



# Mites (*Geckobia hemidactyli*, Actinedida: Pterygosomatidae) in Tropical House Geckos (*Hemidactylus mabouia*) in Cuba: A Review with New Distribution Records

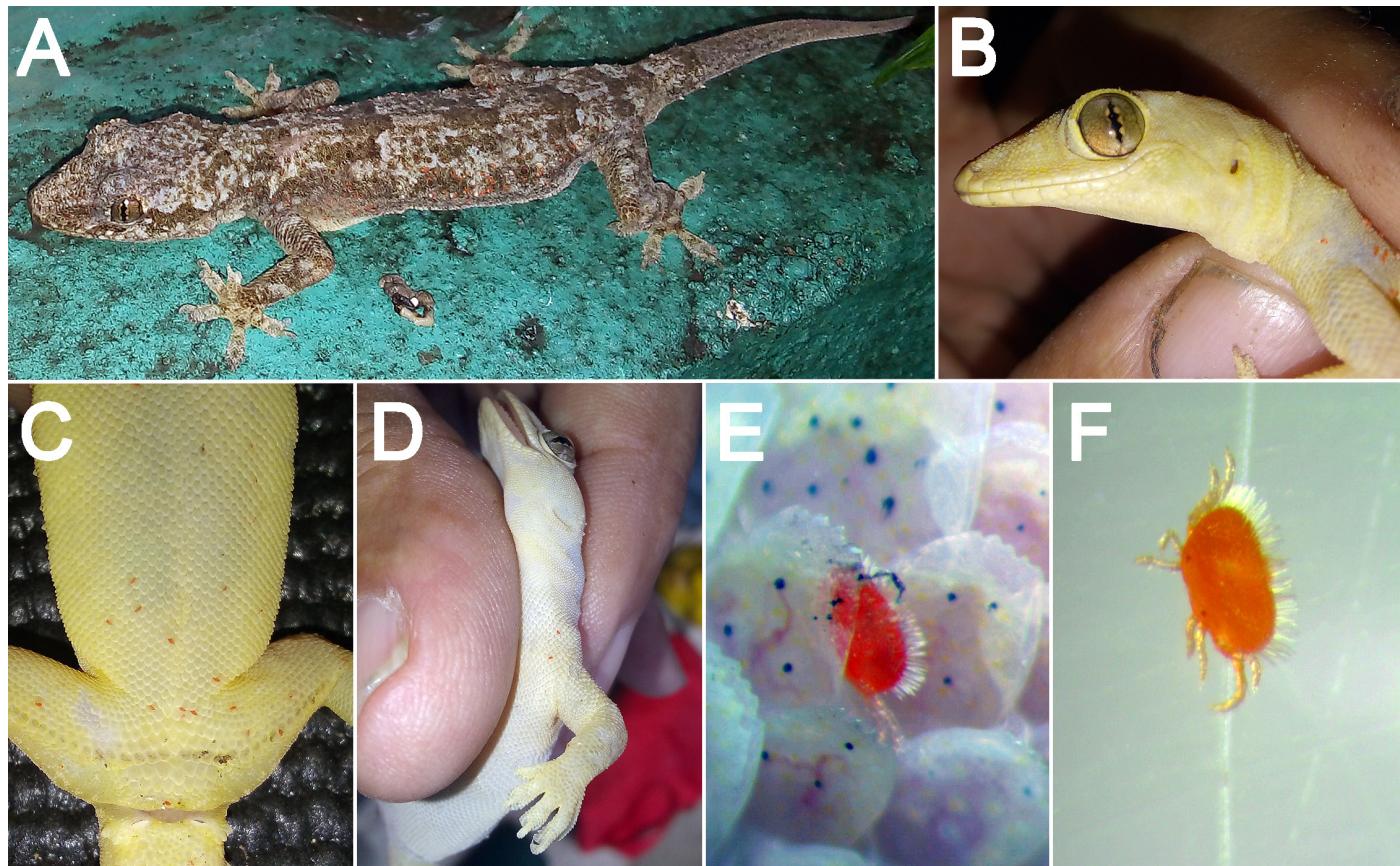
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The Tropical House Gecko (*Hemidactylus mabouia*) is the most abundant of Cuba's four introduced species in the genus *Hemidactylus*. *Hemidactylus mabouia* is distributed

across Cuba and its satellite islands and is particularly abundant in urban and rural areas (Borroto-Páez et al. 2015). It is considered invasive throughout the Caribbean and in most



