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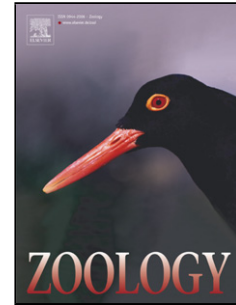
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Short Communication**First observations on the behavior of the flightless anomalure (*Zenkerella insignis*)**

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Highlights

- The flightless anomalure (*Zenkerella insignis*) is the sole member of Zenkerellidae.
- There are no published first-hand records of its behavior and live appearance.
- One *Z. insignis* specimen was observed and photographed in the Central African Republic.
- The observations confirmed predictions about the species' preferred habitat.
- Its live appearance and behavior differ from some published assumptions.

ABSTRACT

The sole extant representative of the ancient family Zenkerellidae, the flightless anomalure (*Zenkerella insignis*), is one of the world's least studied mammals. No first-hand observations of its behavior and live appearance have been published to date. I report an observation of *Z. insignis* behavior, live appearance and habitat in the Central African Republic.

Keywords: Anomaluridae; Cameroon scaly-tail; *Zenkerella insignis*; Zenkerellidae

1. Introduction

The flightless anomalure, alternatively known as the Cameroon scaly-tail (*Zenkerella insignis* Matschie, 1898), is one of the world's least known mammals. It is the sole survivor of a lineage dating back to the early Eocene and the only extant member of the family Zenkerellidae (Heritage et al., 2016). Until molecular data became available, the flightless anomalure was included in the family Anomaluridae (Jackson and Thorington, 2012), but it differs from all its members in lacking patagia (gliding membranes) (Kingdon, 2013; Heritage et al., 2016; Jackson, 2016). There are no published observations of its behavior and live appearance (Kingdon, 2015; Heritage et al., 2016; Jackson, 2016), and the first photographs of a live animal, obtained on Bioko Island in 2015, remain unpublished (Curtis Hart, in litt.). The first whole body specimens in currently curated natural history collections were only obtained in 2014–2015, bringing the total number of specimens in museums to 14 (Heritage et al., 2016); these specimens are from Equatorial Guinea (including Bioko Island), Cameroon, Central African Republic, and Congo (Perez del Val et al., 1995; Hutterer and Decher, 2008; Jackson, 2016). The species' lack of patagia, and hence its inability to glide (unlike all other species of Anomaluridae), have been variously interpreted as a sign of being diurnal (Winton, 1898), considering that all extant gliding mammals are nocturnal (Jackson and Schouten, 2012); as an adaptation to living in particularly dense vegetation (Kingdon, 2013); or as a necessity for being partially terrestrial (Perez del Val et al., 1995). The tufted tail was said to be used as a rudder for quick movement through arboreal environment (Kingdon, 2013). Although it is not as rudder-shaped as in Anomaluridae, the use of tufted tails for steering is well documented in some terrestrial rodents (see, for example, Ognev, 1963).

2. Materials and methods

The study area was centered on Sangha Lodge in Dzanga-Sangha Special Protected Area, Central African Republic (2°59'58"N, 16°13'6"E, ~420 m a. s. l.). The lodge has a trail system ~5 km in total length, cut in selectively logged rainforest where almost all logging and hunting have ceased by 2009. Observations were conducted opportunistically by spotlighting on foot using an Energizer Vision HD + Focus LED headlight (250 lm in white light mode, 60 lm in red light mode). The trails were walked in random order for 5–10 h per night on February 3–9, 2017. After February 5 the walks were conducted predominantly during the parts of night with less moonlight (full moon on February 10), as it was found that bright moonlight caused small mammal activity to decrease dramatically. The trail system was also walked daily at dawn, at dusk and during daylight hours. In addition, some spotlighting was conducted along the 3-km access road and the 1-km stretch of the small Babongo River near its confluence with the Sangha River.

