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A Summary of Reports of the Cuban Brown Anole (*Anolis sagrei*) in Texas, USA

Lawrence G. Bassett

Department of Biology, Texas State University, San Marcos, Texas 78666, USA

The Cuban Brown Anole, *Anolis sagrei* Duméril and Bibron 1837 (Dactyloidae) (Fig. 1) is native to Cuba, Little Cayman, and the Bahamas (Powell and Henderson 2012; Powell et al. 2016) and has successfully colonized many regions outside its native range (e.g., Williams 1969; Norval et al. 2016; Vásquez-Cruz et al. 2020). In the United States, populations have become established in Hawaii (Kishinami and Kishinami 1996; McKeown 1996; Goldberg et al. 2002), California (Mahrdt et al. 2014; Fisher et al. 2020), Texas (King et al. 1987; Dixon 2000, 2013), Louisiana (Thomas et al. 1990; Platt and Fontenot 1994; Edwards and Lailvaux 2012), Alabama (Steffen and Birkhead 2007), Georgia (Campbell 1996), South Carolina (Turnbough 2006), and Florida (King and Krakauer 1966). The most notable of these is Florida, where *A. sagrei* was first detected in 1887 (Garman 1887) and by 2002 had been recorded from every county in the peninsular portion of the state (Campbell 2003). Individuals have been collected from other states, including Arkansas (McAllister et al. 2003), North Carolina (Granatosky and Krysko 2013; Hofmann et al. 2018), and Virginia (Mitchell 1982), but whether established populations exist in those states is unclear.

Invasion by *A. sagrei* may include negative consequences for native herpetofauna. For example, *A. sagrei* has been implicated in declines of the North American Green Anole (*Anolis carolinensis*) in the southeastern United States (Campbell 2000; Bush et al. 2022) and likely was responsible for the introduction of exotic helminth parasites in Hawaii (Goldberg and Bursey 2000). Predation of *A. carolinensis* by *A. sagrei* has been reported (e.g., Campbell and Gerber 1996), as has interspecific mating between the two species (Sater and Smith 2018). Whether, however, that predation and reproductive interference occurs frequently enough to significantly affect ecological communities is unclear. Furthermore, recent establishment of *A. sagrei* in Bermuda has been identified as a potential threat to the survival of the critically endangered Bermuda Skink, *Plestiodon longirostris* (Stroud et al. 2017). Given the potential effects associated with the spread of *A. sagrei*, accurate documentation of the species' growing distribution is useful.

The distribution of recently introduced squamates is often dynamic and requires routine examination (e.g., Farr 2014; Bassett et al. 2021; Vásquez-Cruz et al. 2021). *Anolis sagrei* was first discovered in Texas in 1985 (Dixon 1987; King et al. 1987) and since that time several summaries of detections of the species in the state have been published. Dixon (2013) provided a state-wide distribution map in his field guide. Subsequently, Lieto and Burke (2019) summarized records of *A. sagrei* from across the United States. Although their investigation was laudable, Lieto and Burke (2019) limited their examination of the literature to *Herpetological Review*. As a result, distributional records from other peer-reviewed outlets (e.g., King et al. 1987) and museum collections were not included in their map. Additionally, they overlooked a small number of records from *Herpetological Review* (i.e., Krusling et al. 1995; McCoid 2006; Rabe et al. 2012). Most recently, Meshaka et al. (2022) published county-delineated maps of *A. sagrei* records for the entire United States. Although this

Fig. 1. A Cuban Brown Anole (*Anolis sagrei*) photographed among potted plants at a residential property in Bellaire, Texas, USA, on 27 July 2019. Photograph by Lawrence G. Bassett.

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represents a commendable synthesis, the maps for *A. sagrei* in Texas lack several old and new county records (e.g., Swanson et al. 2014; Cortez and Eversole 2021). Both the omission of records from recent summaries and the ongoing publication of new records indicate a need for a revised statewide distribution map. Herein, I summarize reported detections of *A. sagrei* in Texas, USA, in the peer-reviewed literature and the online database VertNet.

