CIS CURTIN-HARRELL

Knight Anoles (*Anolis equestris*; UF 151376) mating on 1 July 2007 in Bonita Springs, Lee County, Florida.

The Knight Anole (*Anolis equestris*) in Florida

Brian J. Camposano[1], Kenneth L. Krysko[1], Kevin M. Enge[2], Ellen M. Donlan[3], and Michael Granatosky[1]

[1]Florida Museum of Natural History, University of Florida, Gainesville, Florida 32611, USA
(biscuit1@ufl.edu, kenneyk@flmnh.ufl.edu, and mgranato@ufl.edu)
[2]Florida Fish and Wildlife Conservation Commission, 1105 SW Williston Road, Gainesville, Florida 32601, USA
(kevin.enge@myfwc.com)
[3]Vegetation Management, South Florida Water Management District, 3301 Gun Club Road, West Palm Beach, Florida 33406, USA
(edonlan@sfwmd.gov)

Abstract.—In this paper, we discuss the likely modes of introduction of the Knight Anole (*Anolis equestris*) into and around Florida, provide data on its current geographic distribution, and summarize life history data in both its native and introduced Florida range. Our field data consist of collections made from 1992 through 2008 and locality data taken from the literature and systematic collections throughout the United States. *Anolis equestris* was first introduced in Miami-Dade County in 1952. The subsequent spread of this species in Florida has been both natural and assisted by human translocations to 10 additional counties, including Brevard, Broward, Collier, Highlands, Lee, Martin, Monroe, Palm Beach, Polk, and St. Lucie. Because this species is nonindigenous and known to consume a wide variety of items, including small vertebrates, it should be removed when encountered in the wild. A comprehensive study detailing its effects on the environment is needed.

Florida is home to a diverse array of amphibian and reptilian species, many of which have been introduced by humans from their native or other donor regions. The Florida herpetofauna currently contains at least 52 recognized species of lizards, 36 (69%) of which are nonindigenous (Krysko et al. 2006, Smith and Krysko 2007). Sixteen (30%) of the total lizard species are classified in the Superfamily Iguania (*sensu* Frost et al. 2001), and only one of the nine *Anolis* (Family Polychrotidae), the Green Anole (*Anolis carolinensis* Voigt 1832), is native to Florida.

The nonindigenous Knight Anole, *Anolis equestris* Merrem 1820, is the largest and most ornate established representative of the genus *Anolis* in Florida. In its native Cuban range, where it is known as a "chipojo," this species can measure up to 179 mm snout-vent length (SVL) in males and 167 mm SVL in females (Schwartz and Ogren 1956, Garrido and Schwartz 1972, Schettino 1999). In its introduced range in Miami-Dade County, Florida, males typically are 100–190 mm SVL and females 90–160 mm SVL, with individual masses of 16–84 g (Dalrymple 1980). *Anolis equestris* has large, flat and smooth, non-imbricate (i.e., non-overlapping) dorsal scales that are separated by small, granular interstitial scales; small, circular and smooth ventral scales; digits with widened, smooth subdigital lamellae; a pinkish-white dewlap present in both genders; and a large head with distinct canthal and frontal ridges (especially in adults). Both juveniles and adults are bright green, with yellow stripes below the eyes and others extending onto the shoulder. These lizards are capable of metachromatic color change (pers. obs., Schwartz and Garrido 1972, Schwartz and Henderson 1991, Schettino 1999). However, hatchlings and juveniles have cream-colored transverse bands along the body. Because of its green body coloration and large size, *A. equestris* is occasionally mistaken for the Green Iguana (*Iguana iguana* Linnaeus 1758)

KEVIN M. ENGE

The nonindigenous Knight Anole (*Anolis equestris*) is the largest and most ornate established *Anolis* in Florida. This specimen (UF 137459) is from Allapattah Flats, St. Lucie County, Florida.

