

Habitat and abundance.—The Puerto Rican Crested Anole was most often found in partly shady habitat and in shadier habitat than its congener the Brown Anole (Meshaka et al. 2004a). A preference for shade was inferred by its use of shaded walls and trunks and lower branches of large-diameter ornamental trees on Key Biscayne (Brach 1977). At the BHSP in Coconut Grove, the Puerto Rican Crested Anole was abundant in a disturbed tropical hardwood hammock, and the Brown Anole was scarcely along the edges of the hammock and was common in the sunnier areas of the park apart from the hammock (Meshaka et al. 2008c).

Diet.—The Puerto Rican Crested Anole ate a wide range of invertebrate prey but especially ants and beetles (Meshaka et al. 2004a). On Key Biscayne its diet was comprised mostly of 5−10 mm arthropods, such as

beetles, caterpillars, halictid bees, and spiders (Brach 1977). One individual defecated the remains of a Brahminy Blind Snake (Meshaka et al. 2004a), and the species was omnivorous in Florida (Brach 1977; Bartlett and Bartlett 1999).

***Reproduction*.—**In southern Florida, the Puerto Rican Crested Anole bred during March-November and females usually laid one, but occasionally two, eggs (Meshaka et al. 2004a).

***Growth and survivorship*.—**A shelled egg removed from a female hatched in June, and the hatchling measured 17 mm SVL (Brach 1977). The smallest sexually mature males (46.0 mm SVL) were larger than the smallest sexually mature females (39.3 mm SVL) measured by Meshaka et al. (2004a).

***Activity*.—**This species occupied the trunk-ground niche (Meshaka et al. 2004a). Males generally perched conspicuously (Brach 1977; Meshaka et al. 2004a) and higher than females and juveniles, which in turn were active closer to the ground and near cover (Meshaka et al. 2004a). The Puerto Rican Crested Anole socially dominated the Brown Anole (Meshaka et al. 2004a) and, where they co-occurred, the Brown Anole occupied a lower perch (Salzburg 1984). Brach (1977) noted that the Brown Anole was rare or absent where the Puerto Rican Crested Anole was present.

***Threats*.—**As an omnivore, feeding heavily on beetles and ants, the Puerto Rican Crested Anole was a potential competitor of the native Green Anole (Meshaka 2008a). Brach (1977) thought that it would displace the Brown Anole as it dispersed in Florida. It appears that the Puerto Rican Crested Anole greatly outnumbers or replaces the Brown Anole in shaded habitats, but not in sunny open situations. The Puerto Rican Crested Anole may be a threat to the Brahminy Blind Snake, even if nominally, and may in turn be threatened by the larger anoles.

ANOLIS CYBOTES COPE 1862 — LARGEHEAD ANOLE

***Description*.—**The body color of this lizard ranges greenish-gray to dark brown, and the color of the dewlap is cream to creamy yellow (Conant and Collins1998; Meshaka et al. 2004a). Bartlett and Bartlett (1999) noted the stocky build and large head of males as well as their ability to extend a nuchal and dorsal crest (Fig. 62).

***Distribution*.—**The Largehead Anole is a West Indian species whose first documentation in Florida is from the Miami area, Miami-Dade County (Ober 1973). In southern Florida, past records are from Broward, Martin,

FIGURE 62. Largehead Anoles (*Anolis cybotes*) from Broward Co., Florida. (Photographed by Richard D. Bartlett [right] and Suzanne L. Collins [left]).

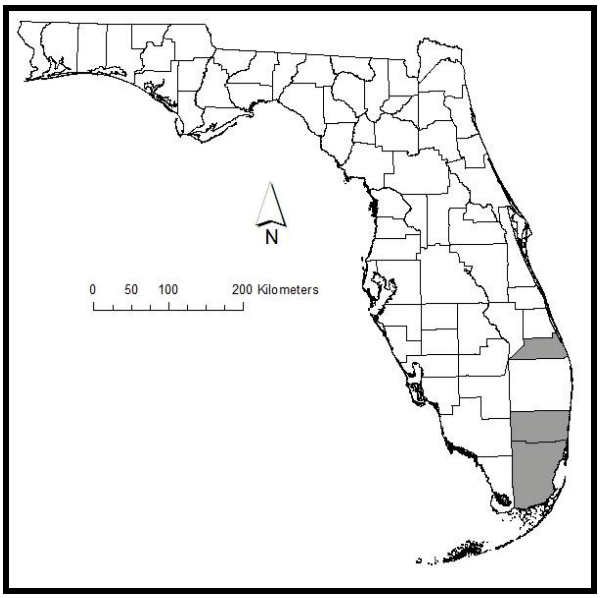

FIGURE 63. Geographic distribution of the Largehead Anole (*Anolis cybotes*) in Florida.

and Miami-Dade counties (Meshaka et al. 2004a). After Meshaka et al. (2004a) went to press, subsequent records appeared for southern Florida: Miami-Dade (Key Biscayne) County (Townsend et al. 2002). A more recent record of this species is from Martin County (Krysko et al. 2005; Fig. 63). This is not a geographically widespread anole within these counties.

Body size.—The largest male (71.4 mm SVL) and female (56.7 mm SVL) were from Broward County (Meshaka et al. 2004a).

Habitat and abundance.—The Largehead Anole occurred on ficus trees and various human-made structures (Meshaka et al. 2004a), and in Port Mayaca, Martin County, an individual inhabited a ficus tree (Krysko et al. 2005). It was usually most abundant in disturbed areas with well-spaced trees (Bartlett and Bartlett 1999). This lizard was very abundant at the Broward County site (Meshaka et al. 2004a).

Diet.—Bartlett and Bartlett (1999) noted an omnivorous diet in this species, which included small vertebrates.

Reproduction.—A female collected in September contained an oviductal egg and an enlarged follicle (Meshaka et al. 2004a) suggesting the potential for multiple clutch production.

Activity.—The Largehead Anole occupied the trunk-ground niche, and males were often seen displaying in head-down position with their heads extending outward so as to be parallel to the ground (Meshaka et al. 2004a). Butterfield et al. (1994b) noted that this species used more kinds of perches and occurred in higher abundances than the Hispaniolan Green Anole with which it occurred.

Threats.—In light of its diet, the Largehead Anole could have been a threat to the native Green Anole (Meshaka 2008a).

ANOLIS DISTICHUS COPE 1862 — BARK ANOLE

Description.—Different subspecies of the Bark Anole have been introduced into southern Florida (Fig. 64), and describing the differences between these races may now be irrelevant (see Distribution). The subspecies are:

- Bark Anole (*A. d. distichus* Cope 1862) has distinct keels on the enlarged scales of the femur (Cochran 1941).
- Florida Bark Anole (*A. d. floridanus* Smith and McCauley 1948) is light gray in body color, and its dewlap is pale yellow (Conant 1975; Meshaka et al. 2004a).
- Green Bark Anole (*A. d. dominicensis* Reinhardt and Lütkin 1863) is yellowish green in body color, and its dewlap is yellow with an orange spot in the center (Conant 1975; Meshaka et al. 2004a). Enlarged scales of the femur are smooth (Cochran 1941).

Distribution.—The Bark Anole is a West Indian species whose first documentation (and described as a new subspecies) in Florida is from Miami, Miami-Dade County (Smith and McCauley 1948). That form was the Florida Bark Anole, which may have (Wilson and Porras 1983) or may not have (Schwartz 1971) been native to Florida. Duellman and Schwartz (1958) believed those specimens to be *A. d. distichus*. Subsequent reports of another form of the species, the Green Bark Anole, exist from Miami (King and Krakauer 1966). Because of extensive intergradation, in Miami-Dade and Broward counties, individuals share traits of both forms rendering subspecific designation impossible (Miyamoto et al. 1986). Through the mixing of two distinct forms and subsequent drift and or selection, the Bark Anole of Florida may represent a new phenotype (Butterfield 1996).

In southern Florida, records of the Bark Anole are from Broward (Meshaka et al. 2004a), Martin (Meshaka

FIGURE 64. A Bark Anole (*Anolis distichus*) from Key West, Monroe Co., Florida. (Photographed by Suzanne L. Collins.

et al. 2004a), Miami-Dade (mainland; Enge et al. 2004b) Meshaka et al. 2004a), Monroe (Key Vaca, Key West, Ramrod Key; Meshaka et al. 2004a), and Palm Beach (Meshaka et al. 2004a) counties, and reports are from Lee and Miami-Dade counties (Meshaka et al. 2004a). After Meshaka et al. (2004a) went to press, subsequent records appeared for southern Florida: Monroe (Cross Key, Long Key) County (Campbell and Campbell 2002). A report exists of the Bark Anole in ENP but no colonies existed in the park (Butterfield et al. 1997; Meshaka et al. 2000). I first saw this species in downtown Homestead along Krome Avenue in 1999 (Fig. 65). The Bark Anole may have been introduced from Hispaniola to Great Abaco (Lever 2003).

Body size.—In Miami, body sizes were available for males (mean = 47.4 mm SVL) and females (45.8 mm SVL; Duellman and Schwartz 1958). In Miami, male body size (mean = 48.7 mm SVL) was larger than that of females (mean = 44.8 mm SVL; King 1966).

Habitat and abundance.—Duellman and Schwartz (1958) noted this species on trunks of trees, particularly noting fig trees and palm trees. King (1966) found the species on tree trunks and house walls in filtered sunlight (King 1966). Among King's (1966) study plots in Coral Gables, the Bark Anole was more abundant in a plot containing large ficus trees, mesophytic vegetation, and reduced sunlight. Meshaka et al. (2004a) noted the species on the trunks of smooth-barked trees and on buildings, where it was most often in shaded areas (Meshaka et al. 2004a). Bartlett and Bartlett (1999) reported this lizard as frequent inhabitants of lushly planted office complexes of south Florida. Potentially abundant, more than 20 individuals occurred on a single large ficus tree (Meshaka et al. 2004a). King (1966) noted strong seasonal fluctuation in abundance, such that individuals were 3.4 times more numerous in November than in July.

Diet.—In south Florida, the Bark Anole was predominantly a predator of ants (King 1966; Meshaka et al. 2004a). Diet differed between the Bark Anole and

FIGURE 65. Geographic distribution of the Bark Anole (*Anolis distichus*) in Florida.

the Green Anole, the latter of which had a broader diet but concentrates of flies (King 1966).

Reproduction.—As per King (1966), in Miami males were sexually active during February-November, and mating took place in March and August. Vitellogenesis began in February, oviductal eggs appeared in March and egg laying continued through October. Females laid single-egg clutches, and multiple clutches were produced. Shelled egg size ranged 10.0−10.5 X 6.0−6.5 mm. The Bark Anole was more fecund than the Green Anole. The breeding season was longer in the Bark Anole, and 30% more eggs were produced in a season.

Growth and survivorship.—As per King (1966), hatchlings were seen during July-November. Minimum body size at sexual maturity was 41 mm SVL in males and 38 mm SVL in females. Most individuals hatched during one summer could breed the following season. No individuals were thought by King (1966) to live more than 75−85 weeks.

Activity.—The Bark Anole was generally a mid-trunk anole as seen at both the Kampong in Coconut Grove (Meshaka 1999a) and the Doc Thomas House in South Miami (Meshaka 1999b). In Coral Gables, mean perch heights above the ground were similar between males (mean = 154 cm) and females (mean = 114 cm) (Paterson 1999). King (1966) noted that the Bark Anole feeds around the base of trees and found both this species and the Green Anole on the trunks of palm trees; however, the Green Anole will also feed elsewhere on the tree. Females occupied lower perch heights when foraging and higher perch heights after prey capture (Paterson 1999). Perch choice differed between the Bark Anole and the Green Anole (King 1966). Activity between the syntopic Bark Anole and Green Anole was similar with respect to periods of the day and year (King 1966). Diel activity was generally bimodal during hot weather and unimodal during cool weather (King 1966). More feeding activity occurred during the morning than in the afternoon (King 1966). In syntopic populations, the active temperatures and critical thermal maxima were lower in the Bark Anole than in the Green Anole (King 1966). Basking frequency was similar between the Bark Anole and the Brown Anole (Doan 1996).

Predators.—The Cuban Green Anole was a predator of this species (Meshaka et al. 2004a), and eggs of the Brown Anole were eaten by ants and the Ringneck Snake (King 1966). The Brown Basilisk (Krysko et al. 2006), Jamaican Giant Anole (Meshaka et al. 2004a), and Knight Anole (Meshaka and Rice 2005), confirmed predators of lizards in Florida, are likely predators of the Bark Anole. The Brown Anole was a possible source of predation on this species (Meshaka et al. 2004a).

Threats.—In south Florida, the Bark Anole preferred shadier habitat than the Green Anole (King 1966); however, where the species co-occurred, the Green Anole shifted to sunnier microhabitat (King 1966). The Bark Anole is threatened by the Cuban Green Anole and potentially by the Brown Anole and the much larger anoles as well.

ANOLIS EQUESTRIS MERREM 1820 — KNIGHT ANOLE

Description.—As described by Conant and Collins (1998) and Meshaka et al. (2004a), adults are bright grassy green but can change to a dark brown. A yellow shoulder stripe is present, and both sexes have a light pink dewlap. Hatchlings and juveniles are green with transverse body bands that are cream in color (Fig. 66).

Distribution.—The Knight Anole is a West Indian species whose first documentation in Florida is from south Florida (Neill 1957). The species had been deliberately released in Miami, Miami-Dade County in the 1950s (King and Krakauer 1966). In southern Florida, past records are from Broward, Collier, Martin, Miami-Dade (mainland, Elliott Key), and Monroe (Plantation Key) counties, and reports are from Highlands, Lee, Martin, and Monroe (Key West) counties (Meshaka et al. 2004a). Bartlett and Bartlett (1999) noted that Lee County reports were those of Jamaican Giant Anoles. More recent records of this species are from Highlands (Parker and Krysko 2009), Lee (Parker and Krysko 2009), Martin (Krysko et al. 2005), Monroe (Key West; Krysko and Borgia 2007a), Palm Beach (Krysko et al. 2005), and St Lucie (Krysko et al. 2005) counties. The Highlands County report represented a waif that was found alive in an agricultural shipment from Miami (Meshaka et al. 2004a). The Knight Anole has been recorded in ENP but no colonies existed in the park (Butterfield et al. 1997; Meshaka et al. 2000).

Elsewhere in Florida, reports of the Knight Anole exist from Polk County as per a 1992 report by the Florida Fish and Wildlife Conservation Commission but the status of the species in that county was unknown (Meshaka et al. 2004a). More recent records of this species are from Brevard (Enge and Coben 2007) and Polk (Parker and Krysko 2009) counties (Fig. 67). The Knight Anole also occurs as an established exotic species elsewhere in the United States (Meshaka 2008a).

Body size.—The Knight Anole is Florida's largest anole species. In Miami-Dade County, adult males from

FIGURE 66. (Above) A Knight Anole (*Anolis equestris*) with a Cuban Treefrog (*Osteopilus septentrionalis*) it captured in South Miami, Miami-Dade Co., on 4 April 2004. (Photographed by Tom L. Jackson)**. (**Below**)** Knight Anoles (*Anolis equestris*) from Homestead, Miami-Dade Co., Florida. (Photographed by Richard D. Bartlett)..

