

REDISCOVERY OF THE ENIGMATIC DAY GECKO *PHELSUMA MASOHOALA* IN NORTHEAST MADAGASCAR

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Abstract.—*Phelsuma masohoala* is a cryptically patterned day gecko endemic to Madagascar, and is one of the rarest geckos known on the island. It is currently known from only four museum specimens and has not been reliably seen in the wild since 1994, despite recent attempts to find it at the type locality. Here we report the rediscovery of *P. masohoala* at Marojejy National Park, and review all known records of this species. Our observations provide important new data on the ecology, distribution, and behavior of this rare species, which appears to be difficult to detect due to its cryptic coloration and arboreal habits.

Key Words.—conservation; distribution; Gekkonidae; Marojejy

INTRODUCTION

Phelsuma masohoala (Raxworthy and Nussbaum 1994) is one of the least known species of gecko in the world. It is distinguished by its grey, black and white coloration; all other *Phelsuma* known to be sympatric with it are primarily green. Raxworthy and Nussbaum (1994) listed the following diagnostics for the species: “A presumably medium-sized *Phelsuma*, 47mm SVL; nostril placed directly above the suture between the rostral and first supralabial; median cleft on the rostral; one intersupranasal granule; chin with two dark chevrons; head and neck without a median line; head and body without green, blue, or red pigmentation.” Meier and Böhme (1996) considered *P. masohoala* to be a close relative of *P. abbotti*, which would place it in the *P. madagascariensis* group, although no molecular study has yet looked at its affinities (Rocha et al. 2010).

The species was first described from a single specimen collected in 1993 at Cap Est on the Masoala Peninsula in northeastern Madagascar. The holotype (Fig. 1), a mature female deposited at the Museum of Zoology, University of Michigan (UMMZ 203688), “was collected at 0900 h, at 0.3 m height, on a tree trunk (0.2 m in diameter), in partly degraded littoral forest, 30 m from the shore.” (15.25°S, 50.48333°E; elevation 5 m; Raxworthy and Nussbaum 1994). Despite extensive searches of the area, no other individuals were found during this field visit.

Information on two further museum specimens has also been published. Meier and Böhme (1996) discussed a female specimen in the Alexander Koenig Research Museum (ZFMK 57881), which was reportedly collected for the pet trade almost 300 km south of the

type locality, from the Tamatave area. However, doubts about the locality of this specimen have been considered sufficiently serious that it was not included in the IUCN Red List species account (Glaw and Rakotondrazafy 2011). Photographs of this specimen in life appear in Meier and Böhme (1996), Glaw and Vences (2007), and Hallmann et al. (2008).

Another specimen was discovered in a jar among specimens of *Phelsuma grandis* at the Museum für Tierkunde Dresden (MTKD D 44291; Hofmann and Toschke 2010). This specimen has no information about the collector or the locality, and is the first male of the species to be described. Photographs of the preserved specimen appear in Hofmann and Toschke (2010), and its coloration appears to have been similar to that of the females, although, unlike previous specimens, it lacks dark chevrons on the throat. Interestingly, *Phelsuma grandis* is sympatric with all known localities for *P. masohoala* except the Tamatave region (see Raxworthy et al. 2007).

Although very little is known about the ecology and life history of *P. masohoala*, a few observations on the breeding biology of this species have been made. The holotype specimen was gravid with three eggs (Raxworthy and Nussbaum 1994), and ZFMK 57881 reportedly mated with a male *P. abbotti* in captivity and laid two clutches of eggs (Glaw and Vences 2007). Although these clutches never hatched, they showed that *P. masohoala* is among the *Phelsuma* species that do not glue their eggs to the substrate. A variety of other *Phelsuma*, including all other putative members of the *P. madagascariensis* group, also do not glue their eggs to substrate (Rocha et al. 2010).



FIGURE 1. (a) The holotype of *Phelsuma masohoala*, UMMZ 203688, in life. (b) Type habitat for *Phelsuma masohoala*, Cap Est, Madagascar. (Photographed by Christopher J. Raxworthy).

MATERIALS AND METHODS

We conducted herpetological surveys (RCS) in Marojejy National Park, Madagascar, in November 2015 during the dry season. Located in Antsiranana Province, Marojejy is one of the most biologically diverse National Parks in Madagascar, with a diverse topography ranging from lowland rainforest to alpine scrub (Patel 2007). Over 40 species of lizards have been recorded in the park to date (Raselimanana et al. 2000; Glaw and Vences 2007). Despite its National Park status, Marojejy faces serious conservation challenges including slash-and-burn agriculture and the illegal logging of rosewood (Patel 2007).