**Fig. 1.** Tropical House Geckos (*Hemidactylus mabouia*) infected with parasitic mites (*Geckobia hemidactyli*) collected in three localities in northern Cuba. (A) A gecko photographed on 10 June 2019 on a building in Víbora, Municipality of Diez de Octubre, La Habana Province (No. 2 on the map in Fig. 2) with a number of mites on its flank. (B and C) A gecko collected in January 2020 in an apartment in Corralillo, Villa Clara Province (No. 4 on the map) with mites in front of its eye, on its shoulder, and on its venter. (D) A gecko collected on 20 February 2020 in a house on Playa Rincón de Guanabo, Mayabeque Province (No. 3 on the map) with mites on the shoulder and forelimb. (E) A mite (*Geckobia hemidactyli*) embedded beneath a ventral scale of the gecko from Rincón de Guanabo. (F) A mite detached from the same host photographed through a microscope. Photographs by Rafael Borroto-Páez.

of the tropical and subtropical climates it has colonized outside of its natural African range (Powell et al. 1998, 2011; Weterings and Vetter 2018).

These invasive geckos can exert numerous direct and indirect effects in the habitats they colonize through predation and interference competition with native species (Rivero 1978; Powell 2004; Meshaka 2001; Iturriaga and Marrero 2013; Borroto-Páez and Reyes Pérez 2019). In some cases, they can be considered a nuisance by having a negative effect on the human economy (Borroto-Páez and Reyes Pérez 2020) and potentially by playing a role in the spread of dengue fever by preying on spiders that act as a natural biological control of *Aedes* mosquitoes (Weterrings et al. 2019). The establishment of invasives also can affect native species by spreading non-native parasites and diseases (Murphy and Myers 1993; Goldberg et al. 1998; Goldberg and Bursey 2000; Kraus 2009; Dunn et al. 2012; Dunn and Hatcher 2015; Jiménez Quirós 2014; Weterings et al. 2019).

Mites and ticks are vectors of several infectious diseases (e.g., dermatitis and anemia) and can have a direct impact on the health of their native hosts (Fajfer, 2012) as well as serve as intermediary hosts to internal parasites (Norval et al. 2014). However, the effects that introduced ectoparasites hitchhiking on invasive species could have on new native hosts has not been assessed effectively in any of the areas invaded by their hosts (Kraus 2009). More importantly, parasites often are key players in the invasion process of their hosts; they can mediate the outcome and impact of invasions or might themselves be invasive species (Dunn 2009; Tompkins et al. 2011), thus identifying their presence along with the invasive host species is of utmost importance.

Pterygosomatid mites, such as *Geckobia* spp., are ubiquitous in some populations of geckos in the genus *Hemidactylus* but are rarely reported when new localities of these invasive geckos are identified. At least two species of *Geckobia* have been reported on Cuban lizards but have not been widely or systematically studied. The first record of *Geckobia* in Cuba was the description of a new species (*G. tarentolae*) parasitizing the native gecko *Tarentola americana* by de la Cruz (1973). The second report documented the presence of *G. hemidactyli* on twenty Tropical House Geckos collected at the U.S. Naval Station at Guantanamo Bay (Martínez Rivera et al. 2003). Five species of pterygosomatid mites have been reported from Cuba (Paredes-León et al. 2013), but the most recent list of Cuban mites (Torres and Cuervos 2019) did not include records in either de la Cruz (1973) or Martínez Rivera et al. (2003).

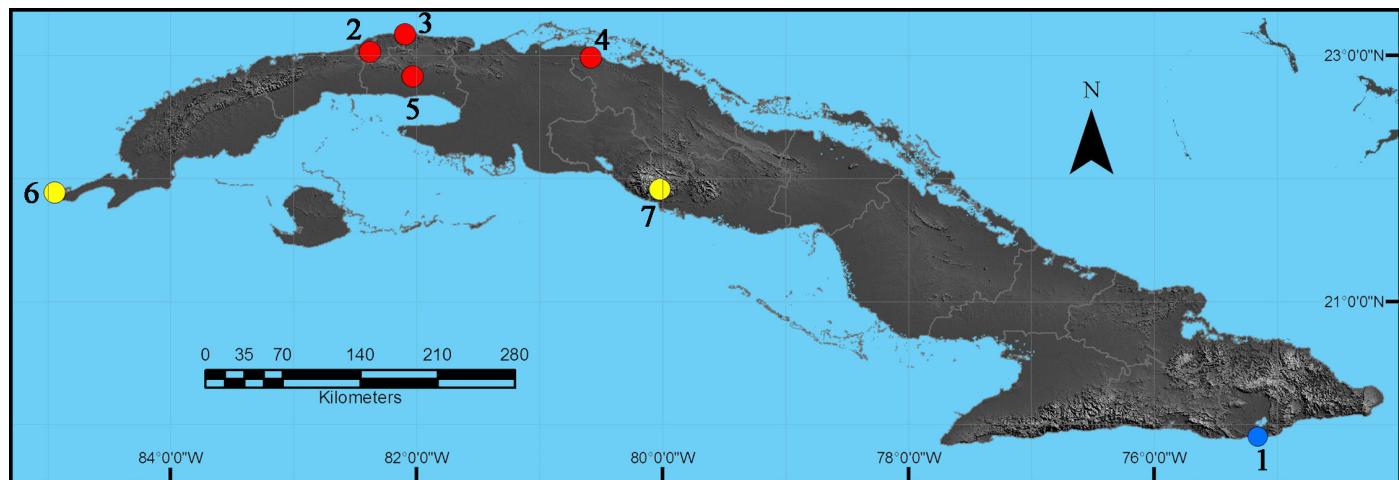
Within the family Pterygosomatidae, the genus *Geckobia* Mégnin 1878 exhibits the widest geographic distribution (Machado et al. 2019). It comprises 73 species that parasitize lizards of different families (Gekkonidae, Phyllodactylidae, Carphodactylidae, Diplodactylidae, and Eublepharidae) in the infraorder Gekkota (Fajfer 2012; 2018) but also in lizards in the family Liolaemidae (Fajfer and González Acuña

