

COMPARATIVE FEEDING BEHAVIOUR AND FOOD PREFERENCES OF OXPECKERS (*BUPHAGUS ERYTHORHYNCHUS* AND *B. AFRICANUS*) IN CAPTIVITY

IRENE M. STUTTERHEIM⁽¹⁾, J. D. BEZUIDENHOUT⁽²⁾ and E. G. R. ELLIOTT⁽²⁾

ABSTRACT

STUTTERHEIM, IRENE M., BEZUIDENHOUT, J. D. & ELLIOTT, E. G. R., 1988. Comparative feeding behaviour and food preferences of oxpeckers (*Buphagus erythrorhynchus* and *B. africanus*) in captivity. *Onderstepoort Journal of Veterinary Research*, 55, 173-179 (1988).

The feeding methods, activities and behaviour of red-billed and yellow-billed oxpeckers in captivity were compared. Both species were found to be very similar with regard to feeding. The differences observed were a greater dependence on ectoparasites such as flies and larger ticks (*Amblyomma hebraeum*) and a higher food intake for the yellow-billed oxpecker. These differences are the result of the larger size, limited choice of host animals and closer host/oxpecker relationship of the yellow-billed oxpecker.

INTRODUCTION

The red-billed oxpecker *Buphagus erythrorhynchus* and the yellow-billed oxpecker *B. africanus* form an endemic Afrotropical family the Buphagidae, with considerable overlap in distributional range. Although both species feed on ectoparasites of large herbivorous animals the extent of competition and mechanisms for avoiding competition between them have yet to be determined. This study was initiated to investigate differences in the feeding behaviour and food preferences of these 2 species.

Feeding and the biological control of ticks by red-billed oxpeckers were evaluated by Bezuidenhout & Stutterheim (1980), who concluded that red-billed oxpeckers could play a significant role in the reduction of ixodid tick populations on free-living animals.

Although no preference was thought to exist for any tick species in their larval and nymphal stages, red-billed oxpeckers were reluctant to feed on adult *Hyalomma marginatum rufipes*, *Rhipicephalus evertsi evertsi* and *Amblyomma hebraeum* (Bezuidenhout & Stutterheim, 1980). It was therefore suggested that *B. africanus*, with its larger beak, would feed mainly on these larger tick species.

In an attempt to limit the number of variables inherent in any ecological study of food preferences, it was decided to restrict the experiment to captive birds.

CAPTURE OF OXPECKERS AND THEIR MAINTENANCE IN THE LABORATORY

Ten oxpeckers (5 red-billed and 5 yellow-billed) were captured in the Eastern Caprivi Tribal lands as described by Stutterheim & Panagis (1988). They were transported by air to the Veterinary Research Institute, Onderstepoort, and released in 2 adjacent cages, each measuring 9 m × 3 m × 3 m, onto a mammalian symbiont. Cage and holding specifications were described by Bezuidenhout & Stutterheim (1980). Each cage housed 5 birds of the same species on a cow.

FEEDING ACTIVITIES, FEEDING METHODS AND BEHAVIOUR

Feeding activities

The behaviour and daily activity patterns of the birds were studied over a period of 10 days, starting 5 days after their introduction into the cages in November 1984.

⁽¹⁾ Department of Agriculture and Nature Conservation, Private Bag 13306, Windhoek 9000 SWA/Namibia

⁽²⁾ Veterinary Research Institute, Onderstepoort 0110

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The mean diurnal time schedule was determined by using an instantaneous scan and sampling method (Altman, 1974). A total of 1 031 activities were recorded over the 10 day period, but data were treated as if they had been obtained during a single day. No observations were made if the birds showed any signs of being disturbed.

The mean diurnal time spent on various activities, calculated from the mean hourly activities from 05h20 to 18h20 for both species, are compared in Table 1.

TABLE 1 Mean diurnal time spent by captive oxpeckers on various activities (n = 1 031)

Activities	Oxpeckers	
	Red-billed (% time)	Yellow-billed (% time)
Resting or inactive	42	41
Feeding	41	40
Flying	3	1
Aggression	0	4
Maintenance	10	14
Other	4	0

Bezuidenhout & Stutterheim (1980) calculated the mean diurnal time spent on feeding by wild red-billed oxpeckers as 68 % (n = 1 944). The availability of excess food on food trays in a readily accessible form for the captive birds could account for the relatively short time spent on feeding in captivity. No significant difference was found in the total time schedules of the 2 species when kept under similar conditions.

