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Host preferences, spatial distribution and interaction of oxpeckers with wild ungulates in and around southern Gonarezhou National Park, Zimbabwe

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Abstract: Availability of information on the host preferences, temporal distribution and interaction of two oxpecker species, Red-billed Oxpecker (*Buphagus erythrorhynchus*), and the Yellow-billed Oxpecker (*Buphagus africanus*), with wild ungulates provides an important understanding of oxpeckers' biology vital to their conservation. Host preferences, temporal distribution and interaction of these two oxpecker species with wild ungulates were investigated using driven road counts between October and November 2014 in southern section of the Gonarezhou National Park (i.e., Mabalauta and Malipati Safari Area), southeast Zimbabwe. The host preference index was used to determine oxpecker host selection and species preference while the Kruskal–Wallis test was applied to test for associations between dominant host species responses and oxpeckers. A total of 19 animals were observed and seven of these animals had oxpeckers on them. Cape buffalo (*Syncerus caffer*) was the most preferred host followed by impala (*Aepyceros melampus*) and greater kudu (*Tragelaphus strepsiceros*). Although host species responded differently to oxpecker presence, Cape buffalo exhibited high neutrality towards oxpeckers foraging on them. The host species for oxpeckers were also distributed in areas that are close to communal areas which have ecological advantages coming along with potential direct socio-economic implications.

Key words: Avoidance, large herbivores, oxpecker, protected area, savanna, tolerance.

The oxpeckers are well-known for their symbiotic relationship with ungulates as they reduce ectoparasites loads on mammal species (Robertson & Jarvis 2000). In sub-Saharan Africa there are only two oxpecker species, the Red-billed Oxpecker (RBO), *Buphagus erythrorhynchus* and Yellow-billed Oxpecker (YBO), *Buphagus africanus* (Hockey *et al*. 2006). These two species, RBO and YBO, are slightly different in their morphology but there seems to be no consensus in literature on host selection, food preference or foraging behaviour (Koenig 1997). The YBO possess thicker bills and significantly heavier bodies compared to the slender-built RBO (Ndlovu & Combrink 2015). The YBO and RBO prefer large ungulates with manes to access high loads of tick for growth, reproduction and to effectively detect and hide themselves from predators (Mooring & Mundy 1996a).

In Zimbabwe, the recovery of major mammal hosts like the Cape buffalo (*Syncerus caffer*) which had been decimated by the rinderpest outbreak and tsetse fly (*Glossina* species) infection (Grobler 1976,

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Table 1. Ethogram of selected oxpecker–host interaction behaviours adapted from Mooring & Mundy (1996b).

Type of response	Grouped host responses to oxpeckers	Operational definition
Resistant behaviours	Rejection	Involves host overt responses (i.e. swinging the head, jumping, foot movements and skin shake) that resulted in oxpeckers either changing their position on their host body or departing
	Running	Attempt by ungulate host to evade oxpecker attacks through agonistic movements in an attempt to repel or dislodge oxpecker
Tolerance behaviour	Receptive	Host making certain body regions accessible –achieved through postural adjustments such as lifting the tail or lowering the ears
	Neutral	Host remain standing still in response to oxpecker attendant

1979) caused oxpeckers to successfully re-colonize areas from which they had been extirpated (Hall-Martin 1987). An understanding of oxpecker species interactions alongside their hosts is critical for the evaluation of management actions, including the assessment for actions to improve their status and effect of habitat changes on them. Although oxpeckers are useful indicators of ecosystem status and ungulates health (Plantan 2009), no attempts have been made to explore host preferences, distribution and interaction of oxpeckers in and around Gonarezhou National Park yet these are important aspects of their ecology that should be known in order to make informed management decisions. The objectives of this study were to: (1) assess the distribution of the RBO and YBO; (2) investigate the preferences by oxpecker to forage on available host species, and (3) explore the types of host responses to oxpeckers foraging on them in Mabalauta (southern section of Gonarezhou National Park) and the neighbouring Malipati Safari Area. We hypothesised that YBO and RBO would occur sympatrically and being associated with large ungulate mammal species (with greater ectoparasites searching area) in the study area. In addition, we also hypothesised that oxpecker are perceived as beneficial by their hosts and their responses to them would be receptive.