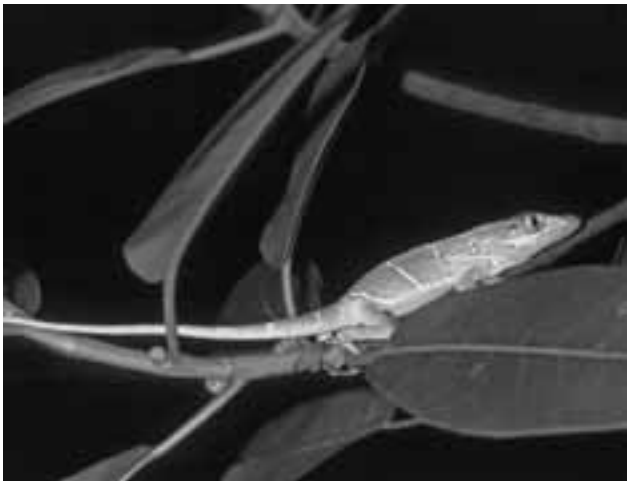
(see Meshaka et al. 2004), and people in Miami often refer to them as "iguanas" or "iguanitos" (Bartlett and Bartlett 1999). Since the species' introduction into Florida during the 1950s, *A. equestris* has been confined mostly to southern peninsular Florida. Herein, we discuss likely modes of introduction of this species into and around Florida, provide data on its current geographic distribution, and summarize life history data in both its native Cuban and introduced Florida range.

Materials and Methods

In order to determine the current geographic distribution of *Anolis equestris* in Florida, we made field collections from 1992 through 2008. Specimens were collected opportunistically by hand, with nooses (Strong et al. 1993), blowguns shooting tapered corks (Krysko et al., in press), and fishing rods using invertebrates (mainly dead insects found on the radiators of vehicles, and live domestic crickets) for bait (Krysko 2000). Nooses were made out of dental floss loops tied onto the ends of poles and extended upwards to reach lizards that were high in the tree canopy or on tall structures. When nooses were ineffective, we used a fishing rod to cast a food item as close as possible to a lizard. Lizards typically moved quickly from high on perches or within dense vegetation to eat the bait, and were then easily reeled in and collected. Specimens were deposited in the

KEVIN M. ENGE

Neonate *Anolis equestris* from Miami, Miami-Dade County, Florida, hatched in captivity from an egg found at the bottom of a collecting bag.



KEVIN M. ENGE

Juvenile *Anolis equestris* (UF 131530) from Port Mayaca, Martin County, Florida, found sleeping on low vegetation.

KEVIN M. ENGE

Anolis equestris (UF 131449) from Port Mayaca, Martin County, Florida, illustrating the large head with distinct canthal and frontal ridges, pinkish-white dewlap, and yellow stripes below the eye and extending onto the shoulder.

KENNETH L. KRYSKO

Dead dragonflies (*Odonata*) found on the radiators of vehicles and used to collect *Anolis equestris*.

KRISTIN CHILD

Anolis equestris (UF 144334) perched on palm tree in Lake Worth, Palm Beach County, Florida.

JOSEPH P. BURGESS

Anolis equestris from Miami, Miami-Dade County, Florida, perched high above the ground on vegetation.

Florida Museum of Natural History (FLMNH), University of Florida (UF collection). We also obtained locality data from the literature, systematic collections throughout the United States, photographs sent to us for identification purposes, and personal communications from reliable sources. Source acronyms for collections follow Leviton et al. (1985), with the addition of Everglades National Park (EVER), from which the entire collection is now accessioned into the UF collection (Appendix). All records with locality data were plotted using ArcGIS ver. 9.3 (ESRI).