The mean diurnal activity patterns of the 2 species are indicated in Fig. 1 & 2. Early morning (08h00 to 10h00) and later afternoon (16h00 to 17h00) feeding peaks were observed for red-billed oxpeckers. Yellow-billed oxpeckers' feeding activities peaked between 17h00 and 18h00, with some activity continuing after dark. A lesser feeding peak was observed during the morning from 08h00 to 11h00. Considerable overlap in feeding times of these species is evident, restricting this avenue of resource partitioning.

Feeding methods

Feeding methods used by red-billed oxpeckers were described by Bezuidenhout & Stutterheim (1980) as scissoring, plucking, pecking and insect catching. Similar feeding methods are employed by the yellow-billed oxpeckers. Engorged *Boophilus decoloratus* female ticks (8 mm × 12 mm) were the largest ticks either species of oxpecker could swallow whole. It was found that when oxpeckers are offered large ticks which they cannot

COMPARATIVE FEEDING BEHAVIOUR AND FOOD PREFERENCES OF OXPECKERS IN CAPTIVITY

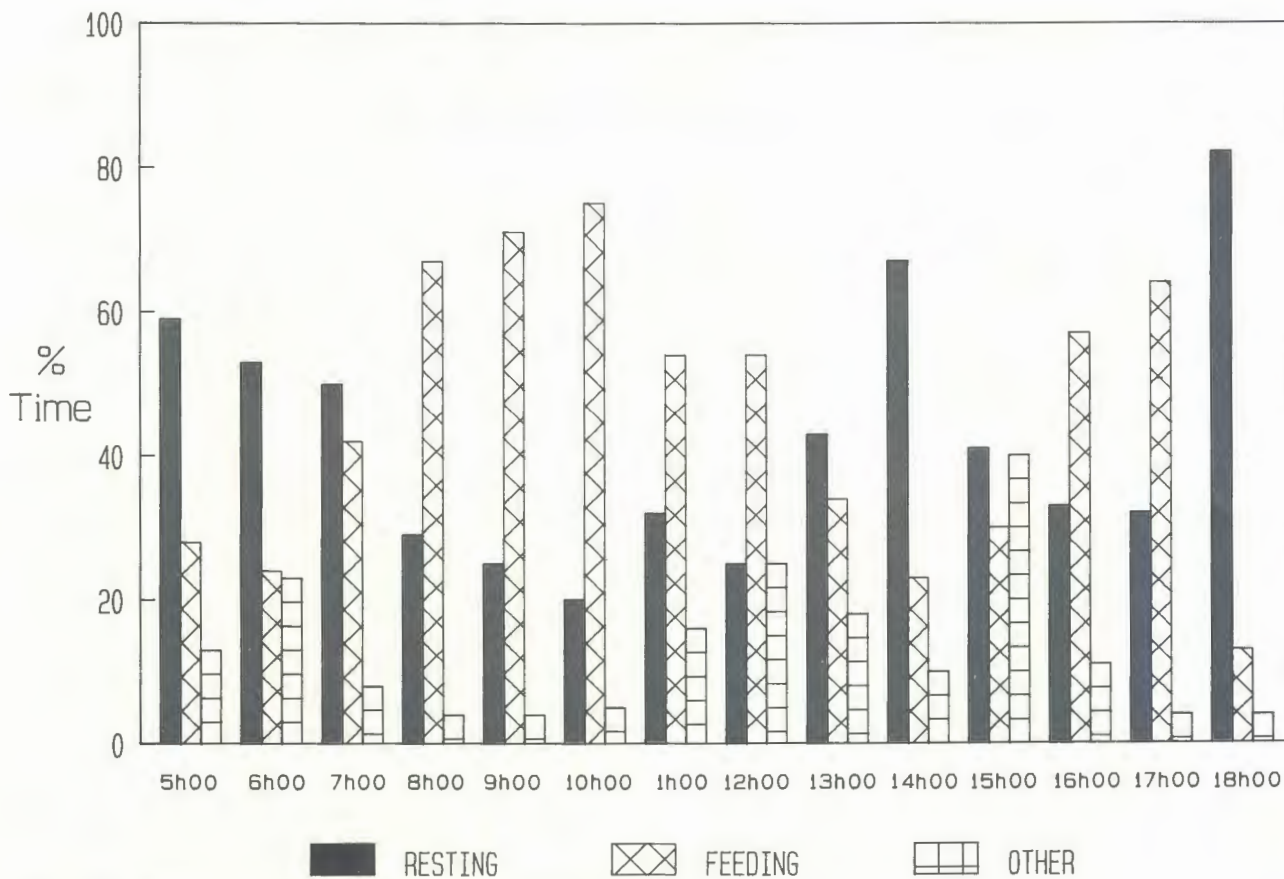


FIG. 1 The mean diurnal activity pattern of red-billed oxpeckers in captivity

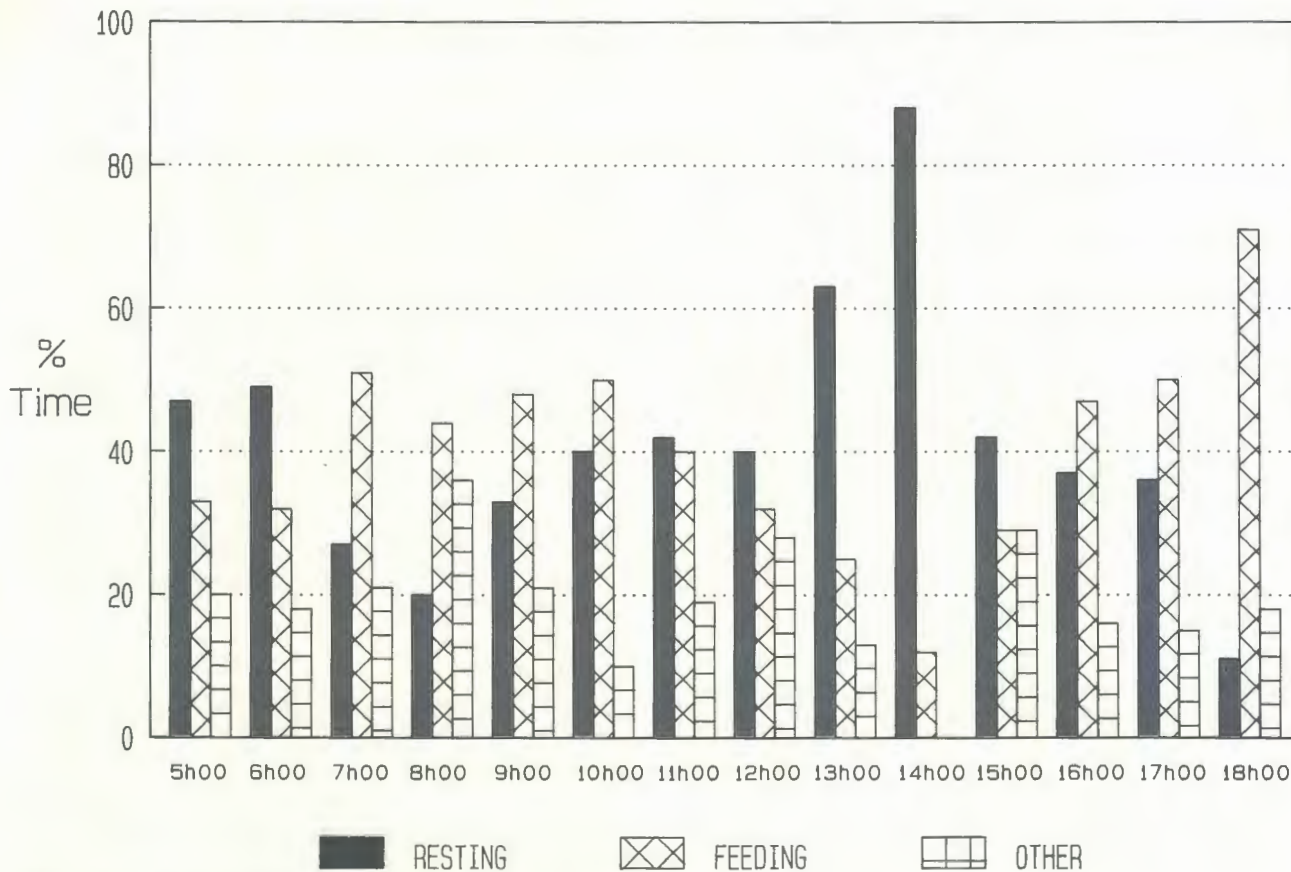


FIG. 2 The mean diurnal activity pattern of yellow-billed oxpeckers in captivity

swallow whole, such as engorged *A. hebraeum* females, they peck at them dorsally until the integument is opened. The entire inside of the tick is then consumed until just the outer skin remains. This skin is softened by squeezing it back and forth through the bill, then it is dislodged and consumed.

