

Original article

## Macro- and microhabitat use of Telfair's skink (*Leiolopisma telfairii*) on Round Island, Mauritius: implications for their translocation

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Received 1 March 2005; accepted 6 June 2005

Available online 14 July 2005

### Abstract

The successful eradication of introduced rodents from islets off the coast of Mauritius has led to local conservation bodies investigating the possibility of translocation as a measure of safeguarding endemic reptile populations. The present study was the first to determine the habitat and microhabitat requirements of Telfair's skinks (*Leiolopisma telfairii*) on Round Island, Mauritius, with a view to aiding future translocation projects to islands within their historic range. Contrasting preferences found for Telfair's skink at macro- and micro-habitat levels underline the importance of sampling at multiple ecological scales in such investigations. Significantly fewer sightings of *L. telfairii* were recorded in bare rock habitats compared to more vegetated habitats. Conversely, at a microhabitat scale principal component analysis indicated structural characteristics were the primary determinant of microhabitat choice. The first dietary analysis of Telfair's skinks confirmed their status as omnivores. Cockroaches (*Blattodea* spp.) appeared to be a primary food source. Four exotic plant species were also present in faecal samples and the potential for *L. telfairii* to aid their dispersal is discussed. Implications for the long-term management and proposed translocation of Telfair's skinks are discussed.

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**Keywords:** Conservation; Ecological scale; Habitat use; Invasive species; *Leiolopisma telfairii*; Lizard; Mauritius; Microhabitat; Round Island; Translocation

### 1. Introduction

The insular nature of island biotas has resulted in their increased susceptibility to invasive species, which are recognized as one of the major threats to global biodiversity (Mack et al., 2000). Invasive species have caused range reductions of native species (Jones, 1993), which in extreme situations have led to cascades of extinctions (Case and Bolger, 1991). Introduced predators in particular, were regarded as one of the six biggest threats to a population's survival by Gibbons et al. (2000), since many island species probably lack predator defenses necessary for survival (Fritts and Rodda, 1998). Many examples of the impact of introduced predators are now available (Fritts and Rodda, 1998; Towns and Ferreira, 2001; Towns et al., 2003). In an effort to reverse these declines

predators are being removed from islands and native species translocated to these newly available habitats (Towns and Ferreira, 2001).

Animal translocations are defined as the intentional release of wild and/or captive individuals to establish, re-establish, or augment a population (IUCN, 1987). Translocations are increasingly viewed as an important management tool (Tasse, 1989), but few have been described as successful (Dickinson et al., 2001) and their subsequent evaluations are rarely reported in peer-review journals (Dodd and Seigel, 1991). There is also a taxon bias in the use of translocations, with a recent review finding that 168 out of 180 translocation examples were concerned with birds and mammals (Fischer and Lindenmayer, 2000). Translocations for the conservation of reptile populations have had mixed results. Early attempts, such as that of the Giant tortoise (*Geochelone gigantea*) translocation from Aldabra to Curieuse Island in the Seychelles, may have failed due to lack of knowledge regarding the species' original extirpation (Hambler, 1994). Translocations of

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reptiles in New Zealand have had more success with Tuatara (*Sphenodon guentheri*), skinks (*Cyclodina spp.* and *Oligosoma spp.*) and species of *Hoplodactylus* and *Naultinus* gecko (Towns and Ferreira, 2001; Towns et al., 2001; Nelson et al., 2002). However, such published successes remain a minority (Dickinson et al., 2001).

The Mascarene islands, and in particular Mauritius, are infamous for numerous predator introductions (Jones and Hartley, 1995) and severe habitat loss, following human settlement (Safford, 1997). Cats, mongooses and pigs have all been introduced to Mauritius, but ship rats (*Rattus rattus*) have been attributed with causing the extinction of all the larger lizard species (Cheke, 1987) by colonizing the island from passing ships, before permanent human settlement in 1598 (Tonge, 1990). Consequently of the 15 species once native to Mauritius, five are extinct and a further five are restricted to one or more offshore islets (Arnold, 1980; Tonge, 1990).

Round Island, 22.5 km off the northeast coast of Mauritius has been protected as a nature reserve since 1957 and is one of the few islands never reached by introduced predators. The island's relative isolation and difficult access have helped to protect its native fauna and flora (Carpenter et al., 2003) and the island has become the sole refuge for several plant and reptile species once found on Mauritius (Tonge, 1989). Its habitats include the largest remaining area of palm forest that once dominated the lowlands of north and west Mauritius (Bullock, 1986), and natural populations of 12 plant species listed in the 1997 IUCN Red List of threatened plants (Johansson, 2003). Since the removal of introduced goats in 1978 and rabbits in 1986 (Merton, 1987), Round Island has become the largest island in the Mascarene group to be free from introduced mammals and major woody-weeds (Merton et al., 1989). The reptile community is the least modified of any Mascarene island (Bullock, 1986) and contains eight of the 10 reptile species known to occur in Mauritius (North et al., 1994). Of the eight species present, five are restricted to Round Island (Arnold and Jones, 1994; North et al., 1994)

and of these already one is presumed extinct (Table 1). Since small island populations are particularly susceptible to stochastic environmental events and there still remains the possibility of rats being introduced to Round Island, re-introduction of the keel-scaled boa, Günthers gecko and Telfair's skinks to islands within their historic ranges, which are now rat-free, has been suggested (Merton et al., 1989).

One of the fundamental problems of ecology is to determine the causes of the distribution and abundance of an organism (Krebs, 1978). For translocations, this information is vital to determine the suitability of recipient sites and often establishes the success of such programs (Dodd and Siegel, 1991). Some researchers (Fischer et al., 2004) acknowledge a tendency to oversimplify ecological complexity through restricting the scale of habitat studies, whether by sampling at the organism's "perception of scale" (Morris, 1987), or as an artefact of the levels of resolution used to measure a process (Allen and Star, 1982). For many lizard species, the spatial element of their ecological niche may be dependant on both microhabitat and habitat specializations (Pianka, 1973). However, this is often overlooked in many ecological studies, and in the case of translocation programs, may result in the selection of inappropriate recipient sites.

