REPTILES & AMPHIBIANS

Invasive Vertebrate Interactions in Cuba: Black Rat (*Rattus rattus*) Predation on Eggs of Tropical House Geckos (*Hemidactylus mabouia*)

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The invasion of islands by non-native predators can lead to dramatic effects on island ecosystems (Atkinson 1985, 2001; Courchamp et al. 2003; Towns et al. 2006; Simberloff and Rejmánek 2011). Although the co-occurrence of invasive vertebrates is a ubiquitous global phenomenon, the study of interactions between invaders is poorly represented in the literature and limited understanding of the interactions between co-occurring vertebrates can be problematic for predicting their management and control (Jackson 2015; Ballari et al. 2016). Among the most negative interactions between co-occurring invasive species are predation and competition (Doherty et al. 2015; Jackson 2015; Ringler et al. 2015).

Invasive vertebrates like Black Rats (*Rattus rattus*) and Tropical House Geckos (*Hemidactylus mabouia*) that, like many other introduced invasives, were unintentionally relocated, are included in the list of the world's worst invasive species (Lowe et al. 2001; Weterings and Vetter 2018). The negative impact of invasive vertebrates on tropical islands is greater than on continental mainlands or islands at higher latitudes due to high levels of species endemism; the West Indies, in particular, are among the 'hottest of global biodiversity hotspots' (Myers et al. 2000; Kier et al. 2009).

Invasive predators like Black Rats and Tropical House Geckos are ecological generalists that can successfully colonize a wide range of habitats on islands in tropical and subtropical regions, where they can attain wide distributions, high abundance, and varied and substantive effects on biodiversity and human life. Black Rats arrived in the Americas with the first Europeans and Tropical House Geckos somewhat later with the African slave trade (Simberloff and Rejmánek 2011).

In Cuba, Black Rats and Tropical House Gecko are considered among the worst invasive vertebrate species based on their effects, extensive distributions, abundance, and commensal nature (Borroto-Páez 2009, 2011, 2013; Rodríguez Schettino et al. 2013; Borroto-Páez et al. 2015; Borroto-Páez and Mancina 2017); and similar conditions apply in the broader Caribbean (Henderson 1992; Kairo et al. 2003; Powell et al. 2011, 2013; Borroto-Páez and Woods 2012; Borroto-Páez et al. 2015, Borroto-Páez et al. 2021). Although the impact of invasive rats on island fauna and flora is widely acknowledged as important and devastating, often leading to local or even global extinctions of native species, the effects of rats on herpetofauna in particular are relatively rarely documented (e.g., Whitaker 1973; Henderson 1992; Cree et al. 1995; Towns et al. 2006; Daltry et al. 2013; Escoriza 2020). In particular, direct evidence quantifying the complexities of interactions between rats and abundant and commensal invasive reptiles like Tropical House Geckos is almost nonexistent.

Herein we contribute to the sparse knowledge of the natural history, ecological interactions, and feeding behavior of these two invasive vertebrate species by documenting what we believe is the first report of predation by *Rattus rattus* on the eggs and possibly adult and hatchling *Hemidactylus mabouia*. At 1410 h on 21 August 2022, in a small, rarely-used workshop in Corralillo, Villa Clara Province, Cuba (22.980000 N, 80.601389 W) (Figs. 1A–B), we found evidence of the presence of Black Rats and Tropical House Geckos. We previously had noted a communal gecko ovipositioning site on small shelves in a cabinet used to store screws, nuts, and other small mechanical and electrical components in small plastic bottles (Fig. 1C); the cabinet usually is closed but not locked. On a nearby work table, we documented evidence of feeding rats in the form of at least three broken gecko eggs (Fig. 1D), remains of insects (a beetle and cockroaches), a mollusc shell, mango seeds, and rat excrement (Table 1).

