

# Activity patterns and habitat selection in a population of the African fire skink (*Lygosoma fernandi*) from the Niger Delta, Nigeria

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The African fire skink, *Lygosoma fernandi*, is a poorly known, large scincid species inhabiting the rainforests of central and western Africa. Aspects of its field ecology (daily and seasonal activity patterns and habitat selection) were studied at a coastal site in southeastern Nigeria. Skinks were studied by both pitfall traps and visual encounter survey techniques for a total of 40 field days (20 in the dry and 20 in the wet season) by nine researchers. Over 98% of skinks ( $n=106$ ) were active between 1715 and 1830, while only 2% were found out of their burrow earlier in the day. Above-ground activity was significantly more intense during the wet season. *Lygosoma fernandi* selected habitat types regardless of their relative availability in the field, and showed a clear preference for swamp forest and lowland forest patches. Mangrove swamps were, on the other hand, actively avoided.

*Key words:* ecology, morphometry, Scincidae, West Africa

## INTRODUCTION

The African fire skink, *Lygosoma* (= *Lepidothyris*, = *Mochlus*, = *Riopa*) *fernandi* (Burton, 1836) (Fig. 1) is one of the largest Scincidae of the Afrotropical regions (Schmidt & Noble, 1998; O'Shea & Halliday, 2001). It is generally considered a rare species and, despite being mentioned in several biodiversity studies on local reptile faunas in Africa (e.g. Böhme, 1975; Zug, 1987; Lawson, 1993; Akani et al., 1999; Schmitz et al., 2000), very little is known about its ecology. *Lygosoma fernandi* has a wide distribution in west and central Africa, and is considered a typical rainforest species, also occurring in forest islands and the plantations surrounded by forests (Schmidt & Noble, 1998; Akani et al., 2002a). Previous anecdotal field observations report that this giant skink is a burrowing species and that it is habitually solitary (Schmidt & Noble, 1998). The only quantitative data on free-ranging individuals come from a swamp rainforest site in southern Nigeria (Eket, Akwa-Ibom State; Akani et al., 2002a), showing that *L. fernandi* was essentially an insect-eating species, avoiding diet overlap with the sympatric *Trachylepis* (= *Mabuya*) by eating a larger amount of Tenebrionidae beetles and small lizards. Akani et al. (2002a) provided the first evidence that this species has a bimodal diel activity pattern (with one peak between 0800 and 1000 and a second between 1600 and 1800), and that it is abundant in bushy boundary strips surrounding the forest as well as in former and current cultivations. It is preyed upon by genets and the snakes *Psammophis phillipsii* (Akani et al., 2002a) and *Naja melanoleuca*

(Luiselli et al., 2002). In some localities of southern Nigeria, *L. fernandi* is regarded as an omen or totem, and is erroneously thought to be venomous by rural people.

The aims of this paper are to convey additional information on diel and seasonal activity patterns and habitat selection in relation to habitat availability, based on a substantial sample of free-ranging *L. fernandi* at a coastal site in southern Nigeria.

## MATERIALS AND METHODS

### Study areas

*Lygosoma fernandi* was studied in the onshore area of Brass Island (6°13'–6°16'E, 4°16'–4°18'N), in the Brass Local Government Area, Bayelsa state, Nigeria. The study area is located within an oil-producing area of the Niger



**Fig. 1.** A specimen of *Lygosoma fernandi* located in Okpoama at 1745 one evening in the early rainy season 2008 (Photo: G.C. Akani).