The present study was conducted to provide the kinds of information on the ecology of Telfair's skinks (*Leiolopisma telfairii*) on Round Island that would be used when reinstating populations on islands within the species' historic range. *L. telfairii* has been cited as the most studied of the Mauritian skinks (Jones, 1993), but previous work has concentrated on those aspects of the species' natural history and changes in abundance that followed the removal of introduced mammals from Round Island. Little is known about its macro- and microhabitat use and diet is only known from incidental observations. In order to redress this lack of information the present study aimed to a) investigate habitat and microhabitat use by *L. telfairii* on Round Island in relation to factors such as body condition and body temperature and b) to con-

Table 1

The eight species of reptile found on Round Island, with details of their current and historic distributions and conservation status (IUCN Species Survival Commission, 1994) on Mauritius and its neighbouring islets

Species	Common name	Historical distribution	Current distribution	IUCN status
Scincidae				
<i>Cryptoblepharus boutonii</i> <sup>a</sup>	Bouton's skink	MM, RI, GQ,	MM, RI, GQ,	–
<i>G. bojeri bojeri</i>	Bojer's skink	MM, RI, GQ, FI, GA, PR	RI, GQ, FI, GA, PR	–
<i>L. telfairii</i>	Telfair's skink	MM, RE, RI, GQ, FI	RI	Vulnerable
Gekkonidae				
<i>Nactus durrelli</i>	Durrell's night gecko	RI	RI	Vulnerable <sup>b</sup>
<i>P. ornata</i>	Vinson's ornate day gecko	MM, RI, GQ, FI, IA	MM, RI, GQ, FI, IA	–
<i>Phelsuma guentheri</i>	Gunther's gecko	RI, MM, FI	RI	Endangered
Bolyeridae				
<i>C. dussumieri</i>	Round Island Boa	RI, MM	RI	Endangered
<i>Bolyeria multocarinata</i>	Round Island Island boa	RI	RI?	Extinct?

MM = Mauritian Mainland RE = Réunion, RI = Round Island, GQ = Gunner's Quoin, FI = Flat Island, IA = Ile Aux Aigrettes, GA = Gabriel Island, PR = Pigeon Rock.

<sup>a</sup> Pantropical distribution.

<sup>b</sup> Current IUCN status based on previous classification as a sub-species of *N. serpensinsula*. Recent work has re-described this as a distinct species (see Arnold, 2000).

duct a dietary analysis of faecal samples from wild animals. The results of this study are then discussed with respect to *L. telfairii*'s suitability for translocation.

## 2. Methods

### 2.1. Study site and species

Round Island (57°47'0"E, 19°54'03"S) is the remnants of a basaltic volcanic cone, aged between 25,000 and 100,000 years old (Merton et al., 1989), which is estimated from a digitized map to cover 219 ha (Johansson, 2003) and rise 280 m above sea level. Recent work on the vegetation of Round Island revealed seven distinct communities, which have been characterized by Johansson (2003) as:

- 1. *Bare rock*: -Very low vegetation cover, low in species number of both native and exotics. Plant community dominated by *Chloris barbata* and *Dactyloctenium ctenoides* together with creepers (especially *Passiflora suberosa* and *Ipomea pes-caprae*).
- 2. *Closed palm forest*: -Dominated by *Latania loddigesii*; in areas of open canopy tall undergrowth of *Acyranthes aspera*, *Abutilon indicus* and *Boerhavia coccinea* occurs.
- 3. *Open palm forest*: -Again dominated by *Latania loddigesii*, but at a lower density with more open spaces in the habitat. Exotic grasses, such as *Cenchrus echinatus*, *C. barbata* and *D. ctenoides*, dominate these open areas.
- 4. *Mixed weed community*: -Mostly exotic species, with little tree cover and dominated by creepers (*I. pes-caprae*, *Passiflora suberosum* and *Tylophora coriaca*). The most species-rich of the communities.
- 5. *Herb-rich weed community*: -Again little tree cover, dominated by exotic grasses (*C. echinatus*, *C. barbata* and *D. ctenoides*). Herbs such as *Solanum americanum*, *Amaranthus viridis* and *Commelina benghalensis* grow readily in these areas.
- 6. *Helipad community*: -A very distinct species association with some species restricted to this area including: *Aerva congesta*, *Chloris filiformis*, *Lepturus repens*, *Zoysia tenuifolia* and *Fimbristylis cymosa*. Generally found to have low vegetation cover, it is the only community dominated by native plant species.
- 7. *Summit community*: -Highly exposed and covering a small area, this community includes a number of native species including *Lomatophyllum tormentorii*, *Phyllanthus mauritianus*, *Stenotaphrum micranthum*, *Sporobolus indicus* var. *capensis* and *Euphorbia prostate*.

Telfair's skink, the type species of *Leiolopisma*, is known to have occurred on the neighboring islands of Gunners Quoin and Flat Island, as well as the mainland of Mauritius and Réunion (Arnold, 1980), but is now confined to Round Island. *L. telfairii* is the largest extant species of Mauritian skink (Jones, 1993), with individuals attaining snout to vent lengths (SVL) in excess of 160 mm (pers. obs.). Immature skinks (> 100 mm SVL) are lightly built but as they exceed this size

become noticeably broader (Jones, 1993). This diurnal skink is primarily terrestrial (Bullock, 1986) although incidental observations have recorded individuals climbing *Latania loddigesii* palms to feed from their inflorescences (Jones, 1993). Dietary observations suggest that Telfair's skinks are omnivorous (Vinson and Vinson, 1969; Bullock, 1986; Jones, 1993) and cannibalism of juveniles has been recorded (Bullock, 1986). Breeding is seasonal, with mating from July to September (Winter) and egg-laying in November and December (Summer) (Tonge and Barlow, 1986).