Searching for the specific epithet "*sagrei*," I examined individual PDF files of *Herpetological Review*, the primary journal in which distributional records for North American herpetofauna are published, for distributional notes involving *A. sagrei* in Texas. I also used the online search engines *Google Scholar*, *Scopus*, *Web of Science*, and *BioRxiv*, using the search terms "*Anolis sagrei* Texas," "*Anolis sagrei* Texas distribution," "*Norops sagrei* Texas," and "*Norops sagrei* Texas distribution" in an effort to find additional peer-reviewed distributional records of *A. sagrei* in the state. Finally, I searched the online database *VertNet* for physical specimens of *A. sagrei* collected in Texas that have been accessioned in museum collections. Because *A. sagrei* is sometimes assigned to the genus *Norops* (e.g., Savage and Guyer 1989; Nicholson 2002; Steffen and McGraw 2009), I searched for both "*Anolis sagrei*" and "*Norops sagrei*."

Anolis sagrei has been documented from 21 Texas counties, with the most recent distributional record published in 2021 (Table 1; Fig. 2) and nine county records reported since publication of Dixon's (2013) field guide. The occurrence of *A. sagrei* in Travis County has not, to the best of my knowledge, been previously documented in the peer-reviewed

Table 1. Texas (USA) county records of Cuban Brown Anoles (*Anolis sagrei*). Those in bold harbor established populations (although additional surveys might reveal such populations in counties for which only isolated records exist at this time). Criteria for evidence of an established population are the detection of ≥ 20 individuals including juveniles (as evidence of recruitment). For Cameron and Montgomery Counties, the evidence is in the cited literature, whereas the author has observed hundreds of *A. sagrei*, including juveniles, throughout Harris County. Asterisks (*) indicate that the specified county was not included in Dixon (2013). Daggers (†) indicate that the digital or physical voucher(s) associated with a specified reference was (were) collected from a plant nursery. Note that some vouchers listed are in addition to those cited in the published distributional record listed for the corresponding county. Museum acronyms are CMNH (Cincinnati Museum of Natural History), LACM (Natural History Museum of Los Angeles County), TA-MIU-H (Herpetology Collection, Texas A&M International University), TCWC (Biodiversity Research and Teaching Collections, Texas A&M University), TNHC (Biodiversity Collections, University of Texas at Austin), and USNM (National Museum of Natural History, Smithsonian Institution).

County	References	Voucher(s)
Angelina*	Adams et al. 2014†	TCWC 96833
Aransas*	Reed and LaDuc 2012	TNHC 85234–5
Bexar	King et al. 1987†	None found
Brazoria	McCoid 2006	TNHC 64389; TCWC 63469–72
Brazos	Dixon 2013	TCWC 92434, 94294
Cameron	**King et al. 1987†**	**TCWC 65492–3, 93090; USNM 299713–5**
Fort Bend	Wood 2010	TCWC 94268
Galveston	Dixon 2013	TCWC 83066
Guadalupe	Dixon 2013	TCWC 84307
Harris	**Dixon 1987†**	**TCWC 91329–30, 92891, 94081; TNHC 98988–92**
Hidalgo	McCoid 2006	TNHC 64388; LACM 152434
Kleberg	Rabe et al. 2012	TNHC 85065
Lavaca*	Hernandez et al. 2016†	TCWC 102259
Matagorda*	Swanson et al. 2014	TNHC 85948
Montgomery*	**McMartin 2016**	**TNHC 99819**
Nacogdoches*	Saenz et al. 2013†	TCWC 96834
Nueces	Krusling et al. 1995†	TCWC 71629; CMNH 4206
Travis*	None found	TNHC 93000
Victoria*	Guadiana et al. 2020†	TNHC 114640
Webb*	Cortez and Eversole 2021	TA-MIU-H0009
Willacy*	Guadiana et al. 2020†	TNHC 114621–2