**Table 1.** Numbers of *Lygosoma fernandi* individuals encountered in bi-hourly intervals within each study area.

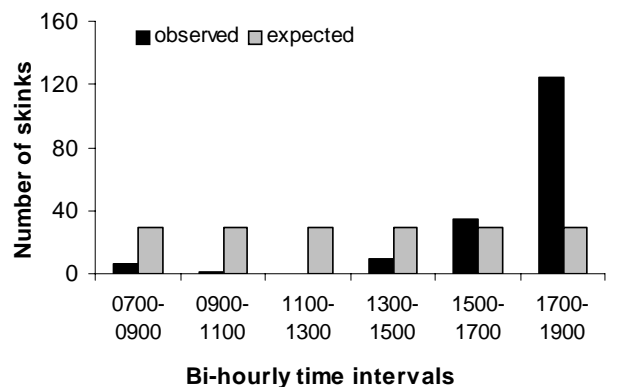
| Study area        | 0700–0900 | 0900–1100 | 1100–1300 | 1300–1500 | 1500–1700 | 1700–1900 | Total |
|-------------------|-----------|-----------|-----------|-----------|-----------|-----------|-------|
| Twon Brass        | 0         | 0         | 0         | 0         | 7         | 34        | 41    |
| Ewoama            | 0         | 0         | 0         | 2         | 8         | 13        | 23    |
| Okpoama           | 3         | 1         | 0         | 5         | 11        | 49        | 69    |
| Diema             | 3         | 0         | 0         | 2         | 9         | 28        | 42    |
| St Nicholas River | 0         | 0         | 0         | 0         | 0         | 0         | 0     |

Delta, with a typically tropical climate characterized by well-marked dry and wet seasons and relatively small monthly fluctuations in annual temperatures (Von Chi-Bonnardel, 1973; White, 1983; mean monthly maximum temperatures range between 27 and 34 °C, while the minima vary between 22 and 24 °C). The dry season extends from November to April, while the wet season spans the period from May to October. Rainfall is usually heavy (above 3000 mm annually) and reaches two peaks in July and September, when most seasonally flooded swamp forests become inundated. Four distinct vegetation types are distinguishable from the onshore towards the inland: littoral strand vegetation, swamp forest, mangrove swamp and lowland forest.

The littoral vegetation covers 50 ha (2%) of the sampling area, and is characterized by small woody plants such as *Alchornea cordifolia*, *Oncoba spinosa* and *Chryobalanus icaco*, and low shrubs and herbs such as *Dalbergia escastaphyllum*, *Ipomoea mauritiana*, *Paspalum vaginatum*, *Conocarpus erectus* and *Hibiscus tiliaceus*. The swamp forest, covering about 1,848 ha (81% of the study area) around the NAOC (Nigerian Agip Oil Company) Administrative office area near Brass River, stretches up to Ewoama, Okpoama, Diema and towards the east. The forest is seasonally flooded, and consists of only a single dominant stratum of trees (*Sacoglottis gabonensis*, *Parinari excelsa*, *Elaeis guineensis*, *Cleistopholis patens*, *Allanblekia floribunda*, *Macaranga spinosa*, *Lophira alata*, *Raphia hookeri*, *Hallea ciliata* and *Xylopi villosa*). The mangrove swamps occupy about 138 ha (6% of the study area). Although smaller scattered patches occur in the central and western parts of Ewoama and Okpoama, it is located mainly in the eastern part of Brass island (St Nicholas River area), from where it spreads towards the hinterland. Two distinct zones are noticeable: the *Avicennia racemosa* zone along the seaward side, and the *Rhizophora africana* zone of the hinterland above the high-tide level. Other abundant species are *Pandanus candelabrum* and the exotic palm *Nypa fruticans*. The lowland forest covers 243 ha (11% of the study area), and holds a high diversity of tree species. It is primarily located around Okpoama, with some patches occurring near NAOC. The forest shows three distinct storeys and the canopy is typically 5–6 m high, with occasional emergent trees up to 50 m. This habitat is in general very shady, with the dominant woody plants being *Elaeis guineensis*, *Anthostema aubreyanum*, *Hallea ciliata* and *Lophira alata*, among others. The forest floor is usually covered with dry leaf litter.

## Protocol

Skinks were studied by two main survey methods: 1) drift fences with pitfall traps along 19 randomly distributed transects to reflect the major habitats in Brass, and 2) direct field search/visual encounter surveys (VES). Ten transects were established in the forests situated behind NAOC Administrative Base at Twon Brass, Ewoama, Okpoama and Diema, while nine transects were located around the mangrove swamp and dry forest patches at the fishing settlements towards St Nicholas River. Each transect was 150 m long. Along each transect, a wooden drift fence (about 30 m long and 61 cm high) was constructed with seven pitfall traps distributed at intervals of 3 m. Into each pitfall trap a large, black, plastic bucket (measuring 75cm in diameter and 1.2 m deep) was lowered. A total of 133 pitfalls were inspected daily over two 10-day intervals each in the dry and rainy seasons. Visual encounter surveys were conducted through random transects sampled across 40 field days by nine independent recorders, moving along transects to assure data independence. VES surveys were done during 20 dry-season days (ten in November/December 2007, and ten in December 2008) and during 20 wet-season days (ten in June/July 2008 and ten in December 2008). Each time a skink was sighted the time, habitat and its behaviour (e.g. foraging, basking or resting in shadow) was noted. In order to analyse activity patterns of skinks between seasons we devoted an identical number of days (20 days in each season) and people (nine researchers) to field surveys in both dry and wet seasons. In order to analyse



