Reproduction in the skinks *Saproscincus tetradactylus* and *Lampropholis similis* with notes on their natural history

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Abstract

The reproduction and general habits of two small sympatrically occurring skinks from the Wet Tropics region are described. *Saproscincus tetradactylus* was active year-round and was mainly crepuscular but also diurnal. The species was terrestrial, inhabiting moist, shaded leaf litter and was rarely seen in direct sun. It also used surface stones as both refugia and oviposition sites. The species had an invariant clutch size of two. Eggs were found in all months of the year except June, but with peaks occurring in February and October–November. Mean hatchling size was: snout-to-vent length (SVL) 15.0 mm, tail length (TL) 15.9 mm and mass 0.06 g. *Lampropholis similis* was active year-round, diurnal, terrestrial and mainly inhabited leaf litter receiving partial sun where it routinely basked and used surface stones as oviposition sites but rarely as refugia. The species produced one to three eggs between September and February with a peak in egg-laying activity in November. Mean hatchling size was: SVL 17.7 mm, TL 20.5 mm and mass 0.12 g. The mean natural incubation time for *S. tetradactylus* eggs was 40.6 days while for *L. similis* eggs it was 42.7 days.

Introduction

Saproscincus tetradactylus and *Lampropholis similis* are small skinks (mean SVL 33 and 41 mm, respectively) endemic to the Wet Tropics region of north Queensland and whose ecology is poorly known (Wilson 2005; Cogger 2018; Singhal *et al.* 2018). Both species inhabit rainforest as well as marginal, early-stage regenerating forest (Wilson 2005; personal observation). *Saproscincus tetradactylus* inhabits moist situations such as gullies and creek lines and occurs in mature as well as regenerating rainforest (Greer & Kluge 1980; Covacevich & McDonald 1991; Wilson 2005; Cogger 2018). *Lampropholis similis* is part of the *L. coggeri* complex and has only been recently described as a distinct species, being distinguished from other members in the complex only by genetic differences (Singhal *et al.* 2018). Compared to *S. tetradactylus*, *L. similis* occupies a broader range of habitats, being found in a variety of rainforest types, wet sclerophyll forest, montane heath and gallery forest (Singhal *et al.* 2018; personal observation). Both species have been the subject of phylogenetic studies (Brandley *et al.* 2015), particularly *L. similis* (often as *L. coggeri*). Recent studies on *L. similis* have examined the behaviour (thermoregulation, activity, exploration, sociability) of both adults and juveniles in laboratory settings (Llewelyn *et al.* 2017; Goulet *et al.* 2021; De Jong *et al.* 2022) and also mating behaviour and chemo-reception (Scott *et al.* 2015). By contrast, despite *S. tetradactylus* being described more than 40 years ago (Greer & Kluge 1980), little has been added

since to the knowledge of this species' biology. Muñoz *et al.* (2016) determined the critical thermal minimum/maximum and optimal sprint temperature for *S. tetradactylus* in the laboratory but acknowledged that data were lacking on the basking behaviour of the species in the field. There is no published data on egg size, hatchling size, and only limited data on clutch size in *S. tetradactylus*, while for *L. similis* there is no published data on egg size but recent work has documented clutch, adult and hatchling size for this species (Llewelyn *et al.* 2018; Martins *et al.* 2019). In this work the timing of egg-laying, oviposition sites, eggs, and hatchlings of *S. tetradactylus* and *L. similis* are described and additional information is provided on the natural history of both species.

Methods

Site

All observations relating to the reproduction of both species occurred on private property at Upper Daradgee (approx. 0.5 ha, 40 m ASL), 18 km west of Innisfail (146°01'E, 17°32'S) in north Queensland from September 2005 through to March 2007 with some additional data on hatchling size collected from June 2008 to July 2009. Oviposition sites were located only 20–50 m from the author's residence and were monitored at least twice weekly for almost all the observation periods. Lizards were encountered beneath stones, occasionally beneath logs, in leaf litter or active on or near the surface. Habitat was a 70 m wide strip of mesophyll vine forest enclosing a small gully on red basaltic clay soil with numerous, mostly small, basalt stones, rotting logs and leaf litter (Fig. 1). In this habitat *S. tetradactylus* and *L. similis* occurred in sympatry with the skinks *Saproscincus basiliscus* and *Carlia rubrigularis*. The identification of *S. tetradactylus* was straightforward, it being easily distinguished from congener *S. basiliscus* with adults considerably smaller and by having four fingers instead of five; dorsal colour and pattern differ significantly also (Greer & Kluge 1980). With *L. similis* and *L. coggeri* morphologically indistinguishable and allopatric (apart from a narrow contact zone; Singhal *et al.* 2018), location alone was used for identification as the site lies well within the known distribution of *L. similis*. Observations pertaining to the general habits of lizards also occurred at various localities throughout the southern Wet Tropics region but all within the known range of *L. similis*. The climate of

