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SHORT NOTE

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# Sleeping site fidelity in three neotropical species of herpetofauna

OLIVER THOMAS[1]*, GISELLE MANGINI[2] & JUAN GUALINGA[3]

[1]Department of Biosciences, Swansea University, Swansea, SA2 8PP, UK
[2]Instituto de Ecología Regional, Consejo Nacional de Investigaciones Científicas y Técnicas, Residencia Universitaria Horco Molle, Edificio las Cúpulas S/N, Yerba Buena, Tucumán, Argentina
[3]Sani Lodge, Sani Isla, Río Napo, Sucumbíos, Ecuador
*Corresponding author e-mail: olliethomas444@gmail.com

## INTRODUCTION

All animal species studied to date have shown sleep or sleep-like behaviour (Tobler, 2000). Sleep aids in a variety of processes including recovery of cellular and endocrine systems through to learning, memory and energy conservation (Mignot, 2008; Libourel & Herrel, 2016). At the same time, periods of sleep could present risks as an animal may be exposed to predation while inactive (Amlaner & Ball, 1983). Regardless of its functions, sleep is among the most prominent of animal behaviours and as such is likely to be a behaviour that responds dynamically and adaptively to different environmental variables (Tobler, 2000).

Sleeping site selection must play an important role in obtaining the benefits of sleep while avoiding predation (Amlaner & Ball, 1983). It is likely influenced by microhabitat preferences, the need for protection from predators or exposure, and remaining within territories to avoid competition (Christian et al., 1984; Clark & Gillingham, 1990). Thus, once selected, a sleeping site may be maintained through days, weeks, or longer, to retain these benefits over time (González-Zamora et al., 2015). However, to date studies of sleeping site preferences or site fidelity have focused mainly on endotherms (mammals and birds) rather than ectotherms such as reptiles, amphibians, fishes or invertebrates (Amlaner & Ball, 1983; Campbell & Tobler, 1984; Christian et al., 1984; Clark & Gillingham, 1990; Hartse, 1994). In reptiles specifically, sleeping sites have been recorded widely in anoles, including some Amazonian species such as *Anolis punctatus*, *Anolis trachyderma* and *Anolis transversalis*. However, there is far less information for other reptiles and amphibians (Clark & Gillingham, 1990; Vitt et al., 2002; Vitt et al., 2003a; Vitt et al., 2003b; Poche et al., 2005). Here we report sleep site fidelity for two species of lizard *Enyalioides laticeps* (Guichenot, 1855) and *Anolis fuscoauratus* D'Orbigny, 1937 and one amphibian species, the toad *Rhinella margaritifera* (Laurenti, 1768).

To gather data, we undertook day and night-time visual encounter surveys between June and August 2019 in the camping area of the Sani Reserve, Sucumbíos, Ecuador (0° 26' 18.47" S, 76° 16' 45.11" W). The habitat in the Sani Reserve is a mixture of mostly terra firme forest, igapó (blackwater flooded forest) and varzea (white water flooded forest) with the Challuacocha lagoon and its surrounding reeds and grasses located around the reserve's ecolodge (Hollamby, 2010). Six trails were surveyed on separate days on a rotational basis. During these surveys we first recorded *E. laticeps* and *R. margaritifera* sleeping on 10th July, and recorded them again on 17th July. Sleeping was determined through behavioural indicators such as closed eyes upon our arrival, lack of escape behaviour, or time of observation outside the reported diel activity pattern. In the camp, we recorded an individual *A. fuscoauratus* that was returning to sleep in the same site from the 19th July. We placed flagging tape a few metres from the sleeping sites of *E. laticeps* and *R. margaritifera* as a warning so that we could approach slowly when nearby while also not drawing attention to the specific site. We then visited these flagged sites daily from 24th July 2019 to 4th August 2019 and the *A. fuscoauratus* site (in camp) from 19th July to 4th August 2019. We did not visit the any of the sites on Mondays, as we were not in the reserve. We were unable to reach the *E. laticeps* and *R. margaritifera* sites on the 1st and 3rd of August due to bad weather, but we could still observe *A. fuscoauratus* as this was within the camp. During each visit we recorded the presence or absence of the individuals at the sites. To characterise the microhabitats used for sleeping, we photographed each location (Fig. 2A, 3A, 4A) and in each case measured the height from the ground and distance from the trail where applicable. The animals were not captured so morphometric data was not collected. Based on their size, all three individuals were considered to be adults and each had unique colour patterns that allowed us to confidently recognise the same individual on successive occasions.