Results and Discussion

Native Distribution and Natural History.—Anolis equestris is native to Cuba and is common throughout much of its natural range (Schettino 1999, Schwartz and Henderson 1991). It occurs at elevations from 0–1,000 m above sea level in many types of mesophilic and occasionally xerophilic habitats, including forests and mangroves, caves, savannas, cultivated areas, and groves or gardens in urban areas (Schwartz and Ogren 1956, Schettino 1999). *Anolis equestris* is a member of the crown-giant ecotype, which is associated with living high in the canopy of large trees (diameter at breast height [DBH] > 30 cm), including mangoes and palms (Williams 1969, 1972; Schwartz and Henderson 1991; Butterfield et al. 1997).

As an arboricolous (tree-dwelling) species, *Anolis equestris* perches on trunks and high branches of trees (sometimes > 10 m high), spending the greater part of its time in the crown (Collette 1961, Ruibal 1964, Schettino 1999). During the warmest part of the day, *A. equestris* will descend the trunks of trees in an apparent thermoregulatory behavior to avoid excessive sunlight (Schettino 1999). When startled, this species will "squirrel" (move to the opposite side of the tree trunk) and quickly ascend to the canopy (Schettino 1999). *Anolis equestris* is an aggressive species that will attempt to bite an attacker when disturbed, opening its mouth and extending its dewlap in a defensive posture (Schettino 1999). It also is capable of inflicting a painful but harmless bite, and will defend its territory by extending its pinkish dewlap and bobbing its head (Schettino 1999, Schwartz and Henderson 1991).

Little information is known on the reproductive cycle of *Anolis equestris* in its native range. Males typically establish territories high in the canopies of trees, with territorial battles between males occurring frequently. Large groups are uncommon, except in large groves of trees that may support many individuals (Schettino 1999). Courtship and mating generally take place high in the tree canopy, and ovipositioning occurs in burrows excavated by females in the ground or in pre-existing tree cavities (Schettino 1999).

Anolis equestris is an omnivorous, opportunistic species that feeds on a wide range of items, including large amounts of fruit and seeds, insects (especially moths, butterflies, and their larvae, beetles, crickets and grasshoppers, and ants, bees, and wasps), and small vertebrates such as frogs, lizards (including its own species), and small birds (Schettino 1999, Schwartz and Henderson 1991). Although *Anolis equestris* is a sit-and-wait predator and is generally territorial, adults are known to move across phone lines or use open ground to move from tree to tree (Schettino 1999, Schwartz and Henderson 1991). Small vertebrates usually are captured and firmly bitten before consumption (Schettino 1999). The dentition of this species includes small,

KENNETH L. KRYSKO

Anolis equestris (UF 137039) from Naples, Collier County, Florida, illustrating its small, conical, blunt teeth. Despite the belief that a bite causes fever in humans, its teeth do not secrete toxins or venom.

conical, blunt teeth that do not secrete any toxins or venom (Schwartz and Henderson 1991, Schettino 1999). Its relatively large size, appearance, and biting habits are the basis of the false belief that its bite causes fever in humans (Schettino 1999). Small juveniles and subadults are susceptible to predation by birds or even other lizards, which suggests why these size classes are found on low shrubs during both the day and night. Individuals living higher in tree crowns are most easily captured by Sparrow Hawks (*Falco sparverius*), effective canopy predators that often "specialize" in lizards in the West Indies (Schettino 1999).

Florida Distribution and Modes of Introductions.—We compiled 216 vouchered records of *Anolis equestris* from Florida collected between April 1957 and September 2007 (Appendix), 60 of which were collected during our field surveys. We documented *A. equestris* in 11 Florida counties: Brevard, Broward, Collier, Highlands, Lee, Martin, Miami-Dade, Monroe, Palm Beach, Polk, and St. Lucie.

