

Interactions between the endemic gecko *Phelsuma inexpectata* and the introduced *Phelsuma laticauda*: understanding the drivers of invasion on Reunion Island

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INTRODUCTION

The introduction of non-native species of reptiles raise many concerns regarding the potential impact they may exert on indigenous species. The day geckos (*Phelsuma* spp) are territorial lizards. Several species have been repeatedly introduced to many areas outside their natural range (Fieldsend et al., 2021). One species, the gold dust day gecko *Phelsuma laticauda* is frequently reported as an invasive species (Dubos et al., 2014) and considered an aggressive competitor (Lund, 2015). It was first reported on Reunion Island in 1975 (Moutou, 1995) and is today present in habitats alongside the endemic *Phelsuma inexpectata*, a species listed as Critically Endangered (CR) on the IUCN Red List (Sanchez, 2021). Here we report observations on interspecific interactions between the two species, including filmed material (BHS video, 2023), from a botanical garden where the native species *P. inexpectata* was first observed in 2012 and the non-native *P. laticauda* was first observed in 2015 (Personal obs., J.M. Luspot).

MATERIALS & METHODS

The study site was located in the botanical garden Café Grillé (21.30° S, 55.42° E) in the south of Reunion Island of the Western Indian Ocean. On 23 November 2022 we monitored basking sites and floral food resources of an occupied patch for one hour. These resources typically attract a large number of individuals of both *P. laticauda* and *P. inexpectata* (Hoarau et al., 2021). Two observers (JMP & JC) were positioned in front of an inflorescence of the introduced palm *Dypsis lutescens* and two observers (GD & XP) in front of the native *Pandanus utilis*. Basking sites were located at different heights on branches and trunks of the trees, while floral food resources were located about 10 m above ground. Geckos were filmed using a Sony RX10 (1-inch sensor /24–200 mm f/2.8 lens) camera. In addition we

counted geckos (JC, XP & ND) along the edges of *Pandanus* thickets. We performed four 5-minute counts between 08:30 h and 14:30 h. On 8 February 2023, we repeated the observation of basking sites and floral food resources, but not the observations on thicket edges, using the protocol described above.

We counted interactions between the two gecko species on two types of substrates: floral food resources (e.g. fruits, nectar and pollen of *Pandanus utilis* and *Dypsis inflorescences*) and sunspots (basking sites) on the branches and trunks of *Pandanus utilis*. Interactions were classified as either aggressive or non-aggressive. We considered an aggressive behaviour as an attempt by one gecko to either bite or intimidate another, leading to its retreat. A non-aggressive (passive) interaction was recorded when both species were present on the same substrate (e.g. food or sunspot) with no observed aggressive interaction. We also recorded for both species the number of ritual displays, i.e. tail movements (raising or flicking) that are behaviours displayed by *Phelsuma* spp. when they are, for example, hunting (Wehsener & Noss, 2022) or territorial signalling (Caceres et al., 2010; Wehsener, 2019). We also recorded the number of retreats following an interspecific interaction.

RESULTS

The count across sampling occasions for *P. inexpectata* was 16 individuals and 188 for *P. laticauda*. We observed 18 interactions between the two species (Fig. 2). Non-aggressive interactions were the most frequent (67 %; n = 12). At sunspots, we observed five non-aggressive interactions and two aggressive interactions (one for each species). On floral food resources we counted five interactions that were non-aggressive with three aggressive interactions of *P. laticauda* against *P. inexpectata* and one of *P. inexpectata* against *P. laticauda* (BHS video, 2023). *Phelsuma laticauda* signalled their presence (tail movements) six times but *P. inexpectata*



Figure 1. Group of *Phelsuma laticauda* and *Phelsuma inexpectata* on the same screwpine *Pandanus utilis*

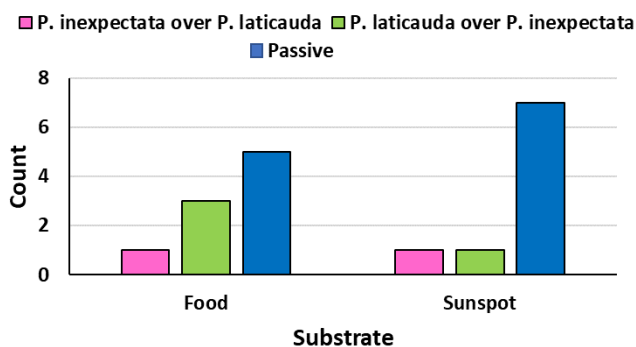


Figure 2. Number of interspecific interactions between *Phelsuma inexpectata* and *Phelsuma laticauda* and the outcome of these interactions on food resources and sunspots (basking sites)

