

Interactions Between Red-Billed Oxpeckers and Black Rhinos in Captivity

Alan G. McElligott,* Ivan Maggini, Lorenz Hunziker, and Barbara König

Zoological Institute, University of Zürich, Zürich, Switzerland

The relationship between oxpeckers and African ungulates has traditionally been considered mutualistic, because the birds were thought to reduce the tick loads of their hosts. However, recent field studies have questioned the validity of this assumption. Red-billed oxpeckers were found to have no impact on the number of ticks living on domestic cattle and they also prolonged the healing time of wounds (Weeks [1999] *Anim Behav* 58:1253–9; Weeks [2000] *Behav Ecol* 11: 154–60). One of the important limitations of these studies is the fact that the two species did not coevolve, and therefore the results may not be representative of the relationships between oxpeckers and their native African ungulate hosts in general. We carried out observations between red-billed oxpeckers and one of their natural host species, the black rhino, in captivity, to investigate their relationship. We found that the rhinos had oxpeckers present on them for almost half (approximately 45%) the time that the two species were in the same enclosure. The oxpeckers spent a large proportion (approximately 40%) of their time on the rhinos foraging, and mostly at wounds. We observed oxpeckers opening wounds on their hosts for the first time; they created four new wounds on the female rhino and nine on the male. Although the rhinos were intolerant of the presence of the oxpeckers at wounds, only approximately 43% of their attempts at removal were successful. Therefore if oxpeckers are housed with any of their native hosts in captivity, observations should be carried out to determine the activities of the oxpeckers on those hosts. *Zoo Biol* 23:347–354, 2004. © 2004 Wiley-Liss, Inc.

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*Correspondence to: Alan McElligott, Zoological Institute, University of Zürich, Winterthurerstrasse 190, CH-8057 Zürich, Switzerland. E-mail: amcellig@zool.unizh.ch

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INTRODUCTION

Cooperative ecological relationships between two species in which both benefit are called mutualisms [Axelrod and Hamilton, 1981; Dickman, 1992; Bronstein, 1994a]. The advantages of mutualistic relationships vary, but can include reduced parasite loads, increased feeding success, and reduced predation risk [Dickman, 1992]. The ecological conditions under which mutualisms occur can change and therefore the nature of these relationships can also vary, becoming commensal or parasitic under different circumstances [Bronstein, 1994b]. The benefits for the species involved are also very difficult to quantify [Dickman, 1992]. Probably the most well-known example of a mutualistic relationship between vertebrates is that between cleaner fish (*Labroides dimidiatus*) and other fish species at tropical reefs [Grutter, 1999; Bshary, 2001]. Another relationship that has traditionally been considered mutualistic is the one between oxpeckers and African ungulates [Dickman, 1992; Mooring and Mundy, 1996a].

Oxpeckers are members of the starling family (Sturnidae). There are two species that occur in sub-Saharan Africa: the red-billed oxpecker (*Buphagus erythrorhynchus*) and the yellow-billed oxpecker (*Buphagus africanus*) [Feare, 1984; Robertson and Jarvis, 2000]. Their diet includes ticks, blood, earwax, dead skin, insects, and mucus [Mooring and Mundy, 1996b, Koenig, 1997; Weeks, 1999]. This food is collected on medium to large African ungulates and they are known to use four different feeding methods; scissoring, plucking, pecking, and insect catching [Bezuidenhout and Stutterheim, 1980]. It is believed that the first step in the evolution of the association between oxpeckers and African ungulates was the catching of insects by the birds as they were flushed from vegetation by moving ungulates [Dean and Macdonald, 1981]. The relationship between oxpeckers and native African ungulates has been usually considered mutualistic, because the birds were thought to reduce the tick loads of their hosts [Mooring and Mundy, 1996a]. Evidence for this was based on the observation that the oxpeckers fed mainly on the places where animals could not groom themselves. In addition, impala (*Aepyceros melampus*) were found to assist the foraging behavior of the oxpeckers by lowering their ears [Mooring and Mundy, 1996a].

Recent field research on the relationship between red-billed oxpeckers and domestic cattle (*Bos taurus*) indicates that the relationship between oxpeckers and ungulates may not always be mutualistic. These studies found that oxpeckers preferred to feed on blood from wounds rather than on ticks, and the presence of the birds did not reduce the number of ticks on the cattle. The oxpeckers increased the healing time of wounds and the cattle responded aggressively to the presence of the birds at wounds and other feeding locations [Weeks, 1999, 2000]. However, it may not be possible to generalize these results to all native African hosts of oxpeckers since domestic cattle and oxpeckers did not coevolve [Weeks, 1999, 2000].