Neill (1957) first reported the introduction of *Anolis equestris* from an unspecified locality in "southern Florida"; however, King and Krakauer (1966) stated that the original introduction occurred in 1952 at the University of Miami's old North Campus in Coral Gables, Miami-Dade County, by a student in their Department of Biology. The original population was centered in a 20-city-block area in Coral Gables, from Coral Way south to Bird and LeJuene roads west to Segovia Avenue, in the middle of which were the main buildings of the University of Miami's old North Campus (F.W. King, pers. comm.; King and Krakauer 1966). Although the old North Campus site is now occupied by University Park, the Ficus trees along Segovia Street (north side of campus) north of Anastasia Avenue were loaded with *A. equestris* in the 1960s (F.W. King, pers. comm.). The first known voucher specimen (LACM 61680) was collected in Coral Gables on 5 April 1957 by D.R. Paulson, supporting King and Krakauer's (1966) hypothesis.

Geographic distribution of the Knight Anole (*Anolis equestris*) in Florida. The star represents the first known voucher specimen (LACM 61680) collected in Coral Gables, Miami-Dade County, on 5 April 1957. Circles with solid dots represent records consisting of voucher specimens and photographs (N = 218). Open circles represent unverified observations (N = 3; see text) in the previously undocumented counties of Orange and Volusia.

The subsequent spread of this species in Florida has been both natural and assisted by human translocations (Lever 2003). In 1972, *Anolis equestris* was reported from Elliott Key (Brown 1972) and the Miami Seaquarium on Virginia Key, Miami-Dade County (Dalrymple 1980). Crowder (1974) reported that *A. equestris* was secondarily transferred by reptile hobbyists to other areas of Miami-Dade County, including Coral Gables (Fairchild Tropical Gardens; see also Dalrymple 1980), Coconut Grove, Sunset Park, and Peters. Brach (1976) reported that *A. equestris* was further expanding its range by human-assisted means in suburban southern Florida, and Wilson and Porras (1983) reported that *A. equestris* was becoming widespread in Miami-Dade County. In the early 1990s, a single collector caught 50–115 *A. equestris* per day in Miami, especially on Black Olive Trees (*Bucida buceras*) in swales, and sold them in the pet trade (R. St. Pierre, pers. comm.). In 1996–1998, *A. equestris* was recorded at 4013 Douglas Road, Kampong National Tropical Garden (Meshaka 1999b), as well as 5530 SW 72nd Street, Doc Thomas House (Meshaka 1999c). Butterfield et al. (1997) reported an observation of *A. equestris* on Parachute Key in Everglades National Park. Our Miami-Dade County vouchers indicate that *A. equestris* has expanded its range throughout the county, especially in heavily planted suburbs. These locality records include Perrine (1959); Coral Gables (1960–68, 1970, 1973–74, 1976–77, 1987–88, 1994, 1996); South Miami (1964, 1975); Miami (1965, 1986); US 1 & SW 126th Street, Miami Serpentarium (1970); 8500 SW 87th Terrace (1984); SW 57th Avenue along Snapper Creek Canal (1991, 1996, 2001); SW 173rd Street & Old Cutler Road (1996); 7711 Camino Real (1996); SW 88th Street & SW 80th Avenue (1996); SR 997 & SW 304th Street, Homestead (1997); SR 997 & NE 16th Street, Homestead (1998); SR 997 & NE 18th Street (1998); SW 64th Avenue (1999); SW 296th Street & SW 197th Avenue, Homestead (1999); 5815 Suncrest Drive (2000); SW 69th Street & SW 63rd Court (2000); SW 69th Street & SW 64th Avenue, All American Park (2000, 2002); Parachute Key, Everglades National Park (2000); 7440 SW 162nd Street (2001); C-111 & C-113 canals (2001); Key Biscayne, Bill Baggs Cape Florida State Park (2002–03, 2005); NE 204th Street & NE 12th Avenue, Hialeah (2002); SW 134th Street & 122nd Avenue, Kendall (2002); 801 Swan Avenue, Miami Springs (2003–04, 2006–07); SW 70th Street & SW 98th Avenue (2004–05); 16701 SW 72nd Avenue, Charles Deering Estate at Cutler (2005); Key Biscayne, Crandon Park (2005); and 6660 SW 117th Avenue (2005).