Figure 1. Rainforest habitat at Upper Daradgee, near Innisfail FNQ, where the study of reproduction in *Saproscincus tetradactylus* and *Lampropholis similis* occurred. Habitat of *S. tetradactylus* and *L. similis* consisting of mesophyll vine forest on basaltic clay soil with numerous surface stones and decaying logs. All photos are by Grant Turner.

the region is wet tropical: the wet season rains typically begin in December or January and there is regular rain through to July; from August through to November rainfall diminishes and both the minimum and maximum daily temperatures increase (Bureau of Meteorology 2012). During the observation period, Cyclone Larry (Category 4) caused significant damage to the forest, temporarily removing much of the canopy, resulting in an increase in both debris and sunlight at ground level.

Inspection of oviposition sites

The term 'oviposition' site is used rather than 'nest' site as there was no apparent construction or excavation of soil by ovipositing females (see below). Inspections took place during the day and night, the latter during dry periods to minimise moisture loss at oviposition sites. The eggs of both species were located beneath stones which were over-turned after first carefully noting their

position. Care was taken to replace stones to their original position. Inspection of individual oviposition sites took only several minutes during which time eggs were counted, additional clutches noted, and empty eggshells inspected. The natural incubation period for the eggs of each species was in some instances able to be determined within a one–to–three–day accuracy depending on frequency of inspections; for other eggs, only a minimum/maximum time could be determined. An 'aggregation' of eggs (i.e. communal egg-laying) refers to the presence of multiple clutches of eggs at a single oviposition site while a 'cluster' of eggs refers to eggs within a single clutch or multiple clutches that are in close proximity to one another. Both species are known to lay eggs communally as single species but also as mixed-species aggregations (*L. similis* as *L. coggeri* in Turner (2006)) and in a small number of cases where eggs were deposited in large clusters, several (non-adjacent eggs) were removed and artificially incubated to confirm whether aggregations were mixed- or single-species. Incubated eggs were placed on moist soil in small cardboard containers with lids permitting limited air flow and then placed in stainless steel drawers of a cabinet that was situated outdoors and undercover. Eggs were initially inspected weekly, and when hatching was imminent, daily. The eggs of both species could be distinguished by size and appearance when located within days of deposition. Egg shells found at oviposition sites were deemed to have hatched rather than been depredated if they exhibited a slit(s) towards one pole of the egg; this was based on the appearance of shells of artificially incubated eggs. Shade temperature at ground level was taken (on most visits) with a digital thermometer ($\pm 0.5°$C). The maximum linear dimensions of stones beneath which eggs were laid were recorded to the nearest 0.5 cm using a flexible tape measure. The length and (maximum) width of recently (< three days) laid eggs were measured using a vernier calliper (± 0.02 mm). Eggs were weighed using a small battery-operated electronic balance (± 0.01 g) but the sample size was kept small because of the risk of eggs rolling. Eggs were not directly handled but instead placed on the balance using plastic blunt-ended tweezers.

Capture and measurement of hatchling and adult S. tetradactylus

The snout-to-vent length (SVL) and tail length (TL) of lizards was measured. Adults were mostly captured by hand. Adult SVL and TL were measured by holding them flush against a 150 mm ruler with 0.5 mm graduations. Mass was measured using an electronic balance (± 0.01 g). Hatchlings were readily identified by a fresh yolk sac scar. Their small size presented difficulties in both capture and in obtaining accurate measurements and so a method was devised that did not require handling. When approached, hatchlings invariably retreated into leaf litter so the leaf litter was scooped into a large plastic bag, and carefully removed until the hatchling was located. Hatchlings were then transferred to small snap-sealed plastic bags, gently manoeuvred within the bag (which was placed on a flat surface) until the body and tail were aligned with a straight edge of the bag and measured using a vernier calliper with the ventral surface facing up (see Wapstra (2005) for a similar method). Measurements of both adults and hatchlings were made in situ, typically took less than three minutes, and lizards were released at the point of capture. Tail condition (original versus regenerated) was noted with regenerated tails easily recognisable by an abrupt change in colour/pattern and in some instances, taper. The general appearance, colouration and body condition were also noted in both hatchlings and adults.

Data analyses

SVL, TL and mass variables were checked for normality using a Shapiro-Wilk test (Zar 1996), and Student *t*-tests were employed (paired/unpaired; two-tailed unless otherwise stated) to compare mean values. The chi-squared statistic χ^2 (with Yate's correction for continuity) was used to compare frequencies. The mean ± 1 standard deviation (s.d.) was computed for numerical variables and the coefficient of determination, r^2, was used to assess the repeatability of SVL and TL measurements. The coefficient of variation CV (= s.d. $\div$ mean $\times 100\%$) was computed and this measure of spread was used to compare variables that had similar measurement errors.

