
Antropogenic effect or niche preference? contributions to the knowledge of *Hemidactylus mabouia* invasion in South America

The African gekkonid lizard *Hemidactylus mabouia* (Moreau De Jonnès 1818) is a nonindigenous species widely distributed in Brazil and other areas of the Americas (e.g. Rocha et al. 2011, Fierro-Cabo & Rentfro 2014). It is usually associated with anthropic environments (Vanzolini et al. 1980), using areas closer to artificial lighting sources as hunting grounds (Daniells et al. 2008). In some cases, *H. mabouia* associates to some degree with the local native assemblage (Anjos et al. 2008, Rocha & Vrcibradic 1998, Hatano et al. 2001, Koski et al. 2013).

The records of *H. mabouia* in Brazilian natural environments are increasing, and include most biomes (e.g. Vanzolini 1968, 1978, Telles et al. 2015) except Amazônia (Rocha et al. 2011). In this study, we conducted surveys to identify new occurrences of *H. mabouia* in natural environments along the coast of Espírito Santo state, in southeastern Brazil. We also documented the vegetation types (mesohabitats) and microhabitats used by the species. Additionally, we evaluated if its presence is related to the intensity of habitat modification.

Restingas are sandy coastal habitats characterized by sand dune formations, with relatively high temperatures and low availability of free water compared to other ecosystems within the Atlantic Rainforest biome (Rocha et al. 2003). The vegetation structure varies as the distance from the seashore increases, resulting in distinct mesohabitats or vegetation zones: herbaceous, sparse shrubs, closed post-beach, and restinga forest.

We surveyed five sandy dune sites along the state of Espírito Santo (datum WGS84): Praia das Neves (21.14°N,

40.24°W), Paulo Cesar Vinha State Park (20.36°N, 40.24°W), Comboios Biological Reserve (19.40°N, 39.54°W), Conceição da Barra Environmental Protection Area (18.35°N, 39.44°W) and Itaúnas State Park (18.20°N, 39.41°). We conducted visual searches for *H. mabouia* by day (from 0800 to 1300 h) and by nighttime (from 1800 to 2300 h) along transects. We searched all potential shelters and microhabitats for adults of *H. mabouia* or eggs. Eggs were identified considering characteristics as size (approximately 8.5 x 10 mm), the number of eggs in the nest (two or more) (Anjos & Rocha 2008), color and texture/consistency (*apud* Rose 1950). We measured the height from soil using a measuring tape when individuals were perched. Our sampling comprised 75 hours of search from February 2011 to December 2013, totaling 15 hours in each vegetation zone in each restinga.

We also estimated the occurrence of environmental modification factors in each site (Table 1, modified from Rocha et al. 2007). We considered as "invaders" only those individuals of *H. mabouia* found in natural environments. Therefore, all lizards documented here were located at least one kilometer away from any residence or urban area (following Cronk & Fuller 1995). Whenever possible, we collected the individuals found in natural habitats as voucher specimens (SISBIO permit N. 28276).

We found 45 adult individuals in natural environments at three of the five study sites, all during nighttime searches, and six eggs/hatched eggs (Table 2). Individuals were found in six different microhabitats, both horizontally (e.g., under bush, sand) and vertically (tree trunks), all of them associated to open vegetation areas (Table 2). The average (\pm 1SD) height above ground that individuals were found perched was 31 ± 13.8 cm ($N_{\text{total}} = 45$, 0 - 75 cm), but most individuals were found perched at heights from ground level to 10 cm ($N = 41$, 0 - 10 cm). Our results showed that *H. mabouia* was usually present in areas where human-mediated modifications in habitat were frequent (Fig. 1). However, in all sites where we found *H. mabouia*, we observed trails, roads and/or streets.

Table 1. Categories of habitat degradation recorded in five restinga habitats along the Espírito Santo state in Southeastern Brazil.

RV	Removal of vegetation
TV	Trampling of vegetation for beach access
ER	Establishment of residences
VT	Vehicular traffic on the vegetation or dunes
EV	Exotic vegetation (e.g. grass, <i>Eucalyptus</i> spp, among others)
RS	Replacement of the original substrate by others (e.g. clay, gravel)
TD	Trash deposition
BV	Burnt of vegetation
TR	Trail/road/street

We provide further evidence that the invasion of *H. mabouia* in natural environments of Espírito Santo state is in an advanced stage. Furthermore, two previously undocumented localities (see Rocha et al. 2011) for this species contribute to the knowledge of the invasion of *H. mabouia* in Brazil.

The genus *Hemidactylus* has had great success in crossing the Atlantic Ocean, naturally colonizing several ecosystems in the Americas (Carranza & Arnold 2006). In our study, we believe we found successfully established populations of *H. mabouia*, due to the occurrence of reproductive events (adults and eggs). Other well-established populations had been already documented in Brazilian coastal plains (e.g. Rocha et al. 2011), and our data adds more information to these observations. The greater number of invasions documented from sandy coastal plains in other Brazilian ecosystems may suggest that these areas provide appropriate environmental conditions within the ecological tolerance limits of *H. mabouia* (Kluge 1969).

