TECHNIQUES

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A novel technique for trapping geckos

Scientific studies and conservation efforts focused on geckos often require catching them. It is sometimes very difficult to obtain the desired sampling (e.g., an un-biased sex ratio or sampling over a gradient), especially of threatened or sensitive species for which non-harmful capture methods are required. Different techniques have been used to capture geckos, such as lassoing (García-Muñoz and Sillero 2010), hand catching (Nelson and Carey 1993; Bennett 1999), using rubber bands (Corona et al. 2018), laser pointers (Cole 2004), artificial cover objects as "retreats" (Lettink 2007; Wilson et al. 2007; Bell 2009; Nordberg and Schwarzkopf 2015; Cheylan et al. 2018), funnel traps (Hardy et al. 2008; Bell 2009; Hare 2012; Lettink and Monks 2016), adhesive traps (Bauer and Sadlier 1992; Ribeiro-Júnior et al. 2006; Fieldsend and Krysko 2020), and fishing for them with baited lines (Fieldsend and Krysko 2020).

Under certain field conditions, such as dangerous or inaccessible habitats, some or all of the above methods cannot be used effectively or are not feasible. While conducting a study of morphological variation between two high-altitude populations of the Reunion Day Gecko (*Phelsuma borbonica*), capture techniques used on other *Phelsuma* species (hand catching with or without bait, and lassoing; Cole 2005; Seifan et al. 2010; Dervin et al. 2013; Fieldsend and Krysko 2020) were inefficient in the rocky cliff habitat. Geckos were extremely vigilant and quickly escaped into crevices used as retreat sites, and vertical cliffs limited access to the habitat occupied by geckos. Due to concerns about the well-being of captured animals, methods like adhesive traps or baited hooks were not appropriate. Faced with this situation, I developed a novel technique to trap geckos.

Materials and Methods

The Reunion Day Gecko (*Phelsuma borbonica*) is native to Reunion Island (Indian Ocean), protected by national laws, and classified as Endangered on the IUCN Red List (Sanchez 2021). This gecko can reach a maximum of 83 mm SVL and 179 mm in total length. It feeds on arthropods, fruits, and flower nectar. It is mainly arboreal in forest habitat, but it is strongly saxicolous in high altitude, rocky cliff populations (>2000 m) that are devoid of tree vegetation (Sanchez and Probst 2017a,b).

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The Economy Mammal Trip-Trap (MTT, Procter Bros. Ltd., 3–6 GBP) is usually used for trapping small mammals (Keskin et al. 2020; Keskin and Selçuk 2021) and has to my knowledge not been deliberately used for capturing geckos (Fig. 1). Made of transparent plastic, a trap is 18.3 cm in length, 4.8 cm in width, 4 cm in height and weighs 65 g. The traps have an anti-reverse, drop-door mechanism which is triggered once an animal passes an internal treadle. The bait section is removable for changing bait, and three ventilation points exist on both sides.

Before using these traps on *P. borbonica*, I conducted an initial test in a garden located in an urbanized area (21.06667°S, 55.21667°E; 10 m elev.), known to be inhabited by several non-native gecko species. Between 8 and 11 February 2012, twenty-nine MTTs baited with mango were installed on trees, palms, and anthropogenic structures (e.g. walls and roofs), by placing traps on horizontal supports or attaching them to vertical faces using double-sided tape. Traps were opened day and night under optimal weather conditions (sunny during the day, no wind) and were checked four to six times per day (between 0600–1900 h). Captured geckos were removed from the traps and dorsally marked with unique signs using black permanent markers before being released near the capture location. Four different species of geckos were trapped, with a total of 45 captures including ten recaptures. Tree species were the frugivorous geckos *Phelsuma grandis* (N = 5 individuals; 3 recaptures), *P. laticauda* (N = 7 individuals; 4 recaptures), and *Gehyra mutilata* (N = 22 individuals; 3 recaptures) and a single insectivorous gecko *Hemidactylus parvimaculatus*, which was probably attracted by insects flying around the bait. Supported by these

Fig. 1. Economy Mammal Trip-Trap (MTT).

FIG. 2. Study site and rocky cliff habitat in the Maïdo, Reunion Island. The Reunion Day Gecko (*Phelsuma borbonica*) inhabits rocky cliffs and crevices such as this.

preliminary results, MTTs were then tested in two populations of *P. borbonica*.