Observations

Sexing

The sex of adult *S. tetradactylus* could be determined in most instances. In reproductive females, large, unshelled ova and shelled eggs were visible through the translucent ventral surface (Fig. 2). In males, the hemipenes were often visible through the (translucent) subcaudal scales, or else the tail base was swollen. Adult male *L. similis* were identified by their non-uniform tail taper due to the swollen tail base and occasionally by manual eversion of the hemipenes, while females had evenly tapered tails. The opaque ventral surface of *L. similis* meant that eggs were not visible through this surface, but some gravid females were conspicuous by their 'bloated' appearance and/or the presence of conspicuous bumps along the flanks when viewed from above. Sex could not be determined at all in immature individuals of both species.

Occurrence of gravid females

Gravid female *S. tetradactylus* (n = 32) occurred in all months except April, May, and June. Only two eggs were ever visible through the ventral surface, indicating an invariant clutch size of two. Although the total number of captured *L. similis* was small (n = 29), gravid females were encountered in September (n = 2), October (n = 3), November (n = 2) and early December (n = 1). The occurrence of gravid females of both species corresponded to peak egg-laying times in the field (see below). Two gravid female *S. tetradactylus* were located beneath stones where eggs had already been deposited, and a post-parturient female was observed lying on top of a clutch of eggs.

Oviposition sites and clutch size

Eggs were located beneath stones on 109 occasions. Of these, 78.9% (n = 86) comprised *S. tetradactylus* eggs, 15.6% (n = 17) *L. similis* eggs, and 5.5% (n = 6) contained the eggs of both species. One hundred and forty-four clutches of *S. tetradactylus* eggs and at least 50 clutches of *L. similis* eggs were recorded (Tables 1 & 2). In both species, single clutches were most frequent: *S. tetradactylus* (78%) and *L. similis* (76%). *Saproscincus tetradactylus* eggs occurred mostly in clusters of two, sometimes adhered to each other (see Fig. 3). Occasionally, single eggs or clusters of three, four or five eggs were recorded; these clusters represented multiple clutches, as was indicated by the occurrence of pairs of eggs within the clusters. Communal egg-laying was recorded separately in both species (Table 1) and together in mixed-species aggregations (Table 2) confirming earlier reports of this behaviour (Turner 2006). A further three aggregations containing the eggs of both species comprising totals of 8, 13 and 6 eggs were located (Table 2). *L. similis* produced clutches of one to three eggs (mostly two or three eggs; 86%; 24 of 28 clutches), with a mean clutch size of 2.50 ± 0.732 eggs. Two potential clutches of four eggs were recorded but these were probably composite based on the appearance of the eggs and so were excluded from the average clutch size calculation. The occurrence of aggregations of five (n = 3) or more (n = 1) eggs comprised multiple clutches, as eggs occurred in clusters of two or three.
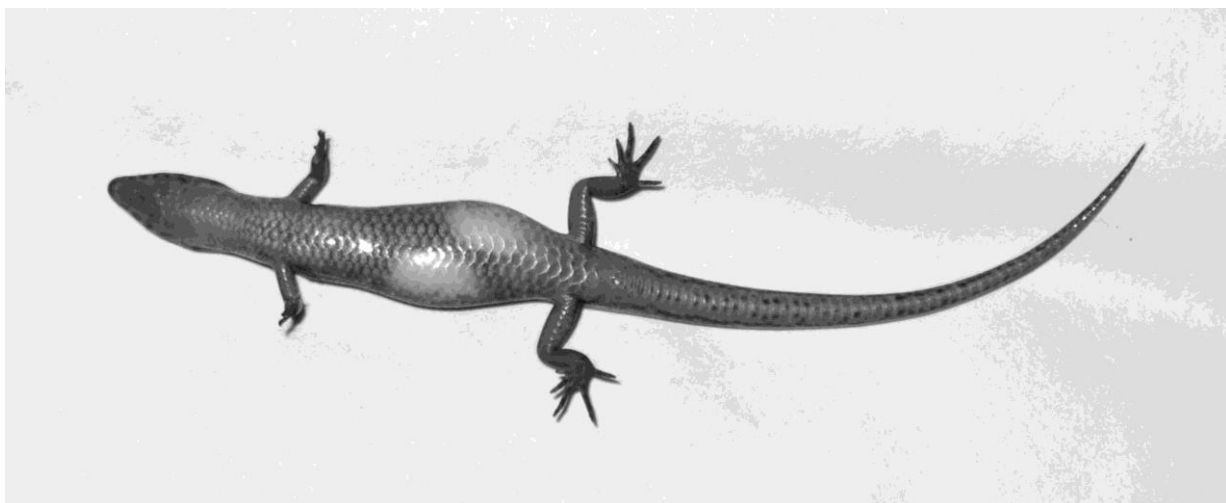
Figure 2. Ventral view of a gravid female *Saproscincus tetradactylus*.
Two shelled eggs are visible through the translucent ventral surface.