Our results showed a frequent association of *H. mabouia* with human-modified habitats within larger natural environments, especially those with some degree of vegetation opening (e.g., due to

Table 2. Number of adult individuals of *Hemidactylus mabouia* and eggs recorded in five sandy coastal plains areas (Praia das Neves, Paulo Cesar Vinha State Park, Comboios Biological Reserve, Conceição da Barra Environmental Protection Area and Itaúnas State Park) along Southeastern of Espírito Santo State Brazil, including vegetation type and microhabitats used.

Restinga	Number of individuals of <i>Hemidactylus mabouia</i> recorded	Eggs/Hatched eggs	Vegetation Type	Microhabitat
Praia das Neves	15	4	HP/FR/CR/OS	UT/SD/TT/UT/UF/BR
PEPCV	0	0	-	-
Comboios	0	0	-	-
APA C. Barra	29	2	OS	UT/UB/CT
Itaúnas	1	0	OS	UB

Legend: (APA C. Barra) Conceição da Barra Environmental Protection Area; (PEPCV) Paulo Cesar Vinha State Park; [Vegetation type]: (HP) halophilous-psammophilous creeper vegetation (OS) open shrubby; (CR) closed rear; (FR) forest. [Microhabitats]: (UB); under bush (UT) under trash; (SD) sand; (TT) tree trunk; (UT) under fallen trunk; (UF) under leaf litter (BR) bromeliad (CT) cactaceae.

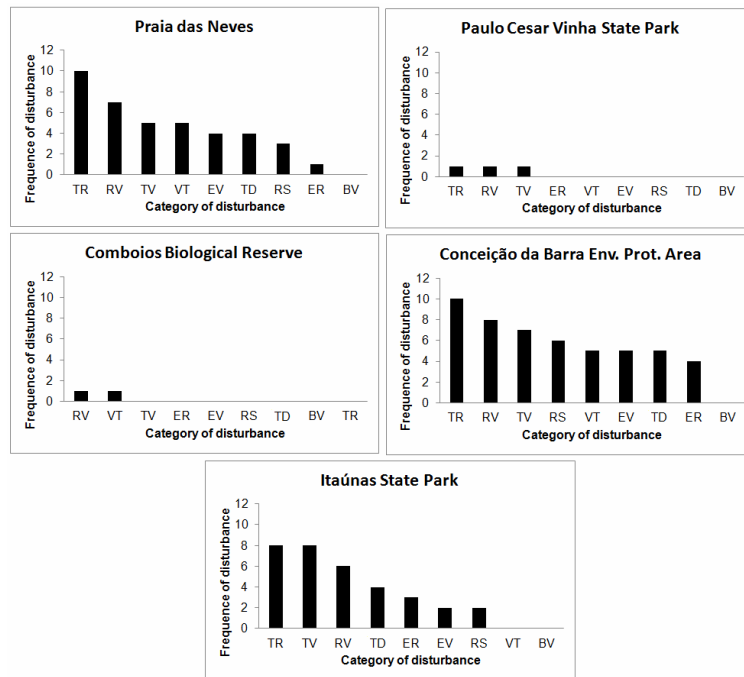


Figure 1. Frequency of disturbances recorded in each Restinga area studied in coastal Espírito Santo State. (A) Praia das Neves; (B) Paulo Cesar Vinha State Park; (C) Comboios Biological Reserve; (D) Conceição da Barra Environmental Protection Area; (E) Itaúnas State Park. Legend: (RV) Removing of vegetation; (TV) Trampling of vegetation; (ER) Establishment of residences; (VT) Vehicular traffic; (EV) Exotic vegetation; (RS) Replacement of substrate; (TD) Trash deposition; (BV) Burst vegetation; (TR) Trail/road/street.

trails, roads or streets). Although there is still no conclusive evidence whether natural environments that are invaded have to present some degree of modification for invasion to occur (Silva et al. 2008, but see Gurevitch & Padilla 2004 to a review), our data suggests that *H. mabouia* may be benefiting by human alterations in sandy dune habitats of Brazil, especially by vegetation removal. Another piece of evidence reinforcing this hypothesis is that two years after the present study ended, we recorded three *H. mabouia* individuals in Paulo Cesar Vinha State Park using the same sampling methods. Although this restinga is one of the areas with the lowest degree of human modification, there are a considerable number of trails for beach access. Some of the species biological characteristics that favour its successful establishment in Brazilian environments may be the wide range of trophic resources and microhabitats used and its nighttime activity. These may facilitate its coexistence with both native diurnal and nocturnal lizards from the invaded communities (e.g., Carranza et al., 2006). There is still no evi-

dence of effects of *H. mabouia* on native communities (Winck et al. in press). However, we should focus on understanding the degree to which the removal of vegetation is a main factor facilitating its invasion, in considering the possibility of invasion by other exotic species. These data could supply the necessary support for the development of appropriate strategies limiting new invasions of potentially harmful species.

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