2013) and in some turtles (Bauer et al. 1990). Twelve species of *Geckobia* have been recorded in the Americas. Of these, three are considered exotic hitchhikers that arrived with invasive lizard hosts: *Geckobia bataviensis* (Vitzthum 1926) and *G. keegani* (Lawrence 1953) with *Hemidactylus frenatus* (Díaz et al. 2020) and *G. hemidactyli* (Lawrence 1936) with *H. mabouia* (Martínez Rivera et al. 2003).

*Geckobia hemidactyli* is a common ectoparasite of *Hemidactylus mabouia* and has been recorded from several localities in the Western Hemisphere, suggesting that its entry occurred with the introduction of its host. To date, the presence of *G. hemidactyli* in the Americas has been found only on *H. mabouia*, and no other pterygosomatid mites have been identified from live hosts (Martínez Rivera et al. 2003). Although Martínez Rivera et al. (2003) reported finding *Geckobia* mites in museum specimens of *H. frenatus*, those mites were never keyed to species and the geckos came from areas where *H. mabouia* is not present, and as such they should be treated as *Geckobia* sp. A first report confirmed the presence of these mites in the Americas by visual inspection of live *H. mabouia* from Puerto Rico and by studying preserved specimens of *H. mabouia* from several American localities deposited in the herpetology collection at the Natural History Museum of the University of Kansas by one of the authors (Martínez-Rivera). In that study, mites were found on *H. mabouia* collected from Puerto Rico (live and museum specimens) and from museum specimens from Antigua, Cuba (Guantanamo only), Culebra (Puerto Rico), Dominica, Grenada, Guadeloupe, Isla de Mona (Puerto Rico), St. Eustatius, St. Lucia, Tortola (British Virgin Islands), Vieques (Puerto Rico), the U.S. Virgin Islands (St. Croix, St. John, St. Thomas, and other localities), Colombia, and northern Brazil (Martínez Rivera et al. 2003). A second study confirmed its presence in the mainland United States (Corn et al. 2011).

As noted above, the only reports of *Geckobia hemidactyli* in the Cuban Archipelago came from mites in a collection jar of 20 *Hemidactylus mabouia* that had been collected at the U.S. Naval Base at Guantanamo Bay in southeastern Cuba between 1965 and 1969 and deposited in a U.S. herpetological collection (Martínez Rivera et al. 2003). Reports of *G. hemidactyli* from live specimens of *H. mabouia* collected elsewhere in Cuba or from specimens deposited in Cuban museums were absent until recently and are listed chronologically.

Our first observation of orange mites on a live *H. mabouia* from Cuba was in June 2019 in a small yard in front of the senior author's (RBP) home in Víbora, La Habana Province. RBP took photographs of the gecko and only later noticed the presence of numerous groups of orange ectoparasites in the lateral view of the animal while curating the images (Fig. 1A). After this initial observation, we began paying attention to all house geckos detected in the region and reviewed the limited literature and anecdotal information available on ectopic mites reported on Cuban herpetofauna. A few days later, we



