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STATUS AND GEOGRAPHIC EXPANSION OF THE MEDITERRANEAN GECKO, *HEMIDACTYLUS TURCICUS*, IN LOUISIANA: IMPLICATIONS FOR THE SOUTHEASTERN UNITED STATES

WALTER E. MESHAKA, JR.[1], SAMUEL D. MARSHALL[2], JEFF BOUNDY[3], and AVERY A. WILLIAMS[4]

[1]Section of Zoology and Botany, State Museum of Pennsylvania, 300 North Street, Harrisburg, PA 17011, USA
[2]Department of Biological Sciences, Northwestern State University, 317 Bienvenu Hall, Natchitoches, LA 71497, USA
[3]Louisiana Department of Wildlife & Fisheries, P.O. Box 98000, Baton Rouge, LA 70898-9000, USA
and
[4]Division of Sciences, Louisiana State University at Eunice, P.O. Box 1129, Eunice, LA 70535, USA
e-mail: wmeshaka@state.pa.us

***Abstract.*—We used literature records, unpublished museum records, and unvouchered reports to evaluate the status of the Mediterranean gecko (*Hemidactylus turcicus*) in Louisiana since its last comprehensive treatment in 1989. During the last 17 years, the known geographic range of this species has expanded from four to 30 parishes following a pattern that is commensurate with extensive human-mediated dispersal. Its strong association with, and use patterns of, buildings in Louisiana are similar to those of the species elsewhere. Potentially limiting competitors and predators have not been identified in urban settings. Potential for competition with hylid treefrogs in ruderal settings remains unresolved, and in many urban settings the potential for syntopy is low. Louisiana and the southeastern United States in general are amenable to colonization by *H. turcicus* with the northern edge of its geographic range being dictated by climate. However, the future status of this species within the southeastern United States will be strongly influenced by the thermal tolerances of a suite of recent and competitively superior gecko species that displace this species in Texas and Florida.**

Key Words.—exotic species; *Hemidactylus turcicus*; invasive species; Mediterranean Gecko

INTRODUCTION

Exotic species constitute a global issue (Mooney and Hobbs 2000; Van Driesche and Van Driesche 2000) of which 276 species are amphibians and reptiles (Lever 2003; Meshaka et al. 2004; Meshaka 2006). Using the criteria of Meshaka and colleagues (2004), 48 exotic species of amphibians and reptiles are established in the southeastern United States (Conant and Collins 1998; Ferner and Ferner 2002; Lever 2003; Hardy 2004; Meshaka et al. 2004; Wallace 2005; Meshaka 2006). In the southeastern United States, the Mediterranean Gecko (*Hemidactylus turcicus*) occurs in Alabama (Conant and Collins 1998), Arkansas (Paulissen and Buchanan 1990, 1991; White and Tumlison 1999; Manning and Briggler 2003; Sheehy 2004; Trauth et al. 2004), Florida (Conant and Collins 1998; Johnson et al. 2002; McCoid 2002; Townsend et al. 2002; Townsend and Krysko 2003; Meshaka et al. 2004; Krysko et al. 2005), Georgia (Mills 1990; Frick 1997; Conant and Collins 1998), Louisiana (Dundee and Rossman 1989; Conant and Collins 1998), Mississippi (Conant and Collins 1998), South Carolina (Eason et al. 2000), and (for eastern) Texas (Conant and Collins 1998; Malone 1998; Saenz 1998; McAllister and Welsh 2001; McAllister 2004). This species is also possibly established in Virginia (Kleopfer et al. 2006).

Hemidactylus turcicus is also the oldest of four species comprising the exotic herpetofauna of Louisiana: the Greenhouse Frog (*Eleutherodactylus planirostris*) (Dundee and Rossman 1989), the Brahminy Blind Snake (*Ramphotyphlops braminus*) (Thomas 1994), and the Rio Grande Chirping Frog (*Syrrhophus cystignathoides*) (Hardy 2004). Like *E. planirostris*, present in New Orleans Parish since 1975 (Plotkin and Atkinson 1979), *H. turcicus* was believed to be present in the same parish since the 1940s (Etheridge 1952; Viosca 1957); its colony, likewise, was thought to be derived from trade along the Mississippi River (Etheridge 1952). Since the work of Dundee and Rossman (1989), *H. turcicus* has been reported elsewhere in Louisiana (Jensen and George 1993; Vidrine and Hatler 1995; Boundy 1994; Burke 1996; Watkins-Colwell et al. 1996; Ray and Cochran 1997; Williams 1997; Boundy 2004; Hardy et al. 2005).