We studied the relationship between red-billed oxpeckers and black rhinos (*Diceros bicornis*) in captivity. The black rhino is known to be a host for oxpeckers in the wild [Koenig, 1997]. We examined the amount of time that the rhinos had oxpeckers present on them when the two species were housed together. Additionally, we determined the activity budgets of the oxpeckers when present on the rhinos. Finally, we recorded removal attempts by the rhinos when the oxpeckers were feeding on them.

METHODS

Study Location

We conducted the study in the Africa house of Zoo Zürich, Switzerland, which is a mixed-species exhibit. In addition to the black rhinos and red-billed oxpeckers, it contains several other bird species and one other mammal. The bird species were: double-toothed barbet (*Lybius bidentatus*), violet turaco (*Musophaga violacea*), cattle egret (*Bubulcus ibis*), African grey hornbill (*Tockus nasutus epirhinus*), and Dinemelli's weaver (*Dinemellia dinemelli*). There was also a pair of pigmy hippopotamuses (*Choeropsis liberiensis*) in an enclosure separated from the rhinos. All the birds could move freely within the Africa house and were provided with food ad libitum at several feeding locations. The food was a mixture of cereals, vegetables, minced meat, and mealworms.

Study Animals

The study animals consisted of five red-billed oxpeckers (three individually identifiable males with leg rings, and two others) and two black rhinos, one female and one male. The rhinos were released from the Africa house each morning at approximately 0900 hr into their outdoor enclosure, and brought back inside between 1630 and 1700 hr each afternoon. The birds were kept inside at all times. The rhinos were not treated against external parasites, and ticks were not seen on the rhinos during our study. An iodine-based disinfectant (Betadin) is used to treat large wounds and it also helps to repel the oxpeckers (R. Zingg, personal communication). However, it was not used during our observation period.

Observations and Analysis

All observations were carried out by two trained observers (I.M. and L.H.), who synchronized their observations and could also communicate with one another during observations. The two observers carried out simultaneous focal watches of each rhino (one observer per rhino) from 27 July 2000 until 17 August 2000. These observations were carried out each day after the rhinos had been brought back into the Africa house, and also after it had been closed to members of the public. In total, the female was observed for 27 hr 18 min, and the male for 29 hr 20 min. These totals differ because the male remained outside on one of the days of observation.

The observers noted the location and behavior of the oxpeckers on the rhinos every 2 min, and did not distinguish between the individual oxpeckers because two of them did not have leg rings. Any incidents of the oxpeckers opening wounds by pecking with their beaks were also recorded. Pecking is a pickaxe-like action that is also used to feed at wounds by increasing blood flow [Weeks, 1999]. The second method of feeding observed was plucking. This occurs when a bird holds a piece of dead skin with its beak and then pulls it off [Weeks, 1999]. We did not distinguish between the two feeding techniques during observations, because both were often used in very quick succession to one another. The number of attempts by the rhinos to remove the birds was used as a measure of the rhinos' intolerance. The rhinos tried to remove the birds using their tails or by shaking their ears or legs when the birds perched on these body parts. A removal attempt was noted as successful if the oxpeckers did not return to the same location for at least 2 min. Our observations

were limited to two rhinos and five oxpeckers and therefore we present descriptive statistics.

RESULTS

Oxpecker Presence on the Rhinos

There was at least one oxpecker on each of the rhinos for 45.2% of the observation time (total = 56 hr 38 min). In most cases (81.8%), there was one individual on each rhino, and to a lesser extent, two (11.8%) and three (6.4%) birds, respectively. The majority of the time (57.7%) was spent on the backs of the rhinos (Fig. 1). The oxpeckers spent smaller but similar proportions of time on the legs (17.8%) and head (17.8%). The smallest proportion of time was spent at the anogenital region and abdomen (6.7%).

Oxpecker Activity Budget and Wound Creation

The oxpeckers fed for 39.7% of the time that they spent on the rhinos, and the remaining time (60.3%) was spent resting. Even though we did not collect detailed individual information on the birds, all three of the identifiable ones were seen feeding at wounds. During the feeding time, they were mainly at wounds (56.3%), and to a lesser extent, in the ears (19.3%) and at the skin over the rest of the rhinos' bodies (15.3%). Feeding at these three locations accounted for more than 90% of the total feeding time (Fig. 2).