The study sites were located in the Maïdo (21.07171°S, 55.38631°E; 2200 m elev.) and in the Dimitile (21.15086°S, 55.50044°E; 2200 m elev.), Reunion Island. The Maïdo site is a tourist area located on the edge of a rocky cliff (Fig. 2). Meteorological equipment (mainly composed of metal poles and plastic tubes) is fixed on the cliff (Fig. 2). The Dimitile site is an isolated patch made up of several "staircase" rocky cliffs. *Phelsuma borbonica* is the only gekkonid to inhabit the study sites. On both sites, geckos mainly use rocky basalt cliffs or man-made structures, and rarely use the surrounding low ericoid vegetation.

The Maïdo and Dimitile populations were sampled in 2012, respectively on six (22 to 25 May, 11 to 12 September), and eight days (17, and 19 to 25 October). The sampling areas were arranged along the rocky cliffs, over a maximum length of 10 m. One or two sampling sessions (mean duration 0430 h, range: 0110–0930 h) were conducted each day. After a brief visual search for geckos, 6–15 MTTs per session were baited with pieces of fruit (pineapple, banana, or mango) and placed near basking and retreat sites in both natural habitat and around man-made structures (e.g., meteorological equipment). The traps were placed directly on horizontal surfaces, attached to the vertical rock faces using double-sided adhesive tape, or attached to a home-made platform lowered with a thin rope to abut the rock face (Fig. 3). Traps were opened during optimal weather conditions (sunny, not windy) and during the activity period of these geckos (between 0700–1700 h). Depending on the movement of the sun, traps could be moved during the capture session to maximize capture rate. One to three observers were positioned along the rocky cliffs to continuously check for captures. Based on the number of traps installed and the length of time traps were open, catch-per-unit-effort (CPUE, number of geckos captured per trap-hour) was examined as a measure of trapping effectiveness.

Captured geckos were extracted from traps using cotton holding bags. The condition of the tail (lost or intact) was recorded during extraction. Geckos were assigned to three groups of age: neonates (<35 mm SVL), juveniles (35–55 mm SVL), and adults (>55 mm SVL). In males, reproductive structures (hemipenal bulges, spurs, and active femoral pores) are clearly present on specimens who reach 55 mm in SVL (MS, unpubl. data). Geckos of equivalent size lacking these structures were

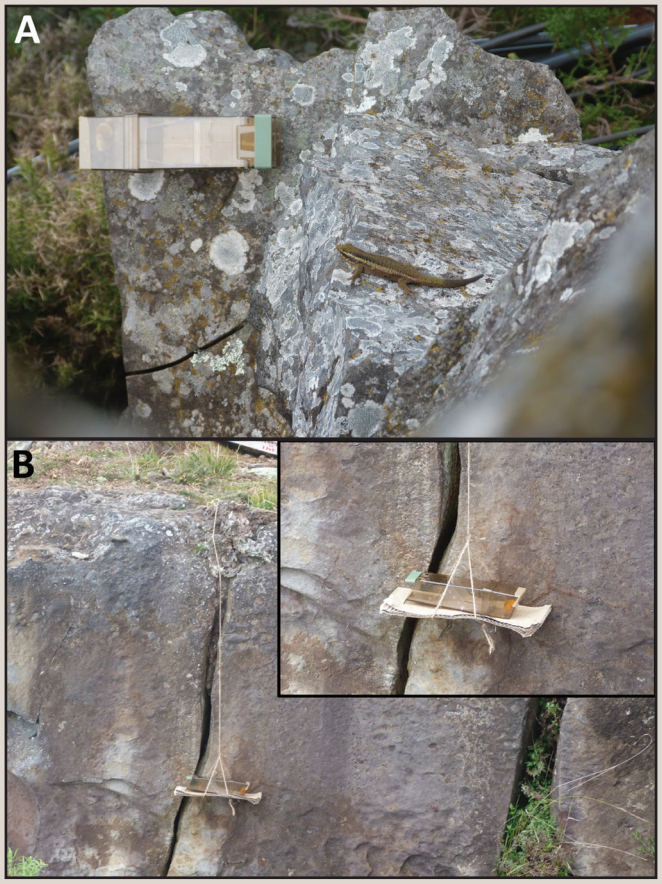

FIG. 3. Economy Mammal Trip-Traps (MTTs) installed along the Maïdo sampling area: A) top view of a trap placed on a rock and a Reunion Day Gecko (*Phelsuma borbonica*); B) horizontal view of a trap attached to a home-made platform.

assumed to be females. Snout-vent length and tail length were measured to the nearest 0.1 mm using digital calipers. Weight was measured to the nearest 0.1 g using an electronic scale. Geckos were photographed in order to be recognized through their individual color patterns in case of recapture. Handling time was a maximum of 20 min per individual. Geckos were released after handling in the exact place of capture.