Northern range expansion into other counties was first documented in 1974, when the first known voucher specimen (UF 86714) was collected at 7530 Plantation Road, Fort Lauderdale, Broward County. By 1992, numerous *A. equestris* were being collected locally and brought into Strictly Reptiles, Hollywood, for sale in the pet trade (R. Van Nostrand, pers. comm.). We have another Broward County record from 3468 Pierce Street, Hollywood (2003–04). Range expansion northward into Martin County occurred in 1986, when numerous *A. equestris* were intentionally released at 19121 SW Conners Highway, Port Mayaca, on the northeastern side of Lake Okeechobee (J. Watt, pers. comm.). Our Martin County vouchers (UF 131449, 131530) illustrate that this population has been established for more than 20 years despite cold weather and intense commercial collecting pressure (Krysko et al. 2005). Hailman et al. (2005) reported at least one *A. equestris* from Stuart in 2004 and 2005.

Despite its close proximity to Broward County, the first known voucher specimen (TCWC 80508, Boca Raton) was not collected from Palm Beach County until 1997 (Krysko et al. 2005). Hailman et al. (2005) reported an *Anolis equestris* from Ocean Drive, Jupiter Inlet Colony, in 2004. Our other Palm Beach County vouchers include 11 Rennie Street, West Palm Beach (2003); Lake Worth (2004); 5233 Arbor Glen Circle, Lake Worth (2005); 485 Cleary Road, West Palm Beach (2006); 3301 Gun Club Road, West Palm Beach (2006); US 1 & Dixie Highway, Delray Beach (2006); and North 123 Trail, and 0.06 mi south of North 169 Court, Jupiter (2007).

Range expansion also occurred on the southwestern Florida coast, as evidenced by the first voucher specimen (UF 141841, a neonate), collected in 1979 in Fort Myers, Lee County. Our other Lee County vouchers include 5207 Palm Beach Boulevard; Fort Myers (2005); 8880 Colonnades Court, Bonita Springs (2007); and Morse Place and Browning Drive, Fort Myers (2007). In 1995, the first known voucher specimen (UF 100104) for Collier County was collected at 3480 10th Street North, Naples (Noonan 1995), which consists only of an anole head because it was killed and partially eaten by a domestic cat. Our other Collier County vouchers (all from Naples) include Parkview Way (2001); Gulf Shore Boulevard North (2003); and West Boulevard, south of Pelican Bay Boulevard (2003).

The first voucher specimen (UF 52748) from the Florida Keys, Monroe County, was collected in 1981 at Mile Marker 87.5, Overseas Highway, Plantation Key (Achor and Moler 1982). Another Monroe County voucher specimen (UF 151192) collected in 2007 at 323 Whitehead Street, Key West, represents the southernmost locality in the United States (Krysko and Borgia 2007).

Along the Atlantic Coast, additional northward range expansion is believed to have occurred more recently than in other areas in peninsular Florida. In 2003, the first known voucher specimen (UF 137459) from St. Lucie County was collected in the Allapattah Flats, east of Carlton Road and 1.0 mi north of Glades Cutoff Road (Krysko et al. 2005). A reptile dealer in the area was likely responsible for this population of *Anolis equestris* (see Enge and Krysko 2004), which inhabited both citrus groves and pine flatwoods habitat, where they could be spotted at night high up in large Slash Pines (*Pinus elliottii*). In 2004, *A. equestris* could be found in trees along Hickock Terrace, Port St. Lucie (R. Goushaw, pers. comm.). In 2007, two *A. equestris* were found in Brevard County at 4310 MacTavish Street, Cocoa (Enge and Coben 2007).