Feeding behaviour

A total of 505 observations of feeding activities was made in aviaries using the instantaneous scan and sampling method (Altman, 1974). These observations include plucking, scissoring, pecking (or wound feeding) and insect-catching as well as feeding at the food tray (from which the captive birds obtained the largest volume of their food). Insect catching was divided between catching on the host and catching on the ground (i.e. off the host). The feeding patterns of the 2 species under the same circumstances are compared in Fig. 3 & 4. Red-billed oxpeckers spent a combined time of 23,1 % of their feeding time off the host either at the food tray or on the ground, compared to 9 % by yellow-billed oxpeckers. This is thought to be the result of the closer oxpecker/host relationship of the yellow-billed oxpecker (Stutterheim & Panagis, 1985a).

Scissoring was the most important method of feeding used by red-billed oxpeckers, with 59,9 % of their total feeding time spent scissoring. Although the yellow-billed oxpeckers spent less time scissoring (39,7 %), this was nevertheless the longest portion of their feeding time spent on a single activity. Yellow-billed oxpeckers spent 21,8 % of their time insect catching, compared to 4,4 % by the red-billed oxpeckers under similar circumstances. Plucking and wound feeding also featured more prominently in the yellow-billed oxpeckers' feeding activities.

It can, therefore, be concluded that yellow-billed oxpeckers spend more time on the host plucking large ticks, insect catching and wound feeding, and less time scissoring, than red-billed oxpeckers under similar circumstances. The whole aspect of wound feeding will be dealt with in another publication.

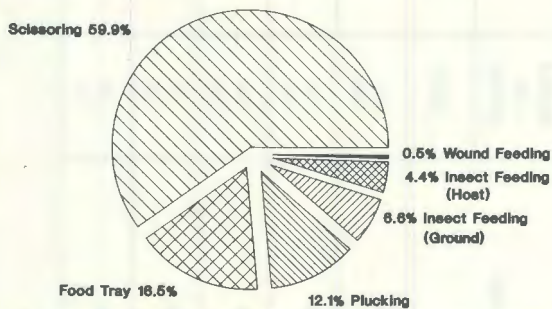


FIG. 3 Feeding behaviour of red-billed oxpeckers: Percentage of time spent on the different feeding activities

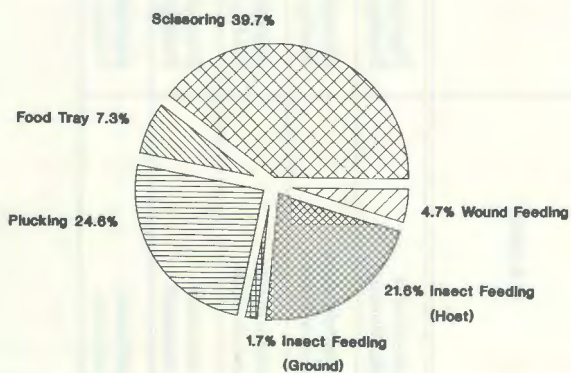


FIG. 4 Feeding behaviour of the yellow-billed oxpeckers: Percentage of time spent on the different feeding activities

PREFERENCES OF OXPECKERS FOR DIFFERENT TICK SPECIES

Resource partitioning by means of preferences for different tick species was investigated experimentally. Two different methods were used. In the first *B. decoloratus*, *Rhipicephalus appendiculatus*, *R. evertsi evertsi*, *Rhipicephalus simus*, *H. truncatum* and *A. hebraeum* ticks in various stages of engorgement were offered live to oxpeckers after being stuck with double-sided tape onto individual petri dishes. This ensured that all ticks were equally visible to the birds. The second method involved offering engorged ticks that were attached to cattle to the birds, following the methods of Bezuidenhout & Stutterheim (1980). Six linen bags were secured onto the backs of the cattle. Ticks were then placed in separate bags at appropriate intervals to ensure that they all become engorged at approximately the same time.