In total, the female had seven wounds; three on the legs, one each on the head and back, and two on the right side of the abdomen. We observed four of those wounds being created during our study period. The male had 14 wounds; six on the back, six on the legs, and one each just below the right eye and on the right side of

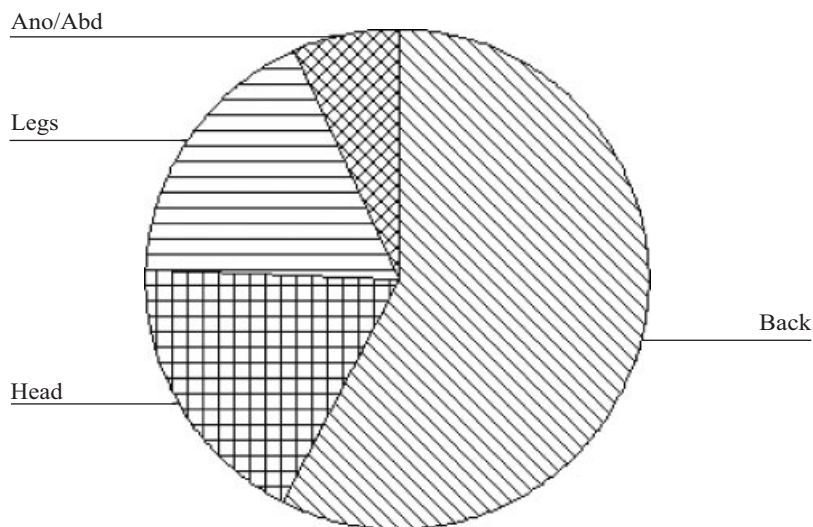


Fig. 1. Percentage of time spent by the oxpeckers on the different parts of the rhinos; back = 57.7%, legs = 17.8%, head = 17.8%, and anogenital region and abdomen (Ano/Abd) = 6.7%.

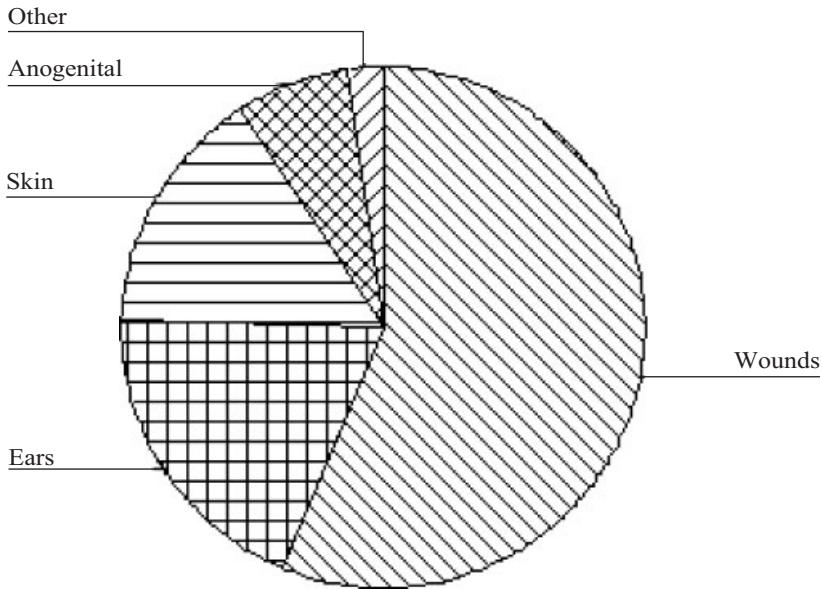


Fig. 2. Foraging time of the oxpeckers divided according to their feeding locations on the rhinos; wounds = 56.3%, ears = 19.3%, skin = 15.3%, anogenital = 6.8%, and other = 2.3%.

the anus. We observed nine of those wounds being created during our study period. The oxpeckers created the wounds by pecking at the skin. All the wounds created were small and only slightly larger than the tips of the beaks. We could measure the time taken for two of the wounds to be created. In one case, the oxpecker took 30 seconds and in the second case, it took 60 seconds.

Rhino Behavior

The rhinos attempted to displace the birds on 116 occasions; 87.9% (102/116) of attempts were at wounds, 6% (7/116) of attempts were at the ears, and 6% (7/116) of attempts were for the rest of the body. Although the rhinos tried to remove the birds from the wounds, in only 43.1% (44/102) of cases were these attempts successful. In contrast, 85.7% (6/7) and 100% (7/7) of attempts at removing oxpeckers from the ears and from any other body parts, respectively, were successful (Fig. 3).

DISCUSSION

We found that the oxpeckers were present on the rhinos for almost half (approximately 45%) of the time that the two species were housed together. The oxpeckers spent a large proportion (approximately 40%) of that time foraging on the rhinos, and most foraging time was at wounds. We also observed the oxpeckers creating 13 new wounds; four on the female and nine on the male. This is an important observation because oxpeckers have never before been observed opening new wounds on any of their host species [Weeks, 2000]. The rhinos were intolerant to the presence of the oxpeckers at wounds. However, less than half (approximately

