




# Sailing by boat: a second arrival point of the exotic gecko *Lepidodactylus lugubris* (Duméril & Bibron, 1836) (Squamata, Gekkonidae) in the Brazilian Atlantic Forest

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## Abstract

We present a new record of the Asian Mourning Gecko, *Lepidodactylus lugubris* (Duméril & Bibron, 1836) in the Atlantic Forest of eastern South America. *Lepidodactylus lugubris* is a widely distributed lizard currently occurring throughout most of the northern Neotropical Region, including the Galapagos and the eastern Pacific islands. Unlike the Amazon Rainforest, which has wide forested cover and essentially diurnal geckos, the threatened Atlantic Forest has had most of its original vegetation removed. The arrival of *L. lugubris* in the region deserves attention and study, aiming understand the impact of this exotic gecko on the Atlantic Forest native gecko fauna.

## Keywords

Bahia state, Brazil, geographic distribution, invader, mitigating actions, niche partitioning, plasticity

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## Introduction

The Asian Mourning Gecko, *Lepidodactylus lugubris* (Duméril & Bibron, 1836) (Squamata, Gekkonidae) is a widely distributed lizard, first described for “l’île d’Otaiti” (Duméril and Bibron 1836), Tahiti (lectotype Museum national d’Histoire naturelle, Paris, MNHN-RA 5323, designated by Wells and Wellington 1985) and native to Southeast Asia (Lewer 2003). A plastic species, *L. lugubris* is the most widespread species of its genus, considered commensal with humans, and having a range extending far beyond the boundaries of its native occurrence (Duméril and Bibron 1836; Wells and Wellington 1985), including to the eastern New World (Lewer 2003;

Powell et al. 2011; Powell and Henderson 2012; Krysko and Mackenzie-Krysko 2016). This species has considerably increased its distribution, currently occurring throughout most of the northern Neotropical Region, including the Galapagos and eastern Pacific islands (Olmedo and Cayot 1994).

In South America, the first record of *L. lugubris* was made in Ecuador (Fugler 1966), followed by Colombia (Moreno-Arias et al. 2006), Suriname (Bauer et al. 2007), Venezuela (Guerreiro and Graterol 2010), and finally Brazil. Since the publication by Hoogmoed and Avila-Pires (2015) on the New World distribution of *L. lugubris*, two

more localities based on vouchered and unvouchered specimens from the Brazilian Amazon rainforest were recently reported, along with its first record to the Atlantic Forest (D'Angiolella et al. 2021). Considering that the occurrence reported by D'Angiolella et al. (2021) is 1,780 km southeast from the earlier and first record in the Amazon Rainforest from the municipality of Belém (Hoogmoed and Avila-Pires 2015) (Fig. 1), the possibility that they belong to distinct populations from different settlement events should be considered (D'Angiolella et al. 2021).

## Methods

In May of 2021, a fortuitous encounter of an exotic gecko stimulated the search for additional specimens. We collected date, time, and geographic coordinates using a handheld Garmin GPS receiver. We also took basic morphological measurements, including snout–vent length (SVL) and tail length (TL), using digital calipers in millimeters. Sexing was not performed. After these procedures, all specimens were photographed and released at the same place where found.