**Fig. 2.** Encounter frequency (2-hour intervals) of *Lygosoma fernandi* in comparison to the assumption of equal activity among intervals. Data from all study areas are pooled.

**Table 2.** Total number of *Lygosoma fernandi* trapped or sighted during dry and wet seasons (2007 and 2008).

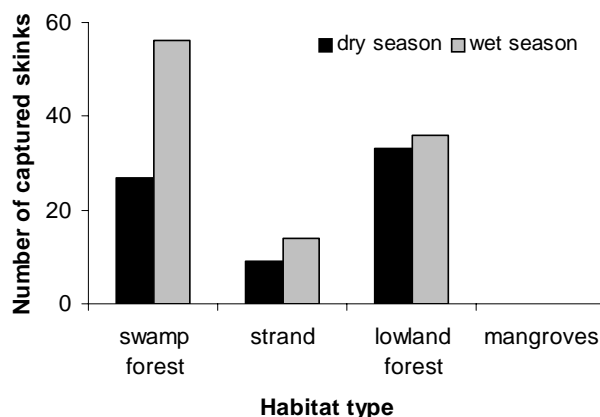
| Study area           | Coordinates  | Dry season | Wet season | Total      |
|----------------------|--|------------|------------|------------|
| NAOC<br>(Twon Brass) | N419595.49,<br>E33190.86                                 | 15         | 26         | 41         |
| Ewoama               | N422017.82,<br>E32689.05 and<br>N422017.90,<br>E32729.58 | 9          | 14         | 23         |
| Okpoama              | N424159.36,<br>E33922.19 and<br>N424160.14,<br>E33962.02 | 33         | 36         | 69         |
| Diema                | N423198.24,<br>E32785.42 and<br>N423198.24,<br>E32744.71 | 12         | 30         | 42         |
| St Nicholas<br>River | N433867.10,<br>E37279.03 and<br>N439675.02,<br>E34803.14 | 0          | 0          | 0          |
| <b>Total</b>         |  | <b>69</b>  | <b>106</b> | <b>175</b> |

daily activity patterns, the lizard counts were subdivided into two-hour intervals from 0700 to 1900. Daily research was suspended during heavy showers, and also, for security reasons, during the night. In order to analyse habitat selection, each lizard captured was assigned to one of four habitat types: swamp forest, lowland forest, mangroves or strand (littoral) vegetation. All lizards were released after being marked by toe-clipping at the capture point.

All statistical tests were two-tailed, and alpha was set at 0.05. Activity intensity at two-hour intervals and interseasonal and interhabitat differences in frequencies of individuals sampled were assessed by  $\chi^2$  tests. Correlations between the availability of each habitat type in the study area (expressed as percentage of the given habitat) and the number of lizards seen in each habitat type were analysed by nonparametric Kendall's tau ( $\tau$ ).

**Table 3.** Numbers of *Lygosoma fernandi* individuals encountered in each transect survey during the study period. All transects from each study area are pooled.

| Study area   | Nov/Dec<br>2007 | April<br>2008 | June/July<br>2008 | Dec<br>2008 | Total      |
|--------------|-----------------|---------------|-------------------|-------------|------------|
| Twon Brass   | 7               | 10            | 19                | 5           | 41         |
| Ewoama       | 3               | 8             | 11                | 1           | 23         |
| Ekpoama      | 11              | 15            | 28                | 15          | 69         |
| Diema        | 5               | 19            | 15                | 3           | 42         |
| St Nicholas  | 0               | 0             | 0                 | 0           | 0          |
| <b>Total</b> | <b>26</b>       | <b>52</b>     | <b>73</b>         | <b>24</b>   | <b>175</b> |