Table 1. The number of eggs and clutches recorded in *Saproscincus tetradactylus* and *Lampropholis similis*.
For oviposition sites containing more than five eggs, the number of eggs is given in parenthesis. Egg shells (of hatched eggs) are not included in counts. Some oviposition sites of *S. tetradactylus* containing more than five eggs were documented in Turner (2006).

Species	Number of eggs at oviposition site						
	1	2	3	4	5	>5	Totals
Saproscincus tetradactylus							
Frequency	7	66	8	8	3	5 (6, 7, 8, 8, 11)	97
No. clutches	7	66	16	16	9	3, 4, 4, 4, 6	135
Lampropholis similis							
Frequency	2	6	7	2	3	1 (8)	21
No. clutches	2	6	9	3	≥6	≥3	≥29

Table 2. The number of eggs in mixed-species communal oviposition sites of *Saproscincus tetradactylus* and *Lampropholis similis*.
Oviposition sites 1 to 3 were documented previously in Turner (2006).

Oviposition site	Number of *Saproscincus tetradactylus* eggs	Number of *Lampropholis similis* eggs	Total
1	2	14	16
2	4	21	25
3	2	7	9
4	2	6	8
5	4	9	13
6	4	2	6
Total	18	59	77

Oviposition sites and their use

Clutches of eggs of both species were located beneath 45 separate stones in the gully. Mean stone size was 30.2 ± 11.63 cm (range 12–66 cm) × 19.8 ± 8.77 cm (range 8.5–52.5 cm). One third of the stones (33%; n = 15) were used only once by skinks over the observation period while the remainder were used between two and five times. Communal oviposition sites of one or both species comprised 32% (n = 12) of all oviposition sites located. The temperature beneath stones during visits when eggs were present ranged from 11–28°C.

All eggs were laid beneath surface stones that were flush against the soil, or nearly so, and some stones were partially embedded into the soil (20%; 9 of 45). The soil beneath stones was bare stiff clay. When available, both species utilised cracks and crevices in the soil beneath selected stones to lay eggs; but when they were not, eggs were laid directly onto the soil surface with no apparent attempt to excavate soil nor bury eggs. Moisture content of the soil varied from saturated to slightly moist but friable, depending mainly on the time since the last (significant) rainfall. At 16 oviposition sites there were large brown scorpions (*Liocheles* sp.), while whistling spiders (*Phlogius* sp.) were recorded at two oviposition sites. Apart from occasional ants and slugs, no other invertebrate species were recorded at oviposition sites.

Appearance and size of eggs

Freshly laid eggs of both skink species had clean white translucent pliable shells giving eggs a slight orange tint when viewed in diffuse natural daylight. The eggs of *S. tetradactylus* (n = 61)

Figure 3. Oviposition site containing two clutches of *Saproscincus tetradactylus* eggs.
The clutch of eggs on the left was laid approximately one week earlier while the clutch of eggs on the right hatched within a week of this photograph being taken. Note the differences in both the shape and size of eggs in the two clutches.

tended to be slightly shorter than those of *L. similis* (n = 24) with mean egg lengths of 7.06 ± 0.451 mm (range 5.02–7.82 mm) and 8.54 ± 0.447 mm (range 7.96–9.52 mm) respectively, but had similar widths of 5.16 ± 0.434 mm (range 4.52–6.52 mm) and 5.05 ± 0.596 mm (range 4.50–6.74 mm) respectively. The mean egg mass for *S. tetradactylus* was 0.12 ± 0.023 g (range 0.09–0.18 g; n = 15) and for *L. similis* was 0.16 ± 0.037 g (range 0.11–0.25 g; n = 7).

The eggs of *S. tetradactylus* were more variable in shape than those of *L. similis*. This was evident in both recently deposited eggs as well as late-term eggs (see below). There was also considerable variation in the shape of *S. tetradactylus* eggs within clutches. Some eggs were distinctly pointed at the poles, while others were more rounded; some eggs were asymmetrical about the polar axis. Some late-term eggs were more rounded at one pole than the other while the shape of a few eggs resembled small kidney beans. Some freshly laid eggs of both species were observed to have concavities on the uppermost surface, but were all turgid on later inspections. One recently laid clutch of *S. tetradactylus* eggs was resting on wet clay and the eggs had swollen to the extent that they had

developed splits in the shell near the poles. Several eggs (of both species) that were in direct contact with decaying leaves had tannin stains but still hatched, as did three *S. tetradactylus* eggs (from two different clutches) that had translucent circular patches on the shell.