We conducted daytime searches within the park opportunistically, recording location and elevation with a GPS unit, and photographing *Phelsuma masohoala* in situ. We then searched the same locality again 5 d later, taking additional photographs when a second sighting of the lizard was made. To compare our observations with previous records, we searched museum collections and reviewed the literature for additional specimens of *P. masohoala*, collating data on these specimens to describe variation within the species and to create a revised distribution map. In addition to referring to the published literature for three specimens (MTKD D 44291; ZFMK 57881; UMMZ 203688), we collected data on a fourth museum specimen (UMMZ 216704). We took photographs and morphometric measurements for this specimen, which has not been described previously.

RESULTS

We encountered a live *Phelsuma masohoala* (Fig. 2) directly at the entrance to the Marojejy National Park (14.46243°S, 049.79627°E; 175 m elevation; Sava re-

gion). We observed this single individual on two occasions, 5 d apart. The gecko, which we did not capture, was photographed on both sightings. We observed it 9 November 2015 in the afternoon (1457), and again on 14 November 2015 in the morning (0916). On the first sighting, we observed it about 1 m from the ground, on the trunk of a small, low-branching tree that was growing in a clearing at the park entrance. When approached, the gecko moved up the trunk and into the branches, climbing out onto a limb about 2 m above the ground. There, it paused at the extremity of the branch before turning around, retreating back toward the main trunk, and climbing higher into the tree. Five days later, we resighted the same individual (determined by comparing markings recorded by photography; Fig. 2c), this time sitting still on a different tree trunk (about 0.22 m in diameter) at a height of approximately 7 m. The second tree was about 15 m from the first tree, and the gecko would have had to come down to the ground to reach it. Because this locality was at the park boundary, there was a sharp transition from intact secondary forest to cleared land (Fig. 2d). The first sighting was in a clearing just outside of the forest, but the second time we observed the gecko it was on a tree directly at the forest edge.

We studied an additional specimen from the Museum of Zoology of the University of Michigan (UMMZ 216704). This specimen was collected in October 1994 by Jürgen Spannring at 5 km from Antalaha (14.941666°S, 50.3°E). The habitat in this area was heavily modified by human activity, and included secondary scrub and areas under cultivation. The Antalaha specimen contributes new morphometric data to the information that is available for this species (Table 1). Our new records are summarized in an expanded distribution map (Fig. 3).

TABLE 1. Selected morphometric characters of *Phelsuma masohoala* specimens (in millimeters).

Character	UMMZ 203688	UMMZ 216704	ZFMK 57881	MTKD D 44291
Sex	Female	Juvenile	Female	Male
Snout-vent length	47	43	50	49
Tail length	52	tail missing	–	61
Head length	–	13.7	–	17
Head width	–	8.7	–	9
Forelimb length	15	9	–	–
Hindlimb length	20	17.5	–	–
Tympanum height	1	1.1	–	–
Chevrons on throat	yes	no	yes	no
Groove in rostral scale	yes	–	no	no
Black and white spots	yes	yes	yes	yes
Black eye stripe	yes	yes	yes	yes

DISCUSSION

Our results show that the distribution of *Phelsuma masohoala* is greater than earlier studies suggested. Previously, the entire known range of this species was restricted to the type locality at Cap Est, with the exception of an uncertain record from the Tamatave region. Two additional records have now been added to the known distribution: Antalaha just to the north of the Masoala Peninsula, and Marojejy National Park. The Antalaha specimen was found 40 km from the type locality, and much like the type specimen, it occupied a habitat near the coast. The Marojejy individual that we observed, however, occurred 114 km northwest of the type locality, and much farther inland. All three known localities for this species are from lowland degraded humid forest sites. This supports the hypothesis that *P. masohoala* is endemic to northeastern Madagascar, and that it occupies low elevation forest. We suspect that *P. masohoala* may occur only within a narrow biogeographic zone in northeast Madagascar (see Boumans et al. 2007). In northern Sava, a transition from humid forest to dry forest serves as a likely barrier to dispersal. Additionally, the Tsaratanana Massif creates a biogeographic barrier in the west for many species. As a result, lowland rainforest in the region occurs primarily in eastern Sava, and it is possible that *P. masohoala* is restricted entirely to this area.

Unlike most species of day geckos, *Phelsuma masohoala* appears to be extremely difficult to detect throughout its range. Marojejy National Park has many visitors, and has been subject to many herpetological surveys (e.g., Raselimanana et al. 2000), so the fact that this species has remained undetected until now underscores its cryptic nature. The infrequency with which it is seen suggests that it is a canopy-dweller, and this is supported by our observations of the species up to 7 m

height on a tree trunk. We suspect that its drab, cryptic coloration provides good camouflage on tree branches, and that it may normally be too high in the canopy to be easily observed either by day or night (when roosting).