The study was conducted in the Mabalauta management block (southern Gonarezhou National Park), and the adjacent Malipati Safari Area, southeast Zimbabwe. Mabalauta management block covers approximately 2,000 km^2 but our study was concentrated in an area of about 800 km^2 and a further 154 km^2 was covered in Malipati Safari Area. The study area is a semi-arid area that receives average annual rainfall of 466 mm, the hottest month is January (mean 36 °C) and the coldest is July (27 °C). Vegetation is typical of semi-arid with dry deciduous savanna woodlands of varying types but predominantly *Colophospermum mopane* (Gandiwa *et al*. 2016). The Mwenezi River and its tributaries that dissect through Mabalauta and Malipati Safari Area are the major water sources for wildlife. The Gonarezhou ecosystem comprises of a wide variety of large ungulates herbivores and high abundance of large carnivores such as spotted hyena (*Crocuta crocuta*) and the lion (*Panthera leo*).

Data on RBO and YBO sighting were collected and recorded over a period of two months from October to November 2014 in Mabalauta and Malipati Safari Area using road strip counts for mammals (Dasmann & Mossman 1962), conducted between 06:00–10:00 hours in the morning and 15:00–17:00 hours in the afternoon as this time coincides with the oxpeckers feeding time (Plantan 2009). Twenty eight transects were covered in Mabalauta, with total length of 192.8 km while only three were done in Malipati Safari Area (total length of 15.2 km). When a singleton or a group of the host ungulates species within 0–500 m from the vehicle was encountered, binoculars were used to record group information, i.e., size, sex for singleton, number and sex of individuals that had oxpeckers on them (Ndlovu & Combrink 2015). Using instantaneous scan sampling, the interaction between the host species and oxpeckers was monitored up to the point at which the oxpeckers flew away or maximum of seven minutes per host (Grobler 1980). Two types of host responses were recorded: (1) resistant behaviour, considered as a response where mammalian host interrupt oxpecker attendants, and (2) tolerance behaviour which entails a behavioural strategy used by a mammalian host to attain an oxpecker (Table 1). Other information recorded was date, host habitat, Global Positioning System (GPS) location, day time and weather condition.

All data were captured in a Microsoft Excel

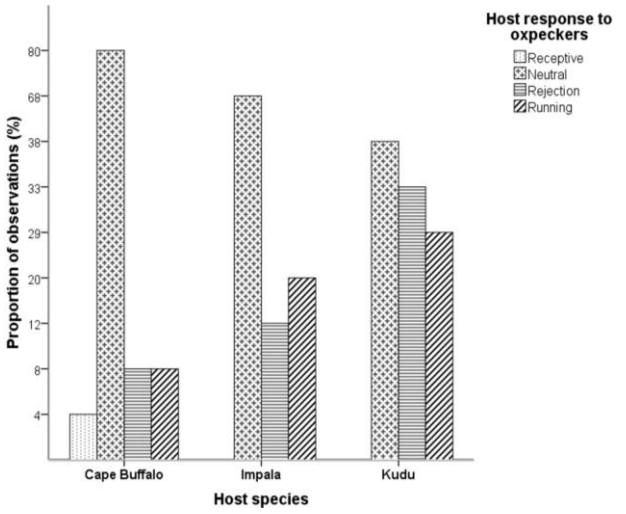

Fig. 1. Host species responses to oxpeckers attendance in Mabalauta and Malipati Safari Area, Zimbabwe.

document. Due to paucity of sightings data we combined all sightings made in Mabalauta and Malipati Safari Area. Host responses to oxpeckers were re-categorised into four classes' namely receptive, neutral, rejection, and running (Table 1), while oxpecker behaviour was categorised into four classes: foraging, flying, preening, and sedentary. The spatial data was used to develop an oxpecker distribution map using Quantum Geographic Information System (QGIS version 2.2, 2005; http://qgis.osgeo.org). Host selection by oxpeckers was analyzed using the preference index described by Grobler and Charsley (1978) where the index for each host species is calculated by dividing the number of individuals of each host species seen by the number of oxpeckers seen on them, preference index (PI) = (n hosts / n oxpeckers). The Kruskal–Wallis test was thus used to examine if there were any associations between the dominant host species responses and number of oxpecker on them using the Statistical Package for the Social Sciences (SPSS version 20, Chicago, USA) since data were not normal.

We recorded a total of 378 RBO and 94 YBO in the study area on seven ungulate species representing 37% of the 19 ungulate species sighted during the study period. An estimate of 33 and 16 sightings of RBO and YBO respectively were recorded in Mabalauta while Malipati Safari Area had 12 and 2 RBO and YBO, respectively. Both RBO and YBO were observed in association with grazers, mixed feeders and browsers. However, RBO used a wider range of hosts including warthog (*Phacochoerus africanus*) and common eland (*Taurotragus oryx*) as opposed to YBO. Cape buffalo was the most preferred host with a combined preference index of 4.6 followed by impala (*Aepyceros melampus*) (4.5) and greater kudu (*Tragelaphus strepsiceros*) (3.0) as shown in Table 2.