Our objectives are to summarize the status and colonization dynamics of *H. turcicus* in Louisiana and relate our findings to the colonization patterns of this species elsewhere in the Southeast and more generally to ecological correlates of colonization success noted in other species (Mayr 1965; Brown 1989; Ehrlich 1989; Pimm 1989).

MATERIALS AND METHODS

We examined historical records (following Dundee and Rossman 1989), published records since Dundee and Rossman (1989), unpublished museum records, and reports (reliable observations) of *H. turcicus* in Louisiana through April 2006. We used the locality data to produce a geographic distribution map for Louisiana (Fig. 1). During 14-16 October 2005, two of us (WEM and SDM) conducted a nighttime survey of buildings centered in the immediate vicinity of 300 South Drive, Natchitoches, Natchitoches Parish, Louisiana. We deposited all specimens of *H. turcicus* collected for this study in the vertebrate collection of Northwestern State University in Natchitoches.

RESULTS AND DISCUSSION

***Temporal and spatial patterns of dispersal.*—**Since the first summary (Dundee and Rossman 1989), 13 new records (Jensen and George 1993; Vidrine and Hatler 1995; Boundy 1994; Burke 1996; Ray and Cochran 1997; Williams 1997; Boundy 2004;

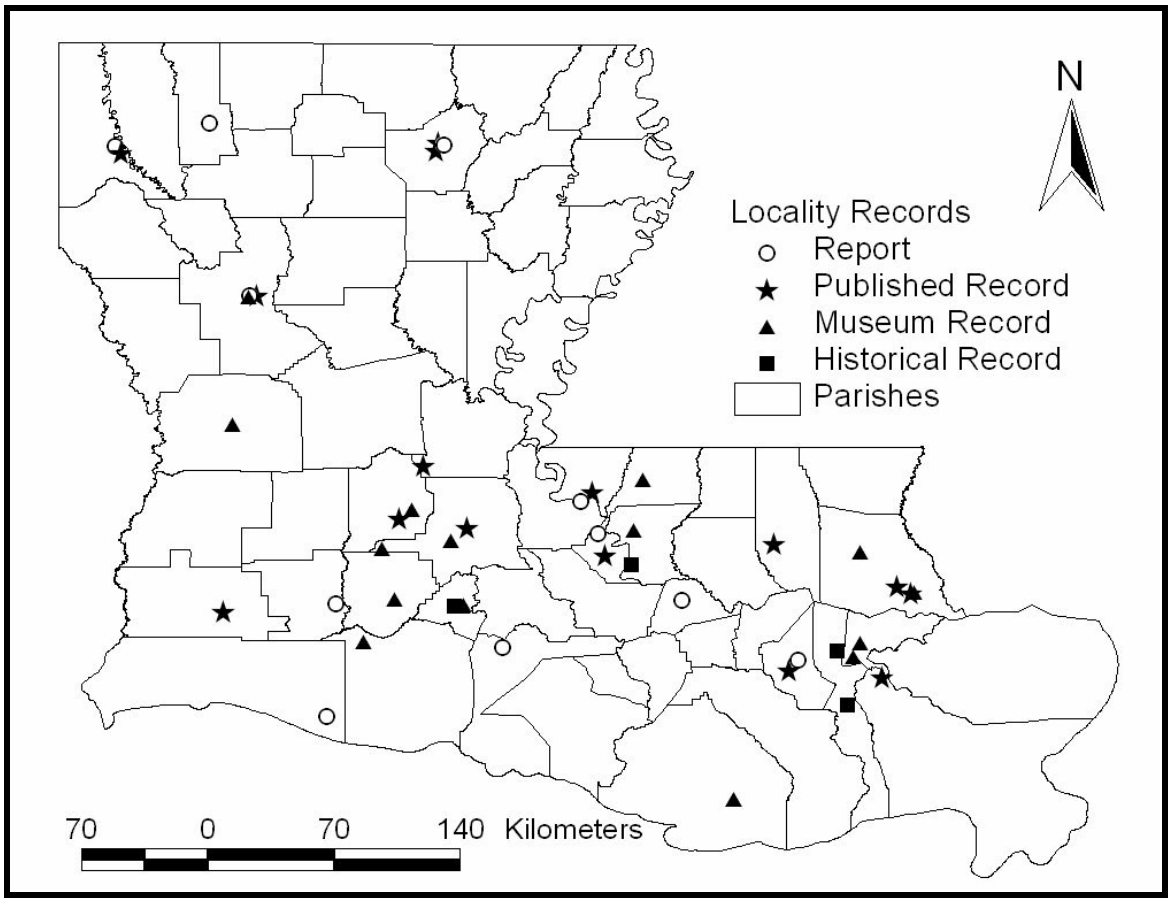

FIGURE 1. Geographic distribution of the Mediterranean gecko (*Hemidactylus turcicus*) in Louisiana.