The Marojejy individual resembles the holotype in many of its characteristics, including its predominantly grey, white, and black coloration, irregular pattern of spots, and bold, black eye stripe. The Antalaha specimen, although its colors have faded, appears to have had a similar pattern and black eye stripe. Like the holotype, the Marojejy specimen also has white labial scales and white spots, and appears to have the nostrils situated above the suture between the rostral and first supralabial as described in Raxworthy and Nussbaum (1994). However, it differs from the holotype in certain characteristics. It lacks a yellow hue on the dorsum, and it also lacks any conspicuous chevrons on the throat, a feature it shares with MTKD D 44291. Additionally, the tail of the Marojejy individual is tinted with a faint blue hue.

We have excluded the Tamatave locality from our distribution map due to uncertainties surrounding the manner in which this specimen was collected. ZFMK 57881 was obtained by an animal dealer, J.B. Donty, in 1992 and kept in captivity for about 2 y before being given to Harald Meier in July 1994 (Wolfgang Böhme, pers. comm.). Meier and Böhme (1996) report that the specimen is from the Tamatave area (or Ambila-Lemaitso; see Fig. 1, Meier and Böhme 1996), although the catalog states “between Brickaville and Tamatave.” The uncertain field source of this pet trade specimen raises concerns about this locality, considering its geographic distance from other well documented sites.

To better determine extinction threats to *P. masohoala*, a clearer understanding of its abundance, habitat requirements, and distribution are needed. The International Union for the Conservation of Nature lists the species as critically endangered because of its restricted