The eggs of both species were readily distinguished from those of *S. basiliscus* and *Carlia rubrigularis* by their smaller size (Goodman 2006 for *C. rubrigularis* egg size; Turner, unpublished data). The shells of newly laid *C. rubrigularis* eggs were slightly glossy and off-white and so they were easily distinguished from the other three species. The eggs of *S. basiliscus* were similar in appearance to, but noticeably larger than, both *S. tetradactylus* and *L. similis* eggs.

Development and hatching of eggs

In both species, egg volume was noted to increase significantly during incubation with an average estimated increase of at least 50% resulting mainly from an increase in egg width. The mean natural incubation time for *S. tetradactylus* eggs was 40.6 days (n = 38), ranging from 37 days in February–March to 55 days in July–August. For *L. similis* eggs, the mean natural incubation period was 42.7 days (n = 29), with a range of 38 to 45 days.

Based on the timing of inspections, eggs of both species hatched during daylight hours, most in the afternoon when temperatures peaked (n = 89). Only one hatchling *S. tetradactylus* was observed at an oviposition site during night-time inspections, indicating that hatchlings dispersed within minutes or hours of hatching. Accidental physical contact with some late-term eggs resulted in hatchlings immediately emerging and scurrying away (n = 6), suggesting that tactile stimuli may induce hatching. Eggs from the same clutch did not necessarily hatch on the same day, but all hatched within two days of each other (n = 34).

Egg mortality

Several sources of egg mortality were recorded. In the months October to December when conditions at ground level were driest, some clutches showed signs of dehydration (n = 9; comprising 15 eggs); in December (2005) some recently deposited eggs dehydrated and died (two clutches, four eggs). Five eggs (from three clutches) had been pierced and hollowed out, most likely the result of being parasitised; ants were observed feeding on the remains of two of these eggs. The removal or predation of egg shells post-hatching was evident at most oviposition sites within a week of hatching, but some shells remained *in situ* for up to three weeks, following emergence.

A major source of egg mortality was due to predation, although the predator(s) responsible were not identified. In 18 clutches (comprising 50 eggs of both species and including one clutch of *C. rubrigularis* eggs) some or all eggs disappeared from oviposition sites. There were no egg shells left at oviposition sites, as occurred when eggs hatched; most of these clutches (n = 15) had been recently deposited (< 2 weeks old) excluding this possibility. While scorpions (*Liocheles* sp.) were common beneath stones, there was no evidence that they were egg predators.

Appearance and size of hatchlings

The hatchlings of both species closely resembled adults in both pattern and colouration, though in *S. tetradactylus* hatchlings and subadults, colouration was more vivid than in adults (n = 36). Hatchling *S. tetradactylus* were smaller than those of *L. similis* in SVL, TL and mass (Table 3). In both species the TL was significantly larger than SVL: *S. tetradactylus* (paired one-tailed test for both) t = 8.49, 41df, $P < 0.0001$; *L. similis* t = 15.00, 38df, $P < 0.0001$. Furthermore, TL exceeded SVL in all individual hatchlings examined and was on average 0.9 mm and 2.8 mm longer in *S. tetradactylus* and *L. similis* respectively. Tail lengths exhibited slightly greater variability than SVL in both species (see Table 3). The SVL and TL measurements obtained were

Table 3. Size of hatchling *Saproscincus tetradactylus* and *Lampropholis similis*.
SVL = snout-to-vent length, TL = tail length, s.d. = standard deviation, n = sample size, CV = coefficient of variation.

Species	SVL (mm)	TL (mm)	Mass (g)
Saproscincus tetradactylus			
mean	15.1	15.9	0.06
s.d.	0.57	0.79	0.008
max	16.0	17.5	0.08
min	13.6	14.2	0.04
n	48	48	35
CV	3.8	5.1	
Lampropholis similis			
mean	17.7	20.5	0.12
s.d.	0.78	1.46	0.014
max	19.2	23.4	0.14
min	16.3	17.4	0.10
n	40	39	28
CV	4.4	7.1	

highly repeatable ($r^2 > 0.9$). The mean size of hatchling *L. similis* (Table 3) determined here closely corresponds to that reported by Martins *et al.* (2019) (as *L. coggeri*): SVL 18.4 mm, TL 22.1 mm and mass 0.14 g.

Hatchling behaviour

Hatchling *S. tetradactylus* sought cover beneath the nearest object. When that object was removed, hatchlings would immediately repeat the behaviour. This behaviour was not usually seen in hatchling *L. similis*: instead, they tended to move rapidly away but did not always seek cover. Hatchlings of both species were observed active typically in the late afternoon in leaf-litter.