The host species responded differently to oxpeckers presence (Kruskal–Wallis $\chi^2 = 10.60$; $df = 2$; $P = 0.005$). The majority of host species had neutral, rejection and running responses to oxpeckers although the most frequent behaviour was neutral (Fig. 1). Cape buffalo exhibited the most tolerance behavioural responses to oxpeckers relative to other ungulate species (i.e., 80% neutral and 4% accommodation) followed by impala (68%) and greater kudu (38%).

Both the RBO and YBO utilised the same area and had a clumped distribution (Fig. 2). Large numbers of oxpeckers were observed in areas near the northern boundary of the study area close to communal areas and along the western Mabalauta boundary mainly along Mwenezi River. Occurrence of the two oxpecker species in the southern part of Mabalauta was low.

Our results were partially consistent with our hypothesis that YBO and RBO would select large ungulate mammal ungulate hosts (with the exception of African elephants) to optimise foraging efficiency although they are sympatric species in the study area. Although, the RBO and YBO utilised similar grazers, mixed feeders and browsing host species, their preference were significantly higher for the Cape buffalo in comparison to other host species. Our results are similar to those of Bishop *et al.* (2014) and Plantan (2009) who noted that oxpeckers generally prefer to forage for ticks (and other ectoparasites) on large herbivorous mammals such as Cape buffalo, giraffe (*Giraffa camelopardalis*), hippopotamus (*Hippopotamus amphibious*), greater kudu, white rhinoceros (*Ceratotherium simum*) and plains zebra (*Equus quagga*). This preference for Cape buffalo by oxpeckers was possibly due to the high surface area to ectoparasite ratio (i.e., relatively larger tick loads) with various life cycle stages (Grobler & Charsley 1978; Koenig 1997) and the usually large group sizes of buffalos. However, the present study showed that impala which are considered to be smaller sized ungulates were highly preferred hosts for both YBO and RBO which is similar to a recent study in Kruger National Park (Ndlovu & Combrink 2015).

This study showed that the Cape buffalo had a more receptive behaviour. Such ungulate host

Table 2. Host selection and preference indices for the RBO and YBO as observed in October and November 2014 in Mabalauta and Malipati Safari Area, Zimbabwe.

Host species	Total hosts	Total oxpeckers	RBO PI	YBO PI	Total PI for oxpeckers
Grazers					
Cape buffalo (*Syncerus caffer*)	1028	225	4.6	11.3	4.6
Plains zebra (*Equus quagga*)	28	14	1.8	0.4	2.0
Waterbuck (*Kobus ellipsiprymnus*)	9	0	-	-	-
Mixed feeders				-	
African elephant (*Loxodonta africana*)	22	0	-		-
Common duiker (*Sylvicapra grimmia*)	21	0	-	-	-
Nyala (*Tragelaphus angansii)*	19	7	0.3	-	2.7
Common eland (*Tragelaphus oryx)*	7	7	0.6	-	1.0
Impala (*Aepyceros melampus)*	320	128	3.2	5.5	4.5
Grysbok (*Rhaphicerus sharpie*)	2	0	-	-	-
Browsers					
Greater kudu (*Tragelaphus strepsiceros*)	236	78	1.4	4.3	3.0
Steenbok (*Raphicerus campestris*)	49	0	-	-	-
Giraffe (*Giraffa camelopardulis)*	20	17	1.4	0.4	1.2
Bushbuck (*Tragelaphus scriptus)*	1	0	-	-	-
Klipspringer (*Oreotragus oreotragus*)	1	0	-	-	-