## Results

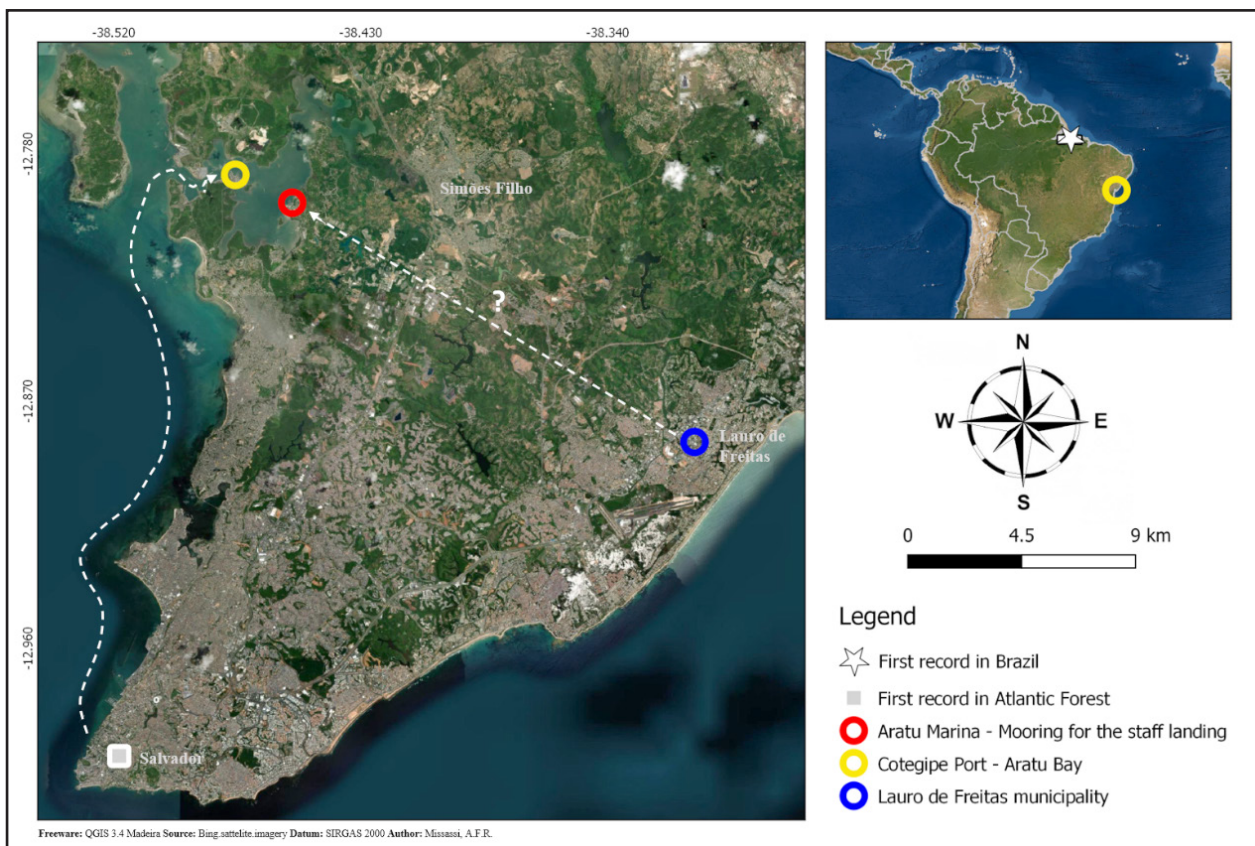
**Observations.** BRAZIL – Bahia • Simões Filho Municipality, Aratu Bay, Cotegipe Port;  $-12.7876$ ,  $-038.4757$ ; 0 m elevation; 23.V.2021, 24.V.2021, 26.V.2021; V.R.

Bandeira obs.; unvouchered specimens, found on a 40-ft monitoring boat (Figs. 1, 2A, B).

This site is 28.9 km north of the first record of *L. lugubris* in municipality Salvador, Bahia, within the Atlantic Forest biome (D'Angiolella et al. 2021) (Fig. 1).

On 23.V.2021 at 6.13 am, a juvenile specimen (SVL 17.9 mm, TL 15.4 mm; Fig. 2C, D) was found in the boat, which had been moored since 20.IV.2021 at Cotegipe Port, Aratu Bay ( $-12.7876$ ,  $-038.4757$ ), Simões Filho municipality, Bahia, Brazil (Fig. 1, 2A, B). On the following night, 24.V.2021 at 21.47 pm, a second but mature individual (SVL 37.8 mm, TL 39.5 mm) was found at the top of the boat, carrying an egg (Fig. 3A), and two more juveniles (SVL 21.1 and 20.7 mm, TL 23.0 and 22.7 mm TL) were also found concurrently at twilight on 26.V.2021 at 21.07 pm (Fig. 3B, C). The boat left Salvador municipality on 20.IV.2021 and then remained in the navigation channel monitoring the dredging vessel in the vicinity of the Cotegipe Port, mooring only for the staff landing and boarding, and for a fuel supply stop at Aratu Marina ( $-12.7977$ ,  $-038.4550$ ) in Simões Filho municipality (Fig. 1, 2A). After the encounters, the specimens were no longer sighted on the boat.