Length of reproductive season

The timing of egg-laying was different for each species. *Saproscincus tetradactylus* clutches were recorded in all months of the year except June. The reproductive season therefore spanned virtually the entire year with two peaks in egg-laying occurring in February and October–November (Fig. 4 - upper) with a late autumn–winter decline in egg-laying evident. *Lampropholis similis* clutches were deposited from September through to February (Fig. 4 - lower). Their reproductive season spanned six months with a November peak in egg-laying occurring just prior to the wet season.
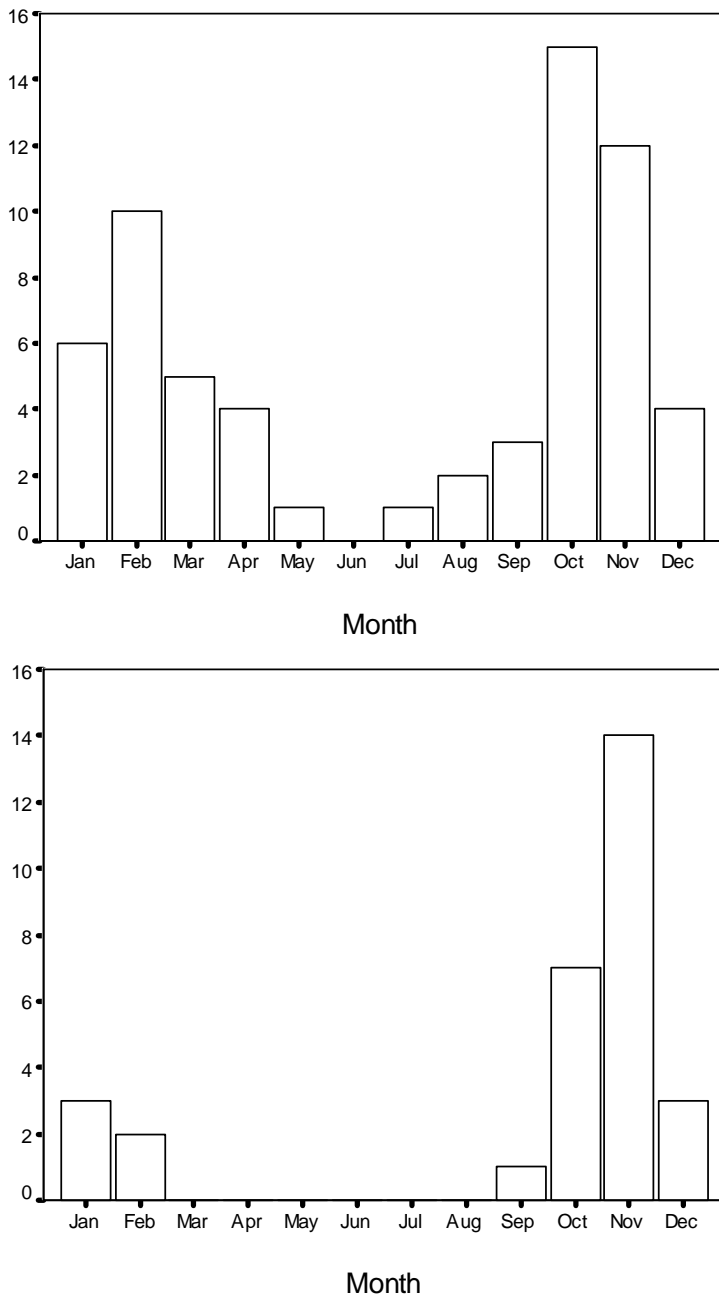

Figure 4. Total number of clutches recorded in each month of the year for 2005 and 2006: upper - *Saproscincus tetradactylus* (n = 63); and lower - *Lampropholis similis* (n = 30).

Adult skinks

The sex ratio of adult skinks (excluding gravid females as they were potentially more prone to capture) was not significantly different from unity: *S. tetradactylus* (M:F = 27:34; χ^2 = 0.60, 1df, *P* = 0.439) and *L. similis* (M:F = 14:15; χ^2 = 0.04, 1df, *P* = 0.842). Morphometric data is presented for a sample of adult *S. tetradactylus* in Table 4. Mean SVL of gravid versus non-gravid females was not significantly different (*t* = 0.80, 30df, *P* = 0.430). Mean mass of gravid versus non-gravid females was also not significantly different (*t* one-tailed = 1.07, 28df, *P* = 0.147) but tail condition and small sample size render this result equivocal. Male and female SVL and mass were also not significantly different (SVL: *t* = 0.04, 12.25df, *P* = 0.969; mass: *t* = 0.87, 13.11df, *P* = 0.398; unequal variances for both). Pooled adult morphometric data indicates minimal variability in SVL with a mean of 31.8 ± 1.64 mm (range 28.5–33.5 mm, CV = 5.2%; n = 44) and original TL with a mean of 35.2 ± 2.70 mm (range 28.0–39.0 mm, CV = 7.7%; n = 21) but greater variability in (non-gravid) mass 0.64 ± 0.086 g (range 0.45–0.85 g, CV = 13.4%; n = 41) was likely due to the variability in tail condition (Table 4). Original tail length for adult *S. tetradactylus* exceeded SVL in all individuals (*t* paired = 7.47, 20df, *P* < 0.0001). Rates of tail-loss were high in adult *S. tetradactylus* with 48% (21 of 44) of sampled lizards having regenerated or missing tail portions, and these rates did not differ significantly between the sexes (χ^2 = 0.11, 1df, *P* = 0.740). Regenerated tails of *S. tetradactylus* were typically sienna and paler than the dorsal colouration. In *L. similis* regenerated tails were essentially the same colour (both dorsally and ventrally) as the original but with a simplified pattern. Sloughing adult *S. tetradactylus* were recorded in both March (n = 7) and July (n = 5); those in which sloughing was imminent were noticeably darker overall in appearance. Several adults that had only recently shed their skins (as indicated by the presence of small pieces of adherent skin) were recorded in July. Sloughing adult *L. similis* were recorded in January (n = 2), March (n = 3), August (n = 1) and November (n = 1).

