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

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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 peninsula portion of the state (Campbell 2003). Individuals have been collected from other states, including Arkansas (McAllister et al. 2003), North Carolina (Granatoky and Kysklo 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 (e.g., 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
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 literature.

### 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; USNM 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              |
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 nursery 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.

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.

**Literature Cited**

Adams, C.K., D. Saenz, and J.D. Childress. 2014. Geographic distribution. *Anolis sagrei* (Brown Anole). Herpetological Review 45: 282.

Bassett, L.G., F.E. Zughaiyir, and M.R.J. Forstner. 2021. New county records for *Anolis carolinensis* (Brown Anole) in Florida and Georgia. Herpetological Review 27: 155–157.

Campbell, T.S. 2003. The introduced brown anole (*Anolis sagrei*) in Florida and Georgia. *Herpetological Review* 34: 173–174.

Campbell, T.S. and G.P. Gerber. 1996. *Anolis sagrei* (Brown Anole). Sauraphy. *Herpetological Review* 27: 200.

Cortez, R. and C.B. Eversole. 2021. Geographic distribution. *Anolis sagrei* (Brown Anole). *Herpetological Review* 52: 345.

Dixon, J.R. 1987. Amphibians and Reptiles of Texas: with Keys, Taxonomic Synopses, Bibliography, and Distribution Maps. Texas A&M University Press, College Station, Texas, USA.

Dixon, J.R. 1996. Amphibians and Reptiles of Texas: with Keys, Taxonomic Synopses, Bibliography, and Distribution Maps. 2nd ed. Texas A&M University Press, College Station, Texas, USA.

Dixon, J.R. 1993. Amphibians and Reptiles of Texas: with Keys, Taxonomic Synopses, Bibliography, and Distribution Maps. 3rd ed. Texas A&M University Press, College Station, Texas, USA.

Edwards, J.R. and S.P. Lilavixay. Display behavior and habitat use in single and mixed populations of *Anolis carolinensis* and *Anolis sagrei* lizards. *Ethology* 118: 494–502. https://doi.org/10.1111/j.1439-0310.2012.02037.x.

Eversole, C.B., J.M. Haverkamp, and T.C. Vaughan. 2021. Geographic distribution. *Anolis carolinensis* (Green Anole). *Herpetological Review* 52: 795.

Farr, W.L. 2014. *Hemidactylus turcicus*, 15 new county records from southeast Texas, USA. *Herpetological Review* 45: 101–102.

Fisher, S.R., L.A. Del Pinto, and R.N. Fisher. 2020. Establishment of brown anoles (*Anolis sagrei*) across a southern California county and potential interactions with a native lizard species. *PeerJ* 8: e937. https://doi.org/10.7717/peerj.8937.

Garman, S. 1887. On West Indian Iguanidae and on West Indian Scincidae in the collection of the Museum of Comparative Zoology at Cambridge, Mass., U.S.A. *Bulletin of the Essex Institute* 15: 25–50.

Godley, J.S., F.E. Lohrer, J.N. Layne, and J. Rossi. 1981. Distributional status of an introduced lizard in Florida: *Anolis sagrei*. *Herpetological Review* 12: 84–86.

Goldberg, S.R. and C.R. Burssey. 2000. Transport of helminths to Hawaii via the *Brown Anole, Anolis sagrei* (Polychrotidae). *Journal of Parasitology* 86: 750–755. https://doi.org/10.1655/0022-3395(2000)086[0750:TOHTHV]2.0.CO;2.

Goldberg, S.R., F. Kraus, and C.R. Burssey. 2002. Reproduction in an introduced population of the brown anole, *Anolis sagrei*, from O‘ahu, Hawai‘i. *Pacific Science* 56: 163–168. https://doi.org/10.1553/pacsc.2002.0014.

Granotosky, M.C. and K.L. Krysko. 2013. The brown anole, *Anolis sagrei* Duméril and Bibron 1837 (*Dactyloidae*), state record and introduction pathway. *Reptiles & Amphibians* 20: 190–191. https://doi.org/10.17161/rannda.2004.13968.

Guadalupe, C.J., P.S. Robinson, M.J. Schalk, and D.R. Davis. 2020. New county records of amphibians and reptiles from south Texas, USA. *Herpetological Review* 51: 799–803.