The bags were removed to expose the ticks just before they started to become engorged, and 2 oxpeckers of the same species were released on the cattle in a bird cage. The ticks were counted on the first day before the start of the experiment and subsequently at regular intervals as indicated in Tables 2-5. The experiment was repeated for yellow-billed oxpeckers.

Red-billed oxpecker preferences

From the results in Tables 2 & 3 it appears that red-billed oxpeckers showed the highest preference for *A. hebraeum* engorged nymphs and *B. decoloratus* adult ticks. The same pattern of utilization was shown for male and female *B. decoloratus* ticks, possibly because the small males were dislodged at the same time as the larger females. Medium preference was shown for engorged *R. appendiculatus*, *R. evertsi evertsi* and *H. truncatum* females. No distinct difference in the preference of red-billed oxpeckers for *R. appendiculatus* and *R. evertsi evertsi*, as noted by Van Someren (1951) and Bezuidenhout & Stutterheim (1980), could be demonstrated. A low preference was shown for unfed adults and *H. truncatum* males. Only one *A. hebraeum* female was opened and consumed. In the absence of any other tick species *A. hebraeum* females were dislodged but not eaten as the integument could apparently not be broken. No *A. hebraeum* males were eaten or dislodged by red-billed oxpeckers. The utilization pattern was similar to that found by Bezuidenhout & Stutterheim (1980) and was therefore not repeated.

Yellow-billed oxpecker preferences

Van Someren (1951) analysed the stomach contents of 7 *B. africanus* in Kenya and found the most important food component to be ticks of the species *R. appendiculatus* (58,3 %) and *Amblyomma variegatum* (35,5 %). In contrast Tables 4 & 5 indicate a high preference of yellow-billed oxpeckers for *B. decoloratus* and *R. simus* adult ticks. Medium preference was shown for *R. appendiculatus* (adults), *R. evertsi evertsi* (adults), *H. truncatum* (engorged females) and *A. hebraeum* (females). The oxpeckers showed a greater preference for engorged females than for males or unfed adults of any species. Male *A. hebraeum* ticks were only eaten when no other ticks were available or when they were accidentally dislodged while the birds were feeding on the large females.

To further investigate this apparent preference for female *A. hebraeum* ticks rather than males, 12 unfed female ticks were placed on an animal on which 20 male ticks had already attached. The females, which attached next to the males, were offered to the birds for 5 min. A subsequent count showed that 83 % (i.e. 10 ticks) of the females and 5 % (i.e. 1 tick) of the males had been

TABLE 2 Preference shown by 2 adult captive red-billed oxpeckers for different ixodid ticks in petri dishes

Tick species	Tick stage	Total number at beginning	Percentage utilized						
			Day 1				Day2		Day3
			Day O 14h30	08h00	09h00	13h00	15h00	08h00	11h00
<i>B. decoloratus</i>	Engorged female	10	10	10	10	60	60	60	100
<i>R. appendiculatus</i>	Engorged female	4	0	0	0	0	25	100	100
<i>R. appendiculatus</i>	Unfed adult	6	0	0	0	0	0	100	100
<i>R. evertsi evertsi</i>	Engorged female	4	0	0	25	25	50	75	100
<i>R. evertsi evertsi</i>	Unfed adult	6	0	0	0	0	0	0	0
<i>H. truncatum</i>	Prefed adult	2	0	0	0	0	0	100	100
<i>A. hebraeum</i>	Engorged female	2	0	0	0	0	0	0	0
<i>A. hebraeum</i>	Unfed adult	7	0	0	0	0	0	0	0
<i>A. hebraeum</i>	Engorged nymph	15	7	7	7	100	100	100	100

TABLE 3 Preference shown by 2 adult captive red-billed oxpeckers for different ixodid ticks on cattle

Tick species	Tick stage	Total number at beginning	Percentage utilized								
			13h00	Day 0 14h30	15h45	Day 1 08h50	Day 2 09h00	Day 3 08h00	Day 4 08h00	Day 5 08h00	Day 6 08h00
<i>B. decoloratus</i>	Engorging female	92	40	78	98	100					
<i>B. decoloratus</i>	Feeding male	92	32	81	98	100					
<i>R. appendiculatus</i>	Engorging female	39	0	8	38	79	97	100			
<i>R. appendiculatus</i>	Feeding male	36	0	8	19	22	83	94	100		
<i>R. evertsi evertsi</i>	Engorging female	36	0	0	67	86	97	100			
<i>R. evertsi evertsi</i>	Feeding male	41	0	0	51	73	85	90	100		
<i>H. truncatum</i>	Engorging female	37	0	8	54	96	100				
<i>H. truncatum</i>	Feeding male	31	0	0	0	6	13	26	26	29	45
<i>A. hebraeum</i>	Engorging female	38	0	0	0	0	2	2	2	2	2
<i>A. hebraeum</i>	Feeding male	41	0	0	0	0	0	0	0	0	0