Hardy et al. 2005) and one duplicate record (Watkins-Colwell et al. 1996) have been published on the distribution of *H. turcicus* in Louisiana. All records were published within 12 years of each other (1993-2005), and captures ranged over a 38-year span (1963-2001) suggesting colony ages were noticeably older than the initial captures from the 1990s.

The spatial disparity of museum records (we include LSUMZ 14166, 45974, 56767, 57657, 59593, 80354; LSUE 0044, 0069, 0331, 0646, 0961, 1021, 1258, 1475, 2163, 2319) and reports suggests an even greater geographic distribution than revealed by our map (Fig.1). Elsewhere in the United States, *H. turcicus* has a scattered geographic distribution often attributed to human-mediated dispersal (Conant and Collins 1998; Meshaka et al. 2004; Trauth et al. 2004). Some of the earliest known records are from port cities, such as Key West (Fowler 1915), New Orleans (Etheridge 1952), and Brownsville (Conant 1955). Many records, including those here, are associated with cities and universities (Davis 1974; Mount 1975; Marion and Bosworth 1982; Selcer 1986; Nelson and Carey 1993; Punzo 2001a; Meshaka et al. 2004; Trauth et al. 2004). These sites also offer the likelihood of intentional—examples have been observed by one of us (Jeff Boundy)—and unintentional human-mediated dispersal. In Louisiana, sites such as Shreveport and Natchitoches to the north, Alexandria in the central region, and Lake Charles, Lafayette, and New Orleans to the south are trade routes that could easily serve as intrastate sources of gecko colonies as well as eventual two-way sources of colonies most readily with east Texas. In this connection, the northward dispersal of *H. turcicus* from Brownsville, Texas, followed major highways with produce trucks being the likeliest dispersal agents (Davis 1974). In south-central Florida, *H. turcicus* colonies also followed major trucking routes (Meshaka 1995). More specifically, Selcer (1986) thought that because of low individual vagility, a trait also noted in Louisiana (Rose and Barbour 1968) and Florida (Punzo 2001), eggs were the more likely life cycle stage to be transported incidentally by humans.

High vagility is a correlate of successful colonization (Ehrlich 1989). For *H. turcicus*, a high rate of human-mediated dispersal is responsible for the rapid and scattershot dispersal pattern of this species in Louisiana and elsewhere with each new colony increasing the likelihood of future dispersal events.

Habitat preference.—Successful dispersal of *H. turcicus* to Louisiana cities is due to its strong association with buildings (Rose and Barbour 1968; Dundee and Rossman 1989). In all but one subsequent Louisiana distribution record for which habitat is described, *H. turcicus* is associated with buildings. Unlike the other sites, the St. Charles Parish record (Boundy 2004) was associated with construction debris that had been dumped in a swamp. In Louisiana, we saw individuals mostly on buildings, especially those made of brick or cement. Wood sidings of such buildings are also used. One of us (Jeff Boundy) observed two exceptions: (1) juvenile individuals at dusk on sidewalks located more than 10 m from houses; and (2) six adults captured from a

TABLE 1. Relative abundances of the Mediterranean Gecko (*Hemidactylus turcicus*) observed at selected sites in the southern United States.

Location	Observations (Geckos/Min)	Source
Alabama		
Fairhope	0.13	(Nelson and Carey, 1993)
Mobile	0.08	(Nelson and Carey, 1993)
Florida		
Panama City	0.03	(Nelson and Carey, 1993)
Pensacola	0.08	(Nelson and Carey, 1993)
Louisiana		
New Orleans	7.2	(Dundee and Rossman, 1989)
Natchitoches	0.6	(This study 15 Oct 2005)
Natchitoches	0.8	(This study 16 Oct 2005)
Mississippi		
Gulfport	0.05	(Nelson and Carey, 1993)
Texas		
Edinburg	0.21	(Selcer, 1986)

dead pecan tree in a large mowed area ca. 33 m from brick buildings. Rose and Barbour (1968) also observed juveniles on sidewalks. A nearly exclusive association with buildings, especially those associated with rough surfaces (Nelson and Carey 1993), has also been noted elsewhere in the United States (Paulissen and Buchanan 1991; Meshaka 1995; Punzo 2001a; Meshaka et al. 2004).