RESULTS

The MTTs were successful in the capture of *P. borbonica*. Over a total of 974.5 trap hours across both populations, MTTs had 38 captures, including three recaptures (1 female in Maïdo and 2 females in Dimitile; Table 1). This total included 15 geckos in the Maïdo (6 females, 4 males, 4 juveniles, and 1 neonate) and 20 geckos in the Dimitile (9 females, 8 males, 2 juveniles, and 1 neonate). The male:female ratios for captured adults were not significantly different for each site (Maïdo: $\chi^2 = 0.82$, df = 1, $P = 0.37$; Dimitile: $\chi^2 = 0.47$, df = 1, $P = 0.49$). Mean CPUE were similar for Maïdo and Dimitile: 0.043 ± 0.012 SE (range: 0.000–0.091) and 0.037 ± 0.007 SE (range: 0.000–0.067) geckos captured per trap per hour, respectively.

SVL, total length, and weight of geckos captured, respectively ranged from 29.9–77.7 mm, 59.6–166.0 mm, and 0.8–12.8 g (Table 2). For immatures, the smallest neonate captured had a SVL of 29.9 mm and weighed 0.8 g, whereas the largest juvenile had

TABLE 1. Sampling effort, number of Reunion Day Geckos captured with Economy Mammal Trip-Traps in Maïdo and Dimitile, Reunion Island, May–October 2012. MTT = Number of traps opened, Duration = total time each trap open, Trap-hours = Duration per trap * N traps opened, N capture = number of geckos captured, CPUE = catch per unit effort (number of geckos captured per trap-hour).

	Maïdo					Dimitile				
Session	MTT	Duration	Trap-hours	N captured	CPUE	MTT	Duration	Trap-hours	N captured	CPUE
1	10	3 h 25 min	34.2	2	0.059	12	6 h 20 min	76.0	4	0.053
2	10	5 h 30 min	55.0	5	0.091	12	5 h 00 min	60.0	4	0.067
3	15	4 h 15 min	78.8	4	0.051	12	5 h 30 min	66.0	4	0.061
4	15	1 h 10 min	17.5	0	0.000	7	2 h 50 min	19.8	1	0.050
5	14	3 h 30 min	49.0	3	0.061	12	3 h 45 min	45.0	2	0.044
6	14	2 h 45 min	38.5	1	0.026	12	5 h 00 min	60.0	0	0.000
7	15	4 h 15 min	63.8	1	0.016	12	3 h 30 min	42.0	1	0.024
8	–	–	–	–	–	12	9 h 30 min	114.0	3	0.026
9	–	–	–	–	–	12	8 h 00 min	96.0	2	0.021
10	–	–	–	–	–	12	3 h 35 min	43.0	0	0.000
11	–	–	–	–	–	6	2 h 40 min	16.0	1	0.063
Total			336.7	16				637.8	22	

a SVL of 53.1 mm and weighed 4.1 g (morphological variables were not recorded for one neonate). For adult geckos, mean SVL was 66.3 ± 1.16 SE (males: 71.0 ± 1.42 SE; females: 62.6 ± 1.00 SE), mean total length was 137.3 ± 2.79 SE (males: 150.4 ± 3.22 SE; females: 127.6 ± 1.76 SE) and mean weight was 8.2 ± 0.49 SE (males: 10.3 ± 0.57 SE; females: 6.5 ± 0.38 SE) (Table 2). No gecko lost its tail during trapping, but one male was found dead inside a trap likely having died from heat exposure. That individual was deposited in the Muséum d'Histoire Naturelle de La Réunion (MHNRE - 2022.E.5.3). No accidental captures of non-target vertebrate animals were recorded during this study.