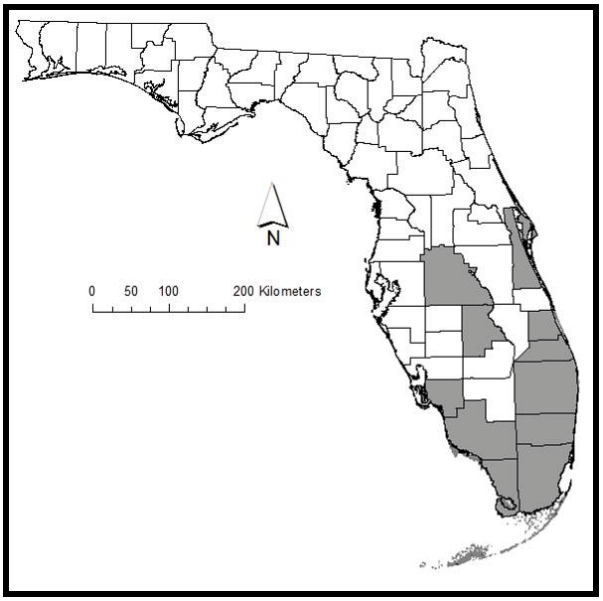

FIGURE 67. Geographic distribution of the Knight Anole (*Anolis equestris*) in Florida.

South Miami (mean = 156.4 mm SVL) and Homestead (mean = 163.4 mm SVL) were larger than females from South Miami (mean = 134.6 mm SVL) and Homestead (mean = 137.8 mm SVL; Meshaka et al. 2004a). From individually marked animals from downtown Homestead, adult males (mean = 157.0 mm SVL) were larger than adult females (136.3 mm SVL; Meshaka and Rice 2005).

Habitat and abundance.—In southern Florida, this anole has been most typically associated with large branches and canopy (Meshaka 1999a,b,c; Meshaka et al. 2004a; Meshaka and Rice 2005). Wilson and Porras (1983) noted its association with large trees, especially exotic fruit trees and ornamental trees. The Knight Anole was often associated with Mahogany (*Swietenia mahogani*; Meshaka et al. 2004a; Meshaka and Rice 2005), Black Olive; Wilson and Porras 1983; Meshaka and Rice 2005), and Royal Palm (*Roystonea* spp.), Wild Tamarind (*Lysiloma latisiliquum*), Bishopwood (*Bischofia javanica*), Live Oak (*Quercus laevus*) and Sabal Palm (*Sabal palmetto*; Meshaka and Rice 2005). In Port Mayaca, Martin County, it occurred on Cypress (*Taxodium* sp.; Krysko et al. 2005), and in St. Lucie County adults and juveniles occurred on Brazilian Pepper and Slash Pine (*Pinus elliotti*; Krysko et al. 2005). Population densities of the adult Knight Anoles were estimated to be 29.5 and 18.0 lizards/ha at two sites in Miami (Dalrymple 1980). In a Wild Tamarind grove in Homestead, estimated population density was 3.3 individuals/ha (Meshaka et al. 2004a). Another site in Homestead was inhabited by 61 new individuals (Meshaka and Rice 2005). Where the Knight Anole was abundant and the Brown Anole was present, the Green Anole was more numerous than in areas where the Knight Anole was uncommon or absent (Meshaka 1999c).

Diet.—Dalrymple (1980) considered the Knight Anole to be an insectivore with a tendency towards omnivory. In Coral Gables, individuals ate ripe Cherry Palm (*Pseudophoenix* sp.) berries, *Ficus* berries, but mostly invertebrates, especially insects and spiders, and most of these were less than 15 mm long (Dalrymple 1980). From another Coral Gables sample, Brach (1976) found some invertebrates, but mostly vegetable matter (*Ficus religiosa* and ornamental palm berries, leaves). In Homestead, this giant among anoles included the Blue-Grey Gnatcatcher (*Poliptila caerulea*) and Brown Anole in its diet (Meshaka and Rice 2005). For south Florida, Wilson and Porras (1983) reported ripe mangos, Azalea flowers, tree sap, caterpillars, and large ants in its diet, and Meshaka et al. (2004a) reported fig berries, palm berries, mango sap, the Purple Martin (*Progne subis*),

Cuban Treefrog, Brown Anole, and Indo-Pacific Gecko in its diet. In southern Florida, the Knight Anole was a potential predator of the Cuban Green Anole (Meshaka et al. 1997b). The Northern Mockingbird and the Blue Jay were thought by Meshaka and Rice (2005) to be potential competitors of the Knight Anole for food. Geckos in general are at risk in the presence of this anole.

Reproduction.—In Homestead, fights between males were observed during March-August, but especially in May (Meshaka and Rice 2005). Mating occurred in January and during March-September, and nearly always conspicuously (Meshaka and Rice 2005). Gravid females were taken during June and July, and shelled eggs averaged 21.1 X 11.4 mm (Meshaka et al. 2004a). Potted plants are occasionally used as nesting sites by female Knight Anoles in southern Florida.

Growth and survivorship.—As reported by Meshaka and Rice (2005), the smallest sexually mature adults were similar between males (110 mm SVL) and females (108 mm SVL). However, males were not sexually mature until 13 mo of age compared to 7.5 mo of age in females. At the mean body sizes, males and females were 31 and 14 mo of age, respectively. The ages at which body sizes reached a plateau was likewise older for males (54 mo) than females (22 mo). Wilson and Porras (1983) noted longevity in this species. At the Homestead colony, annual survivorship was 70%, and the population turned over in about five years (Meshaka and Rice 2005).

Activity.—The Knight Anole's typical association with large branches and canopy was reflected in their preference for high perches that were usually 105+ cm above the ground (Meshaka 1999a,b; Meshaka and Rice 2005; Meshaka et al. 2008a) and generally on large diameter branches and trunks (Meshaka and Rice 2005). This observation should not be surprising in light of the large body dimensions of an adult Knight Anole. An abundance of terrestrial predators could have explained differential perch heights among sites in southern Florida (Meshaka et al. 2004a). In Homestead, the Knight Anole was active throughout the year (Meshaka and Rice 2005). Activity began to increase in April, peaked in May and steadily declined thereafter, such that individuals were scarcely seen during December-March (Meshaka and Rice 2005). In this connection, capture probabilities were higher in summer than winter in Homestead (Meshaka and Rice 2005). In August in Homestead, daily activity was unimodal, beginning early in the morning and lasted even up to last light (Meshaka and Rice 2005). Individuals were very active when monthly average high air temperatures were at least 30° C and when daily highs were over 28.9° C (Meshaka and Rice 2005). Very young individuals were seen uncommonly (Meshaka et al. 2004a; Meshaka and Rice 2005), if at all (Dalrymple 1980). However, recruitment at a Homestead colony was 20.6% (Meshaka and Rice 2005), in the lush replantings that matured since Hurricane Andrew.

In the hours prior to Hurricane Andrew in 1992, individuals descended trees presumably to seek shelter close to the ground (Meshaka 1993). Immediately after the storm, individuals basked and included basking sites not typically used (Meshaka 1993). A temporary loss of habitat resulted from tree blowdown and defoliation; however, the loss was temporary (Meshaka 1993).

Predators.—The Naples, Collier County, record (Achor and Moler 1982) was derived from the head of an individual that was eaten by a cat. No mention was made concerning the origin of the interaction; however, predation was certainly a likely possibility. Potential predators at a Homestead colony were the feral cat, Northern Mockingbird, Blue Jay, and Eastern Racer (Meshaka and Rice 2005).

Threats.—Native and exotic vertebrate species are at risk to its depredations. The ubiquitous Northern Mockingbird and Blue Jay in urban south Florida, were potential predators of very small Knight Anoles and potential competitors for food with this species (Meshaka 1999c; Meshaka and Rice 2005). The Knight Anole may have been a driving force in the anoline assemblage structure in southern Florida and described as a veritable *Tyrannosaurus rex* of the trees (Meshaka 1999c).

ANOLIS GARMANI STEJNEGER 1899 — JAMAICAN GIANT ANOLE

Description.—As described by Conant and Collins (1998) and Meshaka et al. (2004a), body color ranges in shades of green with a gold-flecked pattern. A short spiny vertebral crest is present, and the dewlap is brownish yellow (Fig. 68).

Distribution.—The Jamaican Giant Anole is a West Indian species whose first documentation in Florida is from South Miami, Miami-Dade County (Wilson and Porras 1983). The age of that colony dated back to at least 1975 (Wilson and Porras 1983). In southern Florida, past records are from Lee and Miami-Dade counties, and reports are from Martin County (Meshaka et al. 2004a). The Martin County colony persisted for only five years, extirpated by frost, as reported by the Florida Fish and Wildlife Conservation Commission

FIGURE 68. A Jamaican Giant Anole (*Anolis garmani*). (Photographed by Richard D. Bartlett).

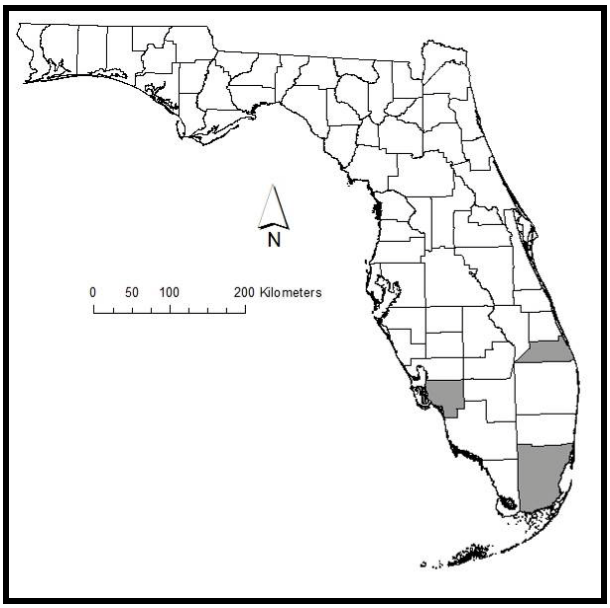

FIGURE 69. Geographic distribution of the Jamaican Giant Anole (*Anolis garmani*) in Florida.

1999−2002 report (Fig. 69). The South Miami colony appears to be static. The Jamaican Giant Anole has been introduced elsewhere in the West Indies (Lever 2003).

Body size.—Body sizes were measured from three males (85, 92.4, 95 mm SVL) and two female (74.0, 78.0 mm SVL; Meshaka et al. 2004a; unpubl. data).

Habitat and abundance.—In South Miami, individuals of this species were most often seen on large branches and smooth trunks up to 12 m above the ground (Meshaka et al. 2004a).

Diet.—The diet of the Jamaican Giant Anole included fruit and the Brown Anole (Meshaka et al. 2004a). Bartlett and Bartlett (1999) observed individuals eating ficus (*Ficus*) fruit, hibiscus (*Hibiscus*) leaves, and the Florida Carpenter Ant (*Camponotus abdominalis floridanus*).

Reproduction.—A fertile male was captured in July by Meshaka et al. (2004a), and females laid four-egg clutches through the summer (Bartlett and Bartlett 1999). In South Miami, a 74 mm SVL female collected in September contained one 11.4 mm shelled egg and one 8.8 mm enlarged follicle in the other ovary.

Activity.—Wilson and Porras (1983) noted a seasonal peak in activity during the warm days of winter. However, Bartlett and Bartlett (1999) found the opposite pattern in its seasonal activity.

Threats.—As an omnivore, the Jamaican Giant Anole may have been capable of negatively impacting the native Green Anole (Meshaka 2008a). The same seems likely of interactions by this large anole with the Brown Anole as well as other arboreal and semi-arboreal lizards.

ANOLIS PORCATUS GRAY 1840 — CUBAN GREEN ANOLE

Description.—Body color is bright green with creamy vermiculations, the skull is rugose with two prominent frontal ridges running lengthwise, and the dewlap is pinkish purple-mauve (Meshaka et al. 2004a). The head is proportionately long and pointed (Bartlett and Bartlett 1999). The Cuban Green Anole is closely related to the Green Anole and superficially similar in appearance. On the third hind toe, 25 or more lamellae indicate a male Cuban Green Anole, and 22 or fewer lamellae indicate a female Cuban Green Anole (Collette 1961). In light of its superficial resemblance to the Green Anole (Fig. 70), the Cuban Green Anole could escape detection (Meshaka et al. 2004a).

Distribution.—The Cuban Green Anole is a West Indian species that whose first documentation in Florida is from Key West, Monroe County (Allen and Slatten 1945). A report of a verified breeding colony exists from North Miami, Miami-Dade County (Meshaka et al.

1997b). That colony had been in existence since 1991 (Meshaka et al. 1997b). In southern Florida, past records are from Miami-Dade and Monroe counties, and reports are from Miami-Dade County (Meshaka et al. 2004a; Fig. 71). This species is becoming more widespread in Miami-Dade County. The Cuban Green Anole has been introduced elsewhere in the West Indies (Lever 2003).

Body size.—In North Miami males (mean = 66.2 mm SVL) were larger than females (mean = 55.6 mm SVL) (Meshaka et al. 1997b).

Habitat and abundance.—The Cuban Green Anole has been found in trees, bushes and exteriors of buildings in disturbed habitat (Meshaka 1999a,b; Meshaka et al. 1997b, 2004a). Bartlett and Bartlett (1999) noted the use of ornamental trees fences, yards, house walls, and piles of rubble by this species.

Diet.—Primarily ants, beetles, and spiders were eaten by individuals from South Miami, and an individual from Coconut Grove ate a Bark Anole (Meshaka et al. 2004a). In South Miami, the Cuban Green Anole consumed the nectar and blossoms of the Areca Palm (*Chyralipedocarpus lutescens*; Townsend 2003). In North Miami, the Cuban Green Anole was omnivorous, having consumed fruit and the Brown Anole but mostly invertebrate prey, especially flies and ants (Meshaka et al. 1997b). Prey recovered from the North Miami sample were generally small in size (mean = 4.0 mm) and often found above the ground (Meshaka et al. 1997b). The largest prey item, a 23 mm SVL Brown Anole, was eaten by a 68 mm SVL male (Meshaka et al. 1997b).

Reproduction.—In July a 45.3 mm SVL female contained one shelled egg (10.3 X 5.2 mm) and one enlarged follicle (7.3 X 5.1 mm), and another female contained one shelled egg (10.8 X 5.5. mm) and one enlarged follicle (5.8 X 4.2 mm; Meshaka et al. 2004a).

Growth and survivorship.—In North Miami, a 25 mm SVL juvenile was captured by Meshaka et al. (1997b) in July. The smallest sexually mature male (55 mm SVL) was larger than the smallest sexually mature female (48 mm SVL; Meshaka et al. 1997b).

Activity.—In south Florida, the Cuban Green Anole most often inhabited the mid-trunk and canopy of trees (Meshaka et al. 2004a). For example, at two sites in Miami (Meshaka 1999a,b) and one site in Coconut Grove (Meshaka et al. 2008c), individuals occurred over 1.8 m above the ground. In North Miami, individuals occurred generally 1−6 m above the ground (Meshaka et al. 1997b).

Predators.—The Knight Anole was a potential predator of the Cuban Green Anole in south Florida (Meshaka et al. 1997b). The Cuban Green Anole will likely face another predator if it comes into contact with the Jamaican Giant Anole.

Threats.—The Cuban Green Anole was an omnivore

FIGURE 70. A Cuban Green Anole, *Anolis porcatus*. (Photographed by Richard D. Bartlett).