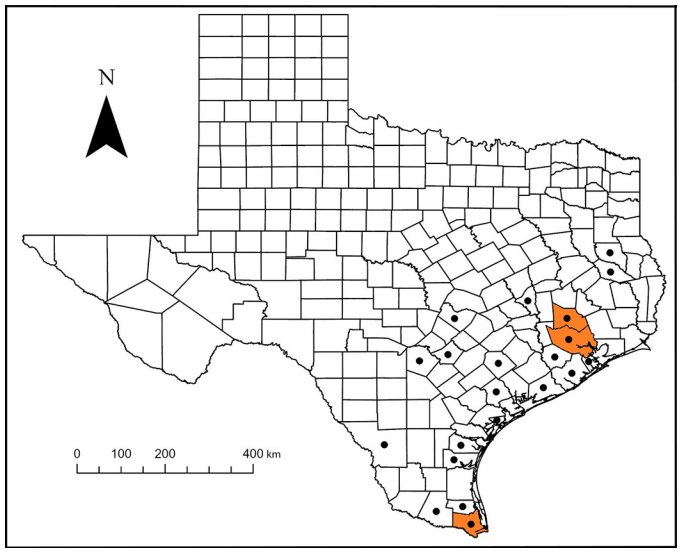

Fig. 2. County map of Texas with black dots indicating that a published record or museum voucher for the Cuban Brown Anole (*Anolis sagrei*) exists for that county. Counties indicated in orange harbor established populations (Table 1).

literature, although a specimen from Travis County was found accessioned in the TNHC (Biodiversity Collections, University of Texas at Austin). Given that *A. sagrei* was discovered initially in Harris County, Texas, only 37 years ago (Dixon 1987; King et al. 1987), the species appears to be quickly expanding its range in the southern portion of the state.

However, some of the published records (e.g., Rabe et al. 2012; Adams et al. 2014) involve only the collection of a single individual and no information regarding the presence of additional conspecifics. Consequently, those records might not represent established populations. Other distributional notes (e.g., King et al. 1987; Swanson et al. 2014; McMartin 2016), however, are indicative of established populations. Therefore, the map presented herein should be interpreted as a summary of reported detections and not necessarily the distribution of established populations within the state.

The commercial plant trade frequently has been implicated in the dispersal of *A. sagrei* (Godley et al. 1981; King et al. 1987; Granatosky and Krysko 2013). Supporting that contention is that nearly half (9 of 20) of the published records examined during this literature review were based on specimens in plant nurseries (Table 1; Fig. 3). Nurseries often provide microhabitats that are dramatically different from the surrounding habitat. For example, frequent watering and greenhouses can provide warmth and humidity throughout the year, even while the outside climate is too dry or cold to support populations of Cuban Brown Anoles. Therefore, many of the published records for *A. sagrei* in Texas may represent trapped populations incapable of exploiting surrounding habitat. However, if a nursey is located in an area surrounded by landscaped properties, the potential for successful establishment is likely much greater. Landscapes in residential neighborhoods sometimes approximate nursery habitats with a high density of ornamental plants and routine watering regimens. Residential buildings also may function as refugia for *A. sagrei* during cold periods.

Fig. 3. A Cuban Brown Anole (*Anolis sagrei*) photographed in a commercial plant nursery in Austin, Texas, USA, on 8 March 2020. Photograph by Dalton B. Neuharth.

Because *A. sagrei* is native to warm, humid islands, these lizards presumably lack the necessary physiological and mor-

phological adaptations to persist in colder and drier portions of the state, such as the Chihuahuan and Kansan biotic provinces (Blair 1950). Nonetheless, the peculiar gaps in the present distribution map suggest that continued spread of *A. sagrei* throughout much of the state is possible, although the northern extent of suitable habitat for *A. sagrei* is unclear. I suggest that this would be an interesting topic to investigate with predictive methods such as ecological niche modeling (e.g., Peterson 2003; Pyron et al. 2008; Sung et al. 2018).

The native congener, *A. carolinensis*, occurs throughout much of southern and eastern Texas and is known from every county in which *A. sagrei* has been recorded (Dixon 2013; Eversole et al. 2021). However, possible effects of the ongoing expansion in the Texas range of *A. sagrei* on sympatric populations of *A. carolinensis* have yet to be examined. Evidence from Florida suggests that behavioral shifts (Kamath et al. 2013; Kamath and Stuart 2015) and a decline in the abundance (Campbell 2000) of *A. carolinensis* can be expected. I strongly recommend that such investigations be implemented along with continuous monitoring of the distribution of *A. sagrei* in Texas.

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