In 1995, an adult male *Anolis equestris* was intercepted in an agricultural shipment sent from Miami to Lake Placid, Highlands County (Meshaka et al. 2004). In 2003, the first known voucher specimen (UF 153968) from Highlands County was collected at 101 Green Dragon Drive, Lake Placid (Parker and Krysko, in press). In 2000, four *A. equestris* fell out of a tree during a cold front in Bartow, Polk County (C. Trumbower, pers. comm.). In 2007, the first known voucher specimen (UF 153967) from Polk County was collected at 3832 Avenue Q NE, Winter Haven (Parker and Krysko, in press);

another *A. equestris* was accidentally run over with a lawn mower at this site a few weeks earlier (D.J. Parker, pers. comm.), suggesting that an established population may be present.

Unverified reports of *Anolis equestris* are known from two other previously undocumented Florida counties, including two adults that fell out of trees during a cold front in December 1994 on Katherine Street, Daytona, Volusia County (A.T. Reppas, pers. comm.), and several individuals brought to Gatorland in 2004 from a neighborhood in Orlando, Orange County (F. Morrissey, pers. comm.).

Natural History in Florida.—In Florida, *Anolis equestris* is a diurnally active, heliothermic species that is most frequently observed from May through October (Meshaka and Rice 2005). Its active season generally coincides with mean ambient air temperatures of >29 °C (Wilson and Porras 1983, Meshaka et al. 2004). Peak activity occurs from mid-morning until late afternoon, with activity ceasing around sunset (Meshaka et al. 2004). However, diel activity is unimodal, and ambient temperature better explains activity patterns than such factors as cloud cover, wind velocity, and relative humidity (Meshaka et al. 2004). During diel activity in Miami-Dade County, individuals generally perch above 3 m from the ground during the late morning hours, retreating to the canopies of trees later in the afternoon and into the evening, where they reside until daybreak (Meshaka et al. 2004). Dalrymple (1980) noted that population sizes in southern Florida can range from 3.3/ha in wild Tamarind (*Lysiloma latisiliquum*) groves to 29.5/ha in a tropical garden. On 4 June 2003, KLK collected by hand seven adults on trees in less than 15 minutes along Gulf Shore Boulevard North, Naples, Collier County, illustrating the potential abundance of *A. equestris* in a relatively small area.

Anolis equestris is seen most frequently on trunks of several different tree species (King and Krakauer 1966, Wilson and Porras 1983), including Ficus (*Ficus benjamina*), Umbrella (*Schefflera actinophylla*) (Krysko 2000), Mahogany (*Swietenia mahagoni*), Black Olive, Wild Tamarind, and Mango (*Mangifera indica*) trees (Meshaka 1993, Meshaka et al. 2004), smaller vegetation (Brach 1976), and edificarian structures. *Anolis equestris* is omnivorous and feeds on a wide range of invertebrates, fruits and seeds, and small vertebrates, including frogs, lizards, and caged birds (Brach 1976, Dalrymple 1980, Nicholson and Richards 1999, Meshaka 1999a, Meshaka et al. 2004).

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Six of seven adult *Anolis equestris* collected in less than 15 minutes in Naples, Collier County, Florida.

Copulating pairs are most frequently observed from April through August (Meshaka et al. 2004, Meshaka and Rice 2005). We were provided with photographs of *Anolis equestris* mating in the wild on 1 July 2007 in Bonita Springs, Lee County. Neonates typically are <4 cm SVL, and development to sexual maturity (100–110 mm SVL) is rapid in males and females (12–13 months, 8–9 months, respectively) (Meshaka 1999a, Meshaka et al. 2004). Populations turn over in about seven years, but adults may live over 10 years in Homestead (Meshaka and Rice 2005). Schettino (1999) reported an individual living over 13 years in captivity.

Anolis equestris is slowly becoming widespread in the state of Florida. Since its initial introduction from Cuba to the University of Miami's old North Campus, 55 years have passed for it to expand its range and be detected in 13 Florida counties. *Anolis equestris* is a large, robust anole with the potential to avoid predation and survive cold winters. Therefore, we believe that the range of this species in Florida will continue to expand, likely with humans being a major factor. Because *Anolis equestris* is nonindigenous to Florida and known to consume a wide variety of items, including small vertebrates, it should be removed whenever encountered in the wild. Additionally, a comprehensive study detailing its effects on the environment is needed.