FIGURE 71. Geographic distribution of the Cuban Green Anole (*Anolis porcatus*) in Florida.

that could eat surprisingly large lizards (Meshaka et al. 1997b, 2004a), and it fed heavily on flies (Meshaka et al. 1997b) as did the Green Anole (King 1966). Meshaka et al. (1997b) raised the concern of the Cuban Green Anole negatively impacting the Green Anole. Furthermore, the possibility of hybridization with the Green Anole was also possible this species (Meshaka et al. 2004a). The potential for competition and hybridization with, and predation on, the Green Anole was, therefore, a concern not to be taken lightly (Meshaka 2008a). The Cuban Green Anole is a threat to the Bark Anole through predation. Although the Knight Anole was a potential predator of the Cuban Green Anole in south Florida, the evolutionary familiarity of this species with many of the syntopic species of exotic herpetofauna could have been an advantage to the colonization process of the Cuban Green Anole in Florida (Meshaka et al. 1997b).

ANOLIS SAGREI DUMÉRIL AND BIBRON 1837 — BROWN ANOLE

Description.—The body color of this species is brown (Conant and Collins1998; Bartlett and Bartlett 1999; Meshaka et al. 2004a). Males may have bands of yellowish spots, and can erect a nuchal, dorsal, and anterior caudal crest (Bartlett and Bartlett 1999). Meshaka et al. (2004a) noted that males with a caudal crest are occasionally seen. The development of this crest varies among individuals. The dewlap is red or reddish-orange with a light border (Meshaka et al. 2004a). Bartlett and Bartlett (1999) noted that the dewlap may also be pale yellow. The dorsum of females and juveniles has a scalloped pattern (Bartlett and Bartlett 1999; Meshaka et al. 2004a) and a vertebral stripe (Bartlett and Bartlett 1999; Fig. 72).

Distribution.—The Brown Anole is a West Indian species whose first documentation in Florida is from the Florida Keys, Monroe County (Garman 1887). In southern Florida, past records are from Broward (Lee 1985; Meshaka et al. 2004a), Collier (Lee 1985; Meshaka et al. 2004a), Glades (Meshaka et al. 2004a), Hardee (Meshaka et al. 2004a), Highlands (Meshaka et al. 2004a), Lee (Lee 1985; Meshaka et al. 2004a), Manatee (Meshaka et al. 2004a), Miami-Dade (Duellman and Schwartz 1958; Lee 1985; Enge et al. 2004b; Meshaka et al. 2004a), Monroe (Bahia Honda; Lazell 1989), Monroe (Big Pine Key; Lee 1985), Monroe (Cudjoe Key; Duellman and Schwartz 1958), Monroe (Garden Key of the Dry Tortugas; Meshaka et al. 2004a), Monroe (Grassy Key; Lee 1985), Monroe (Key Largo; Lee 1985), Monroe (Key Vaca; Lee 1985), Monroe (Key West; Carr 1940; Duellman and Schwartz

FIGURE 72. A male Brown Anole, *Anolis sagrei*. (Photographed by Richard D. Bartlett).

FIGURE 73. Geographic distribution of the Brown Anole (*Anolis sagrei*) in Florida.

1958; Lee 1985; Lazell 1989), Monroe (Little Torch Key; Lazell 1989), Monroe (Long Key; Lee 1985),

Monroe (Marathon; Lee 1985), Monroe (Middle Torch Key; Lazell 1989), Monroe (No Name Key; Lazell 1989), Monroe (Plantation Key; Lee 1985), Monroe (Stock Island; Lazell 1989), Monroe (Summerland Key; Lee 1985; Lazell 1989), Monroe (Upper Matecumbe Key; Lee 1985), Palm Beach (Lee 1985; Meshaka et al. 2004a), Sarasota (Meshaka et al. 2004a), and St. Lucie (Meshaka et al. 2004a) counties, where it was widespread (Meshaka et al. 2004a). In southern Florida reports are from Charlotte, DeSoto, Hendry, Martin, Monroe (mainland), and Okeechobee counties, where it was widespread (Meshaka et al. 2004a). Reports of this species also exist from Monroe (Cudjoe Key, Middle Torch Key; Lazell 1989). After Meshaka et al. (2004a) went to press, subsequent records appeared for southern Florida: DeSoto (Campbell 2003), Hendry (Campbell 2003), Lee (Townsend et al. 2002), Martin (Townsend et al. 2002), and Okeechobee (Campbell 2003) counties.

Elsewhere in Florida, records of the Brown Anole exist from Alachua (Lee 1985; Meshaka et al. 2004a), Brevard (Meshaka et al. 2004a), Citrus (Meshaka et al. 2004a), Flagler (Meshaka et al. 2004a), Hillsborough (Lee 1985; Meshaka et al. 2004a), Indian River (Meshaka et al. 2004a), Levy (Meshaka et al. 2004a), Marion (Meshaka et al. 2004a), Orange (Lee 1985; Meshaka et al. 2004a), Osceola (Meshaka et al. 2004a), Pasco (Meshaka et al. 2004a), Pinellas (Lee 1985; Meshaka et al. 2004a), Polk (Meshaka et al. 2004a), Putnam (Meshaka et al. 2004a), and Volusia (Meshaka et al. 2004a) counties where it was widespread (Meshaka et al. 2004a) and reports exist form Hernando, Lake, Seminole, and Sumter counties where it was widespread (Meshaka et al. 2004a). Farther north in Florida, records of the Brown Anole exist from Baker, Bay, Clay, Columbia, Duval, Franklin, Hamilton, Nassau, St. Johns counties (Meshaka et al. 2004a). After Meshaka et al. (2004a) went to press, subsequent records appeared for

central and northern Florida: Bradford (Campbell 2003), Dixie (Campbell 2003), Gilchrist (Townsend et al. 2002), Hernando (Campbell 2003), Hillsborough (Egmont Key; Dodd and Griffey 2002), Lake (Campbell 2003), Levy (Townsend et al. 2002), Suwannee (Campbell 2003), Taylor (Townsend et al. 2002), and Union (Campbell 2003) counties. More recent records of the Brown Anole are from Leon (Jackson 2007; Means et al. 2008) and Okaloosa (Bishop 2005) counties.

The Brown Anole is ubiquitous and continuous in its geographic distribution throughout the Florida Keys and much of peninsular Florida (Fig. 73). The ease with which this species dispersed via human agency (Godley et al. 1981), even directionally (Campbell 1996), provides an explanation for its rapid geographic range expansion in Florida.

The Brown Anole in Florida represents a unique form (Lee 1985, 1987, 1992) derived from multiple sites (Oliver 1950; Lieb et al. 1983; Lee 1985, 1987, 1992). Kolbe et al. (2004) found that at least eight different introductions comprise the Florida population of the Brown Anole, which has resulted in an introduced population that was genetically more variable than native counterparts, perhaps a distinct species. Furthermore, this genetically robust Florida population has been the source of recent international introductions of the Brown Anole (Kolbe et al. 2004). The Brown Anole also occurs as an established exotic species elsewhere the United States (Meshaka 2008a) and has been introduced elsewhere in the West Indies (Lever 2003).

Body size.—On Key West, adult males (mean = 53.9 mm SVL) were larger than adult females (mean = 42.4 mm SVL; Duellman and Schwartz 1958). Likewise, on the Dry Tortugas, adult males (mean = 57.5 mm SVL) were larger in body size than adult females (mean = 45.1 mm SVL; Meshaka et al. 2004a). Three males (54.6, 55.5, 61.5 mm SVL) were larger than two females (43.9, 44.9 mm SVL) that I collected from the ABS.

Habitat and abundance.—On Key West, the Brown Anole occurred in disturbed habitat (Carr 1940; Duellman and Schwartz 1958). Whereas Carr (1940) noted a particular use of "coco-palms" at one site, Duellman and Schwartz (1958) saw individuals most often on the ground or on rocks or walls and seldom saw the species on trees and bushes. In the 1990s I found this species to be very abundant on the campgrounds of Garden Key, of the Dry Tortugas, Monroe County. The Brown Anole occurred in sunnier habitat than its congener, the Puerto Rican Crested Anole (Meshaka et al. 2004a). At the BHSP in Coconut Grove, the Brown Anole was most abundant in the sunnier areas of the park, and the Puerto Rican Crested Anole was more strongly associated with a disturbed tropical hardwood hammock, (Meshaka et al. 2008c).

In ENP, Dalrymple (1988) found the Brown Anole to be most abundant in disturbed habitat but it was also present in tropical hardwood hammock. In ENP, the Brown Anole has been seen since at least the 1970s and occurred in pineland, hammock, and mangrove and on buildings (Meshaka et al. 2000). This anole was the most abundant reptile in six pine rockland parks in Miami-Dade County (Enge et al. 2004b). In keeping with its preference for sunny habitats, immediately after Hurricane Andrew I observed a spike in numbers of individuals along the Gumbo Limbo Trail in Royal Palm Hammock in ENP. In the years following the storm, the numbers of Brown Anoles in the hammock receded as the canopy regrew and shaded out much of the Brown

Anole habitat and the earlier burst in Grape (*Vitis* sp.) vines. On the ABS, small ephemeral populations came and went in the palm plantings of the parking lot. This recent phenomenon was associated with increased human visitation. The Brown Anole occurred on one cottage, and colonies such as this could eventually result in an extensive colonization of the ranch (Meshaka 1997). The Brown Anole was present in downtown Lake Placid, where I have found it on and around buildings, on low vegetation, and on the ground.

The Brown Anole could be very abundant (e.g., Carr 1940; Duellman and Schwartz 1958; Wilson and Porras 1983; Bartlett and Bartlett 1999) greatly outnumbering other anoles (Meshaka 1999a,b; Meshaka et al. 2008a). This often happens at the expense of the Green Anole (e.g., Carr 1940; Campbell and Gerber 1996; Campbell 2000). In southern Florida, population densities of the Brown Anole could exceed 0.97 individuals/m^2 (Enge et al. 2004b). However, where the Knight Anole, a predator, was abundant, the Brown Anole was less common (Meshaka 1999c).

Diet.—The Brown Anole was primarily an insectivore; however, it also ate conspecifics (Nicholsen et al. 2000), hatchling Green Anoles (Campbell and Gerber 1996), and perhaps Bark Anoles (Meshaka et al. 2004a).

Reproduction.—A copulation record of this species exists on Key West in August (Duellman and Schwartz 1958), and copulation records exist for Brown Anoles in Miami-Dade County in August and September (Meshaka et al. 2004a). On long Boat Key, Sarasota County, I found a pair of Brown Anoles in copula on 12 June 2007 at 2030. In Miami, testis mass was greatest during April-June, and male fat mass was negatively associated with monthly testis mass (Lee et al. 1989). On the Florida Keys the Brown Anole tended to lay one egg at a time every two weeks and throughout the year unless conditions were too cool or dry (Lazell 1989). In Miami, the frequency of gravid females was highest during April-July and no females were gravid during November-February (Lee et al. 1989). On the ABS, I collected two females in June. The first female (43.9 mm SVL) contained one shelled egg (8.4 X 5.1 mm), an unshelled oviductal egg (8.0 X 4.5 mm), and a single enlarged ovarian follicle (5.4 mm). The second female (49.9 mm SVL) contained two shelled eggs (9.0 X 5.7 mm, 8.9 X 4.9 mm) and two enlarged ovarian follicles (6.0 mm, 4.5 mm). Day length was the best predictor of female reproduction more so than it was for males (Lee et al. 1989). Monthly female fat mass was negatively associated with the monthly proportion of gravid females (Lee et al. 1989).

Growth and survivorship.—I collected a 17 mm SVL hatchling On the Dry Tortugas in September. In Miami, hatchlings measured 15.0−18.0 mm SVL (Duellman and Schwartz 1958). In Homestead, hatchlings appeared as late as October (Meshaka et al. 2004a). In Miami, hatchlings were present in June (Duellman and Schwartz 1958) and in August (Meshaka 1993). In Miramar, Broward County, I found a hatchling on 17 June 2007. In Miami, minimum body size at sexual maturity was smaller in males (39 mm SVL) than in females (34 mm SVL; Lee et al. 1989), and both sexes were sexually mature within one year of life (Meshaka et al. 2004a).

Activity.—In southern Florida, the Brown Anole was a ground-mid-trunk anole and found most often < 105 cm above the ground (Meshaka 1999a,b; Meshaka et al. 2004a; Meshaka et al. 2008a). The entire population remained generally very close to the ground at a site I had repeatedly visited in Sarasota, where the habitat was open and both Northern Mockingbird and Blue Jay were very abundant. Females and juveniles were active closer to the ground than males (Meshaka 1999a,b; Meshaka et al. 2008a). This extremely successful colonizing species benefited by Hurricane Andrew by exploiting the newly created habitat of open areas and branch piles on which individuals could bask and feed (Meshaka 1993). The timing of the hurricane provided hatchlings in August with habitat that previously did not exist; however, the effect in urban areas was short-lived because of clean-up (Meshaka 1993). This highly adaptable species will forage around lights at night (Lazell 1989; Meshaka et al. 2004a), even in the rain (Meshaka et al. 2004a). In Homestead, during daytime storms, individuals will dart out from cover to capture prey stirred up from the rain.

Behavior of the Brown Anole from southern Florida has been the subject of study. Among conspecifics, males were less aggressive to neighbors than to non-neighbors (Paterson and McMann 2004), and males outside of core areas produced more headbob displays (McMann and Paterson 2003). Territories made vacant by the artificial removal of the resident male, were subsequently acquired by both neighbors and non-neighbors (Paterson 2002). Display activity did not appear to have been affected by handling, observation, or captivity by the investigator (McMann and Paterson 2003). As captives (Tokarz 2002) or as free-ranging individuals (Tokarz et al. 2005), dewlap display was not a factor in copulation rate. Among other anoles, males tended to be more aggressive to each other than to males of the Green Anole (Tokarz and Beck 1987).

In southern Florida, the Brown Anole was socially dominated by the Puerto Rican Crested Anole (Meshaka et al. 2004a) and where syntopic, it occupied a lower perch than the Puerto Rican Crested Anole (Salzburg 1984). The Brown Anole was rare or absent in areas where the Puerto Rican Crested Anole was present

(Brach 1977). However, at the BHSP in Coconut Grove, both species were relatively common in the semi-shaded habitat of the site (Walter Meshaka and Henry T. Smith, unpubl. data). Basking frequency was similar between the Brown Anole and the Bark Anole (Doan 1996). The brains of dominant males from Brandon, Hillsborough County, contained higher levels of dopamine, norepinephrine, acetylcholinesterase activity and lower concentrations of 5-hydroxytryptamine and gamma amino butric acid (Punzo 2001c).

Predators.—The Brown Anole was subject to a wide range of predators in Florida (Meshaka et al. 2004a): Eggs were eaten by the Southern Ringneck Snake (Meshaka et al. 2004a), Giant Ameiva (Meshaka et al. 2004a), and Nile Monitor (Enge et al. 2004c). Individuals were eaten by the Cuban Treefrog (Meshaka 2001; Meshaka et al. 2004a), Knight Anole (Meshaka et al. 2004a), Jamaican Giant Anole (Meshaka et al. 2004a), Cuban Green Anole (Meshaka et al. 1997b), Brown Basilisk (Krysko et al. 2006), Northern Curlytail Lizard (Callahan 1982), Eastern Corn Snake, American Crow, Broad-winged Hawk (*Buteo platypterus*), and Cattle Egret (*Bubulcus ibis*; Meshaka et al. 2004a). The Red-shouldered Hawk captured and ate this species in the Fakahatchee Strand State Park (Bartareau and LeBlanc 2006). In Gainesville, a Great Egret (*Casmerodius albus*) captured and ate four individuals within minutes of each other (Franz 2001). The Common Agama was a likely predator of this species (Meshaka et al. 2004a).