Among the small plastic bottles in the cabinet, we found more than 28 unhatched gecko eggs, many broken shells, and

Reptiles & Amphibians ISSN 2332-4961
https://doi.org/10.17161/randa.v30i1.19670

several hatchlings (Figs. 1E–G). At least some of the broken eggs with remains of embryos and yolk were attributable to rats, the fecal pellets of which were abundant. While we cannot reject the possibility that rats had trampled the eggs, the damage to some shell fragments appeared to be the result of active egg predation. We collected the eggs that remained

Figure 1. Site where Black Rats (*Rattus rattus*) were feeding on the eggs of Tropical House Geckos (*Hemidactylus mabouia*) in Corralillo, Villa Clara Province, Cuba: Exterior (A) and interior (B) of a small rural workshop; shelves with plastic medicine bottles used to store screws, nuts, and other items and the site of a communal gecko ovipositioning site (C); location where rats were feeding with remnants of arthropod, mollusc, and gecko eggs (D); part of a gecko communal ovipositioning site after removal of plastic bottles, evidence of egg predation by rats is indicated by arrows pointing to broken egg shells and an egg presumably indented by a rat (E); evidence of egg predation indicated by arrows pointing to a broken egg with yolk leaking out and rat excrement pellets (F); hatching geckos on another shelf (G); and some of the 28 collected eggs with three hatchling geckos that emerged from eggs a few days later (H).

Table 1. Organisms (or parts or remains thereof) where Black Rats (*Rattus rattus*) were feeding in a small rural workshop in the Corralillo, Villa Clara Province, Cuba.

Organism	Details
Tropical House Gecko (*Hemidactylus mabouia*, Gekkonidae)	Three broken eggs shells
Black Rat excrement (*Rattus rattus*, Muridae)	Numerous excrement pellets
Unidentified beetle (Coleoptera: Scarabaeidae)	Tarsal fragments
Cockroach (*Periplaneta americana* [?], Blattidae)	Fragments of limbs
Cockroach (*Blaberus craniifer* [?], Blaberidae)	Fragments of abdomen and wing
Ants (Hymenoptera: Formicidae)	Presumably foraging
Unidentified arthropod remains	—
Tree Snail (*Liguus fasciatus*, Orthalicidae)	Broken shell fragments
Mango (*Mangifera indica*, Anacardiaceae)	Seed fragments

intact and kept them in a plastic container until a total of 24 hatched, all of them *Hemidactylus mabouia* (Fig. 1H). For future observations, we released the hatchlings where the eggs were collected over the course of the next several weeks.

Although egg predation in this instance was facilitated by humans, who had not locked the cabinet door, predation by rats on gecko eggs, hatchings, juveniles, and even adults could easily have been an adventitious exploitation of a concentrated and vulnerable resource. We unsuccessfully searched the site for remains of geckos, presumably because rats would completely devour their prey or because ants (observed at the site) quickly consumed the remains.

We have observed communal ovipositioning by *Hemidactylus* geckos in places accessible only through small openings too small to permit entry by predators like rats or mice. We also have observed that when a communal nest is disturbed or removed, female geckos tend to avoid the site for some time. We plan to continue checking this cabinet to monitor any new activity.

Interactions between vertebrate invaders are complex, often antagonistic, and can reduce the population sizes and affect the impact of other interactions (Jackson 2015). Interactions of Black Rats and Tropical House Geckos are not limited to predation as both species might compete for space and prey. Both are known to prey on arthropods that are pests and some of which also are invasive, including, for example, cockroaches, which we observed at this site. All of these invasives can and have shared and transferred pathogens and parasites, including some that can affect native species and even humans (e.g., Chalkowski et al. 2018). Recently, a filarial nematode of veterinary importance was reported in the skin of *Hemidactylus mabouia* in Cuba (Borroto-Páez et al. 2022); this was a new host record for any species of *Hemidactylus* and could have been the result of transmission from another invasive species.

Acknowledgements

We thank Luis F. de Armas, formerly of the Institute of Ecology and Systematics, Habana, for the identification of the arthropodan remains found where the rats were feeding and for reviewing an earlier draft of this manuscript and providing important comments and suggestions. Thank you also to Denise Reyes Pérez, Instituto de Geografia Tropical, for photographs of the study site.

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