Hemidactylus turcicus populations in Natchitoches, as elsewhere (Table 1; Selcer 1986; Punzo 2001a; Hibbs et al. 2004) vary widely in size and can be exceedingly dense. Preferred habitat in the southeastern United States is a combination of masonry buildings with dim incandescent lighting (Nelson and Carey 1993). Such might be the case in stone masonry crypts of cemeteries favored by this species in New Orleans (Rose and Barbour 1968). Differences in population size, thought to be affected by prey abundance, are also associated with differences in body length and condition of the geckos (Hibbs et al. 2004). In turn, spiders, roaches, and crickets (Nelson and Carey 1993) and, more specifically nocturnal wolf spiders and crab spiders (Punzo 2005), decline in the presence of *H. turcicus*.

Coexistence with humans is a correlate of colonization success (Brown 1989). For *H. turcicus*, a close association with human-made structures has provided it with an abundance of potentially high quality habitat in Louisiana and elsewhere in the southeastern United States that simultaneously functions as sources for further dispersal.

Potential competitors.—During our searches in Natchitoches, all individuals we encountered were in areas away from non-incandescent lights, a phenomenon also noted by Nelson and Carey (1993). The species avoids direct light, favoring partial light and darkness (Paulissen and Buchanan 1991; Nelson and Carey 1993). Likewise, we found individuals not only in dark areas but not in even peripherally-lighted areas that could provide superior sources of insect prey. This behavioral limitation is absent in its superior competitive congeners, the Indo-Pacific Gecko (*Hemidactylus garnotii*) and the Wood Slave (*Hemidactylus mabouia*) in Florida (Meshaka et al. 2004), each with differential colonization traits (Punzo 2005). Although the mechanisms for its replacement by *H. garnotii* and *H. mabouia* in Florida are unknown (Meshaka et al. 2004), *H. turcicus* is socially dominated by *H. garnotii* (Frankenburg 1984) and has a lower fecundity and narrower habitat range than its two congeners (Meshaka et al. 2004 and citations therein). Also, digestive and assimilation efficiencies and the rate of its gastric evacuation in *H. turcicus* are lower than those of *H. mabouia* (Punzo 2001b). Perhaps, the aversion of *H. turcicus* to bright incandescent lights and non-incandescent lights (e.g., fluorescent and orange sodium vapor lights) (Nelson and Carey 1993; this study), even when alone, may be added to the list of disadvantages contributing to its sharp decline in Florida.

The species is a dietary generalist in Florida (Punzo 2001a; Meshaka et al. 2004), Louisiana (Rose and Barbour 1968), and Texas (Saenz 1996). Its diet varies seasonally (Rose and Barbour 1968) and spatially on building walls (Saenz 1996). However, in Texas, it is replaced by the Roughtail Gecko (*Cyrtodactylus scaber*), concomitant with behavioral (Vaughan et al. 1996) and dietary shifts (Klawinski et al. 1994). Urban settings often have many poorly occupied niches decreasing the opportunities for competition between hylids and geckos. The potential for food competition between *H. turcicus* and arboreal hylids in this setting where syntopy is possible in Louisiana as well as in ruderal settings remains an unresolved topic. In southern Florida, dietary overlap is high between the Green Treefrog (*Hyla cinerea*) and the Squirrel Treefrog (*H. squirella*); whereas, dietary overlap ranges from low to intermediate between the treefrogs and two syntopic hemidactyline gecko species (Meshaka 2001). Open niche space is a correlate of successful colonization (Brown 1989). For *H. turcicus*, this correlate appears to be met in Louisiana; however, in Florida and Texas this species is gradually being displaced by other exotic geckos.

Predators.—No reported limiting predators of *H. turcicus* are known in Louisiana. In Florida, it is preyed upon by spiders, whip scorpions, cats, bats, and Cuban Treefrogs (*Osteopilus septentrionalis*) (Punzo 2001a). Yet, even under those circumstances, population densities of *H. turcicus* can still be high (Punzo 2001a). In Natchitoches, Louisiana, we observed none of the adults near the ground. Similarly, adults in Florida are generally found higher on walls and also found in the vicinity of refuges more often than subadults (Gomez-Zlatar and Moulton 2005). Subadults and juveniles were preyed on by cats when ascending buildings in the evening and at normal foraging times, subadults and adults are generally within 33 cm of porch ceilings (Jeff Boundy, pers. obs.). In Arkansas, most individuals were found higher than 4.5 m above the ground (Paulissen and Buchanan 1991). Predator-free space is a correlate of successful colonization (Pimm 1989). For *H. turcicus*, predators are not as well documented in Louisiana as they are elsewhere and truly limiting predators of this species do not yet appear to have been identified. Like *O. septentrionalis* in Florida (Meshaka 2001), *H. turcicus* in Louisiana might be relatively free of predators in some places and able to flourish in other places even with a suite of predators that also eat one another and do not specialize in eating this small nocturnal vertebrate.