TABLE 4 Preference shown by 2 adult captive yellow-billed oxpeckers for different ixodid ticks in petri dishes

Tick species	Tick stage	Total number at beginning	Percentage utilized					
			Day 1 14h30	Day 1 14h45	Day 2 08h30	Day 2 13h00	Day 3 08h30	Day 3 13h00
<i>B. decoloratus</i>	Engorged female	10	10	10	50	70	100	100
<i>R. appendiculatus</i>	Engorged female	4	25	25	25	100	100	100
<i>R. appendiculatus</i>	Unfed adult	6	0	0	0	0	33	100
<i>R. evertsi evertsi</i>	Engorged female	4	0	0	0	50	75	100
<i>R. evertsi evertsi</i>	Unfed adult	6	0	0	0	0	0	100
<i>H. truncatum</i>	Prefed female	2	0	50	100	100	100	100
<i>H. truncatum</i>	Engorged female	1	100	100	100	100	100	100
<i>A. hebraeum</i>	Engorged female	2	0	50	50	100	100	100
<i>A. hebraeum</i>	Unfed adult	7	0	0	0	14	14	100
<i>A. hebraeum</i>	Engorged nymph	15	7	7	47	47	47	100

utilized. As these ticks are closely attached during copulation it therefore appears that a very strong preference exists for female (even unfed) *A. hebraeum*. It is important to note that female *A. hebraeum* do not attach readily to a host unless males have been attached for at least 4 days (Rechav, Parolis, Whitehead & Knight, 1977).

DISCUSSION

The results of stomach content analyses by Van Someren (1951) and Bezuidenhout & Stutterheim (1980) led Stutterheim & Brooke (1981) to conclude that, although both oxpeckers utilize *R. appendiculatus*, a difference in food preference existed which resulted in *B. africanus* utilizing mainly *A. variegatum* and *B. erythrorhynchus* utilizing *B. decoloratus*. These conclusions were, however, not confirmed during this study. Both species of oxpeckers show roughly the same pattern of preference for different species of ticks. The main difference was that the smaller red-billed oxpecker could not utilize the large engorged *A. hebraeum* ticks. The differences in food utilization by the two oxpecker species can, therefore, be attributed to differences in food availability rather than a distinct food preference.

EFFICIENCY OF OXPECKERS AT CONTROLLING LICE

In an investigation into the level of tick control possible with red-billed oxpeckers Bezuidenhout & Stutterheim (1980) concluded that the level of control increased as the parasite's size increased. Considering the relatively shorter daily period spent scissoring by yellow-billed oxpeckers it would appear superficially as if red-billed oxpeckers would be more efficient than yellow-billed oxpeckers at controlling small-sized ectoparasites. To test this, an experiment was designed to obtain information on the relative level of control that could be obtained by the 2 species of oxpeckers using lice as typical small parasites.

One red-billed oxpecker and 1 yellow-billed oxpecker were isolated and placed individually on cattle which were heavily infested with lice, *Damalinea bovis*. The skin of these cattle displayed white, flaky areas as a result of louse damage and dead skin was compacting on the skin surface. The hair was dull and thinning, with bare patches appearing on the shoulders and neck. A 5 cm² skin scraping from the right shoulder of 1 animal contained 311 lice. Two lice-infected animals were kept as controls.

The birds were provided with alternative food in the form of a minced meat, "ProNutro"¹ and egg mixture. Female *B. decoloratus* engorged ticks and flies were added *ad lib*. From time to time pellets (casts containing undigested food) regurgitated by the birds were collected and analysed.

