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# HABITAT USE, EGG LAYING SITES AND ACTIVITY PATTERNS OF AN ENDANGERED MAURITIAN GECKO (*PHELSUMA GUENTHERI*)

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Günther's gecko, *Phelsuma guentheri*, is an endangered gecko that was endemic to the Mascarene Islands but is now confined to Round Island, a small island 20 km off the northern coast of Mauritius (Merton *et al.*, 1989). Estimates of population size vary greatly from 1500-1800 (Vinson, 1975), to only 180-550 individuals in 1982 (Bullock, 1986) and has remained small (D. J. Bullock, pers. com.) despite goats (*Capra hircus*) and rabbits (*Oryctolagus cuniculus*) being removed in 1978 and 1986 respectively, resulting in increasing vegetation cover (North *et al.*, 1994).

The survival of Günther's gecko has depended largely on the absence of introduced predators, such as rats (*Rattus norvegicus, R. rattus*) (Cheke, 1987) and accidental introduction of such species is an ongoing risk. Due to this risk – or that of a catastrophic stochastic event and the small population size – translocation of geckos to neighbouring islands was suggested (Merton *et al.*, 1989; Dulloo *et al.*, 1997). *Phelsuma guentheri* has been considered a primitive day-gecko (Vinson & Vinson, 1969; Staub, 1993), and it differs from other members of its genus by its larger size, duller coloration, and a number of other, less conspicuous morphological features (Vinson & Vinson, 1969). However, insufficient knowledge exists on the behaviour and ecology of the species. For example, the activity pattern of Günther's gecko has been described as diurnal (Vinson & Vinson, 1969; Vinson, 1975), crepuscular (Bloxam & Vokins, 1978; Staub, 1993), and nocturnal (Bullock, 1986). There are also conflicting descriptions of its feeding habit (insectivorous, herbivorous, nectivorous, or carnivorous), habitat use (terrestrial or arboreal), and choice of egg laying site (Vinson & Vinson, 1969; Vinson, 1975; Bullock, 1977, 1986; Bloxam & Vokins, 1978; Bullock & North, 1991).

The aim of the present study was to provide quantitative information on the behaviour and ecology of *P. guentheri*, to clarify some of the uncertainties concerning this species. We focused on two specific aspects, namely habitat use and egg laying site characteristics, which were investigated through surveys of all habitats on Round Island. The information gathered here should allow a more objective evaluation of the behaviour and ecology of *P. guentheri*.

Round Island (longitude 57°47'03"E, latitude 19°54'03"S) measures only 187 ha in area (Carpenter, 1998) and lies 281 m above sea level at its highest point (Merton *et al.*, 1989). Its relative isolation and difficult access helped to protect its native fauna, creating a refuge for eight reptiles, including six lizards (*Leiolopisma telfairi*, *Gongylomorphus bojerii*, *Cryptoblepharus boutonii*, *Phelsuma ornata ornata*, *Phelsuma guentheri*, *Nactus serpensinsula durrelli*) and two snakes (*Casarea dussumieri* and *Bolyeria multocarinata*; Bullock, 1986). Access to the island is by permit only and is limited to seven consecutive days. Two one-week visits were made during this study: a preliminary visit in April 1998, and a survey visit in May 1998. An aerial photograph of Round Island in 1991 was obtained from the Department of Housing and Land Use (Port Louis, Mauritius) and enlarged to a scale of 1:200,000. All parts of the island were classified into one of five main habitat types: (1) rock, (2) creeper, (3) grassland, (4) palm rich forest, (5) *Lomatophyllum* spp. The area of each habitat was measured by overlaying the map with a fine-scale grid (equivalent to 25 m x 25 m quadrats) and allocating each quadrat to a habitat. Due to time constraints, one hundred and five quadrats (out of a possible 2995) were chosen at random prior to visiting Round Island with sampling stratified so that the number of quadrats in each habitat was proportional to the area covered by that habitat. During the rainy season, from 14 May to 21 May 1998, each randomly chosen quadrat was surveyed by one of five recorders for both vegetation and presence of *P. guentheri* or other saurian species. The position of each quadrat was marked, and percentage cover of the stratified vegetation layers were assessed visually using a six-category Braun-Blanquet scale (Bullock, 1997), to which a category of 0% cover was added. Each quadrat was searched for a period of 30 min. For each *P. guentheri* sighted, the following variables were recorded: time of sighting, activity (resting, i.e. motionless with head down, vigilant, i.e. motionless with head up, stalking, walking, feeding/drinking), substratum on which the individual was first observed (e.g. rock, *Latania*, *Pandanus*) as well as microsite choice (e.g. rock face or overhang, *Latania* frond, crown or trunk, etc.) and aspect (recorded with a compass), vertical distance above ground (estimated visually), and presence of, and distance to, any other lizard species. Searches for *P. guentheri* were carried out twice in each quadrat: once during daylight (06.00-18.00 hr) and once at night (18.00-06.00 hr).