TABLE 2. Body size ranges for Reunion Day Geckos caught with Economy Mammal Trip-Traps in Maïdo and Dimitile, Reunion Island, May–October 2012. Number represent means ± SE above range in parenthesis.
N = number of geckos; SVL = snout–vent length.

	N	SVL (mm)	Total length (mm)	Body mass (g)
Male	12	71.0 ± 1.42 (60.2–77.7)	150.4 ± 3.22 (130.4–166.0)	10.3 ± 0.57 (6.3–12.8)
Female	15	62.6 ± 1.00 (56.2–69.3)	127.6 ± 1.76 (115.7–139.7)	6.5 ± 0.38 (4.7–9.7)
Juvenile	6	43.4 ± 3.37 (32.7–53.1)	89.3 ± 7.03 (70.3–117.8)	2.9 ± 0.51 (1.5–4.1)
Neonate	2	31.9 ± 2.00 (29.9–33.9)	61.9 ± 2.15 (59.6–63.9)	–

DISCUSSION

To my knowledge the Economy Mammal Trip-Trap is the first mammal trap described to capture geckos. Indeed, although commercially-available mammal traps (like Elliott, Tomahawk, Sherman, Havahart, INRA traps) can trap some lizards (i.e. Scincidae, Varanidae, Iguanidae, Teiidae, Polychrotidae, Anguidae; see Duffield and Bull 2002; Thompson and Thompson 2007; Barun et al. 2010; Rocha et al. 2015; Vieira et al. 2015; Waudby et al. 2019; Wasilewski et al. 2022), I did not find published reports of mammal traps being used to effectively capture geckos.

This trapping technique can be considered effective for capturing *P. borbonica* in cliff habitats that are difficult to sample by other means. Based on the mean CPUE from both sites (0.04 captures per trap-hour), this method had a capture rate of 47.5 captures per 100 traps per day (12 hours). This method has the advantages of capturing both immature and large adult geckos, allowing recaptures, requiring no special expertise and minimal learning time, and is relatively inexpensive. Indeed, the trap trigger system is very sensitive (minimum gecko weight 0.8 g), and traps caught small geckos, which are difficult to capture with other methods that are unlikely to harm them. Despite the occurrence of mice (*Mus musculus*) at both sites, none were captured. The recapture rate is low (7.9%), and only females were recaptured in this study. Although the method should be tested with other species and in different habitats, it has potential utility for capturing geckos as well as for monitoring that requires multiple capture events of the same individual (e.g. body condition monitoring).

Given that no tail loss was recorded during the trials, and that the probability of tail loss during trapping seems low, the technique appears to minimize the risk of tail loss and is of particular use in the repeated measurement of morphological variables. By comparison, the rate of tail loss using hand capture and lassoing capture was 7% (N = 200) on this species in forest habitat (MS, unpubl. data). On the effectiveness of the traps, it should be noted that the drop door mechanism of the traps is sensitive to wind, and at high humidity the drop door may also become less sensitive and not fall. These traps cannot therefore be used during windy or wet conditions.

One major drawback to Economy Mammal Trip-Traps is the risk of animal mortality. Exposed to the sun, traps are like "ovens" and geckos can quickly die inside by overheating. The probability of reaching critical thermal maxima inside the traps depends on both local climatic conditions, the thermal conditions of the trap location and the time of use (day or night). For safe use, I recommend considering the thermal habitat conditions (e.g., sunny rocky habitats differ from shaded areas in gardens or forests) and avoiding both critical locations for traps (e.g., high solar exposure or high thermal diffusivity of abutting support structures) and trapping during the hottest hours of the day. Additionally, shade covers could be designed and tested,

and studies of the internal temperatures of the traps could be carried out. Indeed, a comparison of the recorded temperature profile with ambient temperatures and the thermal limits of the target species would make it possible to define acceptable/unacceptable temperature ranges, and therefore to exclude critical moments for a particular site. The frequency of checks must be adapted according to the recommendations put in place. Constant monitoring remains the most relevant preventive measure to limit the risk of mortality (from overheating or predation by ants).

In New Zealand, funnel traps are commonly used for general surveys and can catch geckos (Bell 2009; Hare 2012; Lettink and Monks 2016). Thus, the method described here is the second trapping technique described for arboreal geckos. In view of the encouraging results described in this paper, the "trip-trap method" could be useful for catching other species in difficult sampling areas, as well as for capturing invasive species, and requires more trials to obtain broader feedback.

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