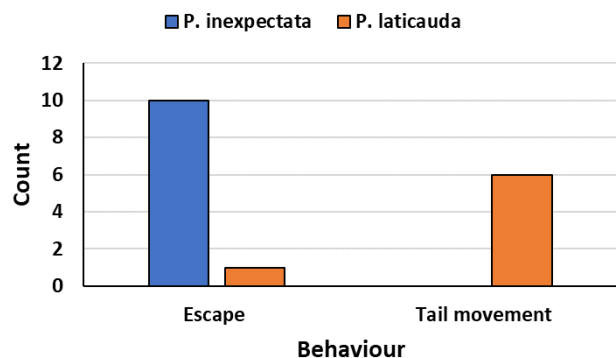


Figure 3. Number of ritualistic displays and escape behaviours during interspecific interactions between *Phelsuma inexpectata* and *Phelsuma laticauda*

was not observed to display this behaviour (Fig. 3). On ten occasions *P. inexpectata* avoided contact with *P. laticauda* by circumnavigating, whilst *P. laticauda* retreated only once from *P. inexpectata* (Fig. 3).

DISCUSSION

Our study was brief, comprising observations from two days only, hence, represent limited data. Furthermore, gecko behaviour may show seasonal variation (Choeur et al., 2023) so that any conclusions about the interactions between the two species are at present tentative until more data are available. This should include information on population size and how populations are distributed in different habitats. Nevertheless, we provide some evidence of direct competition for floral food resources and basking sites between the invasive *P. laticauda* and the endemic *P. inexpectata*. While both species are capable of physically repelling each other (BHS video, 2023) most of the observed interactions were non-aggressive. However, *P. laticauda* showed frequent use of ritual displays towards the endemic species. *Phelsuma inexpectata* showed these displays intra-specifically suggesting that the signals from *P. laticauda* were possibly recognised and likely causally related to *P. inexpectata* retreat behaviours.

In lizards, inter-specific interactions are complex with subtle differences in behaviour and habitat occupancy that allow coexistence, such as differences in activity peaks (Luiselli & Capizzi, 1999; Porcel et al., 2021), use of supports (Williams et al., 2020; Porcel et al., 2021), food resources (Simbula et al., 2019), and sometimes distinct diurnal and nocturnal roosting sites (Zughaiyir, 2016; Zdunek, 2022; Meek & Luiselli, 2022). All species of the genus *Phelsuma* are frequent visitors of floral food resources, these are often very localised, thus attracting several individuals to the same location. This increases the likelihood of contacts and hence conflicts. It should be noted that our observations were made at a site with abundant floral food resources that might be expected to increase tolerance between the two species. However, when resources are limited, aggressive interactions may increase. The local association Nature Océan Indien addresses this issue in the framework of the ‘Refuges pour le Gecko vert de Manapany’ project using citizen conservation. The association works with local homeowners and provides endemic plants and guidance for the restoration and protection of urban habitat within the *P. inexpectata* distribution.

Despite the fact that *P. inexpectata* was first detected in the botanical garden, three years before *P. laticauda*, the latter is in now the most abundant species. This suggests that it has higher population dynamics; a factor that may contribute to its status as an invasive species. In addition, *P. inexpectata* has colonised only specific sections of the botanical garden whereas *P. laticauda* is now found widely across the whole estate, suggesting the use of a wider range of habitats. The displacement of other native gecko populations by non-native lizards to more specialised habitats has been documented, a good example being *Phyllodactylus pulcher* by *Hemidactylus mabouia* in Barbados (Williams et al., 2020).

We recommend demographic studies and the monitoring of habitat use for both species to better understand the population dynamics of *P. laticauda*. Potential avenues to explore are the observed more frequent use of native plants by *P. inexpectata* than *P. laticauda* (Porcel et al., 2021) and comparisons of the geckos thermal ecologies.

This study found some support for the notion that aggressive behaviour of *P. laticauda* is a driver of its invasiveness. However, we emphasise that wider habitat use, potentially higher population dynamics and the predicted positive response of *P. laticauda* to climate change (Dubos et al, 2022a; 2022b) may be even more powerful drivers of invasion in the future.

