

Discovery of a novel association between baobab trees (*Adansonia*) and the poorly known Standing's day gecko *Phesulma standingi* in Madagascar

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Standing's day gecko *Phesulma standingi* is one of the largest and yet most poorly studied geckos in Madagascar. We report the discovery of a substantial northern range extension and document a previously unrecognized association between this gecko and baobab trees in southwest Madagascar. At three survey sites we found *P. standingi* associated with three baobabs: *Adansonia grandidieri* in northwest Morombe, *A. rubrostipa* at Ranobe and *A. za* at Zombitse Reserve. Although *P. standingi* is not an obligate baobab tree specialist, these massive trees appear to offer secure refuge and climbing surfaces, and baobabs are the main microhabitats occupied by these large day geckos. This unrecognized gecko–baobab association might partly explain why so few field observations have been made previously for *P. standingi*.

Key words: *Adansonia*, Gekkonidae, Reptilia

One of the largest and yet most poorly studied geckos in Madagascar is *Phesulma standingi* Methuen & Hewitt, 1913. This arboreal day gecko is endemic to a small arid region of southwest Madagascar, living in deciduous dry forests that may also include elements of southern thorn forest with many succulent plants. Its known distribution extends along the Fiherenana River from the Zombitse forest in the east (Raxworthy et al., 1994) to Ifaty and Ranobe in the Toliara region (Raxworthy & Nussbaum, 2000; D'Cruze & Sabel, 2005), and to the immediate south also includes Maroamalona (the type locality) and the Belomotse forest in the lower Onilahy River (Methuen & Hewitt, 1913; D'Cruze et al., 2009), and, to the immediate north, the Mikea forest (Raselimanana, 2008, see Fig. 1a). However, until now the rarity of this species has thwarted the collection of ecological data. D'Cruze & Sabel (2005) and D'Cruze et al. (2009) categorize *P. standingi* as rare in the Ranobe and Belomotse forests (lower Onilahy River), recording this species at just one site and elevation, and collecting just a

single specimen over a period of 12 months fieldwork at Belomotse. Detailed herpetological surveys at the Mikea forest were also unable to find the species, although it is reported from this area (Raselimanana, 2004).

Although *P. standingi* has never been subjected to detailed field research, it has been collected by the pet trade because of its size and attractive coloration. Commercial collecting and export, primarily to Europe and the USA, occurred between about 1985 and 1994, before a trade moratorium on the species was implemented by CITES in 1995. The impact of this commercial collecting is not known, but by 1995 at least one local population subjected to collecting was reported to have become extremely small (if not locally extinct) in forest within 5 km of major roads at Ifaty (Raxworthy & Nussbaum, 2000). In 1996, the IUCN Red List of Threatened Species listed *P. standingi* as Vulnerable (IUCN, 1996). We report here field observations for a recently discovered population of *P. standingi*, found during a Centre de Coopération Internationale en Recherche Agronomique pour le Développement (CIRAD) survey of Grandidier's baobab trees (*Adansonia grandidieri*), which, combined with observations from other sites, reveal a previously unrecognized association between this day gecko and baobab trees.

Observations of *P. standingi* were made by the authors during herpetological and botanical surveys of primary forests in southwest Madagascar between 1993 and 2009. Individual day geckos were located during diurnal visual surveys, and photographed at their point of first observation whenever possible. In some cases, animals were also captured and photographed, and representative reference specimens collected and deposited at the University of Michigan Museum of Zoology (UMMZ) and the Université d'Antananarivo Département de Biologie Animale (UADBA). Baobab trees occupied by *P. standingi* were identified in the field or from photographs (held by CJR) using flower morphology and tree architecture (Baum, 1995). For each observation, time of observation, microhabitat, height above ground and behaviour were also recorded. Localities were recorded using GPS units and altimeters. Because of the continued substantial risk of illegal commercial collecting for the pet trade (Raxworthy & Nussbaum, 2000), we do not list here the exact geographical coordinates for populations of *P. standingi*, but these are available from the authors upon request. Table 1 summarizes the baobab species distributions and site features of the four sites that we surveyed for *P. standingi*, and additional known sites that have been reported in the literature for this species.