### 2.2. Habitat and microhabitat preferences

All seven vegetation communities were sampled on Round Island. A fine-scale grid (equivalent to 25 × 25 m quadrats) was overlaid onto a map and sampling quadrats selected using random number tables. One hundred and 26 quadrats from a possible 2261 were chosen, with sampling stratified so that the number of quadrats surveyed in each habitat was proportional to the area of island covered by that habitat. The eastern crater region and northern coast of the island (70 ha) were excluded from sampling because steep slopes and crumbling substrate, made walking treacherous.

Commencing in April 2004 and for the following 11 weeks, each randomly selected quadrat was systematically searched for all Telfair's skinks for 30 min. Skinks seen were, if possible, captured by hand or with a noose. Captured skinks were bagged and placed in the shade until the end of the survey. For all skinks, whether or not caught, the time and type of skink behavior when first seen were recorded and the sight marked with flagging tape, before resuming the survey. Temperature data for the skinks and their microhabitats were also collected during the latter period of this study. Cloacal body temperature was recorded for individuals immediately after capture and ground and air temperatures recorded at the point of initial sighting using an Omega HH11 digital probe thermometer (± 0.1 °C).

Morphometric data collected using vernier callipers from all captured skinks included: snout to vent length (SVL), tail length (TL), regenerated tail length (RGL), width at base of tail, head width and head length (all to the nearest mm). Body mass was measured to the nearest gram using a 100 g pesola balance and the numbers of scars and ectoparasites were noted. All skinks captured were photographed dorsally on a uniform background next to a greyscale and assigned a score on a black–white scale of 1–10. The sex of individuals captured could not be determined through eversion of the hemipenes and so was not recorded in this study. All skinks were then marked with non-toxic correction fluid (Tipp-ex®) prior to release.

Twelve microhabitat characteristics, together with time of day of sighting and skink's activity were recorded in a 3 m<sup>2</sup> area around each point marked as a skink sighting (Table 2).

In order to determine whether skinks were selecting microhabitats non-randomly, 30 random perch sites were measured in each of the seven habitats using a previously

Table 2  
Description of the twelve microhabitat characteristics recorded within 3 m<sup>2</sup> of all *L. telfairii* sightings on Round Island, Mauritius

Microhabitat variables	Description	Categories or units
Units vegetation		
Ground level	Visually assessed on Braun–Blanquet scale	+ > 1%, 1 = 1–5%, 2 = 5–25% 3 = 26–50%, 4 = 51–75, 5 = 76–100%
50 cm from ground	Visually assessed on Braun–Blanquet scale	+ > 1%, 1 = 1–5%, 2 = 5–25% 3 = 26–50%, 4 = 51–75, 5 = 76–100%
100 cm from ground	Visually assessed on Braun–Blanquet scale	+ > 1%, 1 = 1–5%, 2 = 5–25% 3 = 26–50%, 4 = 51–75, 5 = 76–100%
Substrate cover		
Bare rock	Visually assessed	% of 3 m <sup>2</sup> area
Soil	Visually assessed	% of 3 m <sup>2</sup> area
Leaf-litter	Visually assessed	% of 3 m <sup>2</sup> are
Perch details		
Type	Visually assessed	1: Rock, 2:Soil, 3:Leaf-litter, 4:Vegetation, 5:Log
Height from ground	Measured	centimetres
Aspect	Recorded with a compass	N,NE,E,SE,S,SW,W,NW
Thermal characteristics		
Ground temperature	Recorded with thermometer	Degrees Celsius
Air temperature	Recorded with thermometer	Degrees Celsius
Amount of sunlight	Visually assessed	1:Shaded, 2:Dappled sun, 3: Full sun

described method (see Mellville and Schulte, 2001). Three 100 m transects were traversed in each habitat to record random perch sites every 10 m. Random perches were determined by throwing a stick, within the size and weight range of *L. telfairii*, in a random direction and recording the microhabitat variables recorded for a skink sighting.

### 2.3. Dietary analysis

Faecal samples collected from all animals that defecated during handling were stored in 70% alcohol until they could be analyzed under a dissecting microscope. Plant materials were identified using the guide to the native and alien plants of Round Island (Virah Sawmy et al., 2002). Due to the digested nature of the material examined, invertebrates in faeces could only be identified to family level. Reptilian remains were identified to species by comparison of scales present in faecal samples with a reference collection made during the study. This fragmentary material was then scored as present or absent.

### 2.4. Statistical analysis

Linear regression analysis was applied to the log<sub>10</sub> transformed weight and SVL data of skinks to obtain residuals that provide an index of skink body condition (Jakob et al., 1996; Kotiaho, 1999). Analysis of variance was then used to determine differences in juvenile and adult body condition. Analysis of variance was used to determine whether the mean number of *L. telfairii* per quadrat differed between habitats. Post-hoc analysis was then used to determine where the differences lay. All percentage microhabitat variables were arcsine- square root transformed prior to analysis. All variables were continuous and so a principal component analysis (PCA) was used to reduce the microhabitat variables into a smaller number of components that describe the underlying dimensions of the data. The number of principal components (PC) used in analysis was determined by their eigenvalues;

those components with a value  $\geq 1$  were used in further analysis. Correlations of the original values to the PC with values greater than 0.4 were considered important (Field, 2000). An analysis of variance was used to determine whether the PC values for lizard microhabitats differed from random microhabitat data. The PC values obtained for lizard sightings were used in backwards stepwise multiple regressions to attempt to explain variation in lizard body condition, temperature and log SVL. In the cases of non-normally distributed data (number of scars and skink greyscale score), correlations were used.