Threats.—The degree to which the Brown Anole depredated hatchlings of the Green Anole was sufficient to negatively impact populations of syntopic Green Anoles (Campbell 2000), and in caged settings it was more inclined to prey on the Green Anole and Green Anole hatchlings than the other way around (Gerber and Echternacht 2000). The Brown Anole is a potential threat to the Bark Anole and subject to the negative impacts of a wide range of predators, both native and exotic reptiles. Brach (1977) believed that the Brown Anole would be displaced by the Puerto Rican Crested Anole as it dispersed in Florida. Whereas the Brown Anole was outnumbered or replaced by the Puerto Rican Crested Anole in shaded habitats, it maintained its advantage in sunny open situations (Brach 1977).

FIGURE 74. Brown Mabuya (*Eutropis multifasciata*) from Coconut Grove, Miami-Dade Co., Florida. (Photographed by Richard D. Bartlett).

EUTROPIS MULTIFASCIATA (KUHL 1820) — BROWN MABUYA

Description.—As described by Meshaka et al. (2004a), the body is drab olive in color. A bright yellow lateral stripe runs from the axilla and fades near the hind leg. The tail is yellow (Fig. 74).

Distribution.—The Brown Mabuya is an Old World species that whose first documentation in Florida is from Coconut Grove, Miami-Dade County (Meshaka 1999a). In southern Florida, past records are from Miami-Dade County, and reports are from Lee County (Meshaka et al. 2004a) (Fig. 75).

Body size.—Individuals of Florida's only exotic skink could reach approximately 130 mm SVL (Meshaka et al. 2004a).

FIGURE 75. Geographic distribution of the Brown Mabuya (*Eutropis multifasciata*) in Florida.

FIGURE 76. Giant Ameivas (*Ameiva ameiva*) from Miami (top) and Virginia Key (bottom) in Miami-Dade Co., Florida. (Photographed by Richard D. Bartlett).

***Habitat and abundance*.—**In Coconut Grove, the Brown Mabuya inhabited the Kampong, a lush tropical private residence (Meshaka 1999a; Meshaka et al. 2004a). This colony had been in existence since at least 1990 (Meshaka 1999a). The species colonized private properties in the close vicinity of the Kampong as well; residences across the street and land north of the Kampong (Meshaka 1999a). All sites shared sunny open patches with mulch borders (Meshaka 1999a).

***Diet*.—**At the Kampong, a large Brown Mabuya subdued a large scorpion (Meshaka 1999a). Captive individuals were omnivorous (Meshaka et al. 2004a).

***Reproduction*.—**Behavior of these skinks noted in March could have been related to courtship (Meshaka 1999a).

***Activity*.**—At the Kampong, the Brown Mabuya was diurnal and ranged from terrestrial to semi-fossorial (Meshaka 1999a). Individuals were often seen basking and foraging near refuges around the tangle of branches near mulch piles (Meshaka 1999a). Individuals basked on a cement walkway and foraged in and around leaf litter (Meshaka 199a). Ambient temperatures of active individuals at the Kampong ranged from at least 26−27° C (Meshaka 1999a).

***Threats*.—**Because of its omnivory, the Brown Mabuya was a potential threat to some of the south Florida vertebrate fauna (Meshaka 2008a).

AMEIVA AMEIVA (LINNAEUS 1758) — GIANT AMEIVA

***Description*.—**As described by Conant and Collins (1998) and Bartlett and Bartlett (1999), two color phases occur in Florida (Fig. 76). In the green-rumped phase, individuals are brilliant green dorsally, either posteriorly or entirely. Regarding the former situation, individuals are warm tan anteriorly, and the color grades to brilliant green. Regardless of the extent of green, individuals of the green-rumped phase are patterned with dark-edged white spots on the upper sides, and the spots shade to blue ventrolaterally. The belly has brilliant blue spots on

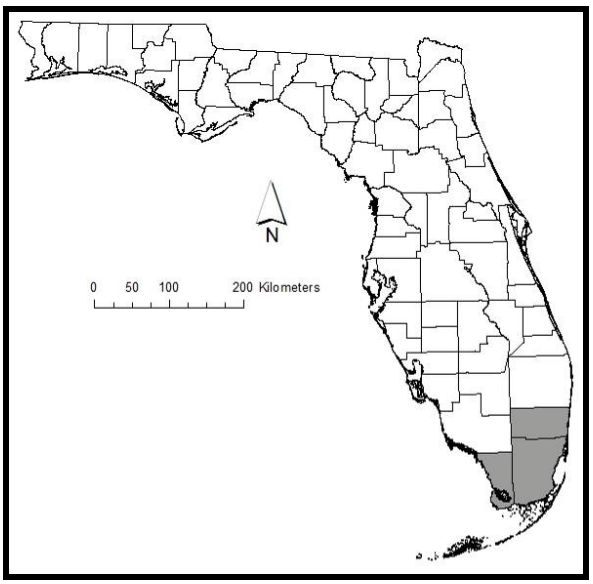

FIGURE 77. Geographic distribution of the Giant Ameiva (*Ameiva ameiva*) in Florida.

the outermost rows of ventral scales. In the dusky phase, males are darker than females. The dorsal color of adult males is charcoal to bluish-gray and is patterned in crossrows of pale blue to yellowish or whitish spots. The belly has numerous blue spots on the outer several rows of scales. Blue to whitish blue spots are present on the limbs. Females maintain striping or greenish color anteriorly and are dusky olive-gray posteriorly. A broad buff vertebral stripe may be present and there is prominent light ventrolateral spangling present. Males of both phases have blue bellies, whereas females have white bellies. Hatchlings of both phases are light gray, tan, or brown in body color and prominently striped in green (Fig. 76). Both forms and intergrades occurred at an urban south Miami population (Meshaka et al. 2010). Smith and Krysko (2007) provided a key to most of the whiptails in Florida.

Distribution.—The Giant Ameiva is a New World species whose first documentation in Florida is from an unspecified location (Neill 1957). Duellman and Schwartz (1958) reported the species as established in Miami, Miami-Dade County, since at least 1954. In southern Florida, it has been recorded Miami-Dade (mainland, Key Biscayne; Meshaka et al. 2004a) and Miami-Dade (mainland; Enge et al. 2004a) County, and reports are from Miami-Dade (mainland, Key Biscayne) County (Meshaka et al. 2004a). More recent records of this species are from Broward (Krysko et al. 2005) and Monroe (Grassy Key; Hardin et al. 2009) counties, and reports are from just north of the Miami-Dade County line in Broward County (Meshaka et al. 2008a; Fig. 77).

Body size.—The largest male (200 mm SVL) and female (159 mm SVL) Giant Ameiva were from Key Biscayne (Meshaka et al. 2004a). Individuals of the dusky phase tended to be larger than those of the green-rumped phase (Bartlett and Bartlett 1999).

Habitat and abundance.—The Giant Ameiva occurred in open habitat with nearby cover (Meshaka et al. 2004a). Bartlett and Bartlett (1999) noted suitable habitat, such as fields and weedy canal banks, and especially trash piles and rubble. In Deerfield Beach, Broward County, several individuals were observed along a railroad track (Krysko et al. 2005), and in Miramar, Broward County, a large male lived in part along the roadside of a development (Meshaka et al. 2008a). Individuals dig their own burrow, to which they return at night to sleep or if frightened (Bartlett and Bartlett 1999).

Diet.—In south Florida, the Giant Ameiva ate various invertebrates and eggs of the Brown Anole (Meshaka et al. 2004a).

Reproduction.—Bartlett and Bartlett (1999) reported October breeding for this species in Florida.

Growth and survivorship.—In Miami, a 50 mm SVL hatchling was collected in June by Duellman and Schwartz (1958). On Key Biscayne, two hatchlings (48.6 and 49.2 mm SVL) were captured in May by Meshaka et al. (2004a).

Activity.—The Giant Ameiva was active throughout the year (Meshaka et al. 2010) and diurnally, especially during mid-morning and again briefly during late afternoon (Meshaka et al. 2004a, 2009b). Individuals were active foragers, poking with their noses and digging with their forelimbs in much the same manner as the Six-lined Racerunner (*Aspidoscelis sexlineata*; Meshaka et al. 2004a). Individuals warily move between patches and can run fast, even bipedally (Bartlett and Bartlett 1999). Sexual pairs would forage together, and large males would occasionally forage in open areas, whereas females and juveniles tended to remain closer to cover (Meshaka et al. 2004a).

Threats.—Among the negative species, the Giant Ameiva was ecologically most similar to the Six-lined Racerunner, with which it could potentially compete (Meshaka 2008a). Its predatory habits on native species in disturbed habitat warranted concern (Meshaka 2008a). Likewise its ecological relationships with Giant Whiptail and Rainbow Whiptail also warrant attention. It seems likely that the Giant Ameiva is a threat to the Brown Anole as well.

FIGURE 78. Giant Whiptails (*Aspidoscelis motaguae*) from Miami-Dade Co., Florida. (Photographed by Richard D. Bartlett [top] and Suzanne L. Collins [bottom]).

ASPIDOSCELIS MOTAGUAE SACKETT 1941 — GIANT WHIPTAIL

Description.—As described by Meshaka et al. (2004a), the dorsum is light brown in color with yellow spots. The sides are light gray in color with lighter spots. The belly is blue in color with black blotches. The tail is brownish blue in color at the base and grades to reddish toward the tip. Bartlett and Bartlett (1999) noted that females are paler than males (Fig. 78). Smith and Krysko (2007) provided a key to most of the whiptails in Florida.

Distribution.—The Giant Whiptail is a New World species whose first documentation in Florida is from Kendall, Miami-Dade County (Bartlett 1995). This colony had been in existence for eight years. A second colony in Opa-Locka also existed in Miami-Dade County Meshaka et al. 2004a). This colony had been in existence for 20 years (Meshaka et al. 2004a). In southern Florida, past records are from Miami-Dade County (Meshaka et al. 2004a) (Fig. 79).

Body size.—From the Kendall colony, the body sizes of three adult males (127.6, 134.7, 136.6 mm SVL) were larger than those of two females (101 and 123 mm SVL) (Meshaka et al. 2004a).

Habitat and abundance.—The Giant Whiptail inhabited open sandy rocky areas near water in both Kendall and Opa-Locka (Meshaka et al. 2004a). Bartlett and Bartlett (1999) noted favored habitats as open fields, canal banks, grassy parking lot edges, and road shoulders.

FIGURE 79. Geographic distribution of the Giant Whiptail (*Aspidoscelis motaguae*) in Florida.

***Diet.*—**In Kendall, the Giant Whiptail fed on invertebrates, especially adult and larval beetles, ants, and roaches (Meshaka et al. 2004a).

***Reproduction.*—**In June, testes dimensions were enlarged (mean = 7.6 X 5.8 mm), and females contained three sets of previtellogenic follicles (Meshaka et al. 2004a). Bartlett and Bartlett (1999) reported a four-egg clutch laid by a captive female Giant Whiptail.

***Growth and survivorship.*—**Meshaka et al. (2004a) collected a 37 mm SVL juvenile in September.

***Activity.*—**The Giant Whiptail actively foraged on sunny days and was rarely active on overcast days (Meshaka et al. 2004a). Sexual pairs would forage together, and peak activity was midmorning (Meshaka et al. 2004a). Foraging generally occurred not far from cover or burrows (Meshaka et al. 2004a). In this connection, individuals typically moved back and forth from sunny sidewalks to the shade and cover of adjoining hedges all the while having maintained high body temperatures.

***Threats.*—**There has been some speculation as to the ability of the Giant Whiptail to persist in Florida (Bartlett and Bartlett 1999). Eradication of this species might be feasible. This lizard was ecologically similar to the Six-lined Racerunner with which it was a potential competitor (Meshaka 2008a). Among other exotic species of herpetofauna, its ecological relationships with the Giant Ameiva and Rainbow Whiptail also warrant attention.

CNEMIDOPHORUS LEMNISCATUS (LINNAEUS 1758) — RAINBOW WHIPTAIL

***Description.*—**As described by Conant and Collins (1998) and Meshaka et al. 2004a), males are brighter in color than females or immature males. The sides of the head, throat, and anterior surfaces of the limbs of adult males are bright blue or turquoise in color. Males have a brown middorsal stripe, and the sides of the body are green, greenish yellow, or bright yellow with lighter spots. The tail is blue or bluish green. In females, the sides of the head tend toward orange, seven to nine

FIGURE 80. Rainbow Whiptail (*Cnemidophorus lemniscatus*) from Miami-Dade Co., Florida. (Photographed by Suzanne L. Collins).

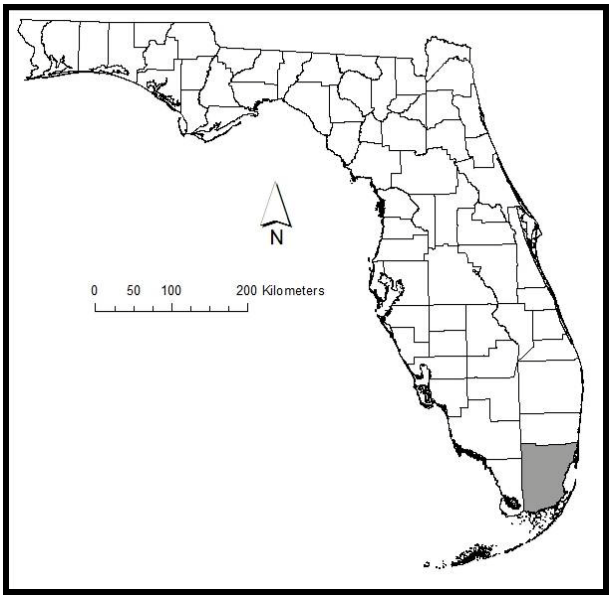

FIGURE 81. Geographic distribution of the Rainbow Whiptail (*Cnemidophorus lemniscatus*) in Florida.

light longitudinal body stripes are present, and the hind legs and tail are green (Fig. 80). Smith and Krysko (2007) provided a key to most of the whiptails in Florida.

***Distribution*.—**The Rainbow Whiptail is a New World species whose first documentation in Florida is from Hialeah, Miami-Dade County (King and Krakauer 1966). Wilson and Porras (1983) noted that the Hialeah colony no longer existed, but that the species still occurred in isolated colonies in northern Miami-Dade County (see also Bartlett 1995; Meshaka et al. 2004a). In southern Florida, past records are only from Miami-Dade County, and reports are also only from Miami-Dade County (Meshaka et al. 2004a; Fig. 81). More recent records of the Rainbow Whiptail are from several sites in Miami-Dade County that were considered to be one continuous population (Butterfield et al. 2009). Comparisons of color pattern and meristic characters indicated that the derivation of Florida individuals was likely Columbia, Venezuela, or certain Caribbean Islands (Butterfield et al. 2009).

***Body size*.—**In south Florida, males (mean = 65.3 mm SVL) were larger than females (mean = 62.2 mm SVL) of this species (Meshaka et al. 2004a). In Miami-Dade County, Butterfield et al. (2009) likewise noted sexual dimorphism in body size, whereby males (mean = 71.0 mm SVL) were larger than females (mean = 61.2 mm SVL).

***Habitat and abundance*.—**The Rainbow Whiptail inhabited the sandy soil of railroad rights-of-way and adjacent vegetation (Meshaka et al. 2004a). Bartlett and Bartlett (1999) noted the species in heavily pebbled sandy habitat with sparse cover of low vegetation, an observation corroborated by Butterfield et al. (2009). Punzo (2001d) collected this species in a sparsely vegetated well-drained open sandy area adjacent to an asphalt parking lot that was overgrown with weeds. A large area with clumped vegetation and woodlot bordered the sandy area on two sides. The Rainbow Whiptail dug its own burrows in the ground and under objects (Meshaka et al. 2004a) and was extremely abundant (Butterfield et al. 2009).

