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LETTER FROM THE CONSERVATION FRONT LINE

The threat of Peters's Rock Agama (*Agama picticauda*) to reptile diversity across the Lesser Antilles

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During the ongoing sixth global extinction wave, island ecosystems are among the most impacted due to a high introduction rate of non-native species (Tershy *et al*., 2015; Bellard *et al*., 2016; Fernández-Palacios *et al*., 2021). Within one of the global biodiversity hotspots (Myers *et al*., 2000), the Caribbean Lesser Antilles are known for their high degree of endemism across numerous taxa, including reptiles (e.g., Smith *et al*., 2004; Losos *et al*., 2006). However, continuing introductions of non-native species are homogenizing the regional herpetofauna diversity (Capinha *et al*., 2020), leading to extinctions and loss of functional trait diversity across islands and ecosystems (Kemp, 2023).

The most common terrestrial non-native vertebrates, throughout the Lesser Antilles, are reptiles (Thorpe, 2022). Their interactions with native reptile species have led to local extinctions and continuing declines in both native population sizes and distribution ranges through predation, hybridization, disease transmission and competition for resources (Daltry, 2022). Multiple non-native species have already spread nearly regionwide, including *Gymnophthalmus underwoodi*, *Hemidactylus mabouia*, *Indotyphlops braminus*,

Anolis/*Norops sagrei* and Latin American *Iguana iguana* (Thorpe, 2022; Thibaudier *et al*., 2023; van den Burg *et al*., 2023), while others are spreading rapidly (e.g., *Hemidactylus frenatus*: Thibaudier *et al*., 2023 and references therein). Importantly, several of these non-native species are known to have been introduced to the Lesser Antilles from non-native populations in Florida (Powell *et al*., 2011); a pattern we fear is likely to be repeated by Peters's Rock Agama (*Agama picticauda*), although no established population has yet been reported in the Lesser Antilles.

Agama picticauda is a medium-sized lizard native to sub-Saharan western and central Africa, with both sexual dichromatism and size dimorphism. Adult males have a bright orange head and tail, while females are light brown and can have yellow to orange dorsolateral patches (Fig. 1). The species is diurnally active, has a maximum recorded snout-vent length of 15.7 cm (Krishnan *et al*., 2019), and can produce up to three clutches annually, each of 5–12 eggs (Blunden & Krysko, 2007; Krysko *et al*., 2019). It occupies both horizontal and vertical surfaces from where it uses a sit-and-stalk approach to identify and pursue arthropods (Enge *et al*., 2004) and small vertebrates (Henigan *et al*., 2019).

In Florida, the first *A. picticauda* population was found in 1976 (Wilson & Porras, 1983) and it has since extended its range across the state (Enge *et al*., 2004). Recent analyzes show high genetic variation within the Florida population due to introductions from different native origins (Nuñez *et al*., 2016). Given populations across its native range occupy different climatic niches (Krishnan *et al*., 2019), hybridization between populations of differing origins could result in high ecological adaptability (Consuegra *et al*., 2011), that in turn can increase establishment success when Florida individuals are translocated to other regions. Alarmingly, *A. picticauda* appears to be spreading to Caribbean islands as sightings are being reported from the Bahamas and Tortola (British Virgin Islands) (observations 139983395 and 89972864, https://www.inaturalist.org/). On Tortola, at least two adults as well as three juveniles have been observed, suggestive of an establishing population (C. Petrovic, pers. obs.). Further research on the status and impacts on the Bahamas is urgently needed, whilst on Tortola immediate action is necessary to remove the existing population.

Figure 1

Photographs showing both male and female Peters's Rock Agama, *Agama picticauda*, in Florida. Photos taken by Vijay Barve and John Wolaver, unedited from iNaturalist (https://www.inaturalist.org/observations/37604254 and https://www.inaturalist.org/observations/72025522) under licenses CC BY and CC BY-NC.

Although the native and non-native dietary range and ecology of *A. picticauda* are poorly studied, when it spreads to the Lesser Antilles this could have a major impact on numerous native species. There is clear evidence this species preys on smaller lizards. For example, Henigan *et al*. (2019) dissected a large female that had cannibalized a smaller individual (5 cm snout-vent length) and Florida residents have observed predation of *Anolis* species (e.g., iNaturalist record 19472282), and a predation attempt on an *Ameiva ameiva* (J. Wasilewski pers. obs.). These data are highly troubling given many taxa have life stages within these size ranges, while others (or at least one sex) never grow larger. Species of *Alinea*, *Anolis*, *Bachia*, *Capitellum*, *Copeoglossum*, *Gymnophthalmus*, *Mabuya*, *Marisora* and *Spondylurus* would be susceptible to predation, as well as juveniles of *Ameiva*, *Cnemidophorus*, *Kentropyx* and *Pholidoscelis*: an assemblage of >45 species (Thorpe, 2022). Furthermore, native adult lizards are likely to experience interspecific competition and potential displacement. Although *Agama picticauda* is mainly reported from urban and suburban environments, suggesting a low impact within intact forests, given the high threat to the Caribbean forests and their transition to (sub)urban areas, it is expected that *A. picticauda* could become widely distributed. Besides, not all native Lesser Antillean species are limited to forests, as (pet-free) suburban gardens can also act as important habitats or even sanctuaries for critically endangered reptiles (e.g., Debrot *et al*., 2013).

Within the Lesser Antilles, local stakeholders should be on high alert for *A. picticauda* sightings, with rapid early detection being the best way to counter incursions. For *A. picticauda*, the most probable manner of overseas dispersal is as stowaways on boats, given the high occurrence in the urban areas of Florida (Mitchell *et al*., 2021), although fertile eggs could also arrive through shipments of soil or potted plants (see nesting substrate, Steele *et al*., 2018). On-island stakeholders could consider setting up a local community network to further aid rapid detection and reporting of potential sightings to relevant authorities, e.g., using call hotlines as implemented on several Lesser Antillean islands for other alien species (Knapp *et al*., 2021; Debrot *et al*., 2022). For a review on how to create a local reporting application for invasive alien species, see Howard *et al*. (2022). When *A. picticauda* presence is suspected or confirmed, and although the species is wary of humans, several simple and proven methods can be employed to capture individuals (Krysko, 2000; J. Wasilewski pers. exp.):

1. A fishing technique in which a telescopic rod (or cane pole) is used in combination with a very small hook, baited with a cricket or another small insect. Lizards generally tend to grab the insect and simply refuse to release, even without using a hook.
2. Trapping using a minnow trap with several entrances, baited with any type of insect in a clear container within the trap.

Finally, given the abundance of *A. picticauda* in Florida and the high volume of shipments from Florida to ports throughout the Caribbean, we strongly emphasize the responsibility of state authorities (including border control), as well as transport and shipping providers, to

prevent animals from leaving those shores. Florida-based conservationists and alien species experts, with *A. picticauda* experience, are encouraged to help Lesser Antillean stakeholders and authorities through training and knowledge transfer to tackle this major threat to Caribbean biodiversity.

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