**Fig. 3.** Frequency of *Lygosoma fernandi* in the four habitat types of Brass Island during the dry and wet season.

## RESULTS

### Activity patterns

Skinks were essentially fossorial, and were often observed to feed close to their burrows. In all, 175 individuals active above ground were seen and monitored. Over 70% of them were active between 1700 and 1900, a pattern which was consistent across study sites (Table 1). The frequency distribution of the skinks observed between 0700 and 1900 was significantly uneven ( $\chi^2=398.31$ ,  $df=5$ ,  $P<0.0001$ ; Fig. 2). We directly observed several instances of predatory behaviour by skinks, with ants, Lepidoptera larvae, Diptera and beetles being the most frequently captured prey. Skinks were observed more frequently in the wet season than in dry season (Table 2), and overall the inter-seasonal difference was statistically significant ( $\chi^2=7.823$ ,  $df=1$ ,  $P=0.0052$ ). The numbers of skinks observed by survey period and study area are given in Table 3.

### Habitat preferences

The distribution of the 175 recorded skinks across habitats was strongly uneven (Fig. 3), in both the dry ( $\chi^2=41.087$ ,  $df=3$ ,  $P<0.0001$ ) and the wet season ( $\chi^2=68.642$ ,  $df=3$ ,  $P<0.0001$ ). The preferred habitat types were swamp forest and lowland forest, whereas the skink was absent in the mangrove swamp (Fig. 3). There was no correlation between the availability of each habitat type in the study area (expressed as percentage of the given habitat) and the number of individuals seen in each habitat (Kendall's  $\tau=0.667$ ,  $P=0.174$ ), thus showing that the preference of *L. fernandi* for swamp and lowland forests was not due to the higher availability of these habitats in the study area. There was also no significant difference in habitat preference by lizards between seasons (in all cases, at least  $P>0.355$ ;  $\chi^2$  tests with  $df=1$ ). However, among sites, there was a significantly uneven number of captured skinks ( $\chi^2=74.571$ ,  $df=4$ ,  $P<0.0001$ ), with the highest total encountered in Okpoama, followed by Diema, NAOC and Ewoama (Table 1).

## DISCUSSION

This is the most detailed field study on *L. fernandi* available to date, shedding light on the activity patterns and habitat characteristics of this neglected skink in the wild. Given that a considerable amount of time was spent in the field, we are led to think that the data obtained comprehensively represent the activity patterns of an otherwise elusive and fossorial species.

Our data revealed that *L. fernandi* is active above-ground mainly in the late afternoon and early evening, and it is also possible that it may be active during early night-time (L. Luiselli et al., unpublished observations in Calabar, Nigeria). Our results confirm the bi-modal peaks in diel activity patterns already shown in conspecifics from a forest plantation in Nigeria (Akani et al., 2002a). It is very likely that the bi-modal diel activity pattern depends on the high ambient temperatures around midday, forcing the skinks to rest inactive inside their burrows. Afrotropical reptiles, also if inhabiting shady forested regions, are required to adapt their activity to reduce their body temperature (e.g. Hailey & Coulson, 1996a,b; Hailey & Loveridge, 1998; Akani et al., 2002b; Luiselli, 2005), rather than increasing it as is the case in temperate zones (e.g. Stevenson, 1985; Rismiller & Heldmaier, 1988; Forsman, 1995).

*Lygosoma fernandi* was active above-ground mainly in the wet season. This pattern was not unexpected, given that many other reptile species in tropical Nigeria also show activity peaks during this time of the year (e.g. Akani et al., 1999b; Luiselli & Akani, 2002); we, however, demonstrate it for the first time in *L. fernandi*. With regards to habitat use, we showed that *L. fernandi* selected habitat types independently of their relative availability in the field, and that swamp forest and lowland forest were preferred and mangroves actively avoided. These data are in good agreement with Lawson's (1993) suggestions that this species is linked to primary forests and their disturbed margins in southwestern Cameroon. The high number of observed skinks also suggests that *L. fernandi* is fairly common in its primary habitat in Nigeria, and that quantitative field studies are certainly feasible when appropriate sites are selected. This is in contrast to previous field studies showing that this species is rarely observed in the wild (e.g. Lawson, 1993).

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