Traveling with an invader: ectoparasitic mites of *Hemidactylus frenatus* (Squamata: Gekkonidae) in Colombia

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Biological invasions associated to human activities are one of major threats to biodiversity worldwide, with impacts at the population, species and ecosystems levels (Chornesky and Randall, 2003). Invasive animals can disperse their parasites and potentially transmit them, which may pose potential risks to native species (Prenter et al., 2004). Lizards, like other vertebrate groups are hosts for several internal and external parasites (e.g., Avila and Silva, 2010; Fajfer, 2012) that may affect behavior and fitness of individuals. Besides, parasites may present important ecological implications at population level and interspecific relationships of their hosts (Prenter et al., 2004; Norval et al., 2014).

Species of the gekkonid lizard genus *Hemidactylus* Gray, 1825 are common hosts of external parasites such as mites of the family Pterygosomatidae, which comprises 184 species and nine genera, mostly permanent ectoparasites of lizards (Fajfer, 2018). Within Pterygosomatidae, the genus *Geckobia* Mégnin, 1878 exhibits the widest geographic distribution and is composed by 73 species that parasitize lizards of different families, like Gekkonidae, Phyllodactylidae, Carphodactylidae, Diplodactylidae, Eublepharidae, and Liolaemidae (Fajfer, 2012; 2018).

In Colombia, four species of non-native *Hemidactylus* occur: *H. angulatus*, *H. mabouia*, *H. garnotii* and *H. frenatus* (Vásquez-Restrepo and Lapwong, 2018), but aspects of their natural history and potential impacts on the native fauna have been poorly studied. Regarding *H. frenatus* (Fig. 1A) in this country, there is information on its geographic distribution, diet and reproduction (Caicedo-Portilla and Dulcey-Cala, 2011; Diaz et al., 2017). However, there are no further data on its parasites. On this matter, we report herein for the first time two *Pterygosomatidae* mite species parasitizing *Hemidactylus lizards* in Colombia.

**ABSTRACT**
Information about natural history of invasive species (such as parasitism) is a relevant issue in order to consider potential threats to native fauna. In this work we report two pterygosomatid mites for the first time in Colombia, *Geckobia bataviensis* and *G. keegani*, parasites of the invasive house gecko *Hemidactylus frenatus*. Although it has not been demonstrated that these mites may infest native gecko lizards, our study highlights the need to explore the prevalence of internal and external parasites in native and invasive geckos, to better evaluate the potential impact of invasive *Hemidactylus* lizards in Colombia.

**Key Words:** Biological invasions; Parasitism; Mites; Pterygosomatidae; *Geckobia*.

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fixed in 10% formaldehyde and preserved in 70% ethanol (Pisani, 1973).

We removed external mites (Fig. 1B) from the lizards using entomological tweezers under a stereomicroscope, and preserved them in 70% ethanol. Mites were clarified using lactophenol and permanent mounts were made on microscope slides using Hoyer medium (Faraji and Bakker, 2008). Mites were identified following the key of Bertrand et al. (2013) for genera and species of Pterygosomatidae. We also reviewed the original description of G. keegani by Lawrence (1953). Prevalence and mean intensity were determined according to Bush et al. (1997). Vouchers of H. frenatus are housed in the Colección Herpetológica (UIS-R) of the Museo de Historia Natural of the Universidad Industrial de Santander (Colombia) and vouchers of mites are housed in the Colección Zoológica “Dr. Eustorgio Méndez” (CoZEM), Departamento de Investigación en Entomología Médica, Instituto Conmemorativo Gorgas de Estudios de la Salud (Panamá).

Specimens of H. frenatus in the study area were infested by two mite species of the family Pterygosomatidae: Geckobia bataviensis Vitzthum, 1926 (Fig. 1C) and Geckobia keegani Lawrence, 1953 (Fig. 1D). Both species of Geckobia are characterized by the presence of five setae on tibiae I-IV, but they differ because G. bataviensis has one setae in trochanter IV, which is absent in G. keegani (Bertrand et al. 2013).

Mites were observed mainly on the dorsum of posterior legs and in the distal part of the fingers between claws (Fig. 1B). In this study, 80% (24) of the collected lizards were parasitized by at least one species of Geckobia. On the other hand, 37.5% (3) of juveniles and 95.45% (21) of adults were parasitized by one or both mite species. From the total, 58.3% (14) of lizards were parasitized by the two mite species at the same time. The prevalence of G. bataviensis (50%) was lower than that of G. keegani (76.6%) and the mean intensity was similar for both
mites (Table 1).

This is the first record in Colombia of *Geckobia bataviensis* and *G. keegani*, parasitic mites usually dispersed by the Asian house gecko *H. frenatus*, as previously reported from other regions, both in native areas and in those where this gecko was introduced (Bochkov and Mironov, 2000; Frenkel and Vargas, 2005; Heath and Withaker, 2015). *Geckobia bataviensis* is the most common scale mite on *H. frenatus* throughout its distribution, even in sites where this lizard is invasive and can be found along with other mite species but more often found with *G. keegani*, as we observed in the present study (Prawasti et al., 2013; Heath and Withaker, 2015).

In the studied area, we observed *H. frenatus* inhabiting houses also with the native Yellow-headed Gecko *Gonatodes albogularis* (Duméril and Bibron, 1836), which is more frequent in backyards and gardens into crevices. It is known that invasive species can transmit their parasites to native relatives when colonizing new areas, affecting the local parasite dynamics and native host species (Prenter et al., 2004; Barnett et al., 2018). Hoskin (2011) considers that the ectoparasitic mites of *H. frenatus* could represent a potential threat for native lizard species; blood-feeding mites are capable of transmit blood parasites, such as pentastomids of the genus *Raillietiella*, which could affect host reproduction, competitive abilities and survival (Barton, 2007; Hoskin, 2011). Nevertheless, there is still no evidence about transmission of pterygosomatid mites from invasive to native gecko species or vice versa (Bertrand et al., 2008; Barnett et al., 2018). Pterygosomatid mites spend their entire life on geckos, and may be only transmitted during close and prolonged contact (e.g., during mating or fighting). Native and invasive gecko species in Colombia may occupy different microhabitats, which may reduce the chance or eventually prevent mite transmission from the latter (Barnett et al., 2018). In the study area *H. frenatus* and *G. albogularis* occupy different microhabitats and are active at different times of the day (*H. frenatus* is mainly nocturnal and *G. albogularis* is diurnal). Additionally, we did not observed agonistic interactions between them. Thus, we hypothesize that these factors would not favor mite transmission from *H. frenatus* to native geckos (*e.g.*, *G. albogularis*). However, this topic should be evaluated more rigorously.

*Hemidactylus frenatus* is a common species in the Caribbean Region and inter-Andean valleys of Colombia, occurring generally between 0 and 1600 m. elevation (Caicedo-Portilla and Dulcey-Cala, 2011; this species was also registered in the Amazonia region of Colombia, in Leticia municipality (Caicedo-Portilla, 2019). Therefore, is possible that parasitic mites reported also occur in other ecosystems across the distributional range of this invasive gecko in Colombia. Regarding mites, *H. frenatus* may host other parasites such as cestodes, nematodes, trematodes, coccidia, apicomplexans and pentastomids (Upton et al., 1994; Hanley et al., 1995; Hanley et al., 1998), but the impact of this parasites on native species remains to be studied. Finally, we aim that future research would address the evaluation of the prevalence and effects of external parasites in both native and invasive geckos living in syntopy, to obtain valuable information on the potential impacts of invasive *Hemidactylus* species.

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