**Amazon forest dragon - *Enyalioides laticeps***

This is a small, ornamented arboreal lizard that ranges throughout Amazonia (Bartlett & Bartlett, 2003). We have observed that this species tends to 'hug' thin sticks and remain there during sleep (Fig. 2). They remain immobile and seem unbothered by flashlights or by people moving in their vicinity. We recorded one adult individual sleeping repeatedly at the same site across seven different nights (Fig. 1). The individual used two sleeping sites within one small area. The first site (hereafter: EL-A) was a small plant 95 cm from the edge of the trail where the lizard slept on a foliated branch measuring 23 cm wide, 20 cm long and 92 cm above the ground (Fig. 2B). The second sleeping site (EL-B) was on a

thin stick (Fig. 2C) located 73 cm away from EL-A and 131 cm from the edge of the trail. The lizard's perch on the stick was 49 cm above the ground. On 28th July 2019 at 15:08 h the lizard was seen a few metres from the sleeping plant showing that it was leaving the perch for other activities.

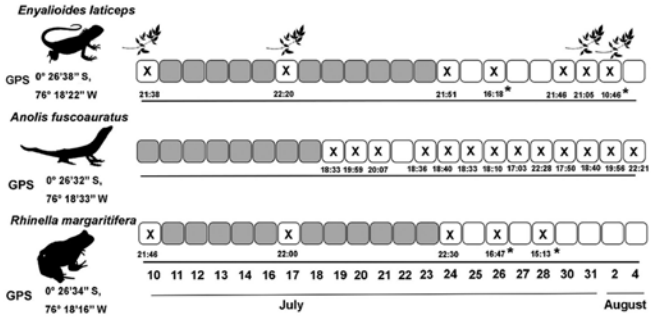


**Figure 1**. Date and time records for each individual recorded in their sleeping site across our surveys, the boxes represent days. Grey boxes represents days in which we did not survey the individuals. An X within a box denotes presence of the individual and clear boxes absence of individuals. Asterisk (*) next to time denotes where a record was at a time early enough that we cannot be sure the animal was sleeping. For *E. laticeps* there are two sub-sites, the foliated branch (EL-A) indicated by a symbol of a foliated branch above a box and a thin stick sleeping site (EL-B) with no symbol.

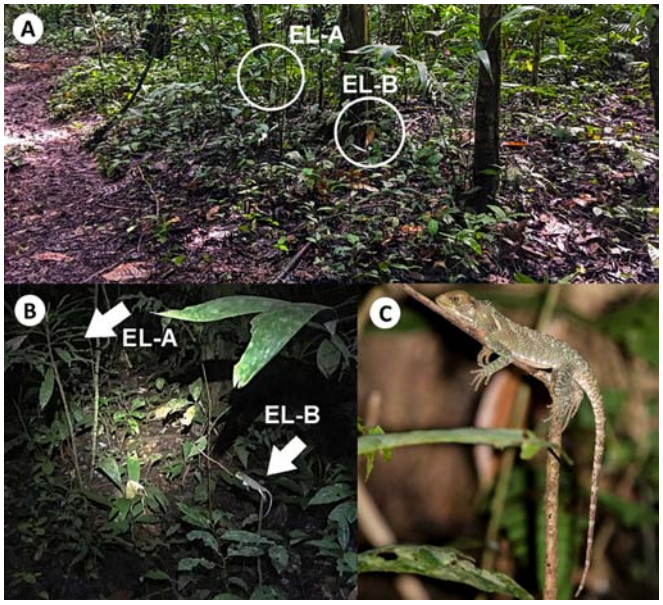


**Figure 2.** *Enyalioides laticeps* sleeping site - **A.** Circle EL-A indicates the first location in which the lizard was encountered sleeping and circle EL-B indicates the second location, **B.** A closer image of the sleeping site with the respective perches indicated by arrows EL-A and EL-B, the lizard can be seen in-situ at EL-B below arrow 2, **C.** Close up of the individual *E. laticeps* on the small stick at EL-B

**Slender anole - *Anolis fuscoauratus***

This is a cryptically coloured, arboreal lizard that is found in clearings as well as within the forest throughout the amazon basin and are often recorded sleeping over leaf surfaces, or on thin sticks (Bartlett & Bartlett, 2003; Fig. 3). One adult male individual was recorded returning to the same perch over the 13 nights that we checked the location (Fig. 1). The sleeping site was a dead 'Cruz Caspi' (*Browneopsis* sp.) stem in a pot on a table of one of the camp's raised platforms, covered by a roof made from palm leaves (Fig. 3A). The sleeping perch on the plant was 77 cm above the table it was resting on, whilst the total height from the ground to the sleeping perch was 286 cm. We did not observe the lizard arriving to rest every night, however on 27th July 2019 at 17:03 h, during heavy rainfall, the lizard made its way across the handrail and jumped from the handrail to the stem (roughly 10 cm). It then came to rest at the small fork towards the distal end of the stick (the same position as in previous observations) and fell asleep (Fig. 3B), 17:03 h was the earliest time of arrival recorded for the lizard, perhaps due to the rain. We also noted that the lizard became habituated to both the stick bouncing as a result of the floor moving from foot traffic, and to head torch shine, which normally awoke this species found sleeping on the trails.