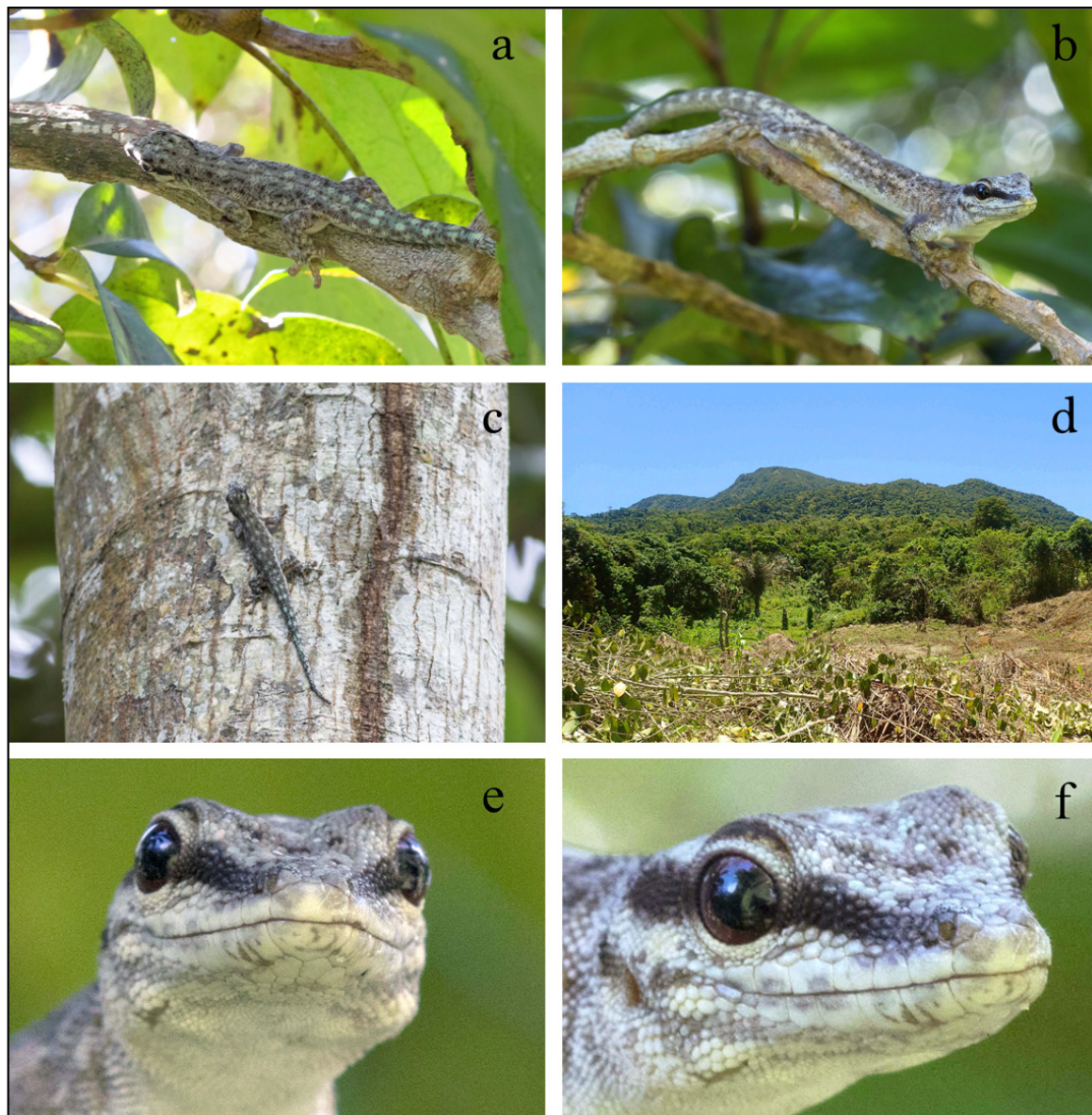


FIGURE 2. (a & b) *Phelsuma masohoala* in different views (first sighting), Marojejy, Madagascar. (c) *Phelsuma masohoala*, second sighting. (d) The edge of Marojejy National Park, Madagascar. (e & f) Close-up views of the head of *Phelsuma masohoala*. (Photographed by Richard C. Stanley).

range and threatened habitat (Glaw and Rakotondrazafy 2011). This assessment was made on the basis that its extent of occurrence was $< 100 \text{ km}^2$, and the area of occupancy was $< 10 \text{ km}^2$. Additionally, the IUCN assessment judged the habitat of the species to be in a state of continuing decline, and commented on the long-term absence of sightings. The discovery of *P. masohoala* in Marojejy National Park marks the first recorded sighting in over 20 y. It is now clear that *P. masohoala* is not restricted to just littoral environments (found up to 175 m elevation), that it is tolerant of at least some humid forest degradation, and that it is probably distributed more widely in lowland northeastern rainforests of Madagas-

car between Marojejy and Masoala. We hope that our observations will stimulate new surveys of this cryptic day gecko.

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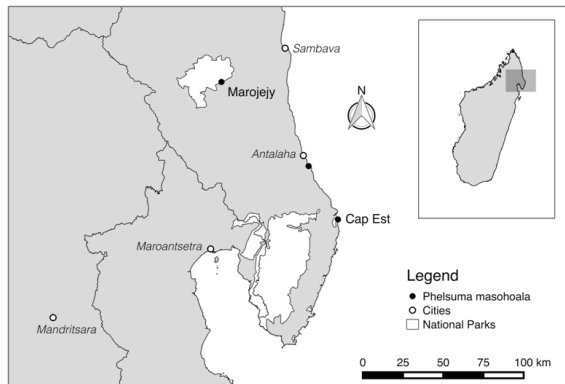


FIGURE 3. Known range of *Phelsuma masohoala*. Park boundary limits accessed from The World Database on Protected Areas (International Union for Conservation of Nature and United Nations Environment Programme's World Conservation Monitoring Centre 2015).

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RICK STANLEY grew up in Maryland, where he developed an early interest in natural history. Rick is broadly interested in ecology and the conservation of biodiversity, and he has traveled throughout the tropics to study and observe birds, herps, and insects. He holds a degree in biology from Harvard University, USA, and is pursuing a Master's degree in Ecology, Evolution and Conservation at Imperial College, London, UK. Rick has also worked as a research collaborator at the Smithsonian National Museum of Natural History, where he is involved in a project to catalog the beetle diversity of Hispaniola. (Photographed by Gabrielle R Salazar).



Since 1985, **DR. CHRISTOPHER RAXWORTHY** has researched reptiles and amphibians, primarily in Madagascar, although he has also conducted fieldwork in the Mascarene Islands, Seychelles, Cuba, Papua New Guinea, Vietnam, Ghana, Morocco, and Mali. Most recently he has been focused on chameleon and snake molecular and morphological systematics, and the use of remotely sensed data (from satellites) to help predict the distributions and model the ecological niches of species. While teaching, earning NSF grants, and publishing more than 130 papers, Dr. Raxworthy has also advised 30 students to date, including from Columbia University, University of Kansas, The University of Antananarivo in Madagascar, and the Richard Gilder Graduate School at the American Museum of Natural History. From 2000 he has been an Associate Curator, and is currently Curator-in-Charge, at the Department of Herpetology, American Museum of Natural History, in New York City, USA. (Photographed by Evrard Wendenbaum).