In each quadrat, the daylight search for geckos was followed by a search for egg-laying sites. Female *P. guentheri* attach their eggs to various surfaces, and prominent egg scars remain on the substratum after the

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eggs have hatched (Bloxam & Vokins, 1978; Osadnik, 1984; Jones, 1988). Some egg-laying sites appear to be communal and traditional, as judged by the great number of egg scars in discrete clusters and the overlap observed among egg scars, which suggests repeated use from year to year (Vinson & Vinson, 1969; Jones, 1988). Whenever such egg scars were found, we recorded substratum type, vertical distance to the ground, evidence of previous site use (by counting the number of egg scar overlaps), number of discrete egg clusters and surface area of each cluster, and microsite choice and aspect (as above). The total area of each egg laying site was obtained by summing the areas of all clusters present at that site.

The predominant habitat of Round Island, based on the 1991 aerial photograph, was bare rock, which covered just over half (52.4%) of the island. However, an examination of the vegetation scores obtained for the 105 randomly selected quadrats reveals an increase in vegetation cover since 1991. Indeed, while bare rock should have scored only very low values on the Braun-Blanquet scale, this habitat scored mainly non-zero values in herb (98% non-zero scores) and canopy layers (88.7% non-zero). Two of the three ground-cover habitats, – creeper and grassland – showed, as expected, mostly very low values of canopy cover (creeper: 100% of scores < 1; grassland: 93.3%). However, the third ground-cover habitat, *Lomatophyllum*, scored only non-zero values for the canopy layer. This suggests that the habitat designation used, although useful in establishing the initial sampling design, was not an accurate descriptor of the current state of habitats encountered in quadrats classified as rock and *Lomatophyllum*.

In over 100 hours spent surveying, Günther's geckos were sighted 25 times. There were significantly more sightings during the day ($n$=18, 72% of the total sightings) than at night ($n$=7, 28%; $G$=4.61, df=1, $P$<0.05). However, sighting rates (number of sightings per survey) did not differ between day and night (Mann-Whitney $U$ test; $U$=4.00, $n$=7, $P$=0.63). Adult *P. guentheri* were recorded in 17% (18/105) of all quadrats surveyed. All quadrats with *P. guentheri* were originally classified either as rock (48% of sightings) or palm rich forest (52%). There were significantly more sightings in palm rich forest than expected based on the availability of this habitat ($G$=10.67, $P$<0.05).

When initially sighted, *P. guentheri* was observed significantly more often on *Latania* palm ($n$=18, 72% of sightings), and less frequently on rock ($n$=5, 20%) or *Pandanus* ($n$=2, 8%; $\chi^2$=17.43, df=2, $P$<0.001). On *Latania*, *P. guentheri* was found either on the trunk (20% of sightings during the day, 33.3% at night), crown (day: 46.7%, night: 33.3%), or fronds (day: 33.3%, night: 33.3%). There was a significant difference between daytime and night-time microsite choice on *Latania* ($n$=18, $U$=9, $P$=0.05). By contrast, the two *P. guentheri* seen during the day on rock were under an overhang, while the three individuals sighted on rock at night were on the exposed rock face. The overall mean vertical height above ground of arboreal sightings was 2.5±1.5 m (mean±SD, $n$=19), with the mean height on *Latania* (2.7±1.5 m, $n$=17) being greater than the mean height for *Pandanus* (1.3±0.5 m, $n$=2).

The majority (14/25, 56%) of *P. guentheri* appeared to be resting at the time of sighting. Active geckos were either vigilant (6/25, 24%), walking (4/25, 16%), or stalking *P. ornata* (1/25, 4%). There was one record of predation on *P. ornata* by *P. guentheri*. There was no significant difference in gecko activity among macrosites ($\chi^2$=4.39, df=2, $P$=0.09), and there was no difference in proportion of active geckos between day and night-time ($\chi^2$=0.68, df=1, $P$=0.45).

One or more of three other saurian species were recorded with 16 (64%) of the *P. guentheri* sightings. These included ornate day gecko, *P .ornata* (eight sightings; all diurnal), Durrell's night gecko, *Nactus serpensinsula durrelli* (five sightings; four diurnal, one nocturnal), and Telfair's skink, *Leiolopisma telfairi* (three sightings; two diurnal, one nocturnal).