Experimental observations and discussions

Eight fresh pellets were collected and analyzed between 3 and 30 days from the start of the experiment. Pellets contained a mean number of 85.25 (range 11–244) lice per pellet. Other food items included hair, dead skin, ticks, flies, food mixture and grit. The mean number of pellets produced per day is 8 (E. G. R. Elliott, Irene M. Stutterheim & J. D. Bezuidenhout, unpublished data, 1985–86), which implies a mean daily intake of 682 lice per bird besides the other food items used.

Two days after the introduction of the oxpeckers onto the cattle an improvement in the condition of the hide on the neck and shoulder regions could be seen. Dead skin and visible signs of lice infestation had been removed. Despite the still heavy infestation of lice, the development of bare patches was halted. This process continued, and after 5–6 weeks the whole hide had changed from white crusty skin covered by flaky dead matter to healthy, clean pink coloured skin. By the 9th week both animals had returned to peak hide condition, with new hair growth evident on the bare patches. In contrast, control animals retained their ragged appearance and lice infestations. A skin-scrape was repeated on the animals with the oxpeckers. No lice were found either in the scrapes or in the pellets produced by these oxpeckers after this period of weeks.

The experiment was repeated with very similar results. Both species managed to remove the lice infestation within 5–6 weeks, despite the fact that the birds had unlimited access to alternative food. This resulted in visual healing of the skin lesions within 9 weeks. Both species of oxpeckers are therefore capable of controlling small-sized ectoparasites, even lice.

DAILY FOOD INTAKE

Methods

Two red-billed and 2 yellow-billed oxpeckers were kept in 30 cm square isolation cages in the laboratory for

¹ A proprietary food, produced by Cerebos Foods Limited, 299 Surrey Avenue, Randburg 2194, containing maize, soya bean, non fat milk solids, sugar, food yeast, wheat germ, minerals and vitamins

TABLE 5 Preference shown by 2 adult captive yellow-billed oxpeckers for different ixodid ticks on cattle

Tick species	Tick stage	Total number at beginning	Percentage utilized (figures in parentheses = No. of ticks eaten)													
			Day 1 13h20	Day 1 16h05	Day 2 06h50	Day 2 11h20	Day 2 18h00	Day 3 15h40	Day 4 15h30	Day 5 08h15	Day 6 09h30	Day 7 08h00	Day 8 14h20	Day 11 08h50	Day 12 08h00	
<i>B. decoloratus</i>	Engorging female	113	33 (37)	74 (84)	79 (89)	91 (103)	91 (103)	100 (113)	100 (113)							
	Feeding male	113	41 (46)	71 (80)	78 (88)	87 (98)	87 (98)	100 (113)	100 (113)							
<i>R. appendiculatus</i>	Engorging female	61	44 (27)	56 (34)	57 (35)	7 (48)	7 (48)	100 (61)	100 (61)							
	Feeding male	106	30 (32)	38 (40)	77 (82)	77 (82)	77 (82)	98 (104)	100 (106)							
<i>R. eversti eversti</i>	Engorging female	18	50 (9)	67 (12)	94 (17)	94 (17)	100 (18)	100 (18)								
	Feeding male	55	5 (5)	9 (5)	42 (23)	42 (23)	93 (51)	100 (55)								
<i>H. truncatum</i>	Engorging female	30	53 (16)	57 (17)	86 (26)	86 (26)	93 (28)	100 (30)	100 (30)							
	Feeding male	32	3 (1)	6 (2)	19 (6)	22 (7)	28 (9)	66 (21)	84 (27)	84 (27)	91 (29)	100 (32)				
<i>A. hebraeum</i>	Engorging female	111	(1)	(1)	(27)	(40)	(58)	(88)	(109)	100 (111)						
	Feeding male	97	8 (8)	8 (8)	11 (11)	11 (11)	11 (11)	23 (22)	41 (40)	51 (50)	53 (51)	55 (53)	63 (60)	100 (97)		

monitored. The mass of the birds was determined with a Sauter RP 3000 top-loading balance, which was also used to determine the mass of the food before and after each meal. One bird of each species was fed twice daily on a mixed diet consisting of varying amounts of ticks and flies. The other was fed the food mixture. This procedure ensured that fresh food was always available in excess.

RESULTS AND DISCUSSIONS

The red-billed oxpeckers mass-measured 52,2 and 50,8 g and the yellow-billed oxpeckers 55,2 and 66,0 g respectively. The mean food intake of the oxpeckers is indicated in Table 6. In terms of mass the mean daily intake is roughly equivalent to 12 500 larvae or 98 engorged *B. decoloratus* female ticks for the red-billed oxpeckers and 13 600 larvae or 109 engorged *B. decoloratus* female ticks for the yellow-billed oxpeckers. This intake is significantly higher than those found by Bezuidenhout & Stutterheim (1980) simply because they were using an immature bird mass-measuring only 39,5 g.