Cold tolerance.—Louisiana populations are active in ambient temperatures as low as 3.3^{o} C (Rose and Barbour 1968; Dundee and Rossman 1989.). This ability, combined with the thermal inertia associated with brick and concrete buildings may allow

colonies to persist in northern Louisiana (this study), in northern Arkansas (Paulissen and Buchanan 1991; Trauth et al. 2004) and central Oklahoma (Conant and Collins 1998). The cost, at least in northwest Arkansas as compared to more southerly populations (Rose and Barbour 1968; Selcer 1986; Meshaka 1995; Punzo 2001a), is an abbreviated egg-laying season and more seasonal limitations to foraging activity on the exterior of buildings where most individuals were seen (Paulissen and Buchanan 1991). Thus, in the southeastern United States, especially in lower elevations, climate provides a weak constraint to the colonization of *H. turcicus*. Ultimately, however, colder climate farther north will determine the northern distributional range of this species at a point where not enough time is available for breeding or foraging. Tolerance of a wide range of physical conditions is a correlate of successful colonization (Mayr 1965). For *H. turcicus*, the ability to function across a wide thermal gradient has contributed to its northern expansion in Louisiana and the southeastern United States in general.

Our study corroborated several characteristics of Louisiana *H. turcicus*: High vagility in the agency of humans, near exclusive association with buildings or building materials, an apparent open niche space in urban areas, potentially predator-free in some areas, and the ability to remain active at low ambient temperatures. These aforementioned characteristics conform to predictions of successful colonization. Rapid dispersal over wide areas and the potentially high abundance of *H. turcicus* are measures of its colonization success both in Louisiana and elsewhere in the southeastern United States. However, as this species has been replaced by recently introduced competitively superior geckoes in Texas and Florida, in addition to climate, its geographic distribution in the southeastern United States will be affected by the ultimate range expansion of its competitors. In this regard, *H. turcicus* could potentially be extirpated from the southeastern United States if its thermal tolerances are exceeded by those of its competitors.

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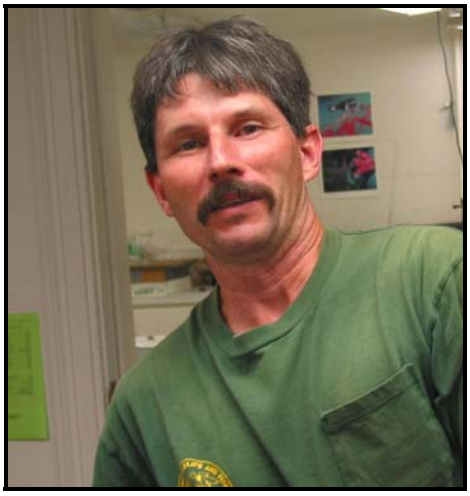
WALTER E. MESHAKA, JR. is the Senior Curator of Zoology and Botany at the State Museum in Harrisburg, PA. His research interests in herpetology combine field and museum techniques that center around the ecology of native and exotic eastern North American amphibians and reptiles. Photographed by Robert Mulvihill of Powdermill Nature Reserve (Carnegie Museum Natural History).

SAMUEL D. MARSHALL is Assistant Professor in the Department of Biological Sciences at the Northwestern State University of Louisiana in Natchitoches. His research interests focus on the evolutionary and ecological factors that shape ecological communities using spiders as the primary model organism.



JEFF BOUNDY, PhD, is a herpetologist with the Louisiana Department of Wildlife and Fisheries. Aside from watching Mediterranean Geckos on his house at night, he is interested in all aspects of herpetological natural history. Photographed by Frank Burbrink, College of Staten Island/CUNY.

AVERY A. WILLIAMS is an associate professor of biology, the biology coordinator, and the curator of vertebrates at Louisiana State University at Eunice. Since fall 1993, he has been teaching zoology courses at LSU-E and, on occasion, biology and herpetology courses at McNeese State University as a guest lecturer. Williams holds two degrees from McNeese State University, B.S. in Zoology and M.S. in Biology. While at LSU-E, Williams has been the recipient of an Endowed Professorship Award in the Division of Sciences, and the Teaching Excellence Award. His research interests and published works include the behavioral physiology and ecology of amphibians, and the natural history of the vertebrates of Louisiana. As an active researcher, Williams enjoys working with students as he has directed a wide variety of undergraduate research projects in the natural sciences. Several students working with Williams have presented and/or published their research at state and national professional meetings.