Saproscincus tetradactylus were more far more commonly encountered in the gully than *L. similis* (172 vs 65). They were observed active in all months of the year and were crepuscular, although were active at other times when subdued light conditions prevailed, as indicated by the following observations: (i) only two *S. tetradactylus* were observed active at night (after 8 pm EST) and in both instances observer disturbance could not be ruled out, (ii) between 10 am and 4 pm most individuals (87%) were encountered inactive beneath stones, (iii) under subdued light conditions (i.e. at twilight and on overcast days) most individuals (73%) were not located beneath stones and some were observed active in leaf litter (n = 24). When active, *S. tetradactylus* were inconspicuous in their movements which were confined largely to the litter layer. They were rarely seen: (i) in direct sun, (ii) moving over patches of bare ground, nor (iii) climbing over small stones or other surface debris. On the coldest winter days (overnight temperatures as low as 8°C) all *S. tetradactylus* located beneath stones were capable of rapid movement.

When active, *L. similis* was the more conspicuous of the two species (at least to human observers) owing to their larger size, tendency to bask and frequent sun-lit patches of the forest floor and the fact that they were active on the ground surface for much of the day (as well as within leaf litter). They were observed active in all months of the year. Only one individual was observed active at night, but observer disturbance could not be ruled out. They were only very occasionally encountered (singly) beneath stones by day or night (n = 8).

Adult *S. tetradactylus* occurred singly beneath stones with three exceptions (<1% of all observations): (i) two adult *S. tetradactylus* beneath the same stone several centimetres apart, (ii) an adult *S. tetradactylus* and a subadult *C. rubrigularis* both inactive and lying in direct body contact and, (iii) one adult *S. tetradactylus* and adult *S. basiliscus* both inactive and lying several centimetres apart beneath a stone. All *L. similis* were encountered singly.

Discussion

Consistent with other small species of *Saproscincus*, *S. tetradactylus* is known to have a clutch size of two eggs; however, this was based on a total of only five specimens with oviductal eggs (Greer & Kluge 1980; Greer 1989). The consistently observed clutch size of two in both gravid females and in clutches of eggs deposited beneath stones recorded in this work confirms that *S. tetradactylus* has an invariant clutch size of two. Clutches discovered in the field comprising odd numbers of

Table 4. Morphometric data for a sample of adult *Saproscincus tetradactylus* (n = 44).
SVL = snout-to-vent length, TL =tail length (* indicates regenerated/incomplete tail);
see Methods for details of determining reproductive status and sex.

Number	SVL (mm)	TL (mm)	Mass (g)
Females (non-gravid)			
1	30.0	34*	0.60
2	31.0	27*	0.60
3	33.0	24*	0.66
4	31.5	37*	0.65
5	33.0	31*	0.66
6	33.0	39	0.69
7	32.0	33	0.50
8	31.5	33*	0.60
9	33.0	34	0.65
Females (gravid)			
1	31.0	–*	–
2	32.5	37	0.67
3	32.0	27*	0.68
4	32.0	30.5*	0.60
5	33.5	36	0.71
6	31.5	30*	0.61
7	33.0	24*	0.57
8	32.0	31*	0.64
9	33.0	37	0.76
10	31.5	37	0.66
11	29.5	35	0.56
12	31.0	32*	0.50
13	32.0	32.5	0.65
14	31.5	36	0.65
15	32.5	32*	0.65
16	31.5	39	0.63
17	32.0	19*	0.74
18	32.0	37	–
19	33.0	34	0.71
20	30.5	36	0.85
21	30.0	24*	0.55
22	31.0	35	0.70
23	30.0	35	0.65
Males			
1	32.5	34	0.50
2	29.5	30*	0.60
3	33.0	38.5	0.82
4	33.0	19.5*	0.65
5	31.0	37*	0.67
6	32.0	31*	0.65
7	30.5	18*	0.53
8	31.5	37*	0.65
9	32.0	37	0.74
10	29.0	36.5	0.48
11	29.0	28	-
12	28.5	30*	0.45

eggs (one, three or five) were the result of the asynchronous hatching of single or multiple clutches or the removal/consumption of eggs or egg shells by predators.