REFERENCES

- BHS video (2023). Interactions between the endemic gecko *Phelsuma inexpectata* and the introduced *Phelsuma laticauda* on Reunion Island. Filmed by Gregory Deso. <https://youtu.be/hKDp473N6hE>.
- Caceres, S., Jasmin, J.-N. & Sanchez, M. (2010). Observations comportementales chez le Gecko vert des Hauts, *Phelsuma borbonica* Mertens, 1942 (Squamata: Gekkonidae). *Bulletin Phaethon* 30: 10–19.
- Choeur, A., Clémencet, J., Le Corre, M., Roesch, M.A. & Sanchez, M. (2023). Intra-annual variations of microhabitat use and movements of a critically endangered arboreal day gecko endemic to Reunion Island: implications for conservation. *Amphibia-Reptilia* (published online ahead of print 2023). <https://doi.org/10.1163/15685381-bja10125>.
- Dubos, N., Piludu, N., Andriantsimanarilafy, R.R., Randrianantoandro, J.C. & Andreone, F. (2014). New findings of *Phelsuma grandis* and *P. laticauda* (Sauria : Gekkonidae) at the southern edge of the range of the endangered *Phelsuma serraticauda* in eastern Madagascar. *Herpetology Notes* 7: 21–23.
- Dubos, N., Montfort, F., Grinand, C., Nourtier, M., Deso, G., Probst, J.-M. et al. (2022a). Are narrow-ranging species doomed to extinction? Projected dramatic decline in future climate suitability of two highly threatened species. *Perspectives Ecology and Conservation* 20: 18–28.
- Dubos, N., Fieldsend, T.W., Roesch, M.A., Augros S., Besnard A., Choeur A. et al. (2022b). Choice of climate data influences current and future global invasion risks for two *Phelsuma* geckos. *BioRxiv*. <https://doi.org/10.1101/2022.08.04.502765>.
- Fieldsend, T.W., Krysko, K.L., Sharp, P. & Collins, T.M. (2021). Provenance and genetic diversity of the non-native geckos *Phelsuma grandis* Gray 1870 and *Gekko gecko* (Linnaeus 1758) in southern Florida, USA. *Biological Invasions* 23: 1649–1662.
- Hoarau, G., Crestey, N., Porcel, X., Luspot, W., Deso, G., Dubos, N. & Probst, J.M. (2021). Interactions alimentaires du Gecko vert poussière d'or *Phelsuma laticauda* (Boettger, 1880) et du Gecko vert de Manapany *Phelsuma inexpectata* Mertens 1966 sur des fleurs exotiques (Île de La Réunion). *Bulletin Phaethon* 53: 89–91.
- Luiselli, L. & Capizzi, D. (1999). Ecological distribution of the geckos *Tarentola mauritanica* and *Hemidactylus turcicus* in the urban area of Rome in relation to age of buildings and condition of the walls. *Journal of Herpetology* 33: 316–319.
- Lund, I. (2015). Moorea's newest invasive species: the distribution and behavior of *Phelsuma laticauda*. Biology and Geomorphology of Tropical Islands. Unpublished Manuscript. http://www.moorea-ucb.org/uploads/6/6/8/3/6683664/lund_final.pdf.
- Meek, R. & Luiselli, L. (2022). Living in patchy habitats: substrate selection by basking sympatric lizards in contrasted anthropogenic habitats in western France. *Russian Journal of Herpetology* 29(4): 227–236.
- Moutou, F. (1995). *Phelsuma laticauda*, nouvelle espèce de lézard récemment introduite à La Réunion. *Bulletin Phaethon* 1: 33–34.
- Porcel, X., Deso, G., Probst, J. & Dubos, N. (2021). Sympatrie entre le Gecko vert de Manapany *Phelsuma inexpectata* endémique de la Réunion et le Gecko vert poussière d'or *P. laticauda* introduits au Domaine du café grillé : peuvent-ils cohabiter? *Bulletin Phaethon* 53: 36–38.
- Sanchez, M. (2021). *Phelsuma inexpectata*. The IUCN Red List of Threatened Species 2021: e.T17450049A17450059. <https://dx.doi.org/10.2305/IUCN.UK.2021-2.RLTS.T17450049A17450059.en>. Accessed on 5 February 2023.
- Simbula, G., Luiselli, L. & Vignoli, L. (2019). Lizards and the city: A community study of Lacertidae and Gekkonidae from an archaeological park in Rome. *Zoologischer Anzeiger* 283: 20–26.
- Wehsener, J.W. (2019). Foraging mode and the factors affecting foraging behavior in the diurnal arboreal gecko, *Phelsuma laticauda*. Unpublished Manuscript. http://www.moorea-ucb.org/uploads/1/1/8/3/118334900/wehsener_final.pdf.
- Wehsener, J.W. & Noss, C.F. (2022). Disentangling Morphological and Environmental Drivers of Foraging Activity in an Invasive Diurnal Gecko, *Phelsuma laticauda*. *Journal of Herpetology* 56(4): 386–395.
- Williams, R.J., Horrocks J.A. & Pernetta A.P. (2020). Habitat use by an endemic and a non-native gecko: natural habitat provides a last refuge for the Barbados leaf-toed gecko. *Neotropical Biodiversity* 6: 127–137.
- Zdunek, P. (2022). Cohabitation, change in habitat use, and locality records for skinks and some geckos in the Society Islands, French Polynesia. *Herpetology Notes* 15: 117–121.
- Zughaiyir, F.E.-H. (2016). Best beach front real estate: microhabitat segregation of sympatric species of geckos on Mo'orea, French Polynesia. *PeerJ Preprints*. DOI: 10.7287/peerj.preprints.2675v1.

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