At northeast Morombe on 3 June 2009, single individuals of *P. standingi* were observed three times, in each case on the trunk of a large *A. grandidieri* baobab tree whose canopy circumference was 10–15 m. The local habitat is a primary thorn forest, dominated by species of the Didiereaceae and Euphorbiaceae families and *A. grandidieri* baobabs (Fig. 1b). This is the only species of baobab tree recorded at this site. Two of the *P. standingi* observed are shown in Figure 1d,e. The total length of

these specimens was estimated at between 150 and 200 mm, and we therefore assume these were all adults. All observations were made between 1300 and 1500 during the hottest period of the day. Two *P. standingi* were inactive when first observed on baobab trunks at a height of about 1.5–2 m. The third animal was moving on a baobab trunk, and appeared to be hunting for food at a height of about 2 m. When approached, the gecko became still, and did not attempt to climb. It was surprisingly easy to approach all three animals to within a few metres before they moved to the far side of the trunk. At this single site (approximately 0.5 km²) we inspected and measured 30 baobab trees, thus giving an observed frequency of occupancy by *P. standingi* of 10%.

At Zombitse Reserve, the forest was surveyed for amphibians and reptiles between 11 and 20 April 1993 as part of a multidisciplinary survey (Raxworthy et al., 1994).

Phelsuma standingi was observed multiple times on large baobab trees with a trunk diameter of over 1 m (at a height of 1.5 m). Geckos were found on the trunk at heights between 1 and 8 m, between 0900 and 1600. In addition, one animal was found on the trunk of a dead standing typical deciduous tree (not identified, but certainly not a baobab) at a height of 6 m. The Zombitse forest includes blocks of primary and degraded western deciduous forest, interspersed with grassland. Large baobab trees are common in the reserve, but the only baobab species identified during the botanical survey of Zombitse was *A. za* (Du Puy et al., 1994). The botanical team also reported (to CJR) finding *P. standingi* on baobabs encountered on survey transects in 1993.

At Ranobe and Ifaty, between 18 and 30 March 1995, the forests (including the PK32 forest, immediately south of Ranobe) and coastal margins were surveyed for am-