**Fig. 2.** Map of Cuba showing localities where mites (*Geckobia hemidactyli*) are known to infect Tropical House Geckos (*Hemidactylus mabouia*) or where geckos were free of mites. (1) Mites are known to infect geckos at the U.S. Naval Base at Guantánamo Bay (Martínez Rivera et al. 2003), which is marked by a blue dot. Red dots mark four new localities where we found mites infecting geckos: (2) Víboras, Municipality of Diez de Octubre, La Habana Province ( $23^{\circ}05'19''\text{N}$ ,  $82^{\circ}22'40''\text{W}$ ); (3) Playa Rincón de Guanabo, Mayabeque Province ( $23^{\circ}10'20.62''\text{N}$ ,  $82^{\circ}05'48.29''\text{W}$ ); (4) Corralillo region (family apartment and Elguear Hotel) of Villa Clara Province ( $22^{\circ}58'48''\text{N}$ ,  $80^{\circ}36'05''\text{W}$ ); (5) Güines, Mayabeque Province. Yellow dots mark localities where geckos were free of mites: (6) Guanacahabibes Peninsula National Park, Pinar del Río Province; (7), Topes de Collantes National Park, Sancti Spíritus Province.

observed another adult *H. mabouia* at the same locality with similar groups of orange ectoparasites.

Subsequently, RBP reviewed his private collection and selected all photographs of *H. mabouia* taken at multiple locations since 2006. Geckos with *G. hemidactyli* were found in four previous years and at one new locality, the town of Corralillo. Mites were found in 2016 in Corralillo in the axilla and on the sides of hosts, in 2017 at home (RBP) in the axillae, in 2018 in the yard at home (RBP) on the shoulder of a gecko shown in Borroto-Páez and Reyes Pérez (2019) but from an unpublished photograph, and in 2019 in Güines, Mayabeque Province, south of La Habana in a photograph taken at a friend's house. Photographs from 2006 and 2011–2015 do not show *Geckobia* mites in RBP's home or at the Corralillo localities, nor do photographs from 2018 from Guanahacabibes, Pinar del Rio Province, in the extreme west of Cuba, and Topes de Collantes in Sancti Spíritus Province in central and southern Cuba. Given that most of the photographs depict dorsal views of geckos, sometimes showing a bit of the sides, a complete count of all mites present was not possible, especially as the mites tend to preferentially congregate on the venter. Thus, the photographic review is very likely flawed.

We randomly searched for geckos with mites in additional localities along the northern coast of Cuba and inspected any lizard with orange mites. We collected two adult male geckos with *Geckobia hemidactyli* from two different localities, one in the town of Corralillo, in Villa Clara Province (January 2020), a rural area located about 340 km east of Havana (Figs. 1B–C), and one from Playa Rincón de Guanabo, in Mayabeque Province (February 2020) about 25 km east of Havana (Fig. 1D). More recently, in May 2020, we collected and released two *H. mabouia* in the apartment of RBP, a female with six mites on the abdomen and legs, and a mite-free juvenile. All sampled locations are illustrated in Fig. 2.

In August 2020, we collected *H. mabouia* in the family apartment and in the Elguear Hotel, 7 km to the north, both in the Corralillo region of Villa Clara Province. In the family apartment, 23 of 24 geckos had mites (prevalence 95.8%), with only one juvenile (SVL 33.2 mm) free of mites. In the Elguear Hotel, where geckos were abundant, only three of 14 individuals collected (21.4%) had mites, but intensities were very low (1, 2, and 2 mites). The distribution and abundance of mites on the bodies of the 26 infected geckos are provided in Table 1. Relationships (simple linear regression) between

**Table 1.** Distribution and abundance of pterygosomatid mites (*Geckobia hemidactyli*) on the bodies of 26 Tropical House Geckos (*Hemidactylus mabouia*) from the Corralillo region of Villa Clara Province, Cuba; (mean SVL  $\pm$  SE [range] =  $56.9 \pm 1.4$  mm [33.2–66.7 mm]; mean weight  $\pm$  SE [range] =  $4.5 \pm 0.3$  [0.7–7.9]).

	Venter	Forelimbs	Hindlimbs	Axillae	Groin	Flanks	Tail	Neck
n (%)	18 (69.2)	4 (15.4)	18 (69.2)	20 (76.9)	13 (50.0)	21 (80.7)	9 (34.6)	10 (38.4)
Total (range)	151 (1–26)	11 (1–21)	100 (1–15)	131 (1–21)	56 (1–6)	202 (1–38)	18 (1–4)	30 (1–11)
Mean $\pm$ SD	$4.4 \pm 7.6$	$2.4 \pm 2.2$	$3.3 \pm 3.5$	$3.7 \pm 2.7$	$2.4 \pm 1.5$	$6.1 \pm 8.7$	$2.0 \pm 1.3$	$3.0 \pm 3.1$

intensity and body size (SVL) and weight were not significant (SVL:  $r = 0.356$ ,  $t = 1.9$ ,  $P = 0.06$ ; weight:  $r = 0.244$ ,  $t = 1.23$ ,  $P = 0.22$ ).