***Diet*.—**Punzo (2001d) examined the diet of adult males and females from a site in Miami from March to August. Dominant prey taxa in that study were orthopterans of at least four families, beetles, lepidopteran larvae, and spiders. Diet was similar between sexes and among months. Punzo (2001d) noted that individuals were capable of detecting beetle larvae and termites below the ground surface. Punzo (2001d) further noted an avoidance of chemically protected species, like Blister Beetles (Meloidae) and Velvet Ants (Mutillidae) that were common at the study site. Little evidence of herbivory occurred at this site (Punzo 2001d), although elsewhere the Rainbow Whiptail would eat the leaves and flowers of the European Puncture Weed (*Tribulus cistoides*) (Bartlett and Bartlett 1999). Individuals from a Miami-Dade County population fed on a wide range of invertebrates, especially beetles and ants (Meshaka et al. 2004a).

***Reproduction*.—**In south Florida, bisexual populations of this species complex were known but it was unknown if unisexual populations also existed in Florida (Meshaka et al. 2004a). Careful examination of Florida specimens by Butterfield et al. (2009) found only bisexual individuals, thereby resolving the question of reproductive mode in the Florida populations. The mean testes dimensions of males collected in May measured 4.8 X 3.8 mm (Meshaka et al. 2004a). All females collected in May and in July contained either vitellogenic follicles or oviductal eggs (Meshaka et al. 2004a) with embryonic development having commenced in March (Butterfield et al. 2009). Clutch size, as estimated by number of vitellogenic follicles or oviductal eggs, was small (mean = 2.3 eggs) in size (Meshaka et al. 2004a). Captive females laid up to four eggs per clutch (Bartlett and Bartlett 1999) or between two and five eggs per clutch (Punzo 2001d). At least two clutches were possible annually (Meshaka et al. 2004a). Among captives, two clutches were laid in each season (Bartlett and Bartlett 1999; Punzo 2001d). Shelled eggs were longer (mean = 17.8 mm) than they were wide (mean = 8.8 mm; Meshaka et al. 2004a). Butterfield et al. (2009) detected no association between

FIGURE 82. An Argentine Giant Tegu (*Tupinambis merrianae*) from Polk Co., Florida. (Photographed by Richard D. Bartlett).

clutch size and female body size.

Growth and survivorship.—Hatchlings (mean = 29.9 mm SVL) were captured in May by Meshaka et al. (2004a). Individuals reached sexual maturity within their first year of life, although some individuals would not mature until after the breeding season at the end of the year (Butterfield et al. 2009). The smallest sexually mature female examined by Butterfield et al. (2009) measured 54 mm SVL. A female captured in early May laid two eggs on 19 May, which in turn hatched on 17 July. The two captive hatchlings of this clutch measured 27 and 29 mm SVL (Meshaka et al. 2004a).

Activity.—The Giant Whiptail was diurnal and heliothermic, actively foraging on the ground or on vegetation mats (Meshaka et al. 2004a). It was strictly terrestrial in habits and able to make full use of many human-made structures for foraging and cover (Butterfield et al. 2009). Individuals could move quickly when foraging (Bartlett and Bartlett 1999; Punzo 2001d).

Predators.—The Eastern Corn Snake was a predator of the Rainbow Whiptail (Meshaka et al. 2004a).

Threats.—The Rainbow Whiptail was a potential competitor of the native Six-lined Racerunner in light of its ecological similarity with that species (Meshaka 2008a). Among the exotic species of herpetofauna, its ecological relationships with the Giant Ameiva and Giant Whiptail also warrant attention.

TUPINAMBIS MERRIANAE (DUMÉRIL & BIBRON 1839) — ARGENTINE GIANT TEGU

Description.—Adults are banded in black and white. Males have larger heads and jowls than do females. Juveniles are browner than adults and have a greenish cast in the anterior part of their bodies (Enge 2007; Fig. 82). Smith and Krysko (2007) provided a key to most of the whiptails in Florida.

Distribution.—The Argentine Giant Tegu is a New World species whose first documentation in Florida is from a reclaimed phosphate site in eastern Hillsborough and western Polk counties (Enge et al. unpubl. data; Enge 2007). This population was probably derived from a release of Paraguayan specimens by a commercial animal dealer 2000−2002 (Enge 2007). An isolated roadkill from Okeechobee County in 2002 may have been a waif (Enge 2007; Fig. 83). On 20 January 1993, Bert Crawford brought to the ABS a large tegu lizard caught the day before in Avon Park by a resident. The lizard was crawling on a road off Farmer Road near Albritton Road south of US-98 and west of the Atlantic Coast Railroad track. The lizard measured about 61 cm TL and was blackish in color with yellow spots.

Body size.—The Argentine Giant Tegu is a large tegu species and the largest of the Florida's teiid lizards. Males could reach 500 mm SVL and were larger than females (Duarte Varela and Cabrera 2000).

Habitat and abundance.—Individuals occurred in xeric uplands of the Balm-Boyette Scrub Nature

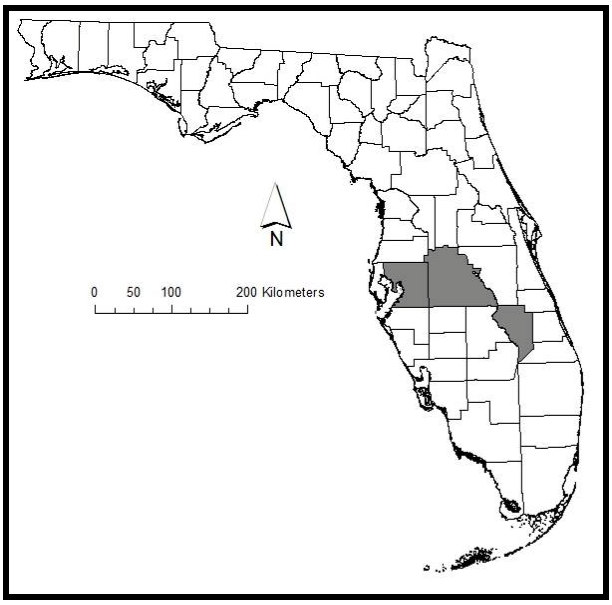

FIGURE 83. Geographic distribution of the Argentine Giant Tegu (*Tupinambis merrianae*) in Florida.

Preserve and the Mosaic Phosphate lands (Kevin M. Enge, pers. comm.; Enge 2007). Individuals used Gopher Tortoise burrows (Enge 2007).

Diet.—Enge (2007) noted omnivory in the Argentine Giant Tegu across its native geographic range and in captivity. In Florida, an individual unearthed Eastern Moles (*Scalopus aquaticus*; Enge 2007).

Reproduction.—Individuals maintained in outdoor pens in Palm Beach County usually bred in March and laid eggs in June (Enge 2007).

Growth and survivorship.—A captive female from southern Florida was sexually mature at 10 months of age and approximately 61 cm TL (Enge 2007).

Activity.—Among captives in maintained outside in southern Florida, individuals became dormant from September to February and emerged in March even if the temperatures were cool (Enge 2007). This observation suggested that day length played a role in its seasonal activity. Individuals subsequently ate a lot of food in preparation for breeding (Enge 2007). The species was diurnal and were most likely seen 1100−1400 on sunny days (Enge 2007).

Threats.—Enge (2007) noted that the Argentine Giant Tegu, a predator of eggs, could have posed a potential a hazard to a wide range of ground nesting vertebrates, including species listed as sensitive in Florida. In turn, Enge (2007) thought that this lizard, particularly during its juvenile state, was potentially at risk to the depredations of a wide range of mammals and birds.

LEIOCEPHALUS CARINATUS GRAY 1827 — NORTHERN CURLYTAIL LIZARD

Description.—The dorsum is brown or gray in color and covered with large keeled scales (Conant and Collins1998; Meshaka et al. 2004a). Scattered iridescent green flecks extend from the dorsal crest to below the lateral fold (Callahan 1982). The dorsal color of the tail is the same color as the body in males and is banded in females and juveniles (Callahan 1982; Fig. 84). Individuals from a Florida City colony are very dark in color.

Distribution.—The Northern Curlytail Lizard is a West Indian species whose first documentation in Florida is from Palm Beach County (Duellman and Schwartz 1958), thought to have initially been introduced on the island of Palm Beach during the 1940s (Weigl et al. 1969). In southern Florida, past records are from Broward (Meshaka et al. 2004a), Highlands (Meshaka et al. 2004a), Martin (Meshaka et al. 2004a), Miami-Dade (mainland, Virginia Key; Meshaka et al. 2004a), Palm Beach (Meshaka et al. 2004a), and St. Lucie (Dean et al. 2004) counties. Reports of the Northern Curlytail Lizard are from Collier, Miami-Dade, Monroe (Key Largo), and Palm Beach counties (Meshaka et al. 2004a). The Highlands County record probably represented a waif (Meshaka et al. 2004a). After Meshaka et al. (2004a) went to press, subsequent records appeared for southern Florida: Collier (Chokoloskee Island; McCoid 2002c) and Lee (Campbell and Klowden 2003) counties. Smith and Engeman (2002) captured an individual 0.3 km south of Hauge and Butterfield's (2000) Martin County record and noted that individuals had been seen there since 1994. More recent records of the Northern Curlytail Lizard are from Martin (Meshaka et al. 2005b), Monroe (Key Largo; Krysko et al. 2005), Monroe (Key West; Krysko et al. 2007c), Monroe (Little Torch Key; Krysko and Borgia 2007b), Monroe (Lower Matecumbe Key; Meshaka et al. 2006d), Monroe (Ramrod Key; Krysko and Borgia 2007b), Palm Beach (Krysko et al. 2005), and St. Lucie (Meshaka et al. 2005b; Moore et al. 2009) counties.

Elsewhere in Florida, records of the Northern Curlytail Lizard exist from Brevard County, and reports are from Indian River County (Meshaka et al. 2004a). The Indian River County report probably represented a waif

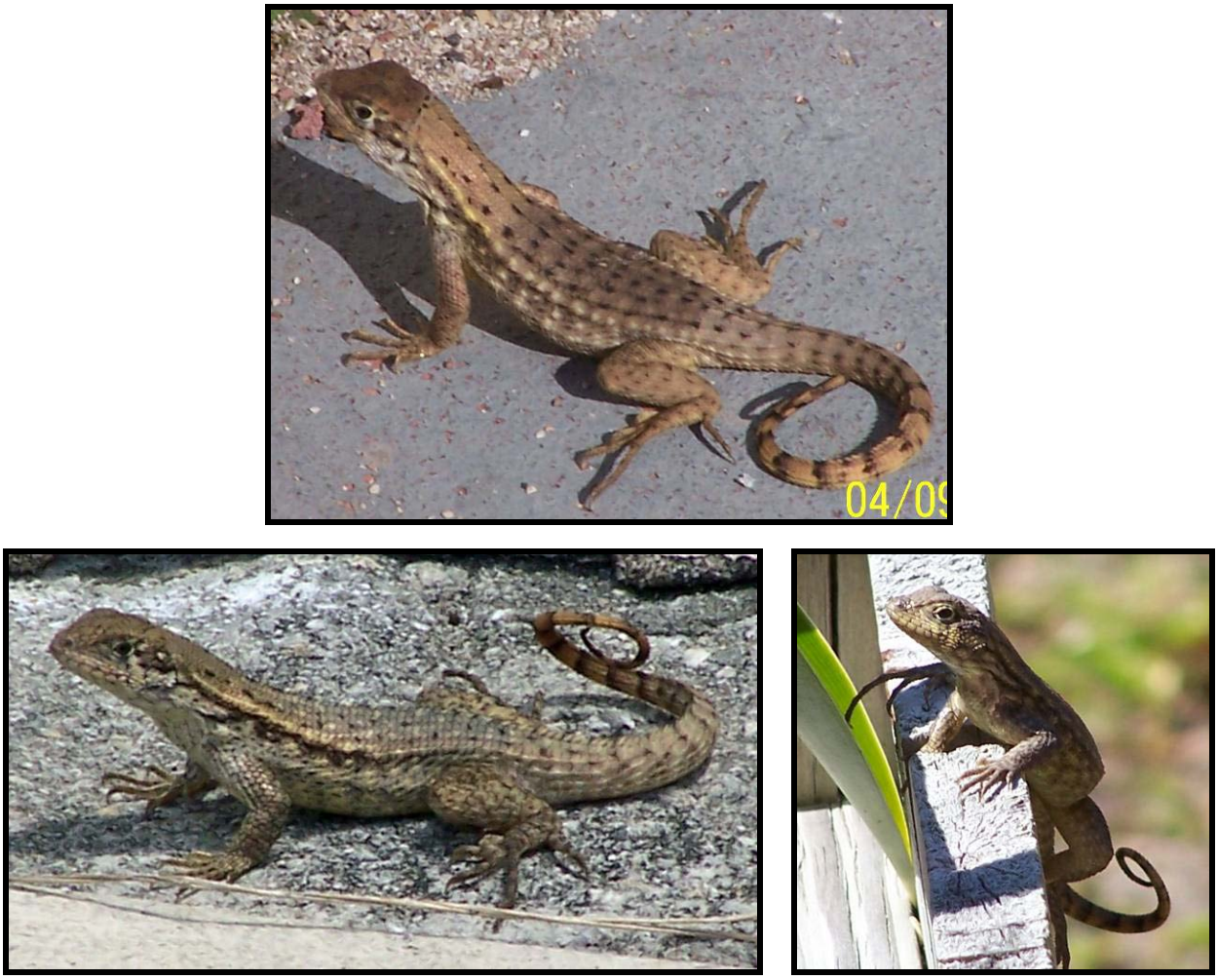

FIGURE 84. Northern Curlytail Lizards (*Leiocephalus carinatus*) from Fort Lauderdale, Broward Co., Florida. (Photographed by Gary Busch).

(Meshaka et al. 2004a), and a subsequent search revealed no individuals (Meshaka et al. 2005b). After Meshaka et al. (2004a) went to press, subsequent records appeared for northern Florida: Brevard County (Krysko and King 2002b). More recent records of this species are from Alachua County (Krysko et al. 2008b). The rate of dispersal along the Florida East Coast by the Northern Curlytail Lizard has been phenomenal (Smith and Engeman 2004a; Smith et al. 2004), with what appeared to be a continuous distribution from northern Broward County to the Martin County line (Meshaka et al. 2005b). Notwithstanding the mediating effects of urban heat islands, frost isotherms predicted unstable populations north of Fort Pierce on the East Coast and just south of Sarasota on the West Coast (Meshaka et al. 2005b). It remains to be seen to what extent the spotty distribution south of Palm Beach County (Fig. 85) was real or an artifact of collecting effort (Meshaka et al. 2005b). Meshaka et al. (2006d) thought that rocky habitat, warm climate, and proximity to roads all but assured this species of extensive colonization on the Florida Keys.

Body size.—In southern Florida, adult males were larger in body size than adult females. For example, In Palm Beach, adult males (mean = 92 mm SVL) were larger than females (mean = 87 mm SVL) that were measured by Callahan (1982) and for males (mean = 94.7 mm SVL) and females (mean = 82.9 mm SVL) measured by Meshaka et al. (2004a). In Martin and Palm Beach counties, males (mean = 96.9 mm SVL) were likewise larger than females (mean = 84.6 mm SVL) that were measured by Meshaka et al. (2006e).