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MICHAEL KERN

Rough Knobtail Geckos (*Nephrurus amyae*) are large, robust lizards that occur in rocky outcrops in the Northern Territory of Australia. They are dietary generalists, eating virtually any small animal they can fit in their mouths. Even juveniles respond to threats by elevating their bodies, gaping, and hissing. Like most true geckos, they lack eyelids and use their tongues to clean the scales that cover the eyes.

MICHAEL KERN

Jackson's Chameleon (*Chamaeleo jacksonii*) is native to the cooler humid uplands of Kenya and Tanzania in eastern Africa. An introduced population in Hawaii served as the primary source of animals for the pet trade until exportation was prohibited in an effort to prevent the introduction and misuse of other species for commercial purposes. Chameleons use crypsis and very deliberate movements to approach prey (mostly insects) that they capture with an extensible tongue. Males have horns that may be used in slow-motion pushing and shoving matches to establish dominance and defend territories. Unlike most chameleons, which lay eggs, Jackson's Chameleons give birth to live young.

MICHAEL KERN

Parker's Tree Frog (*Leptopelis parkeri*) is "vulnerable" to extinction because its distribution is severely fragmented and the extent of its forest habitat in the Eastern Arc Mountains of Tanzania (Africa) is declining. It cannot survive in seriously disturbed habitats and is threatened by expanding human settlements, agriculture, deforestation, and illegal gold mining. It breeds in slow-flowing streams, although its eggs are laid in a nest on land close to water.

MICHAEL KERN

African Coral Cobras (*Aspidelaps lubricus lubricus*) are native to southern Africa. These snakes are nocturnal and fossorial, spending the day underground in rodent burrows, although they have been found in rock crevices and in abandoned termite mounds. They eat small rodents, lizards, and possibly other snakes, and have been known to eat reptilian eggs.

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Appendix. Specimens examined from Florida counties. Note that Everglades National Park (EVER) specimens are now accessioned into the Florida Museum of Natural History (UF) collection.

Brevard: UF 150871. *Broward*: UF 86714, 137715, 140586, 141120, 142894–96, 145031–34. *Collier*: UF 100104, 137037–42; USNM 547963. *Lee*: UF 141841, 144191, 145694, 151376, 152335. *Martin*: UF 131449, 131530. *Miami-Dade*: AMNH 89355; AUM 35823; EVER 302917–18, 302961–75, 303151–58, 303509, 303996-00, 306531, 306539, 307138, 308170, 308776, 39977; KU 172917, 220258; LACM 61680–86, 74878–80; LSUMZ 24010, 30725, 42087, 56737; MCZ 85093, 85564, 93445, 131609, 140112, 142470, 143901–09, 171444–47, 174816, 175020–21, 182994; MPM 19142–44, 25669; MVZ 214996–99; UF 21908–09, 22022–37, 40618, 42432, 63077–82, 66920–21, 74958, 80343, 83799, 89569–74, 90925, 99187, 99674, 100104, 121125, 121425, 121445–48, 122474–75, 130653, 130685, 131449, 131477, 131489, 131530, 132727, 134839, 134916, 137037–42, 137714, 138394, 141229, 141576, 141841, 144135, 144191, 144220, 145027–29, 145216, 145359–61, 145694, 150534, 150732, 151359, 151376, 152322, 152335; UMMZ 225093–97, 227717; USNM 194847, 245588–89, 252596–99, 523789, 547963; UTA 35597; YPM HER.R. 7023, 7028; *Monroe*: TCWC 80508; UF 52748, 137015, 141949, 144334, 149862, 150533, 150535, 151192, 151601; *St. Lucie*: UF 137459.