A total of 31 *P. guentheri* egg-laying sites were found. Rock was the substrate most commonly used (15/31 sites, 48.4%), followed by *Pandanus* branches (10 sites, 32.3%) and *Latania* fronds (six sites, 19.4%). Egg-laying sites were always off the ground (overall mean±SD vertical height: 1.67±0.72 m), although there was no significant difference in egg laying site height among the three habitats (Kruskal-Wallis test, $H$=2.00, $n$=3, $P$=0.37). In the majority of cases (83.8%), the egg laying sites were concealed either under rocky overhangs or on the underside of *Latania* fronds and *Pandanus* branches.

The number of egg scar overlaps increased with egg cluster area ($r_s$=0.75, $n$=18, $P$=0.0004), suggesting that larger sites have had a longer history of use. Egg laying sites on rock were significantly larger (Kruskal-Wallis test, $H$=17.5, $n$=3, $P$<0.001) and had significantly more egg scar overlaps than egg laying sites on either *Latania* or *Pandanus* (Kruskal-Wallis test, $H$= 9.9, $n$=3, $P$=0.007). The orientation of egg laying sites was not random ($\chi^2$=8.1, df=3, $P$= 0.04). Most sites faced a northerly direction (sample mean direction ± 95% CI: 346.4±46°).

A total of 11 males and 3 females were captured, generating a sex ratio of 1 male : 0.27 female. Males and females did not differ in length (mean SVL±1 SD, males: 110.7±10.7 cm; females: 108.1±2.9 cm: $n$=14, $z$=0.39, $P$=0.70), weight (males: 59.3±17.0 g; females: 44.8±6.3 g; $n$=14, $z$=1.32, $P$=0.19), nor in scansor size (males: 5.0±0.8 cm; females: 4.7±0.3 cm: $n$=12, $z$=0.65, $P$=0.60).

Our results suggest that Günther's gecko is mainly arboreal in habit. It appeared to rely greatly on the native fan palm *Latania* for cover during both day and night, but egg-laying sites were located primarily on rock. We confirmed anecodotal evidence of saurian predation behaviour by *P. guentheri* (Vinson & Vinson, 1969; Bullock & North, 1991). The confusion surrounding the activity pattern of Günther's gecko, whether diurnal (Vinson & Vinson, 1969; Vinson, 1975), crepuscular (Bloxam & Vokins, 1978; Staub, 1993) or nocturnal (Bullock 1986, 1977), may stem from the fact

that this species showed no distinct pattern of activity. We found no difference between day and night in the proportion of active geckos or in the type of activity undertaken during day or night sightings. Although more Günther's geckos were observed during the day in absolute terms, difficulty of finding geckos in the dark appeared to have been partly compensated by the more exposed location they adopted at night (e.g. *Latania* trunk instead of crown, rock surface instead of overhang).

The arboreal habit of Günther's gecko was clear during this field study. As was suggested by Bullock (1986) and North *et al.* (1994), this species appears to prefer palm rich forest to other habitats. On a smaller scale, *P. guentheri* was recorded significantly more often on *Latania* than on rock or *Pandanus*. However, since the relative availability of these substrata is not known, it is difficult to say whether this pattern actually represents habitat choice. Nevertheless, the scansor size of *P. guentheri*, relative to its body size, is consistent with that of other arboreal congeners (Russell, 1975, 1985; Carpenter, 1998), supporting the suggestion that Günther's gecko is primarily arboreal.

At first glance, the reliance of Günther's gecko on *Latania* does not appear to be related to reproduction. Nearly half of all egg-laying sites were found on rock (see also Vinson & Vinson, 1969; Vinson, 1975; Bloxam & Vokins, 1978), and less than one-fifth were on green fronds of *Latania*. However, while rock is a permanent feature of the environment, *Latania* fronds are temporary in comparison. It is not surprising that egg laying sites on rocks were larger and had a longer history of use (i.e. more egg-scar overlaps) than those on other substrata. This may not indicate a true preference for rock as egg laying site but may be a reflection of the historical unavailability of other sites. Indeed, as recorded in this study and by North *et al.* (1994), the vegetation of Round Island has been recovering since the extirpation of rabbits and goats. Prior to grazer removal, egg-laying sites on vegetation were probably extremely limited, possibly explaining the repeated use of rock surfaces for reproduction. It will be interesting in the future to monitor the relative use of rocky and vegetation sites by breeding Günther's geckos as vegetation recovery continues.

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