Mites initially observed and photographed on live hosts were quickly identified by the second author (CCMR) as pterygosomatids, possibly of the genus *Geckobia*. *Geckobia* spp. are mostly parthenogenic and sexually dimorphic, with males being rare and considered neotenic deutonymphs (second-stage larvae). The sexes exhibit distinct behaviors and congregate at different levels of maturity at various locations on the bodies of hosts (Bauer et al. 1990). Mobility is reduced in various life cycles; protonymphs (first-stage larvae), tritonymphs (third-stage larvae), and adults are calyptostasic (quiescent stage), whereas deutonymphs (second-stage larvae) are active (Girot 1969). Mites in the genus are characterized by orange color and the rounded and flat morphology of the idiosoma (= body; average size 200–250  $\mu\text{m}$ ). They position themselves in predictable fashion embedded or attached beneath the ventral scales of the host's body. The mites are quite small and are most easily observed in high infestations. Mites prefer to congregate in the axillae, but also on and near the bases of tails, groins, necks, ventral scales, lamellae of the fingers (especially in gekkotans), and between folds of skin, which matches our observations of the mites occurring on Cuban geckos. These characteristics are generally enough to identify mites in the family Pterygosomatidae and tentatively assign them to the genus *Geckobia* based on host species and locality. Of the three species of mites known to colonize *Hemidactylus* geckos in the Americas, *G. hemidactyli* is the only one reported from live *H. mabouia* and on any host in the Caribbean region (Martínez Rivera et al. 2003).

However, further examination of mites was necessary to confirm the identity to genus and species. We used an Embedded System NSZ-800LCD Microscope to observe additional morphological characteristics and assure proper

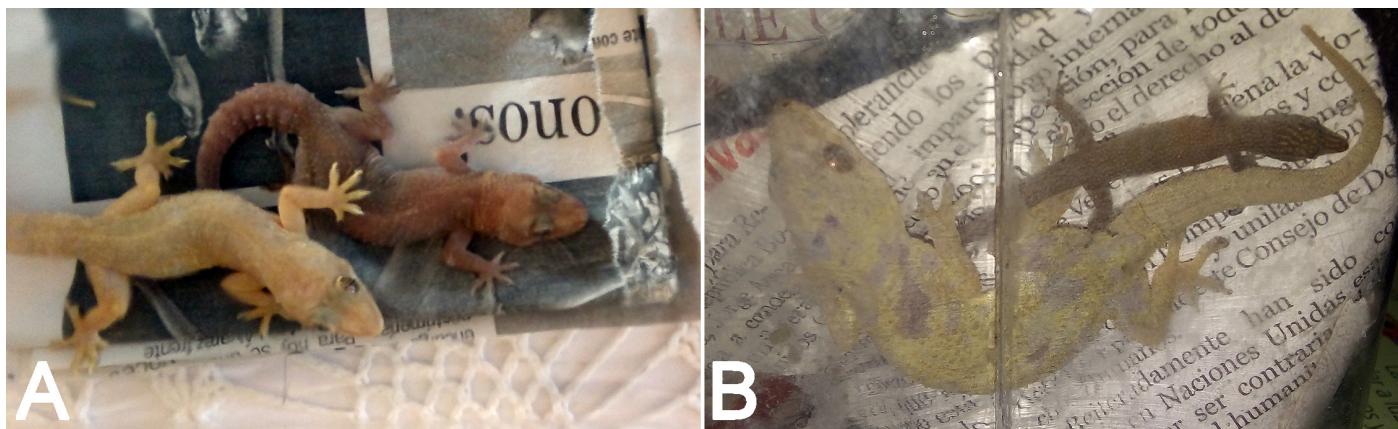
identification (Figs. 1E–F) using the taxonomic key to Cuban species of pterygosomatids in Paredes León et al. (2013). *Geckobia hemidactyli* was identified under the microscope by its inconspicuous dorsal shield and dorsum covered with many short hairs (setae) and by the lateral position of the inconspicuous eyes located on the prodorsal shield.

### Intra- and interspecific transmission of *Geckobia hemidactyli* mites

To test for possible intra- and interspecific transmission of *Geckobia* mites, we confined 13 adult male Tropical House Geckos infected with mites (intensities of 2–41) for 5–15 days with adult conspecifics ( $n = 5$ ), West African House Geckos (*H. angulatus*;  $n = 3$ ; Fig. 3A), and Ashy Geckolets (*Sphaerodactylus elegans*;  $n = 2$ ; Fig. 3B) that were free of mites (Table 2) in ten 2–3-liter containers with corrugated paper as substrate and refugia to facilitate contact between individuals and promote mite transmission.