## 3. Results

### 3.1. Survey results

Three hundred and eleven skink sightings were made in the 126 quadrats (5.6% of the potential survey area) surveyed (Table 3). Of these sightings 74% ( $N = 228$ ) were accompanied by captures of 188 adult specimens (SVL  $\geq 100$  mm) and 40 juveniles (Table 4).

Linear regression analyses revealed a strong allometric relationship between SVL and weight of both adult and juvenile skinks (Fig. 1). There was no significant difference in variation of residuals for juveniles compared with adults ( $F_{1,226} = 0.923$ ,  $P = 0.34$ ). Variation in shade was recorded, with juvenile skinks being significantly darker than adults ( $Z = -2.943$ ,  $P = 0.003$ ,  $N = 228$ ). Ectoparasite loads of *L. telfairii* were extremely low, with only one adult of the 311 skinks captured carrying four small mites in the ear pit.

### 3.2. Habitat and microhabitat use

The mean number of skinks sighted per quadrat (Fig. 2) ranged from 1.03 (bare rock) to 4.91 per quadrat (closed palm forest) and analysis of variance identified a significant difference between habitats ( $F_{6,119} = 5.35$ ,  $P > 0.001$ ). A Fisher's LSD post-hoc test indicated that significantly fewer sightings

Table 3

Mean ( $\pm$  standard error of mean (S.E.)) of each microhabitat variable recorded for *L.telfairii* sightings, in each of the seven habitat types on Round Island, Mauritius. For categorical data modal values are given

Habitat	Temperature ( $^{\circ}$ C)				Vegetation (Braun–Blanquet scale) <sup>b,c</sup>				Substrate (%)			
	N <sup>a</sup>	Air	Ground	Sunlight <sup>b,c</sup>	Ground	50 cm	100 cm	Bare rock	Soil	Leaf-litter	Type of perch <sup>b,c</sup>	Perch height (cm)
<i>Bare rock</i>	41 (20)	25.10 $\pm$ 0.41	26.93 $\pm$ 0.62	Full (58.5)	2 (36.6)	+(95.1)	+(97.6)	79.63 $\pm$ 3.78	10.76 $\pm$ 2.47	6.63 $\pm$ 1.21	Rock (75.6)	8.24 $\pm$ 2.83
<i>Open palm forest</i>	81 (66)	25.69 $\pm$ 0.20	27.67 $\pm$ 0.42	Full (37.0)	2 (30.9)	+(51.9)	+(67.9)	40.56 $\pm$ 3.62	39.95 $\pm$ 3.06	22.48 $\pm$ 2.37	Rock (55.6)	6.88 $\pm$ 1.47
Closed palm forest	54 (21)	25.29 $\pm$ 0.47	27.34 $\pm$ 0.92	Shaded (40.7)	+(31.5)	+(42.6)	+(51.9)	43.09 $\pm$ 4.46	26.76 $\pm$ 3.02	30.06 $\pm$ 3.44	Rock (53.7)	5.63 $\pm$ 2.09
Mixed weed	66 (25)	25.03 $\pm$ 0.21	25.92 $\pm$ 0.32	Full (39.4)	4 (24.2)	0 (59.1)	0 (87.9)	49.24 $\pm$ 4.35	38.56 $\pm$ 3.90	12.58 $\pm$ 1.92	Rock (56.1)	5.53 $\pm$ 1.95
Herb rich weed	36 (28)	25.00 $\pm$ 0.39	25.53 $\pm$ 0.46	Full (38.9)	4 (36.1)	2 (44.4)	0 (94.4)	27.78 $\pm$ 5.01	55.28 $\pm$ 4.84	16.80 $\pm$ 2.73	Rock (44.4)	3.42 $\pm$ 1.75
“Helipad” community	18 (9)	24.84 $\pm$ 0.39	28.82 $\pm$ 1.34	Full (50.0)	3 (50.0)	0 (100)	0 (100)	57.22 $\pm$ 3.51	30.11 $\pm$ 3.57	12.67 $\pm$ 1.96	Rock (72.7)	6.00 $\pm$ 3.02
Summit community	15 (8)	25.19 $\pm$ 0.87	30.20 $\pm$ 1.19	Full (53.3)	4 (33.3)	0 (73.3)	0 (100)	60.33 $\pm$ 7.36	33.26 $\pm$ 6.81	4.4 $\pm$ 1.08	Rock (73.3)	4.46 $\pm$ 1.81
Overall	311 (177)	25.31 $\pm$ 0.13	27.13 $\pm$ 0.25	Full (41.5)	2 (24.8)	0 (58.8)	0 (79.4)	48.43 $\pm$ 1.93	33.62 $\pm$ 1.61	17.51 $\pm$ 1.11	Rock (58.5)	5.99 $\pm$ 0.81

<sup>a</sup> Number of sightings from which thermal data were collected in parentheses.

<sup>b</sup> Modal value displayed for categorical data.

<sup>c</sup> Frequency (%) recorded in parentheses.