The mean food intake of the red-billed oxpecker fed on the food mixture was 10,3 % higher and that of the yellow-billed oxpecker was 12,2 % higher than that of the oxpeckers fed on mixtures of ticks and flies. This is thought to be because the oxpeckers were unable to digest the mince in the food mixture properly.

The mean daily food intake of the yellow-billed oxpecker was 11,3 % higher than the intake of red-billed oxpeckers. However, this is the result of the larger mass of the yellow-billed oxpecker. The mean food intake of the yellow-billed oxpecker per gram bodymass was 0,44 g per day compared to 0,47 g per day for the red-billed oxpeckers.

COMPETITION AND DOMINANCE

The large overlap in food preferences, feeding times and feeding behaviour suggests that there is considerable competition between the oxpeckers. Both species are, however, known to occur sympatrically, and even in mixed flocks (Stutterheim & Panagis, 1985b). In an attempt to resolve the question of dominance, mixed groups of oxpeckers consisting of varying numbers of red-billed and yellow-billed oxpeckers were placed in aviaries and monitored for signs of aggression. Intra-species aggression was observed for both species at preferred feeding sites. Yellow-billed oxpeckers also displayed intra-species aggression for preferred sites (i.e. the rump and back) for roosting or resting on the animal.

A total of 38 aggressive encounters between red-billed and yellow-billed oxpeckers were observed. Thirteen of these encounters were associated with feeding behaviour and 25 with roosting or resting positions on the animal. In all these encounters the yellow-billed oxpecker was dominant. In aviaries where mixed groups were left for long periods, the yellow-billed oxpeckers gradually excluded the red-billed oxpeckers from the host animals, and in some instances attacked the red-billed oxpeckers to the extent that the latter had to be removed to ensure their survival.

It would, therefore, appear that although yellow-billed oxpeckers tolerate the presence of red-billed oxpeckers on host animals, they are dominant and exclude red-billed oxpeckers from preferred roosting and feeding sites.

TABLE 6 The mean food intake of 4 oxpeckers over a 20 day period

Species	Food	Average	Range
Yellow-billed oxpeckers	Ticks and flies	25,42	12,3-49,7
	Food mixture	28,05	17,8-35,7
	Average	26,74 g/bird/day = (0,44 g food/g mass/day)	
Red-billed oxpeckers	Ticks and flies	22,64	10,7-30,5
	Food mixture	25,42	12,0-30,3
	Average	24,03 g/bird/day = (0,47 g food/g mass/day)	

CONCLUSIONS

The feeding behaviour and food preferences of red-billed and yellow-billed oxpeckers show considerable overlap. A few important differences have, however, been demonstrated.

1. Yellow-billed oxpeckers with their larger beaks and overall size have a higher food intake and can feed on larger tick species such as adult female *A. hebraeum* which the red-billed oxpecker have difficulty in utilizing.
2. Yellow-billed oxpeckers spent more time catching insects, notably flies, around the host animals.
3. Yellow-billed oxpeckers spent a larger proportion of their time on the host animals, indicating a closer oxpecker/host relationship.
4. Yellow-billed oxpeckers were dominant and more aggressive than red-billed oxpeckers. This suggests that yellow-billed oxpeckers are better adapted to utilize a variety of ectoparasites on their host species. They are, however, limited in their choice of host species and utilize primarily buffalo and rhino (Attwell, 1966; Buskirk, 1975; Grobler & Charsley, 1978; Stutterheim & Panagis, 1985a), while red-billed oxpeckers utilize a much wider spectrum of host species (Stutterheim, 1976). The red-billed oxpecker would, therefore, seem to be the more general "tick-eating" bird, utilizing a wide variety of host species and occurring in marginal areas that are not suitable for the yellow-billed oxpecker (Stutterheim & Panagis, 1985b). The yellow-billed oxpecker, on the other hand, has adapted more closely to its chosen host species. It utilizes all the available food on the hosts and has developed such a close oxpecker/host relationship that it even sleeps on its host species (Stutterheim & Panagis, 1985b).

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