Hernandez, J.A., A. Villamizar-Gomez, and M.R.J. Forstner. 2016. Geographic distribution. *Anolis sagrei* (Brown Anole). *Herpetological Review* 47: 627.

Hofmann, E.P., C.R. Jones, and J.G. Hall. 2018. Geographic distribution. *Anolis sagrei* (= *Norops sagrei*). *Brown Anole*. *Herpetological Review* 49: 714.

Kamath, A. and Y.E. Stuart. 2015. Movement rates of the lizard *Anolis carolinensis* (Squamata: Dactyloidae) in the presence and absence of *Anolis sagrei* (Squamata: Dactyloidae). *Breviora* 546: 1–7. https://doi.org/10.3099/0006-9068-546.00.1.

Kamath, A., Y.E. Stuart, and T.S. Campbell. 2013. Behavioral partitioning by the native lizard *Anolis carolinensis* in the presence and absence of the invasive *Anolis sagrei* in Florida. *Breviora* 555: 1–10. https://doi.org/10.3099/MCZB.1.

King, K.K., D. Cavazo, and F.W. Judd. 1987. *Anolis sagrei* (Sauria: Iguanidae) established in southern Texas. *Texas Journal of Science* 39: 289–290.

King, W. and T. Krakauer. 1966. The exotic herpetofauna of southeast Florida. *Quarterly Journal of the Florida Academy of Sciences* 29: 144–154.

Kishinami, M.L. and C.H. Kishinami. 1996. New records of lizards established on Oahu. *Bishop Museum Occasional Papers* 46: 45–46.

Krusling, P.J., J.W. Ferner, and J. Patterson. 1995. Geographic distribution. *Anolis sagrei* (Brown Anole). *Herpetological Review* 26: 108.

Lieto, M.J. and R.L. Burke. 2019. Tracking the spread of six invasive amphibians and reptiles using the geographic distribution records published in *Herpetological Review*. *Herpetological Review* 50: 474–479.

Mahdr, C.R., E.L. Ervin, and G. Naifs. 2014. Geographic distribution. *Anolis sagrei* (Brown Anole). *Herpetological Review* 45: 658–659.

McAllister, C.T., S.E. Trauth, and C.S. Harris. 2003. Geographic distribution. *Anolis sagrei* (Brown Anole). *Herpetological Review* 34: 261.

McCoid, M.J. 2006. Geographic distribution. *Norops sagrei* (Brown Anole). *Herpetological Review* 37: 361.

McKeeon, S. 1996. *A Field Guide to Reptiles and Amphibians in the Hawaiian Islands*. Diamond Head Publishing Co., Los Osos, California, USA.

McMartin, D.C. 2016. Geographic distribution. *Anolis sagrei* (Brown Anole). *Herpetological Review* 50: 474–479.

Meshaka, W.E., Jr., S.L. Collins, R.B. Bury, and M.L. McCallum. 2002. *Exotic Amphibians and Reptiles of the United States*. University Press of Florida, Gainesville, Florida, USA.

Mitchell, J.C. 1982. Geographic distribution. *Anolis sagrei* (Brown Anole). *Herpetological Review* 13: 80.

Nicholson, K.E. 2002. Phylogenetic analysis and a test of the current infrageneric classification of *Norops* (beta Anole). *Herpetological Monographs* 16: 93–120. https://doi.org/10.1655/0733-1347(2002)016[0093:PAAHHT]2.0.CO;2.

Norval, G., G. Wang, J. Mao, L. Liu, M. Chiang, Y. Yang, K. Slater, and L.R. Brown. 2016. The known distribution of an invasive lizard, the brown anole (*Anolis sagrei* Duméril & Bibron, 1837), in Taiwan. *Reptiles & Amphibians* 23: 62–67. https://doi.org/10.17161/rannda.v23i1.14101.
Peterson, A.T. 2003. Predicting the geography of species’ invasions via ecological niche modeling. *The Quarterly Review of Biology* 78: 419–433. https://doi.org/10.1086/378926.

Platt, S.G. and L.W. Fontenot. 1994. Geographic distribution. *Anolis sagrei* (Brown Anole). *Herpetological Review* 25: 53.

Powell, R. and R.W. Henderson (eds.). 2012. Island lists of West Indian amphibia and reptiles. *Bulletin of the Florida Museum of Natural History* 51: 85–166.