Table 4  
Sample sizes and mean ( $\pm$  S.E.) morphometric values of adult and juvenile *L. telfairii* captured in all habitats on Round Island, Mauritius

	Adults (N = 188)	Juveniles (N = 40)
Snout-vent length (mm)	129.7 $\pm$ 1.0	69.9 $\pm$ 3.0
Tail length (mm)	105.9 $\pm$ 4.0	89.5 $\pm$ 6.5
Regenerated tail length (mm)	44.5 $\pm$ 3.0	16.1 $\pm$ 4.0
Number of regenerations	1.2 $\pm$ 0.1	0.5 $\pm$ 0.1
Width at base of tail (mm)	19.2 $\pm$ 0.2	10.0 $\pm$ 0.5
Width of head (mm)	19.5 $\pm$ 0.2	10.7 $\pm$ 0.4
Head length (mm)	25.1 $\pm$ 0.2	16.1 $\pm$ 0.5
Weight (g)	79.9 $\pm$ 2.3	14.5 $\pm$ 1.8
Color	3.5 $\pm$ 0.7 (3) <sup>a</sup>	3.0 $\pm$ 0.1 (3) <sup>a</sup>
Number of scars	1 $\pm$ 0.1	0.3 $\pm$ 0.1

<sup>a</sup> Modal value in parentheses.

of *L. telfairii* were made in bare rock quadrats than open palm forest ( $P = 0.003$ ), closed palm forest ( $P > 0.001$ ), mixed weed ( $P > 0.001$ ) and herb-rich mixed weed ( $P = 0.038$ ) quadrats.

Of the skinks caught, SVL, weight (both  $\log_{10}$  transformed) and body condition were not significantly affected by habitat choice ( $F_{6, 221} = 1.87, P = 0.088; F_{6, 221} = 1.50, P = 0.179; F_{6, 221} = 0.854; P = 0.530$ ). The greyscale shade of individuals caught also showed no significant difference between habitat types ( $\chi^2 = 6.406, df = 6, P = 0.379$ ).

At a microhabitat scale, 10 of the eleven variables collected were analyzed using principal component analysis. Perch height was omitted from the analysis due to it not being significantly correlated to any of the other variables measured. Three factors were produced that cumulatively explained 67.8% of the variance within the data (Table 5). The first PC was positively correlated with the percentage of soil cover, ground level vegetation cover and perch surface, and negatively correlated with percentage of bare rock cover. Therefore, PC1 axis denotes a structural gradient with positive scores denoting sites of high soil and ground vegetation cover. Conversely, negative scores denote sites of low ground level vegetation and rocky substrate. Principal component 2 was positively correlated with vegetation cover at both 50 and 100 cm above ground level as well as the percentage of leaf-litter substrate. Negative scores denoted sites of increased percentage rock cover and increased levels of sunlight. The second component produced is best described as a vegetation gradient, with positive scores denoting sites of high vegetation cover at both 50 and 100 cm from the ground, as well as corresponding increased leaf-litter levels. Negative scores again denote rocky sites with reduced vegetation cover and corresponding increased sunlight levels. The third PC only showed positive correlations with both air and ground temperatures and as such, is best described as a thermal gradient with increasing PC scores indicating higher air and ground temperatures.

In order to assess whether microhabitat selection by *L. telfairii* was of a non-random nature, 210 random microhabitat points were included in the PCA (Fig. 3). Comparison of the resultant scores showed that *L. telfairii*'s microhabitat choice

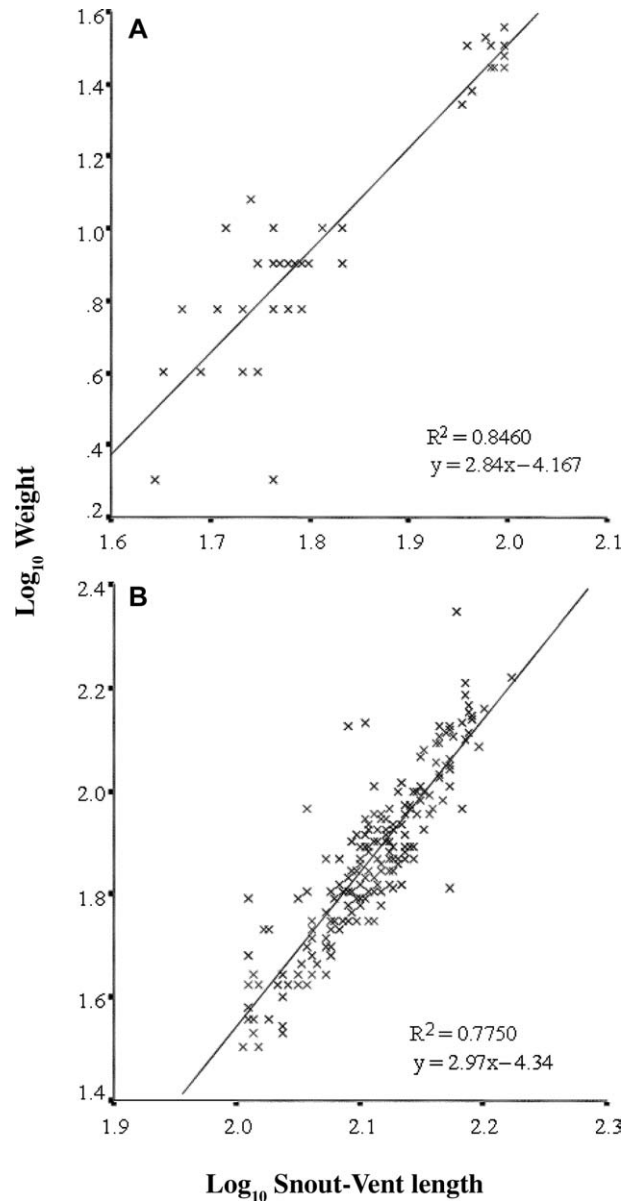


Fig. 1. Relationships between log transformed SVL (mm) and weight (g) for 40 juvenile (A) and 188 adult (B) Telfair's skinks caught on Round Island, Mauritius.

was significantly different for both PC1 (Skink mean =  $-0.87$ , Random mean =  $0.25$ ) and PC2 (Skink mean =  $0.13$ , Random mean =  $-0.28$ ) from random points ( $F_{1, 384} = 11.30, P = 0.001, F_{1, 384} = 21.49, P < 0.001$ , respectively). However, there was no difference observed between random sites and skink PC3 scores ( $F_{1, 384} = 0.11, P = 0.745$ ).