Geckos were fed daily with small flies and lepidopterans and held at ambient humidity (70–80%) and temperature (25–28°C) in a shaded location. Observations confirmed that geckos in each container were in direct contact with each other on multiple occasions each day. After the observation period, all geckos were checked for ectoparasites, some were released (some *H. mabouia* and *S. elegans*); others killed, preserved in 95% alcohol, and stored in the private collection of the senior author (RBP); and some remain in captivity.

After the tests, animals showed no signs of suffering or stress attributable to the restricted environment or the presence of the other individuals. Neither interspecific test resulted in the transmission of mites; the Tropical House Geckos still had *Geckobia* mites, but both the West African House Geckos and the Ashy Geckolets remained free of mites. All but one of the intraspecific tests also were negative; we found only one mite that had moved to a previously unin-



**Fig. 3.** Tests of interspecific transmission of mites (*Geckobia hemidactyli*) by contact in confinement with infected Tropical House Geckos (*Hemidactylus mabouia*) over a period of 10 days: (A) A West African House Gecko (*Hemidactylus angulatus*) (darker gecko) and (B) an Ashy Geckolet (*Sphaerodactylus elegans*) (small gecko). Note that the Tropical House Gecko in B was collected with dorsal skin lesions and a loss of scales not related to the mite infection. Photographs by Rafael Borroto-Páez.

**Table 2.** Results of ten tests for intra- and interspecific transmission of pterygosomatid mites (*Geckobia hemidactyli*) from infected hosts (Tropical House Geckos, *Hemidactylus mabouia*) to non-infected conspecifics (n = 5), West African House Geckos (*H. angulatus*, n = 3), and Ashy Geckolets (*Sphaerodactylus elegans*; n = 2). Abbreviations for species: Hm = *H. mabouia*, Ha = *H. angulatus*, Se = *S. elegans*; sex: m = male, f = female; localities: C = Corralillo (Villa Clara Province), EH = Hotel Elguear (Villa Clara Province), RG = Rincon de Guanabo (Mayabeque Province); VT = Vibora, La Habana (La Habana Province).

Test	Non-infected sp., locality, sex	Infected host (all Hm) locality, sex, intensity	Days in contact	Results
1	Ha, C, f	C, f, 41	10	—
2	Ha, EH, m	C, m, 23	15	—
3	Ha, EH, m	C, m, 21	15	—
4	Se, EH, m	C, f, 11	7	—
5	Se, VT, f	RG, f, 12	10	—
6	Hm, EH, m	C, f, 7	9	—
7	Hm, EH, m	C, m, 11	9	+
8	Hm, EH, m	C, m, 11	9	—
9	Hm, EH, f	EH, f, 2	12	—
		EH, f, 2		
10	Hm, EH, f	C, m, 23	5	—
		EH, f, 2		
		EH, f, 2		

\*one mite on different parts of the body on days 7 and 9 with no means of determining if it was the same individual.

fected host (test 7 in Table 2). On days 7 and 9, a single mite was on a different part of the gecko's body with no means of determining if it was the same mite or not. The transmission of *Geckobia hemidactyli* mites is evidently not an easy event. Successful transmission might require specific microhabitat conditions, the presence of specific developmental stages, or more prolonged contact with infected hosts.

We understand that the sample sizes in our preliminary tests were small and that the tests lacked negative controls, but the observations tentatively support the lack of empirical evidence of any transmission of pterygosomatid mites from invasive geckos to different species or to native geckos (Bertrand et al. 2008; Barnett et al. 2018). Martínez Rivera et al. (2003) noted a similar absence of interspecific transmission when he collected three *H. angulatus* free of mites although they had been syntopic with *H. mabouia*. Hanley et al. (1995) found no evidence of mite transfer between geckos (*Lepidodactylus* spp.) after keeping them together for 48 h. However, anecdotal evidence and the morphology of the mites suggest that *Geckobia* sp. spend their entire lives on geckos and are transmitted only as eggs, in immature stages, or adults during close and prolonged intraspecific contact, such as mating, sharing refuges, and fighting (Bauer et al. 1990; Martínez Rivera et al. 2003). To date no evidence suggests any effect these mites could have on the body condition of hosts or in wild populations (Hanley et al. 1995).