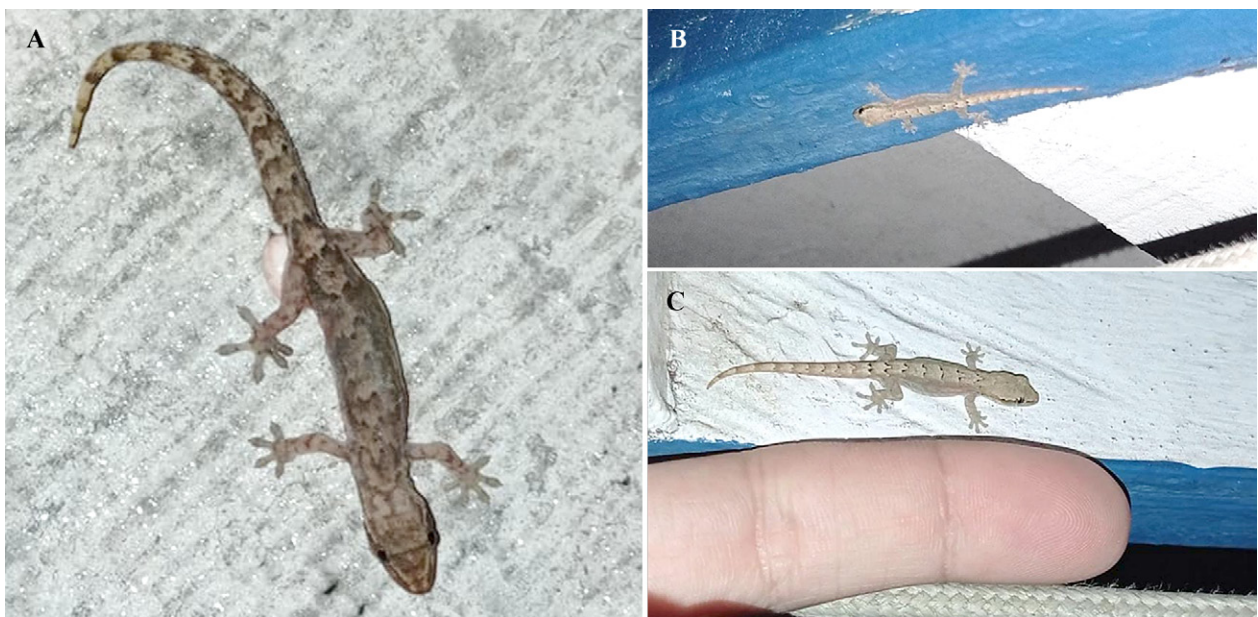
**Identification.** *Lepidodactylus lugubris* is a gekkonid species that is easily distinguished from species of Sphaerodactylidae in having a vertical, lobed pupil (vs. round in Sphaerodactylidae), scansorial lamellae under the fingers and toes (vs. absent in Sphaerodactylidae),



**Figure 1.** Location of the boat where four *Lepidodactylus lugubris* specimens were found, in Cotegipe Port, Aratu Bay, Simões Filho municipality, Bahia state, Brazil. The dashed-line arrow represents two alternative routes for the arrival of the species. The “?” symbol represents uncertainty due to the probable occurrence of the species.



**Figure 2.** Juvenile of *Lepidodactylus lugubris* from Simões-Filho municipality, Bahia state, Brazil. **A.** Boat moored in the region of Cotegipe Port, Aratu Bay for over a month. **B.** Specimen was found among the oxygen cylinders used by the crew of the boat. **C.** Dorsal view. **D.** Frontal view. Photos: V.R. Bandeira.



**Figure 3.** Three additional individuals of *Lepidodactylus lugubris* from Simões-Filho municipality, Bahia state, Brazil. **A.** A female with an egg below her. **B, C.** Two juveniles. Photos: V. R. Bandeira.



**Figure 4.** A juvenile specimen of *Hemidactylus mabouia* photographed in the village of Serraria, rural area of Maragogipe, Bahia state, Brazil. Photo as courtesy of Antonia G. N. Santos. Scale bar: 10 mm.

and nocturnal activity (vs. diurnal in Sphaerodactylidae). From the two phyllodactylid genera present in the region, *L. lugubris* is distinguished by the double distal infradigital lamellae (vs. single in *Phyllopezus*) and uniform supralabial scale coloration (vs. striped in *Gymnodactylus*). From *Hemidactylus*, it can be distinguished by absence of narrow distal phalanges elevated above the part of the digits with expanded lamellae (vs. of narrow distal phalanges elevated above the part of the digits in *Hemidactylus*), by a uniform, small, granular dorsal scales (vs. larger scales interspersed between small ones on the back in *Hemidactylus*), a dark antero- and post-orbital band up to the insertion of the arm (vs. absent in *Hemidactylus*), a more slender head in relation to body and a prominent base of the tail (vs. a more prominent head in relation to body and a slender base of the tail in *Hemidactylus*) (Fig. 4).

## Discussion

During the time that the boat monitored dredging operations, the boat received by road boxes from Lauro de Freitas municipality, approximately 23 km north of Salvador municipality and 19 km southeast of Simões Filho municipality (Fig. 1). The time between the arrival of the boat in Simões Filho municipality and the discovery of the first specimens was 34 days, a shorter time if we consider that the eggs need 70–82 days to hatch (Röll 2002). Snout–vent length of hatchlings is 15–22 mm, and total length 32–44 mm (Manthey and Grossmann 1997; Röhl 2002). Thus, probably egg laying took place and three juvenile specimens hatched on the boat, but from which of the two localities is not clear (Fig. 1, dashed-line arrow). Even so, the possibility that *L. lugubris* specimens may have been transported for some time between these regions, with its first record in Salvador municipality, should be considered. Because *L. lugubris* can be confused with small specimens of *Hemidactylus mabouia* (Moreau de Jonnés, 1818) (Fig. 4), *L. lugubris* may have been present in various localities in the Atlantic Rainforest and gone unnoticed until now. We suggest

that *L. lugubris* is expanding its geographic range in the Atlantic Forest using the movement of boats through the region.