Greer and Kluge (1980) provided notes on the biology of *S. tetradactylus* based on 58 specimens and stated that they almost invariably were found by day under stones and logs, except for a few individuals sighted on a damp surface near a waterfall in mid-morning. Observations in this work indicate that while *S. tetradactylus* were mainly crepuscular they were, under certain conditions, active at other times, retreating beneath leaves or stones when disturbed. Because of their small size, *S. tetradactylus* were virtually inaudible (to humans) when moving through leaf litter and so were relatively inconspicuous. Wilson (2005) has noted similarly that the species is 'very secretive, rarely foraging far from leaf litter and other groundcover'. Surface stones do not appear to be an essential element of the species' microhabitat, as I have recorded them in rainforest habitat entirely lacking surface stones but with leaf litter and decaying logs. They also occurred in disturbed habitats such as swathes of Forked Fern (*Dicranopteris linearis*) thickets on the margins of regenerating rainforest where there is no canopy (personal observation).

Neither *S. tetradactylus* nor *L. similis* bury their eggs. The stiff clay soil on which eggs were deposited would have made this impossible. Despite not being buried, eggs deposited on the ground surface swelled considerably. This increase in egg volume is likely due to the absorption of moisture from the air and high humidity would appear to be crucial as egg dehydration occurred when humidity was (relatively) low. The choice of stones that were flush (or nearly so) against the soil as oviposition sites might ensure a more humid microenvironment for developing eggs as well limiting predator access.

Greer and Kluge's (1980) limited information on the timing of reproduction in *S. tetradactylus* indicated that eggs were laid during the wet season. This study indicates that *S. tetradactylus* inhabiting lowland rainforest reproduce continuously throughout most the year but with a lull during the winter months. Greer and Kluge (1980) similarly found no reproductive females in June through to August and inferred a winter lull in reproductive activity. Wilhoft (1963) also found evidence for a winter lull in reproductive activity in *C. rubrigularis* and suggested this might be due to a lack of sufficient moisture for egg development or insufficient food for hatchlings. It has been suggested that *Saproscincus* species (and *S. tetradactylus* in particular) lay more than one clutch in a season (Greer 1989; Ehmann 1992). The two peaks in egg-laying (February (wet season) and again in October–November (dry season)) determined in this work suggest that two clutches are likely laid each year by *S. tetradactylus*, but not in a single season. By contrast, the single peak in egg-laying determined for *L. similis* suggests that it produces one clutch of eggs per year.

At the study site, *S. basiliscus* and *S. tetradactylus* occurred in sympatry but differences in their habits were evident. While *S. basiliscus* inhabits moist shaded areas with leaf-litter like *S. tetradactylus*, the former often climbs decaying wood, stones, low buttresses, and other ground debris when active and consequently is much more conspicuous in its day-time movements. This species also habitually climbs small plants and saplings to sleep exposed on leaves at night (Anthony & Turner 2002; personal observation), a behaviour I have observed only once in *S. tetradactylus* (an adult perched 3 cm above the ground on the leaf of a Matt Rush (*Lomandra* sp.)). Wilson (2005) and Wilson and Swan (2021) commented that *S. basiliscus* is more obvious in its surface activity and ventures more readily into exposed areas compared to other *Saproscincus* spp.

The disappearance of eggs (of both species) from oviposition sites is attributed to an unidentified predator(s). Observations indicate that, whatever the predator's identity, the entire egg, including the shell, is removed from the oviposition site with no remains or spillage of contents evident at the site. A likely candidate is the Eastern Small-Eyed Snake (*Cryptophis nigrescens*) as this species was common in the gully and two adults were located active at night only metres from skink oviposition sites with their heads (and anterior bodies) beneath stones apparently foraging; two other adults were observed active about 50 m away from the gully, and at least six adults were routinely encountered between sheets of corrugated iron located only 5 m from the nearest recorded oviposition site. Skink eggs have been recorded in the diet of *C. nigrescens* (Shine 1984) and given that they consume eggs whole, this species might

account for the disappearance of skink eggs from beneath stones.

The bulk of this study was conducted nearly two decades ago on private property and the site remains completely intact despite the damage to vegetation caused by two major cyclones (Larry in 2006 and Yasi in 2011). When visited in late 2022, the forest resembled its pre-cyclone condition and both skink species were commonly observed active on the surface and beneath stones. Eggs were numerous beneath stones (and six communal oviposition sites were recorded) and small numbers of hatchlings of both species were seen active in leaf litter. Both species it seems were able to survive the severe structural damage to their habitat that resulted in the removal of much of the canopy layer by utilising the enormous amount of ground debris that provided shade and refuge during the forest's recovery.

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