

# Giraffe bed and breakfast: Camera traps reveal Tanzanian yellow-billed oxpeckers roosting on their large mammalian hosts

Meredith S. Palmer  | Craig Packer

Department of Ecology, Evolution, and Behavior, University of Minnesota, Saint Paul, MN, USA

## Correspondence

Meredith S. Palmer

Email: palme516@umn.edu

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## 1 | INTRODUCTION

Oxpeckers are obligate mammal gleaners, feeding on ectoparasites and dead skin of large herbivores (Bezuidenhout & Stutterheim, 1980; Dean & MacDonald, 1981). There are two sympatric species in sub-Saharan Africa: the red-billed (*Buphagus erythrorhynchus*) and yellow-billed oxpeckers (*Buphagus africana*). The red-billed species is smaller, with a scissor-like bill, while the yellow-billed species is larger, behaviourally dominant, and has a broad, flat beak (Attwell, 1966; Neweklow, 1974; Stutterheim, Bezuidenhout, & Elliott, 1988). These behavioural and morphological attributes are hypothesized to contribute to differences in host niche breadth. The red-billed oxpecker associates with at least 15 host species, ranging in size from impala to elephants (Stutterheim, 1976). Yellow-billed oxpeckers, on the other hand, select megafaunal hosts that have heavier tick loads and larger surface areas, specializing on buffalo (*Syncerus caffer*), eland (*Tragelaphus oryx*), giraffe (*Giraffa camelopardalis*) and rhinoceros (*Diceros bicornis* and *Ceratotherium simum*) (Attwell, 1966; Grobler & Charsley, 1978; Hustler, 1987).

Yellow-billed oxpeckers are more closely adapted to their host species, a relationship that has consequences for other facets of the oxpecker's behaviour (Koenig, 1997; Stutterheim & Panagis, 1985a, b). For instance, whereas red-billed oxpeckers have only definitely been found roosting in trees and reeds (McLachlan & Liversidge, 1981; Newman, 1983; Stutterheim, 1976), yellow-billed oxpeckers are documented to roost on Cape buffalo in Zambia, giraffe in Botswana and cattle in Namibia (Dowsett, 1969; Stutterheim & Panagis, 1985a). Roosting on host species may be a behavioural adaptation to minimize search time for a patchily distributed, limited resource (Stutterheim & Panagis, 1985a). However, the occurrence of this

behaviour across oxpecker species, the range of mammalian hosts used as nocturnal roosting platforms and the geographic spread of this behaviour are difficult to assess in the field, particularly as these behaviours occur during dark periods when visibility is limited.

Camera traps reveal new insights into animals' nocturnal behaviour (e.g. Palmer, Fieberg, Swanson, Kosmala, & Packer, 2017), and here, we describe the use of a camera trap survey in east Africa to investigate the night-time interactions between oxpeckers and large mammals. We report on 25 instances over 3 years of yellow-billed oxpeckers using a variety of host animals as roosts, whereas no cases were observed for the red-billed species. Furthermore, we document a shift between preferred daytime and night-time host species and discuss potential benefits for this behavioural adaptation.

## 2 | MATERIALS AND METHODS

In 2010, we initiated a camera trap survey in the centre of Serengeti National Park, Tanzania, which has run continuously for 7 years. For full details on survey design, see Swanson et al. (2015). A total of 225 camera traps were deployed in a 1,125 km<sup>2</sup> grid and set ~50 cm above the ground. For this study, we used data from 17 July 2010 to 18 December 2013, during which time the survey produced 938,596 independent image sequences containing wildlife. Animals in the images were identified by online citizen science volunteers at the website "Snapshot Serengeti" (<http://www.snapshotserengeti.org>). M.S. Palmer visually examined all images flagged as containing bird species. Of these, 137 images captured oxpeckers associating with host mammals. Nocturnal captures were defined as those that