3. Results

On 3 February 2017, approximately 2 h before midnight, one *Zenkerella insignis* was found along Loop Trail (trail map is available at <http://www.mammalwatching.com/wp-content/uploads/2017/02/VD-CAR-and-Cameroon-2017.pdf>). The habitat at the site is somewhat unusual for the area. A partially stunted lowland rainforest on a low ridge between two areas of swamp forest (Rod Cassidy, pers. comm.), it has a combination of large emergent trees and extremely dense undergrowth composed of small trees, shrubs and vine tangles that reach from the ground level to ~10 m. This impenetrable thicket covers at least 1 km². Although the forest undergrowth around Sangha Lodge is generally dense, the sighting area differs in being covered

with continuous vine tangles; other vine tangles accessible along the trail system are not nearly as extensive.

The animal was immediately identified as *Z. insignis* based on being larger than any dormouse (Gliridae), differing in pelage coloration from all African squirrels (Sciuridae), having a large black tail tuft unlike any Central African rat (Muridae), and lacking patagia unlike all anomalures (Anomaluridae) (Nowak, 1999; Kingdon, 2015; Jackson, 2016; Koprowski et al., 2016; Holden-Musser et al., 2016). A few photos were obtained; they are of poor quality but photography had to be discontinued in favor of prolonged observation, as the animal was clearly disturbed by camera flashes. It tried to avoid the flashes by moving behind foliage, but after the flashes stopped and the light was switched from white to red it re-emerged in full view and was observed continuously for ~20 min.

When moving through vine tangles, the animal always remained on thicker vines and branches (>1 cm in diameter), and stayed 2–5 m above ground. On two occasions it removed something small from branches and chewed it, but due to poor light conditions it was impossible to see what it was. Eventually the animal reached a tree ~30 cm in diameter, started climbing it and disappeared from view by moving to the far side of the trunk.

The animal moved slowly (even when apparently escaping the camera flashes): it never covered its body length in less than 3 s, often remaining motionless for up to 30 s and covering a distance of less than 30 m during the time of observation. It never leaped, and the tail was held straight behind the body even when the animal turned, rather than used as a rudder.

Unlike in preserved specimens (Schunke, 2005; Kingdon, 2015; Heritage et al., 2016; Samuel Turvey, in litt.) and published depictions (i.e., illustrations in Nowak, 1999; Kingdon, 2015; Jackson, 2016), the black tail tuft was “fluffed” so much that the long black hair formed a

spherical shape (Fig. 1). That large black ball stood out against the background and broke the animal's camouflage. Although use of the tail as rudder (as suggested by Kingdon, 2013) still cannot be ruled out, it can also be hypothesized that the shape and color of the tuft are used for either intraspecific signaling or to distract predators from vital parts of the body.

The site was re-visited more than thirty times during that and subsequent nights, but the animal was not seen again.

4. Discussion

Recent molecular data (Heritage et al., 2016) have shown that *Zenkerella* is a sister taxon to gliding scaly-tails (Anomaluridae), so its lack of gliding ability might be an ancestral condition rather than a secondary adaptation to life in dense thickets as previously suggested (Kingdon, 2013). However, its supposed preference for extensive, dense tangles (Kingdon, 2013) and nocturnality (as first proposed by Bates, 1905) were supported by the present observation and might explain the paucity of visual records and rarity in collections. Although the recently obtained specimens were captured on the ground (Heritage et al., 2016), scales on the underside of the tail are likely an adaptation to climbing vertical tree trunks, shared with gliding Anomaluridae and indicative of a mostly arboreal lifestyle. Notably, the present sighting took place in an area where dense vine tangles and shrubs were mixed with numerous standing trees, and the animal was observed on a vertical tree trunk as well as on branches and vines.

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specimens in museum collections, and the anonymous reviewers for thoughtful and helpful comments.

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Figure caption

Fig. 1. First published photographs of a living flightless anomalure (*Zenkerella insignis*). The lower right inset shows the tail with ball-shaped tuft. Vicinity of Sangha Lodge, Dzanga-Sangha Special Protected Area, Central African Republic.