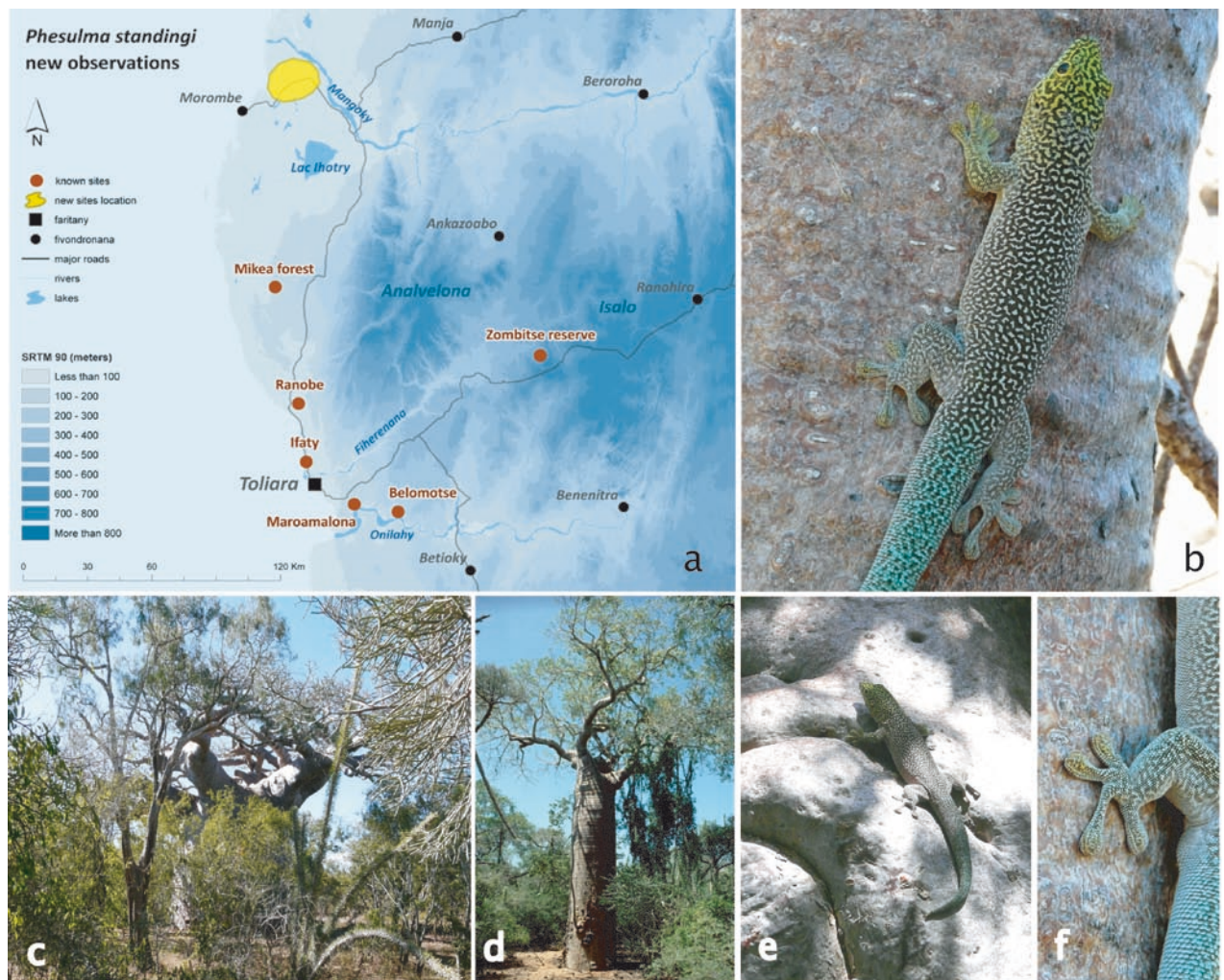


Fig. 1. a) Map of southwest Madagascar showing (in red) the known localities for *Phelsuma standingi*. The new distribution record northeast of Morombe is shown by the area marked in yellow. b) Adult *Phelsuma standingi* resting on an *Adansonia grandidieri* baobab trunk, northeast of Morombe. c) *Phelsuma standingi* habitat at northwest Morombe. The primary vegetation includes succulent and thorn forest, with *Adansonia grandidieri* baobab trees. d) *Phelsuma standingi* habitat at Ranobe, which includes succulent and thorn forest with *Adansonia rubrostipa* baobab trees. e) Adult *Phelsuma standingi* resting on *Adansonia grandidieri* baobab trunk, northeast of Morombe. f) The lateral hind limb region of an adult *Phelsuma standingi* on the bark of an *Adansonia grandidieri* baobab tree at northwest Morombe. The coloration of the body, limbs and tail is similar to the bark coloration, suggesting a possible role in camouflage.

Table 1. Characteristics of the sites with *Phesulma standingi*. *Raselimanana (2008).

Site	Elevation	Drainage	Baobab species (<i>Adansonia</i>)	Other <i>Phesulma</i>	Site protection status
NE Morombe	10–50 m	Mangoky	<i>A. grandidieri</i>	<i>P. mutabalis</i>	None
Mikea	50–80 m	Mikea	<i>A. rubrostipa</i>	<i>P. breviceps</i> * <i>P. mutabalis</i>	Pending
Ranobe/PK32	10–150 m	Ifaty	<i>A. rubrostipa</i>	<i>P. mutabalis</i>	Pending
Ifaty	0–20 m	Ifaty	<i>A. rubrostipa</i>	<i>P. modesta</i> <i>P. mutabalis</i>	None
Maroamalona	30 m	Onilahy	<i>A. rubrostipa</i>	<i>P. mutabalis</i>	Pending
Belomotse	210 m	Onilahy	<i>A. rubrostipa</i>	<i>P. mutabalis</i>	Pending
Zombitse	500–900 m	Fiherenena	<i>A. za</i>	<i>P. mutabalis</i>	National Park

phibians and reptiles. On 26 and 31 March 1995, *P. standingi* were found on the sides of several hotel buildings next to degraded primary forest at Ifaty that included *A. rubrostipa* baobabs. At least eight different individual geckos were observed at heights of 1–6 m, between 1200 and 1600, basking on smooth vertical wooden surfaces. Upon our discovery of these geckos, local guides working with us explained that this species had previously been common in the surrounding forests on baobab trees, but more recently, local collectors for the pet trade had heavily hunted them. Local collectors reported they had been paid 4,000 Malagasy francs per specimen (about \$1 at existing exchange rates) by a resident in Toliara who delivered specimens to animal exporters in Antananarivo. The Ifaty population had apparently survived only because they were on private hotel grounds. We were shown many large baobab trees around Ranobe that still had specially cut long sticks leaning by the trunks that had been used by collectors to knock geckos from the trunks. This type of collecting appeared to have been so effective that we were unable to find any additional *P. standingi* in the Ranobe forest. The forest included both primary and degraded western deciduous forest, with large mature baobab trees. We have identified these baobab trees as *A. rubrostipa* (see Fig. 1c).