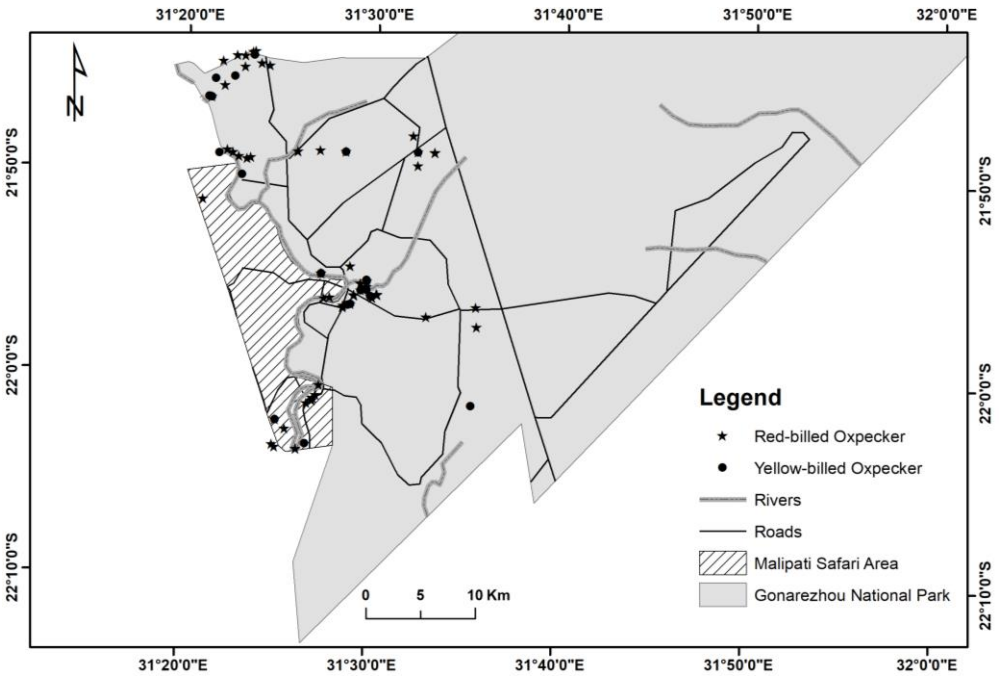

Fig. 2. Illustration of the spatial distribution of the RBO and YBO along established road strip transects in Mabalauta and Malipati Safari Area, Zimbabwe.

species that are physiologically and behaviourally more vulnerable to ectoparasites sometimes use non-tolerance behaviour to control the period and sometimes the location of oxpeckers landing and feeding on them. In so doing they limit parasitism as the hosts shake off oxpeckers before they become parasitic (Johnstone & Bshary 2002). Atwell (1966) and Koenig (1997) suggested that oxpeckers host preference is influenced by host behavioural tolerance to oxpecker attendance. Cape buffalo, in

addition to their natural gregarious occurrence (Mooring & Mundy 1996a), have limited abilities to groom thereby increasing tick loads, providing a stable perch and thus oxpeckers have greater probability of finding food as they move from one individual to the other (Koenig 1997).

The host species behaviour was probably important in influencing the preference index for oxpeckers. The smaller sized ungulates like the impala and greater kudu that exhibited tolerant behaviour to landing and foraging by oxpeckers had significantly high preferences indices. Bushy ecotone habitats (that are normally favoured by browsers and mixed feeders such as greater kudu and impala) provide suitable conditions for the success of ticks (blue tick *Rhipicephalus decoloratus* and bont tick *Amblyomma variegatum*) development cycles (Hart 1990; Mooring & Mundy 1996b) in the wild. Furthermore, thin skinned ungulates like the impala and greater kudu are targeted by many ticks as they can easily attach themselves to their thin skins to suck blood (Uys *et al*. 2015) and therefore tend to have high ectoparasites loads that attract oxpeckers.

The RBO and YBO were found to occur sympatrically in the present study as also reported by Hustler (1987) for Hwange and Gonarezhou National Parks, Zimbabwe. This could be related to the availability of hosts that harbour the major preferred ticks for both oxpecker species (Dickman 1992). Our study revealed that RBO are generally common in the study area and have a wider range of hosts than YBO. Similar findings were reported by Stutterheim & Panagis (1985) and Stutterheim *et al*. (1988) where YBO were more specialized and used a limited number of hosts compared to RBO. However, the two oxpecker species were observed almost on every species seen except the nyala (*Tragelaphus angansii*), bushbuck (*Tragelaphus scriptus*), and African elephant.

Oxpeckers in the study area had a clumped distribution mainly along the boundary and the Mwenezi River probably due to the close proximity of the ungulate hosts to the water source. At water sources, mammal ungulates congregate in high densities thus becoming more visible to oxpeckers compared to other areas (Dale 1992). The distribution of the RBO and YBO in the northern boundary suggests that oxpeckers use domestic livestock particularly the cattle's (*Bos taurus*) as alternative hosts. Thus, further research is needed to understand habitat range (e.g., Santamaría-rivero *et al*. 2016), and diseases transfer risks at the wild-domestic interface (Dickman 1992).

In conclusion, the YBO and RBO tended to prefer foraging on mammal hosts such as Cape buffalo, greater kudu and impala to optimise foraging efficiency besides their sympatric occurrence in our study area. Moreover, the clumped distribution of the oxpeckers near Mwenezi River and the northern boundary Mabalauta, suggest potential interaction between wild and domestic ungulates in the northern boundary, an indication that oxpeckers target areas with high tick loads and prefer substantial large ungulate populations of the host species.

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