First report of the co-existence of the three endemic *Phelsuma* species of Mayotte Island (Indian Ocean) in anthropogenic habitats

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ABSTRACT - We report the first syntopic observation of all introduced and endemic *Phelsuma* species of Mayotte Island from a restricted area dominated by plantations and degraded forest. However, we suggest that more in-depth studies of the interactions between *Phelsuma* species in anthropogenic habitats are urgently needed to guide efforts towards the conservation of the endemic species.

INTRODUCTION

The island of Mayotte is part of the volcanic Comoros archipelago located in the Northern Mozambique Channel in the Western Indian Ocean region. As in many highly diverse tropical regions, 90 to 95% of the island's original habitats are degraded or destroyed (UICN, 2013), but still support a high diversity and abundance of reptiles (Hawlitschek et al., 2011). Five species of day geckos of the genus *Phelsuma* occur sympatrically on the island. The three endemics *P. robertmertensi*, *P. nigristriata*, and *P. pasteuri* mostly occur in natural habitats and more specifically in elevations above 200 m a.s.l. for *P. nigristriata*, while the two introduced species *P. dubia* and *P. laticauda* are very abundant in lowland plantations and degraded forests (Hawlitschek et al., 2011). Substantially modified areas were previously shown to be valuable habitats for some species of *Phelsuma* on other islands (see Thorpe & Crawford, 1979; Randrianantoandro et al., 2012; Theisinger & Ratianarivo, 2015). Possibly because of their divergence in ecological preferences, up to two endemic species of *Phelsuma* were already reported to occur in syntopy in Mayotte, i.e., in one observation site, along with the two introduced species (see Hawlitschek & Glaw, 2014; Wang et al., 2016). Here, we present the first data on the syntopic occurrence of all five *Phelsuma* species of Mayotte in anthropogenic habitats.

METHOD

In 2015, we conducted a complete ecological assessment (unpublished data) for a designated project located in Grande Terre (12°46'S, 45°11'E; 150-250 m a.s.l.; 0.32 km^2). We specifically searched for *Phelsuma* species by walking nine transect lines (Eberhardt, 1978) during the rainy season (March) for a total of 3,237 meters and a duration of 5.4 hours, and five additional transect lines during the dry season (September) for a total of 3,421 meters and a duration of 5.7 hours (Fig. 1). During the second campaign, five stationary vantage points were conducted in areas and types of vegetation where no geckos were found before. They consisted in scanning the surrounding area for 60 minutes with binoculars (8X42) within a radius of 30 meters (canopy to ground, 360°), by allowing the observer to slightly move and improve his visibility through tree crowns (especially for Arecaceae). All surveys were conducted during the optimum period survey advised by Hawlitschek & Glaw (2014) from 7 to 11 am and 3 to 6 pm. Habitat classes were categorised according to Hawlitschek et al. (2011). Complete descriptions and identification keys for *Phelsuma* species were provided by Hawlitschek & Glaw (2014). We apply a strict definition of syntopy based on the potential overlap of home ranges of adult *Phelsuma* species. The only published data on home range extent is from Ikeuchi et al. (2005), where home ranges of male *P. kochi* (from Madagascar) extended over up to 516 m^2, with a maximum distance of 45 meters between two perches used by the same individual. This relates to a hypothetical perfect circle with a diameter of 45 m, specifically for males that potentially overlap with as many female home ranges as possible. We therefore consider any occurrence of *Phelsuma* spp. within twice this distance, i.e., 90.0 m or less, as potentially overlapping home ranges and therefore as syntopic. Within this distance, we also consider observations in different habitat classes as syntopic because in the boundaries between habitat classes in the study area, with the exception of the river, are 'soft' and only marked by thresholds in the abundance of plant species. Therefore, they should not be expected to form barriers to the movement of *Phelsuma* spp.

RESULTS AND DISCUSSION

While Mayotte's natural habitats have become extremely scarce, our surveys yielded the first data on the co-existence of all five *Phelsuma* species of Mayotte in a degraded area close to urban settings and mainly composed of plantations and degraded forests (Table. 1, Fig. 1). A total of 40 observations of *Phelsuma* geckos were made. The two most commonly observed species were the endemics *P. robertmertensi* (30% of total counts) and *P. nigristriata* (27.5%), while the least commonly observed was the