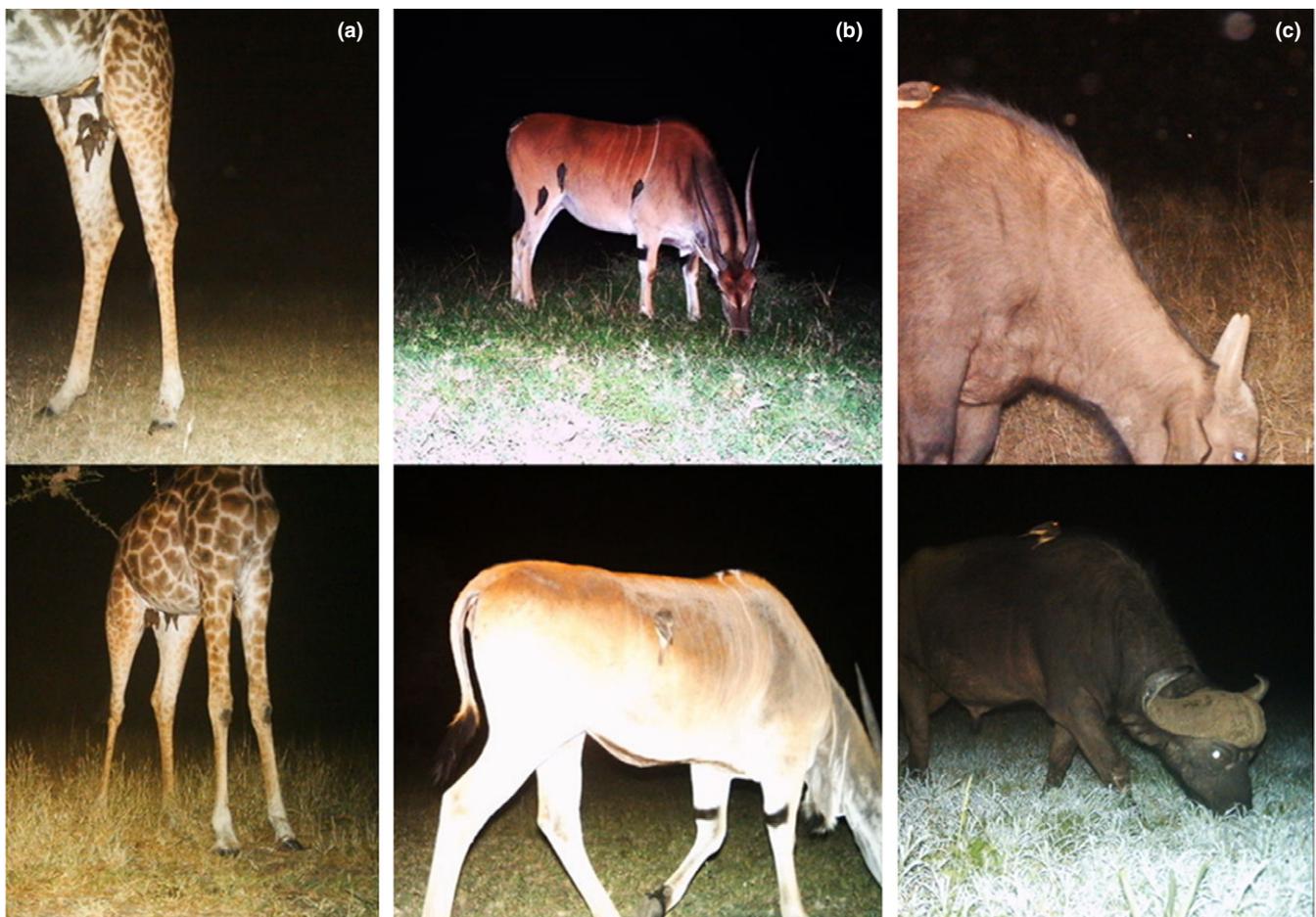
occurred between civil twilights (when the Sun is  $\geq 6^\circ$  below the horizon, obtained from the United States Naval Observatory; <http://aa.usno.navy.mil/data>). Where possible, oxpeckers were identified to species, and the number of birds and their choice of host were recorded.

### 3 | RESULTS AND DISCUSSION

We found 25 instances of nocturnal roosting on large herbivores, the first documented occurrence of this behaviour in east Africa. All oxpeckers which could be identified from the camera trap photographs were yellow-billed (Figure 1). The predominant nocturnal host was giraffe ( $N = 20$ ; Figure 1a), with rarer instances of oxpeckers roosting on eland ( $N = 3$ ; Figure 1b) and buffalo ( $N = 2$ ; Figure 1c). This report is the only recorded instance of throughout the oxpeckers' range of nocturnal association with eland. On giraffe, the oxpeckers were predominantly found roosting on the underbellies and in the "armpits," with an average of 3.3 birds (range: 1–7) per giraffe. Eland and buffalo carried an average of 1.6 (1–3) and 1.5 (1–2) birds per host, respectively, and only on the hosts' back and sides.

Both oxpecker species change their host selection across diurnal to nocturnal periods. During the day, yellow-billed oxpeckers were seen seven times more frequently on buffalo ( $N = 70$ ) than on eland ( $N = 11$ ) or giraffe ( $N = 8$ ). At night, yellow-billed oxpeckers were found on giraffe ten times more often than on the other host species. While buffalo are significantly more abundant in the Serengeti-Mara system than giraffe (30,000 buffalo versus 9,000 giraffe; Mduma & Hopcraft, 2008; Rentsch, Hilborn, Knapp, Metzger, & Loibooki, 2015), eland exist in comparable numbers to buffalo (27,000 eland; Rentsch et al., 2015). We hypothesize that diurnal selection of buffalo is driven by massive sizes of buffalo herd, which frequently contain hundreds of individuals and therefore provide ample feeding opportunities for oxpeckers (Sinclair, 1974). However, the tall stature and long legs of giraffe may present warmer, safer nooks in which to spend the night, supported by our observations of oxpeckers congregating on to the undersides, rather than the more exposed flanks.

Red-billed oxpeckers were found on giraffe as frequently as the yellow-billed during the daytime ( $N = 8$ ) and were also captured perching on buffalo ( $N = 8$ ), despite never associating with these species at night. Historically, the single recorded sighting of a red-billed oxpecker recorded roosting on buffalo in Luangwa Valley



**FIGURE 1** Camera trap images depicting the nocturnal roosting habits of yellow-billed oxpeckers on (a) giraffe, (b) eland and (c) buffalo. Yellow-billed oxpeckers can be identified by their distinctive coloured bills. [Colour figure can be viewed at [wileyonlinelibrary.com](http://wileyonlinelibrary.com)]

National Park, Zambia (Dowsett, 1969), is largely considered to be a misidentification (Stutterheim & Panagis, 1985a). This distinction in roosting patterns between oxpecker species is posited to arise as a result of the differences in feeding niche breadth between oxpecker species: red-billed oxpeckers exploit significantly more host species, reducing their need to remain with their mobile food sources throughout the night, given the abundance of potential hosts in the environment (Stutterheim, 1976; Stutterheim & Panagis, 1985a).

In summary, our extensive camera trapping in Serengeti National Park reveals a new geographic extent of an unusual and difficult-to-observe host-roosting behaviour in yellow-billed oxpecker, expanding both the geographic range within which this behaviour occurs and the taxa of hosts with which these mutualists associate at night.

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## ORCID

Meredith S. Palmer  <http://orcid.org/0000-0002-1416-1732>

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