**Figure 3.** *Anolis fuscoauratus* sleeping site – **A.** The thin, dead branch that the anole slept, held up by the plastic bottle into which it was inserted, the white arrow indicates the fork in the branch where it slept, **B.** the anole sleeping at the fork of the branch with its head facing the terminal end of the branch

**Crested forest toad - *Rhinella margaritifera***

This medium-sized toad ranges across northern South America and inhabits the leaf litter on forest floors for which it is well camouflaged (Ortiz et al., 2018; da Fonseca et al., 2019). This adult toad was first observed sleeping on a large, flat leaf on a thin stemmed plant. The large leaf upon which it was sleeping was 127 cm above the ground and measured 44 cm in the length and 19 cm in width at the widest point (Fig. 4A). The toad was recorded again sleeping on the same perch on two other days (Fig. 1). On 26th July 2019 at 16:47 h the toad was present but was accidentally disturbed causing it to jump from the plant to the ground and into the leaf litter. Though unfortunate for the animal, this proved that the individual had the intent and ability to climb back up to the site, since we observed it back up on the leaf on 28th July 2019 at 15:13 h (Fig. 4B). This behaviour is interesting as *R. margaritifera* is reported as being terrestrial, thus climbing this plant suggests unexpected arboreal abilities in this species. We did not encounter the toad again at the site after 28th July 2019.

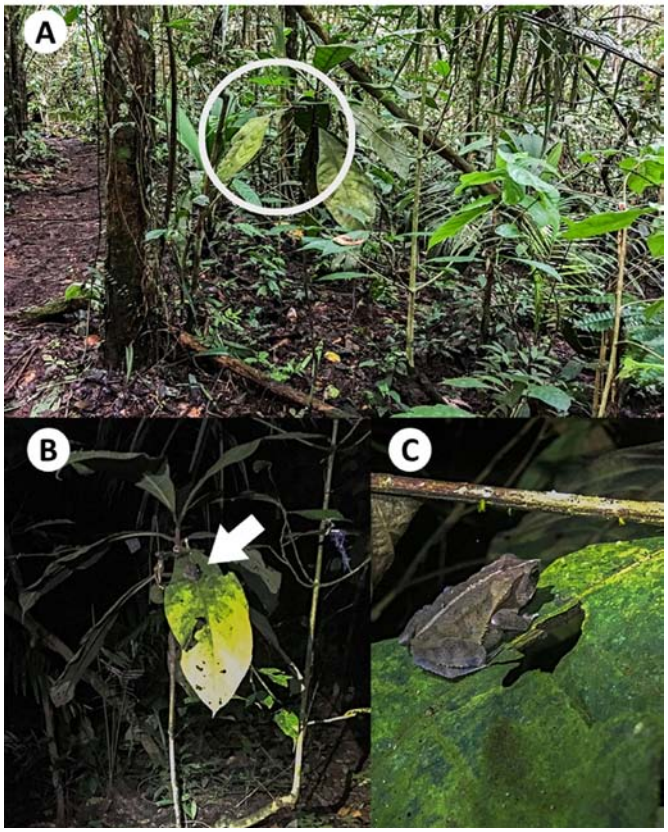


**Figure 4.** *Rhinella margaritifera* sleeping site – **A.** View of the sleeping site, the white circle indicates the leaf upon which the individual was observed sleeping, 127 cm above the ground, **B.** Close up image of the plant where the individual was sleeping,the white arrow indicates the individual in-situ, **C.** Close up of *R. margaritifera* in-situ on the leaf

Avoiding or diminishing predation risk has been proposed as one of the main features that leads individuals to choose a sleeping site (Lima et al., 2005). But, factors other than predation may be more important in sleeping site selection and fidelity. For instance, selection of sleeping sites could be based on site structure (leaf area) or stability, which by extension could help to minimise predation or exposure, or perhaps to improve thermoregulatory opportunities in the morning (Christian et al., 1984; Clark & Gillingham, 1990; Mohanty et al., 2016).

Additional observations of sleeping perches for these species, which were recorded outside the period of this study, include: for *E. laticeps*, branches of small trees and shrubs, normally about 1-2 m above the ground; for *R. margaritifera*, small plants at the trail edge; and for *A. fuscoauratus* the terminal ends of thin branches of vegetation at chest-height. Detailed information on the sleeping perches of *A. fuscoauratus* have been recorded previously but without mention of sleeping site fidelity (Vitt et al., 2003b). The somewhat artificial environment of the camp likely provided added protection for *A. fuscoauratus* from predators and may have been why this individual remained there over several days.

The information gathered here for these three species is a first step in understanding what sleeping sites they select and the degree of site fidelity they show. Further detailed work is needed to understand how these species select sleeping sites and the characteristics of sites to which they would show fidelity.

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