Powell, R., R. Conant, and J.T. Collins. 2016. *Peterson Field Guide to Reptiles and Amphibians of Eastern and Central North America*. 4th ed. Houghton Mifflin Harcourt, Boston, Massachusetts, USA.

Pyron, R.A., F.T. Burbrink, and T.J. Guiher. 2008. Claims of potential expansion throughout the U.S. by invasive python species are contradicted by ecological niche models. *PLoS ONE* 3: e2931. https://doi.org/10.1371/journal.pone.0002931.

Rabe, R.W., R.L. Powell, C.J. Claunch, and E.O. Montalvo. 2012. Geographic distribution. *Anolis sagrei* (Brown Anole). *Herpetological Review* 43: 304.

Reed, A.R. and T.J. LaDuc. 2012. Geographic distribution. *Anolis sagrei* (Brown Anole). *Herpetological Review* 43: 444.

Saez, D., J.B. Pierce, J.D. Childress, C.K. Adams, and A.A. Grady. 2013. Geographic distribution. *Anolis sagrei* (Brown Anole). *Herpetological Review* 44: 474.

Sater, N.M. and C.E. Smith. 2018. *Anolis carolinensis* (Green Anole). Interspecific mating. *Herpetological Review* 49: 114–115.

Savage, J.M. and C. Guyer. 1989. Infrageneric classification and species composition of the anole genera, *Anolis, Ctenonotus, Dactyloa, Norops* and *Semiurus* (Sauria: Iguanidae). *Amphibia-Reptilia* 10: 105–115.

Steffen, J. and R. Birkhead. 2007. Geographic distribution. *Norops sagrei* (Brown Anole). *Herpetological Review* 48: 353.

Steffen, J.E. and K.J. McGraw. 2009. How dewlap color reflects its carotenoid and pterin content in male and female brown anoles (*Norops sagrei*). *Comparative Biochemistry and Physiology Part B: Biochemistry and Molecular Biology* 154: 334–340. https://doi.org/10.1016/j.cbpb.2009.07.009.

Stroud, J.T., S.T. Giery, and M.E. Outerbridge. 2017. Establishment of *Anolis sagrei* on Bermuda represents a novel ecological threat to critically endangered Bermuda skinks (*Platynotus longirostris*). *Biological Invasions* 19: 1723–1731. https://doi.org/10.1007/s10530-017-1389-1.

Sung, S., Y. Kwon, D.K. Lee, and Y. Cho. 2018. Predicting the potential distribution of an invasive species, *Solenopsis invicta* Buren (Hymenoptera: Formicidae), under climate change using species distribution models. *Entomologica Research* 48: 505–513. https://doi.org/10.1111/1748-5967.12325.

Swanson, C.L., R.L. Swanson, and J.E. Lee. 2014. Geographic distribution. *Anolis sagrei* (Brown Anole). *Herpetological Review* 45: 91.

Thomas, R.A., P.J. Thomas, J.O. Coulson, and T. Coulson. 1990. Geographic distribution. *Anolis sagrei* (Brown Anole). *Herpetological Review* 21: 22.

Turnbough, N.W. 2006. Geographic distribution. *Norops (= Anolis) sagrei* (Brown Anole). *Herpetological Review* 37: 361.

Vásquez-Cruz, V., A. Reynoso-Martínez, A. Fuentes-Moreno, and L. Canseco-Márquez. 2020. The distribution of Cuban Brown Anoles, *Anolis sagrei* (Squamata: Dactyloidae), in Mexico, with new records and comments on ecological interactions. *Reptiles & Amphibians* 27: 29–35. https://doi.org/10.17161/randa.v27i1.14442.

Vásquez-Cruz, V., A. Reynoso-Martínez, A. Fuentes-Moreno, E.M. Pérez-Gámez, A. Kelly-Hernández, S.M. Rovito, and J.L.C. Juárez. 2021. New records of the introduced snake *Indotyphlops braminus* (Squamata: Typhlopidae) in the state of Veracruz, Mexico. *Revista Latinoamericana de Herpetología* 4: 192–196. https://doi.org/10.22201/fc.25942158e.2021.02.258.

Williams, E.E. 1969. The ecology of colonization as seen in the zoogeography of anole lizards on small islands. *The Quarterly Review of Biology* 44: 545–589. https://doi.org/10.1086/406245.

Wood, A. 2010. Geographic distribution. *Anolis (= Norops) sagrei* (Brown Anole). *Herpetological Review* 41: 243.