Habitat and abundance.—In Florida, the Northern Curlytail Lizard excelled around open rocky habitat, both natural and in artificial analogs, such as sidewalks, walls, rubble piles, etc. (e.g., Callahan 1982; Layne 1987; Hauge and Butterfield 2000; Krysko and King 2002b; McCoid 2002c). For this reason, the Northern

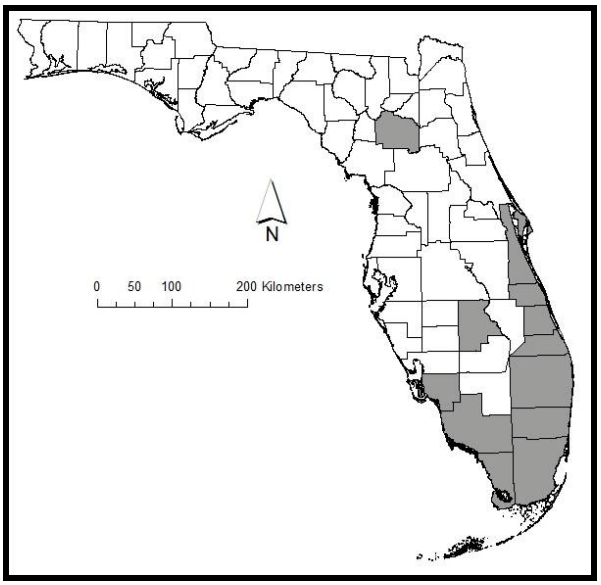

FIGURE 85. Geographic distribution of the Northern Curlytail Lizard (*Leiocephalus carinatus*) in Florida.

Curlytail Lizard is very well-suited to living along sidewalks and parking lots, which provide superabundant habitat in its expanding geographic range in Florida. Burrows were typically excavated under a hard surface, such as large stones, sidewalks, or asphalt (Smith and Engeman 2004a; Meshaka et al. 2004a).

Diet.—Crickets and grasshoppers comprised much of the curlytail's diet in Palm Beach; however, isopods and anoles were also eaten (Callahan 1982). Another diet sample from Palm Beach was comprised of invertebrates, especially beetles, roaches, and ants (Meshaka et al. 2004a).

Reproduction.—In Martin and Palm Beach counties, testes dimensions were at their maximum during spring and summer and peaked from April to August (Meshaka et al. 2006e). Seasonal change in testis length was positively associated with day length, and fat development was lowest fall and winter (Meshaka et al. 2006e). In Palm Beach County, oviposition occurred in June and July (Callahan 1982), and oviductal eggs were present in May and July samples (Meshaka et al. 2004a). In Martin and Palm Beach counties, shelled eggs were present in females during May-August, and September clutches were possible (Meshaka et al. 2006e). Callahan (1982) reported clutches of four to five eggs, and Meshaka et al. (2006e) estimated clutch sizes of four eggs using the number of enlarged follicles (mean = 4.3 eggs) and number of shelled eggs (mean = 4.0 eggs). Clutch size was positively associated with body size using either measure of clutch size estimation (Meshaka et al. 2006e). In southern Florida, single clutch production by the Northern Curlytail Lizard was the rule (Callahan 1982; Meshaka et al. 2004a; Meshaka et al. 2006e); however, multiple clutch production was nonetheless possible, even if rare (Meshaka et al. 2006e). The shelled eggs of the Northern Curlytail Lizard were longer (mean = 18.9 mm) than they were wide (10.8 mm; Meshaka et al. 2006e). Fat development in females was highest preceding shelled egg deposition (Meshaka et al. 2006e).

Growth and survivorship.—In Martin and Palm Beach counties, hatchlings (38.9 and 41.1 mm SVL) were found in August and September, although hatching was possible as early as June (Meshaka et al. 2006e). Minimum body size at sexual maturity was larger in males: 80.0 mm SVL (Callahan 1982), 81.2 mm SVL (Meshaka et al. 2004a), and 78.6 mm SVL (Meshaka et al. 2006e). Minimum body size at sexual maturity was smaller in females: 73.0 mm SVL (Callahan 1982), 70.2 mm SVL (Meshaka et al. 2004a), and 71.3 mm SVL (Meshaka et al. 2006e). Age at sexual maturity was six months in males and five months in females (Meshaka et al. 2006e).

Activity.—The Northern Curlytail Lizard was active throughout the year (Callahan 1982; pers. obser.). In warm weather individuals emerged from retreats 1−2 hr after sunrise (Callahan 1982; Smith and Engeman 2004a). Diel activity was bimodal, whereby lizards were active until early afternoon and then again later in the afternoon (Callahan 1982). On cooler days in November and December, diel activity was unimodal whereby individuals emerged later in the morning and were active continuously until they retreated for the day earlier in the afternoon (Callahan 1982). The Northern Curlytail Lizard was generally terrestrial; however, juveniles could ascend trees to heights in excess of 3 m above ground (Meshaka et al. 2004a). Moore (2008) observed the use of roofs by this lizard, which individuals accessed by climbing adjacent trees. Behavior by those individuals observed by Moore (2008) suggested that the roof served as a defended resource. Bartlett and Bartlett (1999) noted that individuals often allowed a close approach by humans. Both males and females curled their tails as a territorial signal (Callahan 1982).

Predators.—In Palm Beach County, the Northern Curlytail Lizard was preyed upon by the Great Barracuda (*Sphraena barracuda*; Smith and Engeman 2003), Green Heron (Hubbard et al. 2008), Loggerhead Shrike (*Lanius ludovicianus*; Smith et al. 2006b), Northern Mockingbird (Smith et al. 2006c), and feral dog (Smith and Moore 2009a). In one instance, however, a large Northern Curlytail attacked a juvenal Northern Mockingbird in Boynton Beach (Smith and Engeman 2007). A road-killed individual was

scavenged by a Gray Squirrel (Smith et al. 2006d). A Little Blue Heron captured a Northern Curlytail Lizard along a seawall in Martin County (Smith and Engeman 2004b). In southern Florida, the Yellow-Crowned Night Heron (*Nycticorax violaceus*), Great Egret (*Casmerodius albus*), and Cattle Egret (*Bubulcus ibis*) would stalk this lizard (Meshaka et al. 2006e). The Northern Curlytail Lizard was preyed upon by the Madagascar Giant Day Gecko, a diurnally active lizard (May and Krysko 2009). Potential predators include the domestic cat (Callahan 1982; Meshaka et al. 2004a), Red-shouldered Hawk, American Kestrel (*Falco sparverius*), Loggerhead Shrike (Callahan 1982), and the Eastern Racer (Meshaka et al. 2004a). Dean et al. (2006) noted cannibalism in this species.

Threats.—Native lizards such as the Green Anole, Six-lined Racerunner, Southeastern Five-lined Skink (*Plestiodon inexpectatus*), and the Florida Scrub Lizards (*Sceloporus woodi*) were considered to be likely at risk from this geographically rapidly expanding species, especially in the least human-modified habitats (Smith and Engeman 2004a; Meshaka et al. 2005b). Population densities of the Brown Anole were negatively affected by the depredations of the Northern Curlytail Lizard (Callahan 1982). Diet of the Northern Curlytail Lizard overlapped that of the Brown Anole, and the species might also have been a superior competitor of the Brown Anole for food (Callahan 1982). This species is in turn negatively impacted by a wide range of predators, including the exotic Madagascar Giant Day Gecko. An individual from Juno Beach, Palm Beach County, was entangled in a metal ring, which encircled its body just above its waist (Dean et al. 2005). Many lizards were killed in a Boynton Beach colony when resurfacing the parking lot filled in the many refugia (Smith and Engeman 2004a), such that on three sides of the study area 86%, 88%, and 91% of the once active burrows were entombed within a few days (Smith and Moore 2009b). Feasibility of its eradication in Florida was discussed by Engeman et al. (2009c).

LEIOCEPHALUS SCHREIBERSII (GRAVENHORST 1837) — RED-SIDED CURLYTAIL LIZARD

Description.—The dorsum is brownish gray in color, and the sides are marked with dark red and lightly colored spots (Conant and Collins 1998; Meshaka et al. 2004a). As described by Bartlett and Bartlett (1999), males are more brightly colored than females and juveniles. Red bars are present on the flanks with pale blue patches between them. Turquoise may be present on the front and rear limbs. Females and juveniles are paler in color than males and have about eight dark transverse bars crossing the dorsum (Fig. 86).

Distribution.—The Red-sided Curlytail Lizard is a West Indian species whose first documentation in Florida is from Miami-Dade County (Wilson and Porras 1983). The colony had been in existence since 1978 but appeared to no longer exist after habitat modification in 1981 (Wilson and Porras 1983). The first colony gave rise to another colony in Miami Lakes (Wilson and Porras 1983). In southern Florida, past records are from

FIGURE 86. Red-sided Curlytail Lizard (*Leiocephalus schreibersii*) from Haiti. (Photographed by Suzanne L. Collins).

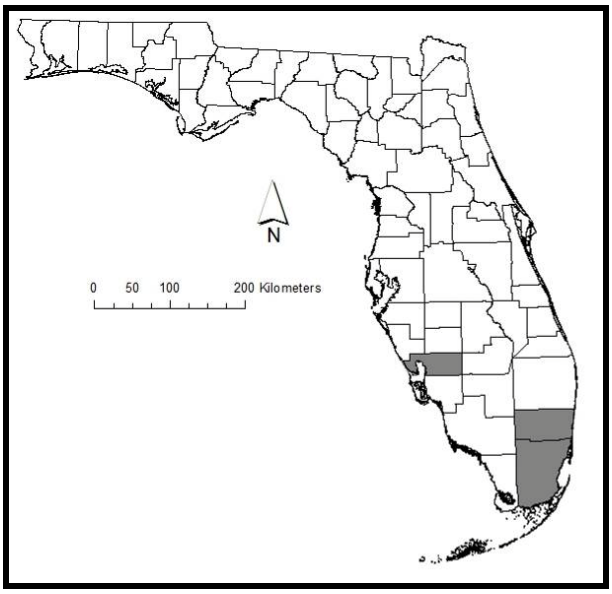

FIGURE 87. Geographic distribution of the Red-sided Curlytail Lizard (*Leiocephalus schreibersii*) in Florida.

Broward (Bartlett and Bartlett 1999) and Miami-Dade counties (Bartlett 1994; Meshaka et al. 2004a), and reports are from Miami-Dade County (Meshaka et al. 2004a). After Meshaka et al. (2004a) went to press, a subsequent record appeared for Broward County in southern Florida (Townsend et al. 2002). More recent records of the Red-sided Curlytail Lizard are from Charlotte (Krysko et al. 2005) and Miami-Dade (Krysko and Burgess 2008) counties (Fig. 87).

Body size.—The smaller of the two Curlytail Lizards in Florida, males of this species occasionally reached 254 mm TL, and females have reached 216 mm TL (Bartlett and Bartlett 1999).

Habitat and abundance.—The North Miami population inhabited a railroad track in a residential area (Meshaka et al. 2004a). In Punta Gorda, individuals were seen on sandy areas along a fence line (Krysko et al. 2005). The Homestead, Miami-Dade County, colony is well-established and appeared to be expanding in range (Krysko and Burgess 2008).

Diet.—The Red-sided Curlytail Lizard described as primarily insectivorous (Meshaka et al. 2004a). Its diet in Florida remains in need of study.

Growth and survivorship.—In Punta Gorda, numerous hatchlings were observed in June (Krysko et al. 2005).

Predators.—The Red-sided Curlytail Lizard might be susceptible to the many of the same predators as the Northern Curlytail Lizard and perhaps more so in light of its smaller adult body size.

Threats.—The Red-sided Curlytail Lizard has long been restricted in its Florida geographic distribution. Disparate recently discovered colonies warrant concern regarding the potential for subsequent geographic dispersal of this species.

VARANUS NILOTICUS (LINNAEUS 1758) — NILE MONITOR

Description.—Adults are dark in color with lighter bands and stippling. Juveniles are boldly patterned in black and gold to yellow (Fig. 88).

Distribution.—The Nile Monitor is an Old World species that whose first documentation in Florida was from isolated reports in central Florida (Meshaka et al. 2004a); however, specimens necessary to make the claim of establishment were not available to Meshaka et al. (2004a), and so the authors listed the status of this species as uncertain. That same year, Enge et al. (2004c) confirmed establishment of the Nile Monitor in Cape Coral, Lee County. This colony dated back to about 1990 (Enge et al. 2004c). The species is common in the pet trade (Meshaka 2006). In southern Florida, the Nile Monitor has been recorded in Lee County, and reports are from Broward and Miami-Dade counties, the latter two counties of which the species was probably not reproducing (Enge et al. 2004c).

Elsewhere in Florida, records of the Nile Monitor exist from Orange County (Enge et al. 2004c; Fig. 89). At the time of this writing, the Nile Monitor appeared to have been limited toa single large area of Lee County where it is very well established. Its popularity in the pet trade, often ending at adult size, its penchant for canals, and a large trophic breadth lead me to suggest that this species will soon follow the colonization path of the Green Iguana.

Body size.—Enge et al. (2004c) noted a 1500 mm TL male and 520 mm SVL female Nile Monitor from Cape Coral.

Habitat and abundance.—In Cape Coral, the Nile Monitor was most closely associated with residential areas but individuals were also seen along canals (Enge et al. 2004c). Individuals have also been seen swimming to shore from mangrove islands (Enge et al. 2004c).

FIGURE 88. A Nile Monitor (*Varanus niloticus*). (Photographed by Richard D. Bartlett).

Diet.—In Cape Coral, the Nile Monitor chased ducklings and Brown Anoles, and ate Goldfish (*Carassius auratus*), a rabbit (*Sylvilagus* sp.), grubs, and eggs of the Brown Anole (Enge et al. 2004c).

Reproduction.—In August, a female contained eight well-developed eggs (Enge et al. 2004c). In captivity, eggs incubated for six to 10 months (Meshaka 2006).

Growth and survivorship.—Enge et al. (2004c) collected a 131 mm SVL hatchling in October (Enge et al. 2004c). In captivity, individuals were sexually mature in about three years (Meshaka 2006).

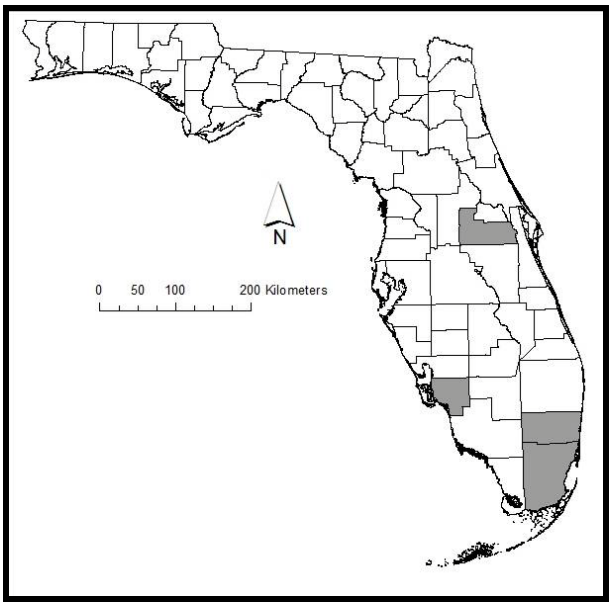

FIGURE 89. Geographic distribution of the Nile Monitor (*Varanus niloticus*) in Florida.

Predators.—The American Alligator was a potential predator of the Nile Monitor (Meshaka 2006).