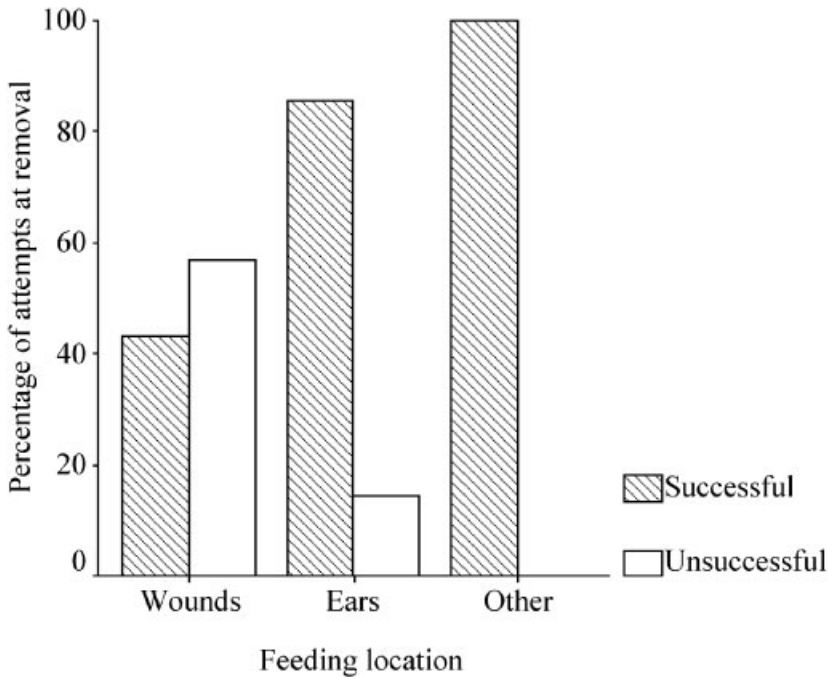


Fig. 3. The percentage of successful and unsuccessful displacements at different feeding locations on the bodies of the rhinos; wounds (43.1% and 56.9%, respectively; $n = 102$), ears (85.7% and 14.3%, respectively; $n = 7$), and other (rest of the body; 100% and 0%, respectively; $n = 7$).

43%) of their attempts at removal at wounds were successful. Our results suggest that the relationship between oxpeckers and rhinos in captivity is similar to that between oxpeckers and domestic cattle in Africa, and may provide no benefits for the rhinos [Weeks 1999, 2000].

There are no data available on the relationship between oxpeckers and black rhinos in the wild. Therefore it is important to determine how these two species interact, even within the limitations of a captive study. The rhinos in our study did not have external parasites. However, studies of both domestic and wild ungulates have observed oxpeckers ignoring clearly visible ticks [Bezuidenhout and Stutterheim, 1980; Weeks, 1999]. In addition, the oxpeckers in our study were observed consuming the food provided by the animal keepers, and therefore they may not have been driven to feed at and create new wounds simply due to hunger. Thus the preference for feeding at wounds suggests that blood is a preferred food item.

Oxpeckers have different relationships with their various native ungulate hosts, providing some evidence that mutualistic relationships can be dynamic, with costs and benefits varying depending on the ecological conditions [Bronstein, 1994a]. For example, they are important in reducing tick loads on impalas [Mooring and Mundy, 1996a]. On the other hand, oxpeckers on hippopotamuses (*Hippopotamus amphibius*) feed entirely on the blood from wounds opened during territorial fights between males [Olivier and Laurie, 1974]. The different skin surfaces of the host species should also be considered as an important factor influencing the behavior of the

oxpeckers. The skin of impala or cattle is covered with hair and scissoring is an important method used by oxpeckers to remove dead skin from the hair. Scissoring occurs when a bird moves its quickly opening and closing beak through the hair of the host animal; this activity forms a large proportion (approximately 25%) of their foraging activity on cattle [Weeks, 1999]. By contrast, rhinos are largely hairless and we did not observe scissoring during our study. Instead, the oxpeckers were only observed pecking and plucking.

It was not possible to quantify the rhino blood loss resulting from the oxpeckers. However, it was likely to be small, as there were only five oxpeckers, all the wounds were small, and the two species were not housed together all the time. The rhinos were highly intolerant of the presence of the oxpeckers at wounds, suggesting that their activities caused irritation. Therefore if oxpeckers are housed with any of their native hosts in captivity, an effective monitoring effort should be put in place to determine the activities of the oxpeckers on those hosts, and to deal with any problems that may arise. Individuals of all the other bird species in the Africa house, except the barbets, were observed perching on the rhinos, but they were never observed to forage on them.

CONCLUSIONS

1. In captivity, red-billed oxpeckers spent much of their time on black rhinos feeding, and this feeding behavior was concentrated at wounds.
2. Oxpeckers were observed opening new wounds on the rhinos, and it appeared that the rhinos had little or no control over these activities.
3. We recommend that if oxpeckers are housed with any of their native African ungulate hosts, their behavior should be monitored.

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