#### Differential arrival times of house geckos and mites to Cuba

As noted above, Martínez Rivera et al. (2003) searched for mites only on preserved specimens of *Hemidactylus mabouia* collected at the U.S. Naval Base at Guantanamo Bay that had been deposited in a U.S. museum. While specimens from multiple localities in a number of other countries were in the collection sampled, the only specimens from the Cuban Archipelago originated in U.S. territory on the island. This was not due to under-sampling, but rather a response to the historically limited access to and exchange of information and museum specimens between Cuba and the rest of the world. However, an extensive record of herpetological studies carried out on the island by local Cuban herpetologists and the international community is available. This information is summarized in many sources (e.g., Barbour and Ramsden 1919; Garrido and Jaume 1984; Estrada and Ruibal 1999; Rodríguez-Schettino 2003; Estrada 2012; Rodríguez Schettino et al. 2013; Borroto-Páez et al. 2015). From 1965 to 1980, many parasitologists from former socialist countries, especially Czechoslovakia, worked extensively in Cuba. Nevertheless, despite the available information, no records of *G. hemidactyli* from the rest of the island have appeared until now.

Acarologist Jorge de la Cruz worked intensively in Cuba and described two species of native pterygosomatid mites: *Geckobia tarentolae* (de la Cruz 1973) from a native American

Wall Gecko (*Tarentola americana*) and *Cyclurobia javieri* (de la Cruz 1984), now *Geckobiella javieri*, from the endemic Cuban Iguana (*Cyclura nubila*). Moreover, he found other species of mites, such as *Bertrandiella otophila*, on *T. americana* (de la Cruz 1984). The available material on the mites and other arachnids of the island fails to show records of any pterygosomatid mites on geckos of the genus *Hemidactylus*, even though Paredes León et al. (2013) did a thorough study of the available acarology collections when describing pterygosomatid mites from Cuban lizards. In that study, they identified three known pterygosomatid mites and described a new species that parasitizes native Cuban lizards: *Geckobia tarentolae*, *Bertrandiella otophila*, and *B. griselda* from *Tarentola americana* and *Geckobiella javieri* from *Cyclura nubila*. Paredes León et al. (2013) were aware that *H. mabouia* was a reported host of *G. hemidactyli* in Cuba and that both species are naturalized on the island, but did not include *G. hemidactyli* in their key of Cuban mites, most likely because none were available in the collections they sampled. The team instead used *G. hemidactyli* from Brazil. This suggests that *G. hemidactyli* is absent from acarological collections with extensive Cuban specimens and poses the questions of how *G. hemidactyli* is distributed in Cuba and if multiple introductions of *H. mabouia* and its mites occurred at different ports of entry. Moreover, several published studies from the past 20 years on several aspects of the natural history and morphology of *Hemidactylus* geckos from throughout Cuba (Rodríguez-Schettino 2003; Rodriguez-Schettino et al. 2013; Iturriaga and Marrero 2013; Paredes León et al. 2013; Díaz 2014; Borroto-Páez et al. 2015; Velasco and Neyra 2016) have involved extensive handling, measuring, and observations of live animals as well as museum specimens.

However, even with a history of published work on pterygosomatid mites and on the ecology and natural history of *Hemidactylus* geckos, no one has reported the presence of *Geckobia hemidactyli* on geckos outside of the U.S. Naval Base at Guantanamo Bay. Consequently, one has to ask why has this ubiquitous mite from such a ubiquitous gecko not been documented? We propose that *G. hemidactyli* was absent from most of Cuba except for the U.S. Naval Base at Guantanamo Bay until as recently as 2016.

House geckos of the genus *Hemidactylus* are classic hitchhikers that commonly travel from place to place in cargo on boats, airplanes, and various terrestrial vehicles (Heath and Whitaker 2015). Several species of *Hemidactylus* regularly show up in new localities and are established introduced species in many tropical and subtropical regions around the world. Weterings and Vetter (2018) compiled all the locality data known for some of the most cosmopolitan species of *Hemidactylus*, including *H. mabouia*, and listed isolated records of individuals as far north as the northern coast of France and the Great Lakes Region in the USA. Such individuals most likely do not represent viable populations but instead are merely chance encounters with hitch-

hikers that were carried so far north by their human dispersers; nevertheless, they highlight the dispersal ability of these geckos. Introduced populations are common in ports and warehouses and quickly adapt and spread to urban settings and coastal towns. Females lay eggs in communal nests in rotten logs and other natural cavities (Sousa and Freire 2010; Meshaka 2011; and references therein), but also in any available cavity in, for example, cinder blocks, plant pots, electrical boxes, and timber in buildings (Rivero 1978; CCMR and RBP, independent personal observations), which further aids their successful dispersal. Recently, a preliminary study of Common House Gecko (*Hemidactylus frenatus*) populations in their native Taiwan suggests that eggs are capable of withstanding submersion in seawater and considerable desiccation (Hsu et al., submitted). Some researchers (e.g., Punzo 2005; Kratochvíl and Frynta 2006) have suggested that the round hard-shelled eggs of these geckos facilitate the retention of moisture and allow females to be less selective of nesting sites.