Our new locality, northeast Morombe, represents a substantial range extension northwards for *P. standingi*, being 100 km north of the Mikea forest record (Raselimanana, 2008), which is itself based on an unspecified report (see Raselimanana, 2004). In 2009, we failed to find *P. standingi* in the Lake Ihotry region (northern Mikea) although forests do include large *A. grandidieri* baobabs. The next closest sites are Ifaty and Ranobe, which are 180 km to the south of northeast Morombe.

We suspect that this species has only rarely been seen until now because its close association with baobab trees has not been previously recognized (for example, see the species account in Glaw & Vences, 2007). In addition, populations with easy access, such as at Ranobe, PK 32, and Mikea, may have been heavily collected by the pet

trade between 1985 and 1995 to a point where they have become extremely rare locally (Raxworthy & Nussbaum, 2000). Prior to 1983 this species was recorded at PK32 (Domergue, 1983), and D'Cruze & Sabel (2005) also recorded *P. standingi* at Ranobe in 2003–2004 (although they noted it was rare). This latter observation suggests that the Ranobe population may have shown some signs of recovery since 1995.

Our observations of *P. standingi* on non-baobab tree trunks and smooth wooden sides of buildings clearly demonstrate that this gecko is not an obligate baobab specialist. However, considering that the majority of our field observations in primary forest have been associated with baobabs, and that this is also the habitat reported to us by local collectors, we feel confident in considering this species as primarily adapted to living in these types of trees. This is the first reported case of a reptile in Madagascar exhibiting an association with baobabs, and this plant association is comparable to other *Phesulma* day geckos that only occupy large and mature *Ravenala* palms and *Pandanus* screw palms (Raxworthy et al., 2007). This baobab association potentially offers *P. standingi* adults secure refuge within the trunk cavities that are common in large baobabs, often at heights that exceed 10 m. The broad trunk and limb surfaces also offer relatively smooth climbing surfaces, which may help to protect the gecko from some aerial and non-climbing predators. Possibly *P. standingi* may also feed on baobab nectar, and nectar-attracted insects, although we have no field observations to support this, and the habits of this rarely seen species in the wild are almost completely unknown. In captivity the species is known to feed on small geckos (Glaw & Vences, 2007). If this behaviour occurs in the wild, it could potentially include predation on smaller diurnal *Lygodactylus* geckos, as well as the broadly sympatric *Phesulma mutabalis*, both of which occupy baobab trunks (Raxworthy, pers. obs.). Interestingly, the unusual pale blue mottled body coloration of *P. standingi* may serve a cryptic function. We found these geckos difficult to spot on tree trunks under certain lighting conditions, and there

is striking similarity in coloration between the trunks of *A. grandidieri* and dorsal body limb coloration at north-west Morombe (see Fig. 1f). It could be argued that these geckos should be easier to observe on large exposed baobab trunks. However, this does not appear to be the case, because most previously reported observations have not mentioned baobabs, suggesting they were located in other microhabitats.

Our results also demonstrate that the *P. standingi*-baobab association is not specific to one baobab species, but rather, that this gecko is associated with large mature baobab trees belonging to three species (*A. grandidieri*, *A. za* and *A. rubrostipa*) within its distribution (Table 1). Also, because large baobabs occur in other regions of Madagascar outside the known distribution of *P. standingi*, there must be other factors that are limiting the distribution of this gecko. *Phelsuma standingi* is currently known to occupy three main river drainages in Madagascar – the Mangoky, Fiherenana and Onilahy – and coastal forests on sandy substrates. We suspect that this species is more widely distributed than currently known: in the southeast coastal primary forests, at higher reaches of the Mangoky and Onilahy, and further to the north, although it was not observed in any other *A. grandidieri* forests surveyed by CIRAD between Morombe and the Kirindy Reserve north of Morondava.

Concerning the conservation of this species, we consider the resumption of commercial collecting for the pet trade as inadvisable at anything except, possibly, tiny quotas, because we still lack adequate population data. However, we hope our results will encourage new surveys, leading to monitoring and management of populations in the future. *Phelsuma standingi* populations already occupy one established protected area: the Zombitse National Park, and plans are being developed to create new protected areas in the lower Onilahy River, and for the Ranobe and Mikea forests. Consequently, the long-term future for this gecko looks good, provided that mature baobab trees and primary forest are protected in these areas, and that illegal commercial collecting is prevented.

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