Backwards stepwise multiple regressions were utilized to investigate relationships between microhabitat choice and aspects of skink biology. Microhabitat choice was not affected by *L. telfairii*'s body condition ( $r^2 = 0.02, F_{1, 134} = 2.02, P = 0.157$ ). However, larger individuals scored significantly higher PC2 (vegetation characteristics) values ( $r^2 = 0.09, F_{1, 134} = 13.209, P < 0.001$ ). Body temperature was found to be significantly related to both PC1 and PC3 ( $r^2 = 0.246, F_{2, 133} = 21.642, P < 0.001$ ), where PC1 describes structural char-

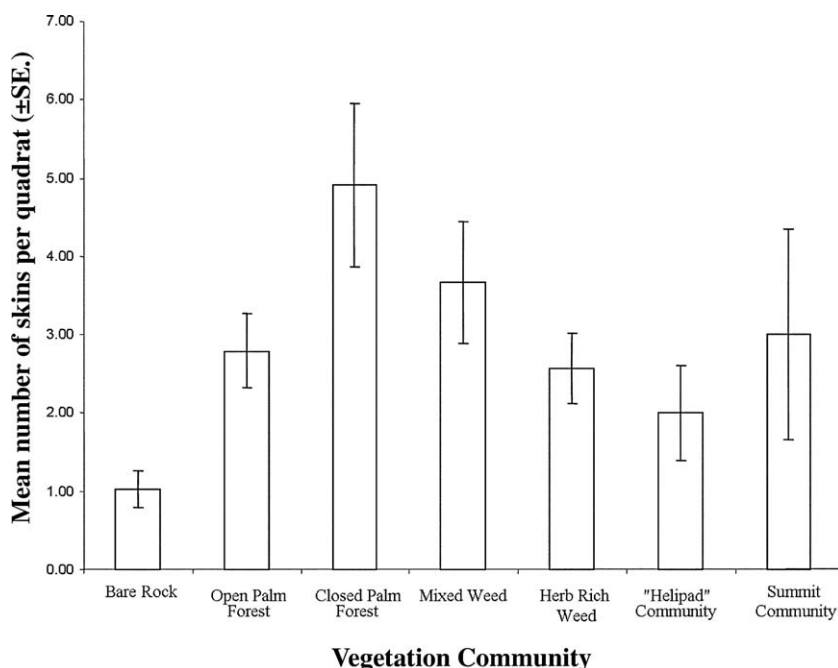


Fig. 2. The mean number of *L. telfairii* sighted per quadrat ( $\pm$  S.E.) in each of the seven habitat types on Round Island, Mauritius.

acteristics and PC3 describes thermal characteristics of microhabitats. Greyscale shade variation of skins showed no significant correlation with microhabitat characteristics (PC 1  $R = 0.109$ ,  $P = 0.206$ ,  $N = 136$ , PC 2  $R = 0.142$ ,  $P = 0.98$ ,  $N = 136$ , PC 3  $R = -0.013$ ,  $P = 0.882$ ,  $N = 136$ ). However, the number of scars on an individual was positively correlated to PC2 ( $R = 0.243$ ,  $P = 0.005$ ,  $N = 133$ ).

### 3.3. Dietary analysis

Fifty-nine faecal samples collected from the 228 *L. telfairii* revealed 20 different food items (Fig. 4), with *Blattodea* spp. present in 85% of all samples ( $N = 50$ ). The second most common constituent of faecal sample were *Vespoidea* spp. in 31% of samples ( $N = 18$ ). Plant material

Table 5

Varimax rotated principal component loadings, eigenvalues and percentage of variation explained by the first three components of a PCA on the microhabitat variables collected for *L. telfairii* on Round Island, Mauritius

	Principal component loadings		
	1	2	3
Vegetation cover (0 cm)	0.821 <sup>a</sup>	-0.299	0.118
Vegetation cover (50 cm)	0.283	0.546 <sup>a</sup>	0.152
Vegetation cover (100 cm)	-0.181	0.820 <sup>a</sup>	-0.104
Substrate-% bare rock	-0.830 <sup>a</sup>	-0.466 <sup>a</sup>	0.007
Substrate-% bare rock	0.894 <sup>a</sup>	0.075	0.024
Substrate-% bare rock	0.263	0.704 <sup>a</sup>	-0.034
Type of perch	0.660 <sup>a</sup>	0.051	-0.127
Air temperature (°C)	0.068	0.06	0.924 <sup>a</sup>
Ground temperature (°C)	-0.106	-0.09	0.922 <sup>a</sup>
Amount of sunlight	0.095	-0.645 <sup>a</sup>	0.023
Eigenvalue	2.993	2.068	1.719
Percentage of variance explained	29.94	20.68	17.2

<sup>a</sup> Component loadings with absolute values of greater than 0.4 are considered important (Field, 2000).

comprised seeds, fruit or flowers of eight of the 10 plant species identified, four of which were the non-native *S. americanum*, *P. suberosa*, *Tridax procumbens* and *Acyrenthes asper*. Saurivory was observed in three separate samples (5%) with both the scales and bones of *Gongylomorphus bojerii bojerii*. *L. telfairii* scales were also observed in two samples. During the study period we also noted skins attempting to catch ornate day geckos (*Phelsuma ornata*) a juvenile keel-scaled boa (*Casarea dussumieri*) and an adult skink feeding on the remains of a freshly dead red-tailed tropicbird (*Phaethon rubricauda*).