We must consider the possibility that *Hemidactylus mabouia* continues to arrive in Cuba (or any place where it is considered invasive) at multiple ports of entry and on multiple occasions in separate incidents of dispersal (Weterings and Vetter 2018). Some suggestions involve natural transatlantic dispersal on ocean currents of several species of *Hemidactylus* from the western coast of Africa to various localities in the Americas (Kluge 1969; Rivero 1978) or with human mediation via ships transporting slaves and other goods from Africa to tropical America (Vanzolini 1978). Such possibilities would explain the presence of *Hemidactylus* spp. native to the Americas and the presence of *H. mabouia* in Brazil and other Neotropical regions prior to globalization (Weterings and Vetter 2018). The Tropical House Gecko is ubiquitous in the Greater Caribbean, and together with three native Cuban species, the Cuban Treefrog (*Osteopilus septentrionalis*), the Cuban Flat-headed Frog (*Eleutherodactylus planirostris*), and the Cuban Brown Anole (*Anolis sagrei*), is among the most frequent herpetofaunal invaders in the region (Powell et al. 2011). Those four species have become invasive generalists in multiple localities during the past century by dispersing as hitchhikers in various cargos. In the case of Cuba, we propose that *H. mabouia* and its ectoparasite, *G. hemidactyli*, arrived separately at the U.S. Naval Base at Guantanamo Bay prior to its arrival elsewhere in the archipelago. Geopolitical realities effectively isolate the U.S. base from the rest of the island while connecting it indirectly to the U.S. mainland, especially Florida, and Puerto Rico, where the gecko is ubiquitous. This same route (Guantanamo to Florida to Puerto Rico and beyond) has been proposed for the dispersal of *Osteopilus septentrionalis* and *Anolis sagrei* (e.g., Eales and Thorpe 2009). Consequently, we presume that the population of *H. mabouia* at the U.S. Naval Base at Guantanamo Bay arrived independently of other Cuban populations that most likely entered the country through different ports of entry.

For many years, *Hemidactylus mabouia* was considered to be very localized and limited to human settlements in Cuba (Barbour and Ramsden 1919; Barbour 1937). More recently, it still was considered relatively abundant only in eastern Cuba (Schwartz and Henderson 1991). Today, however, the species is quite abundant and has an extensive nation-wide distribution. The discovery of *G. hemidactyli* on house geckos at four different localities geographically distant from Guantanamo Bay (Fig. 2), all of them relatively close to the main ports and tourist areas of Habana and Varadero, suggests that these populations correspond to multiple separate introductions of *H. mabouia* into Cuba distinct from that at the U.S. Naval Base at Guantanamo Bay. Although *Hemidactylus* geckos regularly show up in new localities far from any known populations, Short and Petren (2011) demonstrated that once geckos arrived at a particular area in Florida, dispersal was minimal and that, in order for them to become established, multiple human-assisted translocations to the same region and to different areas within that region is likely a necessity. Short and Petren (2011) also found no detectable genetic structure on a statewide scale; in other words, populations from one metropolitan area are more genetically similar to each other than to those from other metropolitan areas, as would be expected for urban species with limited migration abilities. Evidence of genetic differentiation between Florida and other areas where *H. mabouia* occurs was evident.

Hitchhiking geckos presumably arrived at the various Cuban sites from multiple locations like Florida or other Caribbean islands with a relative high exchange of passengers and baggage. Based on published photographs taken in Puerto Rico (Rivero 1978) and Anguilla (Malhotra and Thorpe 1999), the earliest unreported records of *Geckobia hemidactyli* in the Caribbean date to 1972, and Corn et al.

(2011) reported *G. hemidactyli* in the U.S. in 2005. However, the specimens from the U.S. Naval Base at Guantanamo Bay dating to 1965–1969 actually constitute the earliest records in the region (CCMR, unpublished data). Our initial discovery in 2016 of *G. hemidactyli* elsewhere in Cuba (Fig. 4) further reinforces the conclusion that the populations described herein originated independently of that at the naval base.

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**Fig. 4.** The earliest record of a Cuban Tropical House Gecko (*Hemidactylus mabouia*) with pterygosomatid mites (*Geckobia hemidactyli*) photographed in 2016 in a family apartment in Corralillo, Villa Clara Province. Note the orange mites on the shoulder and in the axilla.

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**Note added in proof.**—On 16 November 2020, Ariel Espinosa Lima from Morón in northern Ciego de Ávila Province, Cuba (22°06'56.26"N, 78°37'14.86"W), observed a Tropical House Gecko (*Hemidactylus mabouia*) infected with mites (*Geckobia hemidactyli*). The gecko was not collected but the broken tail bore more than ten orange mites. This extends the known distribution of these mites over 150 km northeast of the nearest previously documented locality.