Threats.—The degree to which the Nile Monitor can colonize natural habitat arguably warranted immediate investigation in light of its trophic position (Meshaka 2006). Likewise, its potential for negatively impacting legally considered at-risk species was a concern (Enge et al. 2004c; Meshaka 2006). The extent to which the Nile Monitor could invade natural systems could have depended in large part on the degree to which it would be threatened by the American Alligator (Meshaka 2006). Because of its large body size and carnivory, Enge et al. (2004c) raised the concern that the Nile Monitor could negatively impact sensitive species and native wildlife. Feasibility of its eradication in Florida was discussed by Engeman et al. (2009c).

RAMPHOTYPHLOPS BRAMINUS (DAUDIN 1803) — BRAHMINY BLIND SNAKE

Description.—As described by Conant and Collins (1998) and Meshaka et al. (2004a), the body is grayish black. The head and neck are similarly thick, and the tail is pointed (Fig. 90).

Distribution.—The Brahminy Blind Snake is an Old World species whose first documentation in Florida is from three separate localities in Miami-Dade County, the earliest record of which was from South Miami (Wilson and Porras 1983). In southern Florida, past records are from Broward (Meshaka et al. 2004a), Highlands (Meshaka et al. 2004a), Lee (Meshaka et al. 2004a), Miami-Dade (Enge et al. 2004b; Meshaka et al. 2004a), Monroe (Big Pine Key, Key Vaca, Key West; Meshaka et al. 2004a), Palm Beach (Meshaka et al. 2004a), and Sarasota (Meshaka et al. 2004a) counties, and reports are from Miami-Dade (Meshaka et al. 2004a), Monroe (Key West; Lazell 1989), and Palm Beach (Meshaka et al. 2004a). After Meshaka et al. (2004a) went to press, a subsequent record appeared for Monroe (Stock Island) County in southern Florida (Collins and Collins 2002). More recent records of the Brahminy Blind Snake are from Charlotte (Klowden and Olson 2007) and Collier (Marco Island; Krysko et al. 2005) counties.

Elsewhere in Florida, records of the Brahminy Blind Snake exist from Alachua (Meshaka et al. 2004a), Brevard (Grace and Van Dyke 2004), Hillsborough (Hennessy and Michalak 2004), Orange (Meshaka et al.

FIGURE 90. A Brahminy Blind Snake (*Ramphotyphlops braminus*) from Palm Beach Co., Florida. (Photographed by Suzanne L. Collins).

2004a), Pinellas (Meshaka et al. 2004a), and Seminole (Meshaka et al. 2004a) counties, and reports are from Leon County (Meshaka et al. 2004a). After Meshaka et al. (2004a) went to press, a subsequent record appeared for Alachua County in central and northern Florida (Townsend et al. 2002). More recent records of the Brahminy Blind Snake are from Alachua (Somma 2007), Brevard (Krysko et al. 2005), Citrus (Krysko et al. 2005), Hernando (Godley et al. 2009), Lake (Fairchild and Enge 2008), Leon (Krysko et al. 2005), Pasco (Wallach 2008), and Volusia (Somma and Skelley 2007) counties (Fig. 91). The Brahminy Blind Snake also occurs as an established exotic species elsewhere in the United States (Meshaka 2008a).

Body size.—The Brahminy Blind Snake is the smallest of the exotic snakes established in Florida. Two adults (113.3 and 137.9 mm TL) were measured from south Miami, Miami Dade County (Meshaka et al. 2004a).

Habitat and abundance.—In ENP, the Brahminy Blind Snake was occurred in the Hole-in-the-Donut area and Royal Palm Hammock (Meshaka et al. 2000). In Miami Dade County, the Brahminy Blind Snake occurred in pine rockland habitat of county parks (Enge et al. 2004b). Meshaka et al. (2004a) found this species in Brazilian Pepper stands, Australian Pine stands, disturbed tropical hardwood hammock, pinelands, and residential areas. Meshaka et al. (2004a) found individuals under logs, rocks, and trash and in nests of Florida Carpenter Ants (*Camponotus abdominalis floridanus*). In Miramar, Broward County, an individual inhabited the palm boot or sheath of a Washington Palm nearly 2 m above the ground (Meshaka et al. 2008a). Hennessy and Michalak (2004) collected an individual from leaf litter in Tampa, Hillsborough County. Grace and Van Dyke (2004) found an individual under decaying pine needles in a garden in West Melbourne, Brevard County. The species used termite mounds in Gainesville (Somma 2007).

Diet.—The pupae of ants and termites comprised the diet of the Brahminy Blind Snake in Florida (Meshaka et al. 2004a).

Reproduction.—Two adults from south Miami of this all-female species were collected in May, one with two

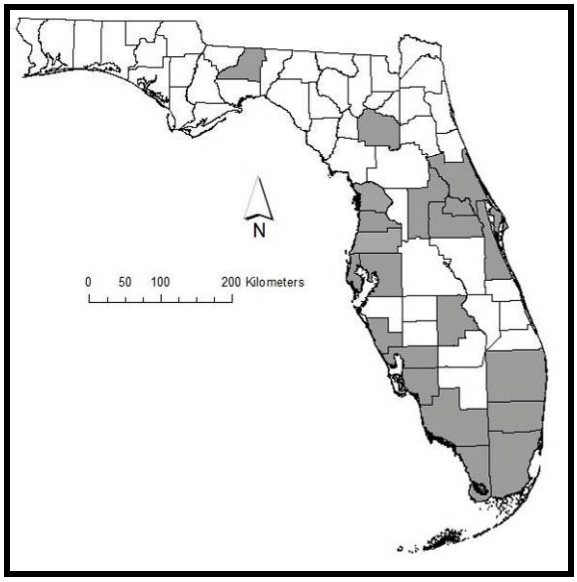

FIGURE 91. Geographic distribution of the Brahminy Blind Snake (*Ramphotyphlops braminus*) in Florida.

yolked follicles and another with six very small ovarian follicles (Meshaka et al. 2004a).

Activity.—A fossorial species in Florida (Meshaka et al. 2004a), individuals were seldom seen in the open. However, heavy rain can force individuals to the surface of the ground.

Predators.—In southern Florida the Brahminy Blind Snake was eaten by the Cane Toad and Puerto Rican Crested Anole (Meshaka et al. 2004a). In Hernando County, and individual had been eaten by a Short-tailed Kingsnake (*Lampropeltis extenuata*; Godley et al. 2009).

Threats.—The Brahminy Blind Snake is at risk to the depredations of the Cane Toad and Puerto Rican Crested Anole, presumably after rains.

BOA CONSTRICTOR LINNAEUS 1758 — BOA CONSTRICTOR

Description.—This is a thick-bodied snake, whose body is heavily patterned in shades of brown and vertebrally marked in brown saddles (Fig. 92).

Distribution.—The Boa Constrictor is a New World species whose first documentation in Florida is from Miami-Dade County, where it thought by Dalrymple (1994) to have been breeding. Butterfield et al. (1997) noted the species from the same site. Meshaka et al. (2004a) noted the existence of a specimen from Miami-Dade County in the FLMNH but did not feel that the aforementioned data were sufficient for them to confirm its establishment in Florida. Consequently, the species was listed by the authors in a section of uncertain status. Providing evidence of mixed-size-classes and corroborating the extensive observations of the species at the Deering Estate, Snow et al. (2007a) provided the evidence necessary to for me to include the species as established in Florida. In southern Florida, past records are from Miami-Dade County (Snow et al. 2007a), where it has occurred in extreme southeastern mainland Florida, apparently since the 1970s (Fig. 93). Its establishment was associated with the pet trade.

Body size.—The largest individual measured by Snow et al. (2007a) was approximately 2510 mm TL.

Habitat and abundance.—In south Florida, the Boa Constrictor inhabited the tropical hardwood hammock, pine rockland, and the nearby human-disturbed areas of a park (Snow et al. 2007a).

Diet.—Snow et al. (2007a) reported a Boa Constrictor captured in August that had eaten a Virginia Opossum (*Didelphis virginiana*).

Reproduction.—In southern Florida, live birth occurred in May and June, and young of the year appear in August and September such that 86% of all captures during those months were young of the year (Snow et al. 2007a).

Activity.—Most captures of Boa Constrictors at the Deering Estate took place during the day, but Snow et al.

FIGURE 92. A juvenile Boa Constrictor (*Boa constrictor*) from Miami, Miami-Dade Co., Florida. (Photographed by Richard D. Bartlett).

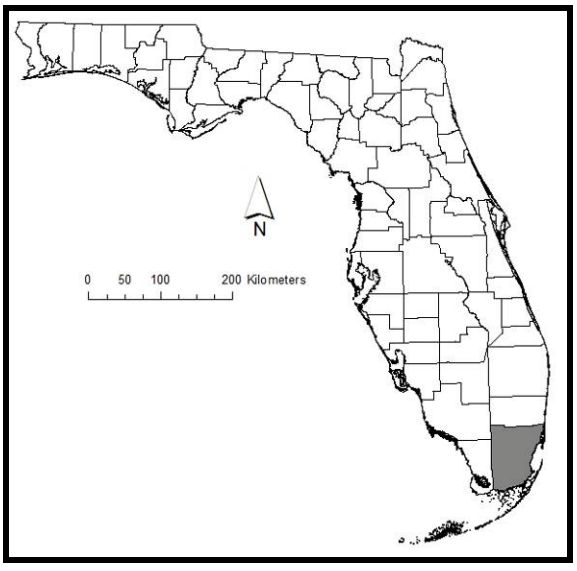

FIGURE 93. Geographic distribution of the Boa Constrictor (*Boa constrictor*) in Florida.

FIGURE 94. Burmese Pythons (*Python bivittatus*) from Everglades National Park, Monroe Co., Florida including an adult female brooding her eggs (lower left). (Photographed by Richard D. Bartlett [upper left] and Mike Rochford [right and lower left]).

(2007a) noted the limited access to the park for research at night.

Predators.—The Eastern Indigo Snake is the likeliest predator of the Boa Constrictor at the Deering property.

Threats.—This large constrictor was a potential threat to a wide range of vertebrates but was also subject to fire, presumably from prescribed burns in the pine rockland of the Deering Estate (Snow et al. 2007a).

PYTHON BIVITTATUS KUHL 1820 — BURMESE PYTHON

Description.—This is a thick-bodied snake, whose body is patterned heavily in tan, brown, and white (Meshaka et al. 2004a; Fig. 94).

Distribution.—The Burmese Python is an Old World species whose first documentation in Florida is from ENP, Miami-Dade and Monroe counties, where most records came from the saline glades of ENP (Meshaka et al. 2000). A steady stream of observations during the 1990s, especially at the southern end of the park, mixed size classes, and vouchers, all from a region of the park that to the present day continues to support this species made the case for Meshaka et al. (2000). In November 1997, I received an individual from the shooting range in East Everglades. In southern Florida, past records are from Miami-Dade (Meshaka et al. 2004a) and Monroe (Meshaka et al. 2000, 2004a) counties and past reports are from Miami-Dade County (Meshaka et al. 2004a). More recent records are from Collier (Snow et al. 2007a), and Monroe (mainland; Snow et al. 2007a, and Key Largo; Greene et al. 2007) counties, and reports are from Broward County (Snow et al. 2007a). Key Largo has been the site of more collections of this species. Since the early 2000s, numbers of individuals found and locations rapidly increased (Snow et al. 2007a)

suggestive of aggressive geographic expansion in southern Florida (Fig. 95). It has become more commonly encountered along Loop Road and on SR-92 near Collier Seminole State Park (Tad Bartareau, pers. comm.). Two models were used to predict the potential geographic distribution of this constrictor outside of its native range. With respect to the United States, the model by Rodda et al. (2008) predicted suitable conditions beyond Florida that included the southeastern United States. A subsequent model that used 19 climatic variables predicted a Florida range that did not extend beyond its current distribution and separate suitable habitat in extreme southern Texas (Pyron et al. 2008).

Body size.—The Burmese Python is Florida's largest snake. In southern Florida, individuals measured up to 4570 mm TL (mean = 2180 mm TL), and most individuals ranged from 3000−3240 mm TL (Snow et al. 2007a). The largest female thus far reported from southern Florida measured 4870 mm TL (Krysko et al. 2008c).

Habitat and abundance.—Through 2001, mixed size-classes of this species were seen primarily but not exclusively, in the saline glade region of ENP, especially in the vicinity of West Lake (Meshaka et al. 2000, 2004a). Outside of the park, individuals were also seen in the mangrove fringe of Miami-Dade County (Meshaka et al. 2004a). Since that time, individuals have appeared in abundance farther inland and to northern reaches of ENP (Meshaka et al. 2004a; Snow et al. 2007a; Wil Hyde, pers. comm.; William Loftus, pers. comm.; Ken Rice, pers. comm.; Ray Snow, pers. comm.), many of the habitats were freshwater glades (Snow et al. 2007a), which underscored a meteoric increase in abundance and expansion of the Burmese Python in its southern Florida distribution from a colony that most certainly had established by the 1990s.

Diet.—A male from West Lake, ENP, contained the remains of a Gray Squirrel (Meshaka et al. 2004a). Popularized in the media, a large Burmese Python died with a large American Alligator in its stomach and remains from other stomachs included those of a Bobcat and wading birds. From southern Florida specimens, Snow et al. (2007a) listed rabbits (*Sylvilagus* sp.), Hispid Cotton Rats (*Sigmodon hispidus*), Gray Squirrels, Raccoons, Virginia Opossums, Round-tailed Muskrats (*Neofiber alleni*), Rice Rats (*Oryzomys palustris*), Domestic Cats, unidentified mammals, Pied-billed Grebes (*Podilymbus podiceps*), House Wrens (*Troglodytes aedon*), Limpkins (*Aramus guarauna*), White ibis (*Eudocimus albus*), and unidentified birds as prey of the Burmese Python. Other items in its diet from ENP include the Cotton Mouse (*Peromyscus gossypinus*), Fox Squirrel (*Sciurus niger*), Old World rats (*Rattus sp*.), Virginia Opossum, White-tailed Deer (*Odocoileus virginianus*), Key Largo Woodrat (*Neotoma floridana smalli*), and Domestic Goose (*Anser sp*.) (Snow et al. 2007b). In light of its attack on American Alligators, the Burmese Python is a potential predator of the Spectacled Caiman (Meshaka 2008a).

FIGURE 95. Geographic distribution of the Burmese Python (*Python bivittatus*) in Florida.

Reproduction.—The left testis of a 2880 mm SVL male in November from ENP measured 310 X 30 mm (Meshaka et al. 2004a). In southern Florida, the species was gravid during January-April (Krysko et al. 2008c). During 5 March-26 April 2004, four females from in or near ENP contained 35−46 large but unshelled oviductal eggs (Snow et al. 2007a). Clutch size estimates based on oviductal egg counts ranged from 21−85 eggs in five gravid females (2980−4870 mm TL) collected during January- March 2005 and in March 2007 (Krysko et al. 2008c). The mean egg length was 52 mm (range = 49−58 mm) from one clutch of 79 eggs (Krysko et al. 2008c). Snow et al. (2007c) found a female guarding her nest in a vegetated debris pile in ENP in May 2006. The clutch size of the nest was 46 eggs and diameters of the eggs averaged 91.8 X 62.7 mm (Snow et al. 2007c). In ENP, clutch size ranged from 19−46 eggs (average = 35.8 eggs), and relative clutch mass of a subsample was 17.6% (Snow et al. 2007c). Hatchlings were present in June (Snow et al. 2007a).