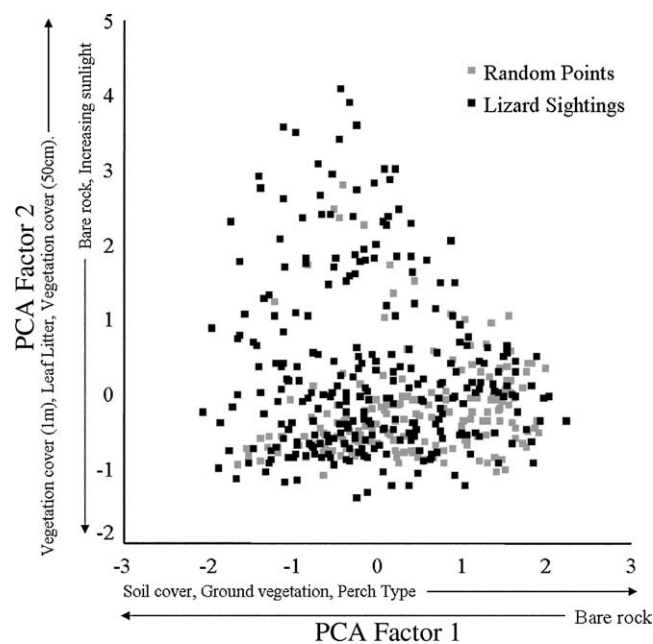


Fig. 3. The relationship between PC1 and PC2 scores for 133 *L. telfairii* (■) and 210 random (■) microhabitat points on Round Island, Mauritius.

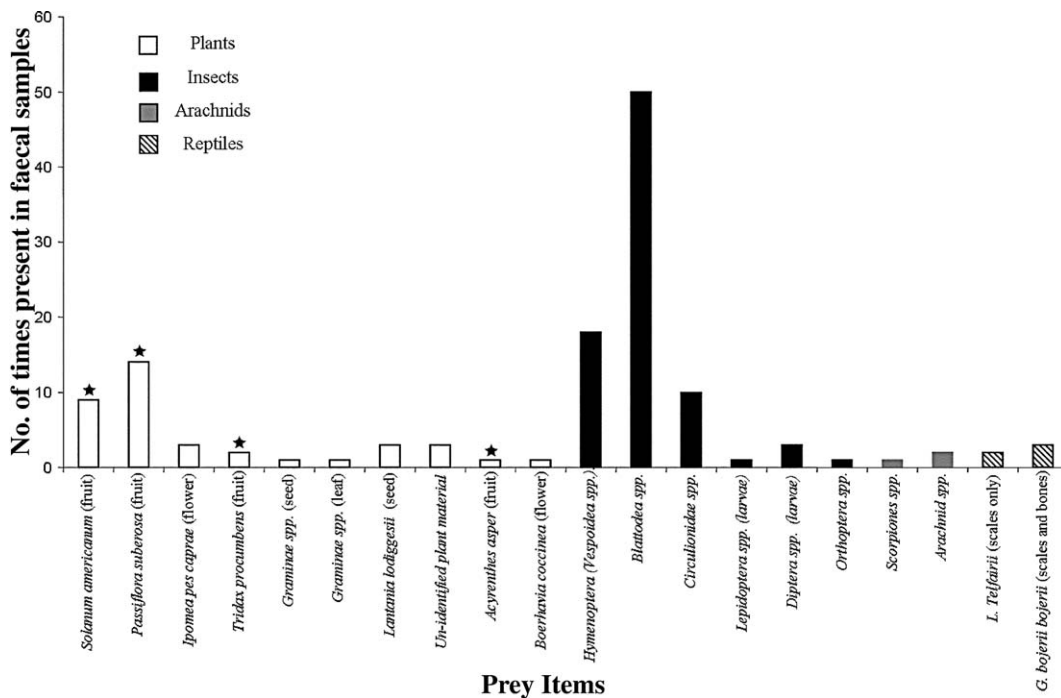


Fig. 4. The frequency of occurrence of 20 prey items in 59 faecal samples of *L. telfairii* from Round Island, Mauritius. Columns with (★) above indicate non-native species.

4. Discussion

4.1. Habitat and microhabitat use

The present study provides the first detailed ecological data collected for *L. telfairii*. Telfair’s skink showed contrasting habitat use at macro- and microhabitat levels. At the macrohabitat level, *L. telfairii* was sighted significantly less frequently in bare rock than in the more vegetated palm forest and weed-based habitats of Round Island. Within those macrohabitats, *L. telfairii* exhibited a non-random selection of microhabitat based on structural and vegetative gradients. Structural variation at ground level explained the greatest amount of variance in the data set, and the mean factor score for lizard presence suggests a tendency for *L. telfairii* to seek more open, rocky areas within vegetated habitats.

The significantly fewer sightings of *L. telfairii* in bare rock habitat could be due to increased predation risk (Huey and Pianka, 1974), reduced food availability (Huey and Pianka, 1974; Pough et al., 2004; Smith and Ballinger, 2001) or habitat homogeneity which may affect *L. telfairii*’s thermoregulatory ability. We believe that food availability is the determining factor, as the only skink predator found on the island is the keel-scaled boa, which is expected to have little effect due to its small population size (Bullock, 1986). Since body condition, SVL and greyscale shade showed no significant relationships with macrohabitat choice, intraspecific competition is unlikely to be determining which individuals are found in bare rock areas. In the event of intraspecific competition individuals with a lower body condition index score would more likely be observed in poorer quality habitats, such as bare rock areas. Aggressive encounters between individu-

als were observed on relatively few occasions, which suggests *L. telfairii* may be a group living species in a fashion similar to the South African lizard *Cordylus cataphractus* (Visagie et al., 2002).