We found four individuals of *L. lugubris* over a four-day period on a 40 ft monitoring boat, moored since 20 April 2021 at Cotegipe Port, Aratu Bay, Simões Filho municipality, Bahia, Brazil (Fig. 1, 2A, B). The municipality is within the limits of the Atlantic Forest, where 46% of the biome’s historical area is anthropized (pastures or a mosaic of pastures and agriculture), 30% is natural forest, grasslands, and other non-forest formations, and 24% is a mosaic of areas without vegetation or is aquatic environments (MapBiomias 2019).

In the Brazilian Amazon rainforest, the arrival of *Lepidodactylus lugubris* in Belém municipality is uncertain, but it is believed that it came by ship, probably in container transport between Guadeloupe and Belém after 2012, via Paramaribo, Suriname, among other places (Hoogmoed and Avila-Pires 2015). Another means of transport, the movement of small local Brazilian boats between localities in the Amazon was hypothesized by Hoogmoed and Avila-Pires (2015). Our findings, reported here, corroborate transport within Brazil of this species on small boats.

Although *L. lugubris* does not seem to influence native geckos in the Amazon rainforest due to the extent of forest cover (Hoogmoed and Avila-Pires 2015), a perilous situation is likely in the Atlantic Forest, which, after hundreds of years of exploitation, has lost most of its original forest cover (Salemi, et al. 2013; Lima et al. 2015; Rosa et al. 2021). Furthermore, of the six native geckos occurring in the Atlantic Forest region (Freitas 2014), only the sphaerodactylid *Coleodactylus meridionalis* (Boulenger, 1888) presents diurnal activity. As for *L. lugubris*, all other native geckos are nocturnal (Vanzolini 1968; Avila-Pires 1995; Recoder et al. 2012; Teixeira 2002), unlike the mostly diurnal geckos found in the Amazon rainforest (Avila-Pires 1995; Hoogmoed and Avila-Pires 2015).

Few studies have addressed niche partitioning and niche overlaps among exotic and native gecko species in the Atlantic Forest. In a study of the native *Gymnodactylus darwini* (Gray, 1845) and the African intruder *Hemidactylus mabouia*, the native gecko was restricted to forest patches while the intruder was restricted to pasture areas (Teixeira 2002). If this pattern can be observed with native Atlantic Forest geckos and *L. lugubris*, the impact of niche partitioning will probably not be significant, but this has not been studied.

*Lepidodactylus lugubris* preferentially lives in structures such as houses and lampposts (Hoogmoed and Avila-Pires 2015), and in a study using natal habitat preference induction, a preference for vertical environments was observed (Allemang 2008). On this premise, it is possible that *L. lugubris* will be restricted to periantropic environments like *H. mabouia*. The latter, presumably introduced into Brazil by slave ships coming from Africa (Vanzolini 1978), occurs in sympatry with *L. lugubris*

(Lorvelec et al. 2011), but no studies on their interactions have been published (Hoogmoed and Avila-Pires 2015).

The eastern region of South America is known to possess several exotic species (Duarte and Eterovic 2009), probably as a result of global trade (Rodda et al. 1997). For example, a long list of species for sale can be found on the internet, many of which are endangered or CITES-listed (Duarte and Eterovic 2009). Problems resulting from the introduction of exotic species, include the reduction of native populations (Dodd 1987; Dodd 1993; Adams et al. 1994), structural changes in the arrival community (Savidge 1987; Rodda and Fritts 1992; Martínez-Morales and Cuarón 1999), and the introduction new diseases and parasites in the native species (Reinert and Ruppert 1999; Cunningham et al. 2003; Jones et al. 2008; Ribeiro et al. 2019). Exotic species, especially in the threatened Atlantic Forest, deserve attention from local authorities to determine impacts on native species and to take action to mitigate the presence of exotic species in Brazilian territory.

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## Authors' Contributions

Conceptualization: VRB, AFRM. Data curation: VRB, AFRM. Formal analysis: AFRM. Investigation: VRB. Resources: VRB. Visualization: VRB. Supervision: AFRM. Validation: AFRM. Visualization: AFRM. Writing – original draft: AFRM. Writing – review and editing: AFRM.

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