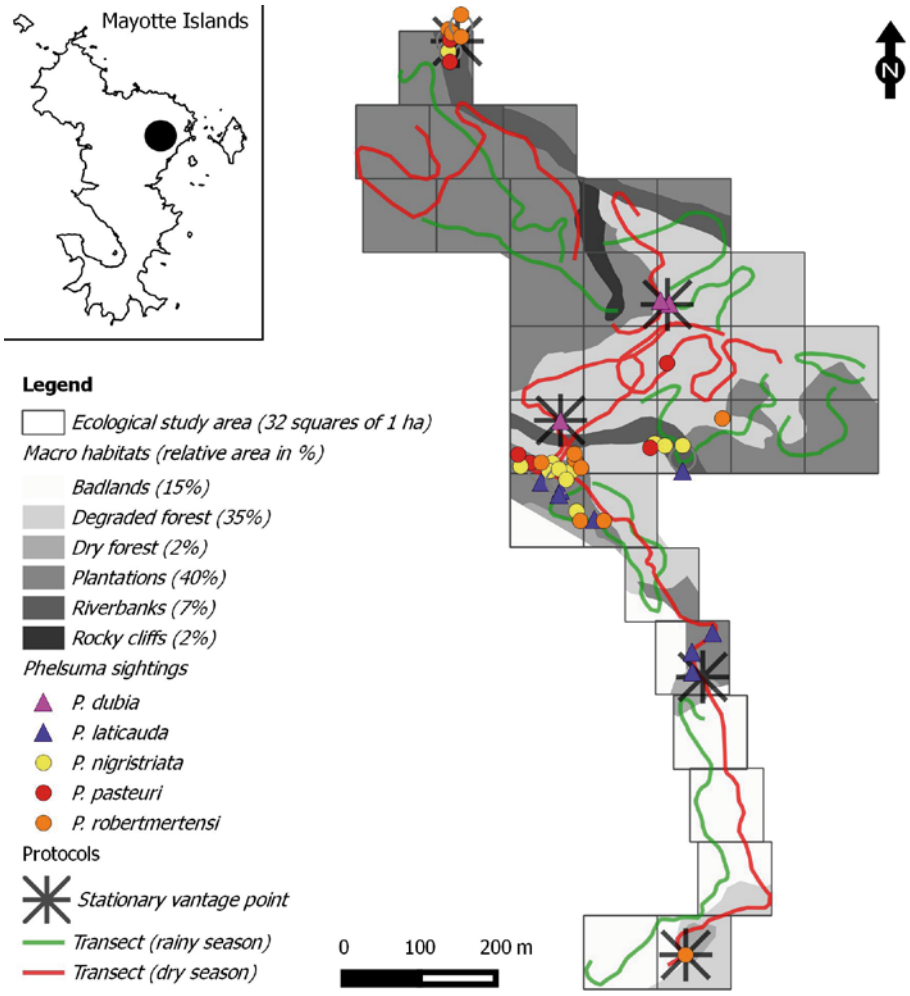

Figure 1. Location map of the study site with habitat types and gecko observations

introduced *P. dubia* (7.5%). Endemic geckos represented 72.5% of total observations. The highest numbers of observations were made in plantations (dominated by banana and coconut trees) along with the maximum species richness (4 taxa); the two most abundant taxa recorded in this habitat were *P. laticauda* and *P. nigristriata* (both representing 30% of the counts in this habitat class). Riverbanks are the second most occupied habitat, with 32.5% of total counts, mainly represented by endemics (30%) (Table. 1). All five species were observed within a minimum distance of 71 m, therefore considered syntopic because their home ranges can be expected to overlap and the species may compete for resources.

We have the view that four major factors may explain species richness in the study area: i) the high diversity and availability of macro- and microhabitats (Arecaceae, Musaceae, Pandanaceae, indigenous wooden trees in canopy); ii) the singular biogeographical context of the study site as a buffer zone between the natural area of Majimbini known to host endemic *Phelsuma* populations (Brückmann, 2010; Hawlitschek et al., 2011), and the nearest human settlements of Mamoudzou, largely colonised by the introduced *P. laticauda* (Hawlitschek et al., 2011; S.A., pers. obs.); iii) the fact that human transportation of plant material

Table 1. Macro habitat types and *Phelsuma* gecko species counts and percentage per type. Σ: total counts; %: percentage of counts; D.O.: duration of observation; PD: *P. dubia*; PL: *P. laticauda*; PN: *P. nigristriata*; PP: *P. pasteuri*; PR: *P. robertmertensi*.

Vegetation types	Total			PD		PL		PN		PP		PR	
	Σ	%	D.O. (h)	Σ	%	Σ	%	Σ	%	Σ	%	Σ	%
Badlands	0	0.0%	1.43	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Degraded forest	8	20.0%	6.65	3	7.5%	0	0.0%	0	0.0%	2	5.0%	3	7.5%
Dry forest	3	7.5%	2.30	0	0.0%	1	2.5%	0	0.0%	0	0.0%	2	5.0%
Plantations	16	40.0%	3.94	0	0.0%	6	15.0%	6	15.0%	2	5.0%	2	5.0%
Riverbanks	13	32.5%	1.67	0	0.0%	1	2,5%	5	12.5%	2	5.0%	5	12.5%
Rocky cliffs	0	0.0%	0.10	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
TOTAL	**40**	**100.0%**	**16.09**	**3**	**7.5%**	**8**	**20.0%**	**11**	**27.5%**	**6**	**15.0%**	**12**	**30.0%**

(e.g. banana plants) from one remote forested area to another on foot is a common practice throughout Mayotte and iv), the presence of rivers crossing the study site and providing riparian habitats that can be seen as refuges excluded from farming and human influences. While anthropogenic ecosystems will probably cover a larger fraction of Mayotte in the near future, the co-existence of closely related endemic and introduced day geckos in these areas may lead to niche overlap, microhabitat partitioning, habitat shift or even species exclusion (Schoener, 1968). Knowledge about these mechanisms in the species from Mayotte is limited to anecdotal reports, but quantitative studies are urgently needed considering the fast and permanent changes in land use and the potentially high pressure from introduced species on this island. Some studies on microhabitat use and intra-generic competition were conducted on the endemic *Phelsuma* species of Mauritius and the Seychelles (Harmon et al., 2007, Cole & Harris 2011, Noble et al., 2011, Buckland et al., 2014, Hagey et al., 2015). Therefore, more in-depth studies of the interactions between the five *Phelsuma* species from Mayotte are urgently needed to guide efforts towards their conservation.

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