At a microhabitat scale, *L. telfairii* appeared to select areas on the basis of structural and vegetative characteristics. The relationship observed between body temperature and both structural and thermal properties of microhabitats concurs with other studies in suggesting that thermoregulation can be an important dictator of microhabitat choice (Melville and Schulte, 2001). However, the level of correlation observed for *L. telfairii* was relatively low suggesting dietary requirements were of greater importance. *L. telfairii* was observed to rely heavily on visual cues when foraging, responding to movements of *G. bojerii bojerii* and other prey items, which may explain the use of more open patches of microhabitat.

The relationship between increasing body size and vegetative factors (PC2) suggests larger individuals within the population may select microhabitats with increased vegetation cover at both 50 and 100 cm from ground level. This results from differences in the thermal tolerance of large and small individuals. For example, larger six-lined racerunners (*Cnemidophorus sexlineatus*) have lower thermal tolerances than juveniles (Paulissen, 1998).

Although greyscale variation was not associated with any of the factors explaining microhabitat preference, its existence suggests it may play some functional role in the species ecology. Previous studies have found polymorphism in reptiles to be sexually (Forsman and Shine, 1995) or genetically (Perry and Buden, 1999) restricted within a population. Further work examining polymorphism in relation to sex and size may be appropriate for Telfair’s skinks.

#### 4.2. Diet

Our studies showed that Telfair's skinks are omnivorous. Although a deviation from the usual diet of arthropods (Greer, 2001) omnivory is known in Scincidae, particularly those found on islands (Olesen and Valido, 2003). The high incidence of cockroaches (*Blattodea* spp.) confirms previous suggestions that they are likely to be an important food source for these animals on Round Island (Dulloo et al., 1996). Research in progress indicates these cockroaches are endemic to Mauritius and its neighboring islets. However, the density at which they are found significantly varies between islets (Dulloo et al., 1996). Saurivory was observed in the skinks sampled in this study. However, it was uncommon, with only three samples containing scales and bones of Bojer's skink. Although scales of *L. telfairii* were observed in two samples these cannot be used to confirm previous reports of cannibalism (Bullock, 1986), since no corresponding bone was found. It is likely that the scales found in these incidences are the result of recent skin-shedding by the individuals. A recent review has proposed that island lizards act as important seed dispersers, since the low predation pressure they are exposed to allows niche expansion to include nectar, pollen and fruit (Olesen and Valido, 2003). In this study 10 plant species were identified in faecal samples, of which four were fruits of exotic species. All four species produce large fleshy fruit, which may explain their presence.

#### 4.3. Implications for translocation programs

The inherent danger of ecologists to oversimplify ecological complexity has been highlighted by the results of this study. Spatially nested ecological studies such as this allow insights to be gained that would not be seen in a single-scaled study (Fischer et al., 2004). Multi-scale work on Leadbeater's possum has shown that individuals respond to environmental conditions at scales ranging from continental, to the individual tree hollow chosen for nesting (Lindenmayer, 2000). Such results highlight how studies conducted at a single scale may yield differing conservation recommendations.

Whilst contrasting macro- and microhabitats requirements were found for *L. telfairii*, their presence in all habitats and omnivorous nature suggest they are a widely tolerant species that are likely to be successfully re-established in parts of their former range. Such a statement can be supported by *L. telfairii*'s ability to persist on Round Island during the presence of exotic herbivores and their subsequent rapid increase in population size following the removal of goats and rabbits (North et al., 1994). Since species previously thought to be highly specialized in their ecological requirements have been reported to use more heterogeneous habitats in new sites at which they have been introduced (Towns, 1994), even greater adaptability might be anticipated from more "generalist" species such as *L. telfairii*.

The results of this study highlight the importance of air and ground temperatures in determining microhabitat use in

*L. telfairii* and supports Towns' (1994) recommendation that a thermal gradient be provided for translocated reptiles. Translocated St Lucia whiptail lizards (*Cnemidophorus vanzoi*) also show reduced thermal tolerance with increasing size and also show seasonal variation in microhabitat use in relation to thermoregulation (Dickinson et al., 2001). However, such seasonal shifts may also be important in some species for the provision of suitable oviposition optimal for egg incubation (Towns and Ferreira, 2001). Suitable candidate sites for translocation must, therefore, provide a thermal gradient that corresponds to structural and vegetative components to suit *L. telfairii* at all life history stages.

Although faecal analysis in this study only provides a "snap-shot" of *L. telfairii*'s diet it has highlighted questions for further research. The omnivorous nature of *L. telfairii* may be advantageous for any translocation program. However, the viability of seeds from several native and introduced plant species recovered from their excreta requires further investigation. A shift to frugivory in any translocated individuals may impact ecological restoration of recipient sites. Other dietary shifts such as increased levels of saurivory could potentially impact species endemic to recipient sites such as *Nactus coindemerensis* on the neighboring islet of Gunners Quoin.

Whilst evolutionary biologists have long been aware of the importance of spatial scale in genetic differentiation of populations (Svensson and Sinervo, 2004), ecologists have only recently realized the importance of distinguishing between macro- and microhabitats and for many taxa the relationship between these remains poorly understood. With translocation programs remaining controversial, and inconsistencies occurring in their results, every effort should be made to ensure a species' ecology is wholly understood prior to their movement. This knowledge should aid the selection of suitable release sites, whilst also highlighting any potential negative effects the species may have on current conservation efforts in the recipient site.

#### Acknowledgements

This study was made possible by the generous logistical support and permissions of the Mauritian Wildlife Foundation and the National Parks and Conservation Service of Mauritius. Financial assistance was provided by the University of East Anglia. We would like to thank Toby Ross, Nicholas Zuel, David Stepnisky, Kimberley Smith, Vikash Tatayah, Nik Cole and Angus Carpenter for support provided both prior to, and during fieldwork. Finally we would like to thank the two anonymous reviewers for comments and improvements of this manuscript.

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