Activity.—Meshaka et al. (2004a) noted observations of this species in mangrove forest and on roads following cold fronts. In southern Florida, activity occurred continuously though the year. Snakes were

FIGURE 96. Spectacled Caiman (*Caiman crocodiles*). (Photographed by Suzanne L. Collins).

primarily diurnal during October-April and primarily nocturnal during June-August (Snow et al. 2007a). This large species, not surprisingly, has made long-distance movements. In one instance, a radio-tracked male had moved 69.8 km (43 mi) in the Everglades (Harvey et al. 2008).

Predators.—In ENP, the American Alligator was a predator of the Burmese Python (Snow et al. 2006). The same was possible by the Spectacled Caiman (Meshaka 2008a).

Threats.—Meshaka (2008a) suggested that this large constrictor had the potential to become the top predator of the southern Everglades system and poses a threat to a wide range of vertebrates, including humans. Harvey et al. (2008) listed a number of sensitive species that could be at risk from the depredations of this species, not the least of which is the Key Largo Woodrat. The Burmese Python may likewise be predator and prey of the Spectacled Caiman.

Advertisements have appeared on the web that offered for sale Burmese Pythons captured from the Everglades and even illegally in ENP. Theft of federal property notwithstanding, illegal removal of these animals diminishes the accuracy of population size and structure estimates being conducted in the park that is necessary to make good management decisions and strategies. This activity also aids in future dispersal events of the Burmese Python as harvested and illegally poached animals and/or progeny escape or are released elsewhere in Florida, thereby undercutting recent efforts at their eradication. Feasibility of its eradication in Florida was discussed by Engeman et al. (2009c) and a very useful update on the methods used to study the species and results within the context of exotic species management was provided by Harvey et al. (2008).

CAIMAN CROCODILUS (LINNAEUS 1758) — SPECTACLED CAIMAN

Description.—As described by Conant and Collins (1998) and Meshaka et al. (2004a), the body is brownish gray in color and patterned in darker blotches. A distinct U-shaped ridge is present between the eyes (Fig. 96).

Distribution.—The Spectacled Caiman is a New World species whose first documentation in Florida is from Miami-Dade County (Wilson and Porras 1983). It had been known to occur in southern Florida since the 1950s (Wilson and Porras 1983) and was breeding since 1960 (Ellis 1980). In southern Florida, past records are from Broward, Miami-Dade, and Palm Beach counties (Meshaka et al. 2004a). The Homestead-Florida City population appears to be the stronghold of its presence in Florida.

Elsewhere in Florida, records of the Spectacled Caiman exist from Brevard and Seminole counties (Meshaka et al. 2004a; Fig. 97). I do not know its present status in these two northern counties. Evaluation of these northerly sites could provide critical information regarding the future of the Spectacled Caiman in Florida.

Body size.—Florida specimens rarely exceeded 2000 mm TL (Meshaka et al. 2004a).

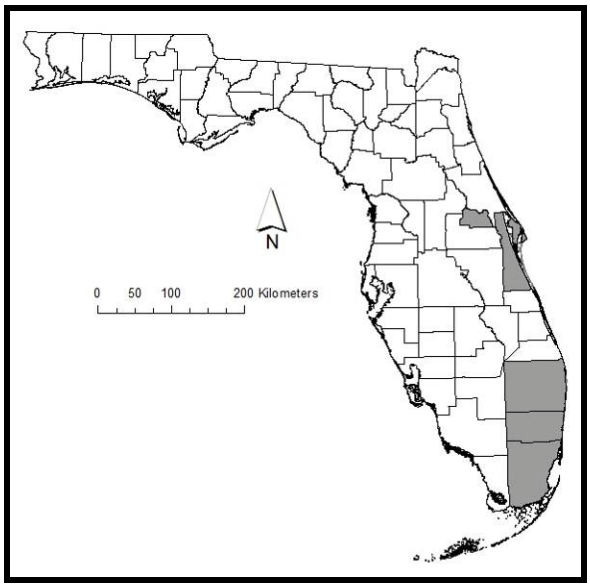

FIGURE 97. Geographic distribution of the Spectacled Caiman (*Caiman crocodilus*) in Florida.

Habitat and abundance.—The Spectacled Caiman was well-established in urban and agricultural areas on southern Miami-Dade County, where it could often be found in small weedy canals and lurking in the culverts of larger canals (Meshaka et al. 2004a). Population sizes in southern Florida had been on the rise in recent years in southern Florida (Meshaka et al. 2004a). The Spectacled Caiman had been seen in, but was not established in, ENP (Meshaka et al. 2004a).

Diet.—In Florida, Ellis (1980) reported fish, amphibians, and mammals in the diet of this species. The Spectacled Caiman was a potential predator of the Burmese Python (Meshaka 2008a). I add aquatic turtles to the list of potential prey items of this crocodilian in Florida.

Reproduction.—The Spectacled Caiman guards its nests; however, the reproductive cycle of this species in southern Florida does not seem to be known.

Activity.—In Homestead-Florida City, I have seen the species throughout the year. Meshaka et al. (2004a) noted wariness of this species. A good time to see this species is at night during the summer, and in the winter individuals can be seen basking on pond edges.

Predators.—The Burmese Python was a potential predator of the Spectacled Caiman (Meshaka 2008a).

Threats.—As a potential competitor of the American Alligator, the Spectacled Caiman presented a potential problem even while restricted in introduced habitat and geographic range (Meshaka 2008a). This crocodilian could be a predatory threat to native aquatic turtles. The Spectacled Caiman was considered to be a potential predator and prey of the Burmese Python (Meshaka 2008a) and predator of the Slider.

FLORIDA'S EXOTIC RUNAWAY TRAIN

As 2003 came to an end, 276 amphibian, reptilian, chelonian, and crocodilian species were documented as exotic introductions on a global level (Lever 2003), 64 taxa of which are introduced and established in the United States (Meshaka 2008a; Snow et al. 2007a; Collins and Taggart 1998−2008 et seq.). The 47 exotic amphibian, reptilian, chelonian, and crocodilian species in Florida as reported here are comprised of four frogs and toads, 38 lizards, one turtle, three snakes, and one crocodilian (Table 1). This exotic herpetofauna represents 24.6% of the total number of herpetofaunal species found in Florida (Meshaka and Ashton 2005). As noted previously (Butterfield et al. 1997; Meshaka et al. 2004a; Meshaka 2006), the accumulation of exotic species updated here has been rapid and has yet to be controlled, thereby representing a continuing runaway train symptomatic of Florida's exotic species problem generally. Using this herpetofaunal subset, I ask the following: Why does this phenomenon exist, where is this train going, and how can it be controlled, if at all?

GENERAL PROFILE

The typical exotic herpetofaunal species in Florida is a lizard, most likely an anole or gecko. It is also likely to be small-bodied, early maturing, and insectivorous. Typically, it is a species strongly associated with people and disturbed habitat, human-mediated or otherwise. Southern Florida is apt to be the center of its introduced distribution and its dispersal rate shows no sign of a plateau. It was most likely introduced through the pet trade. A few exceptions to this general profile exist and are glaring in their differences. For example, some of the species are large in body size, slow to mature, and are not insectivorous, such as the Burmese Python and Boa Constrictor. In some cases association with the pet

trade occurred after an initial and incidental human-mediated introduction, as in the case of the Cuban Treefrog and the Mediterranean Gecko. For some species, dispersal events within Florida can be human-mediated, accidental (e.g., Godley et al. 1981; Campbell 1996; Meshaka 1996a), or otherwise (Meshaka et al. 2004a,b).

Human-mediated dispersal of species (= exotic) has been going on for a long time in this world and for a variety of reasons. Specific to Florida, the opportunity for exotic species colonization began a long time ago, at least as early as the time of Florida's ancient Indians who traded in the Caribbean. The conquering Spanish empire brought with them their own exotic diseases as well as the plants and animals they favored, which themselves carried exotic parasites and diseases. Intentionally and unintentionally, this exotic species accumulation continues through today at frequencies unknown in the past through a combination of relentless habitat modification, isolation and marginalization of native species communities, and an astonishing array and volume of imported species. This entire restructuring of much of Florida's biotic communities has shifted from the days of isolated populations of new exotic species in recently cleared natural habitat surrounded by an intact biota. The scale has tipped, especially in southern Florida, to the inevitability of human development bringing with it an exotic fauna to long-disturbed land parcels with long-diminished native species communities (Meshaka et al. 2008a). These parcels already have the seeds of an exotic community, are benefited by the development, and rejuvenated by hitchhikers during development (Meshaka et al. 2008a). Thus, new exotic species or new populations of exotic species at a new human development are evermore likely to face off with other exotic herpetofauna than native species with which it might compete, depredate, or be depredated at some point.

One can expect to see more species entering extreme southern Florida, more species ranging northward in scattershot fashion, further development of a diverse, region-wide, even if unstable, new urban herpetofauna and, lastly, exotic encroachment into natural areas. This last phenomenon may reveal itself in two ways. First, colonization of natural areas might occur simply through opportunity as populations become established near suitable natural habitats into which individuals can subsequently disperse. Second, searching in natural habitats may detect populations of species previously thought be restricted to disturbed situations. A striking example demonstrating this last phenomenon was the discovery of the Burmese Python in Everglades National Park. Until 2000, an established population was concentrated in the extreme southern portion of the park in what was primarily mangrove forest and hammock. Soon thereafter, the snake began to appear regularly in the freshwater glade system farther north and in the Hole-in-the-Donut restoration area of Long Pine Key (Snow et al. 2007a).

FRAMEWORK TO CONTROL THIS RUNAWAY TRAIN

From the literature, it is apparent that taxonomic content, geographic patterns, ecological distributions, and dispersal agents are the best known elements of colonization dynamics of the Florida exotic herpetofauna. Less well known, however, are the types of impacts or severity of impacts among the exotic species themselves (e.g., Callahan 1982; Meshaka 2000) and between exotic species and native species (e.g., Campbell 2000; Meshaka 2001).

The framework proposed below is based on treating what is known and what is unknown about the colonization patterns of Florida's exotic herpetofauna. Some of these suggestions amplify earlier recommendations (e.g., Meshaka et al. 2004a; Meshaka and Babbitt 2005). Based on what is known about these exotic species, I recommend:

• A restriction in the pet trade of imported herpetological species to minimize the pool of potential introduced taxa. To start, species known to pose a threat to humans should not be imported into Florida, except for use by accredited zoos, or in university or museum research facilities. Alternatively, ownership of such animals could be subject to a registry. Candidate species for this category include venomous snakes, large varanid lizards and constrictors, and poison-dart frogs. Species with a moderate to high likelihood of colonization success should not be kept in Florida. Candidates for this category include boas and pythons and monitors. Taxonomic groups that are demonstrably capable of successfully colonizing Florida, even if harmless to humans, such as geckos and anoles, should likewise be removed from Florida's pet trade. Very simply, an exotic species must be *shown* to pose little if any risk to colonizing the target state *before* it can be legally traded in the United States. The Florida Fish and Wildlife Conservation Commission in conjunction with local wildlife organizations have come to support periodic amnesty days to collect exotic animals. This is a good step, and subsequent efforts at the local, state, and federal level to actively remove exotic species from urban and wilderness areas will provide quantifiable measures of success in restoration efforts. I do not make my aforementioned suggestions lightly. It is most understandable to me and I am empathetic to the fact that this suggestion may be viewed by some as too restrictive and by others not restrictive enough. I believe that my suggestions can even be improved upon. As someone who first and foremost treasures Florida's native herpetofauna and who also supports

herpetoculture, I hope that this approach I proffer will not stifle the herpetocultural business but rather redirect it in a fine-focused and eco-harmless way thereby balancing environmental stewardship with business and genuine interest in non-native herpetoculture.

• A restriction in the pet trade of native amphibian, turtle, reptile, and crocodilian species exports. The goal of this proposal is two-fold. First, to minimize opportunity for exotic species to establish by protecting native community integrity with a full compliment of potential competitors and predators that would otherwise be marginalized from what is an astonishing annual harvest of native species. Second, to protect prey species that would likewise be diminished by unnecessary harvest. In this regard, Enge (2005) quantified the depressing numbers of native herpetofauna removed each year from Florida.

• A greater funding effort to protect natural areas as functionally intact communities. Much of Florida's exotic herpetofauna is associated with disturbance. The few exotic species capable of colonizing natural habitats are generally limited in the number of such areas they can colonize. Further, functional systems exclude or negatively impact many of these exotic species. For example, high water years in Everglades National Park, which came closer to mimicking natural hydropatterns, negatively impacted populations of the Cuban Treefrog (Meshaka 2001). Unburned sandy uplands in south-central Florida were inhabited by more Greenhouse Frogs than nearby tracts that were subjected to a more natural burn regime (Meshaka and Layne 2005). Interestingly, winter prescribed burns reduced population densities of both Cuban Treefrogs and Pinewoods Treefrogs the following year; however, within two years population densities of both species returned to pre-burn levels (Tad Bartareau, unpubl. data). Cane Toads, plentiful enough that captures of 194 individuals took place during one year in a subdivision in south-central Florida, were absent in adjoining sandy uplands (Meshaka et al. 2006a). Likewise, the Brown Anole, established around the main buildings at the Archbold Biological Station in the town of Lake Placid, was absent in adjoining frequently burned and more natural scrub (James N. Layne and Walter E. Meshaka, unpubl. data). The same pattern has held true for this lizard, where it has been absent in managed sandhill habitat owned by the University of South Florida but was ubiquitous in the surrounding developed area even up to the fence between the research area and a main road (Mushinsky 1985; Henry R. Mushinsky, pers. comm.).

• I propose a statewide grade school curriculum on *Florida Ecology* to instill and strengthen a collective ethic among students with respect to environmental stewardship. A *Florida Ecology* program could easily and logically be partnered with adjacent state parks, many of which have interpretive and education staff. This would allow younger students to "graduate" to the *Parknership* program, which successfully links universities with state parks and has produced positive results in training young biologists in the field of ecology. *Parknership* has used state parks in a way fully compatible with state park mission statements relating to successful stewardship of the natural resource. Clearly, a gradual system of education that introduces younger students with state parks and maintains that relationship through university-level involvement holds the greatest promise of benefit to all parties involved- students, native herpetofauna, and the natural environment.

WHAT WILL THIS FRAMEWORK PROVIDE?

These four recommendations will:

• Decrease dispersal events of herpetofauna into Florida, both numbers of exotic species and numbers of attempts by those species.

• Decrease the ability of exotic herpetofauna to establish once they have dispersed to Florida.

• Instill and fortify a public will to value and protect indigenous environments and their native wildlife.

THE UNKNOWN

Life history study, through counts and collections, is necessary in a way that tests correlates of successful colonization. This includes geographic distribution and comparison with native populations.

What will that provide?—This recommendation will:

• Provide a measure of likelihood of colonization success

• Identify and quantify impacts.

• Provide answers regarding the extent to which an exotic species can be eradicated and how best such and eradication might be accomplished.

Why this approach?—

• Species studies provide the biologically sound information necessary to implement the sorts of public policies that can minimize the numbers of exotic species and individuals of those species, thereby creating an

engineer, as it were, to return some semblance of order to this runaway train we now call the Florida exotic herpetofauna.

POST SCRIPT

After this manuscript was in press, there were reports that three new species became established in Florida. Data associated with these three publications met the criteria for establishment used in this manuscript, and I consider them established in Florida.

African Five-lined Skink- *Trachylepis quinquetaeniata* (Lichtenstein 1823): St. Lucie County (Krysko et al. 2010).

Oustalet's Chameleon- *Furcifer oustaleti* (Mocquard 1894): Miami-Dade County (Guillett et al. 2010).

Northern African Python- *Python sebae* (Gmelin 1789): Miami-Dade County (Reed and Rodda 2009).

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