The above procedure was repeated on seven days with seven pairs of pellet samples. The samples were matched so that both members of the pair came from the same reserve (either Bontebok Park or Cape of Good Hope Nature Reserve).

The bontebok usually responded to both his own and strange pellets by sniffing at them and occasionally also by muzzling them. Other overt reactions were less common. After one bout of sniffing at his own pellets, the bontebok performed glandular weaving, a ritualized behaviour pattern involving deposition of scent from the preorbital glands onto a grass stalk and then wiping the horns over the stalk (see David 1973). Sniffing at strange pellets was followed on one occasion by glandular weaving, twice by horning of the food receptacle and three times by defaecation. All of these actions are associated with marking of territorial dung patches (David 1973).

The presence of pellets near the food neither prolonged nor reduced the duration of feeding bouts. Mean durations of first feeding bouts of the day were 13,1 min with no pellets present, 9,0 min with own pellets and 12,4 min with strange pellets. Differences among these means are not statistically significant ($0,5 < P < 0,7$, Kruskall-Wallis test, Siegel 1956).

The bontebok spent more time sniffing pellets from strange animals than his own. Considering only first feeding bouts of the day the mean duration of sniffing at own pellets (1,7 s) is significantly lower than the mean for strange pellets (12,4 s, $P < 0,01$; Mann-Whitney U-test, Siegel 1956).

Results of the seven trials using the habituation procedure are shown in Table 1. Duration of sniffing tended to increase after the presentation of the second half of male A's pellets (see columns A and B, Table 1) but the difference is not statistically significant ($P = 0,13$, Randomization test for matched pairs, Siegel 1956). The further increase in sniffing duration after the presentation of male B's pellets (compare columns B and C, Table 1) is significant ($P = 0,03$).

It was therefore apparent that the bontebok could distinguish not only between his own faecal pellets and a stranger's but also between the pellets of individual males he had not previously encountered. The territorial dung patch could thus communicate its owner's identity to neighbouring territorial males.

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The feeding behaviour of the redbilled oxpecker

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In southern Africa the redbilled oxpecker *Buphagus erythrorhynchus* utilizes 21 ungulate species for feeding (Grobler 1979; Stutterheim 1979, 1980). The food of oxpeckers consists in order of decreasing relative importance, of ixodid ticks, tissue, flies and mucus (Moreau 1933; Van Someren 1951; Bezuidenhout & Stutterheim 1980). Various aspects of the feeding behaviour of the redbilled oxpecker have been reviewed by Attwell (1966). Bezuidenhout & Stutterheim (1980) came to the conclusion that the feeding method used depends on the type of food being eaten. However, the characteristics of the different ungulate species utilized may influence the feeding method adopted.

Feeding behaviour of oxpeckers was studied on 16 ungulate species in the Kruger National Park (March 1973 to January 1975), Tuli-Block in southern Botswana (January 1977), Hluhluwe-Umfolozi Game Reserve complex (June 1977) and on farms in the northern Transvaal (July 1977). The eight feeding postures noted were described by Bezuidenhout & Stutterheim (1980). Counts were related to observation time and species of ungulate. It was not possible to observe the feeding method used while feeding in an ear. The number of times the head was lifted to swallow the collected material was therefore counted. It was impossible to count the number of times the bill was opened or closed during scissoring and the number of cycles completed were counted. It was also not possible to determine if insect catching was successful and any attempt was therefore counted. Observations were timed with a Heuer stopwatch and stopped when the birds changed their activity.

Table 1 The utilization of 16 ungulate species for feeding by the redbilled oxpecker

	Observation time (min)	Scissoring on torso	Scissoring in nose	Scissoring in eye	Scissoring in mouth	Feeding in ear	Plucking	Insect catching	Wound feeding	Total number observations
Roan Antelope	89	2 850	0	0	0	201	95	1	0	3 147
Sable Antelope	67	2 219	0	4	0	120	105	0	0	2 448
Kudu	39	1 247	0	0	0	78	64	1	0	1 390
Eland	18	321	0	2	1	9	24	0	0	357
Nyala	10	109	0	1	0	56	0	0	0	166
Impala	193	3 614	10	29	0	1 835	195	19	7	5 709
Warthog	15	0	0	2	0	18	3	17	0	40
White Rhinoceros	62	0	113	10	3	324	84	8	0	511
Black Rhinoceros	30	0	39	8	1	117	28	6	31	230
Giraffe	117	4 015	36	1	0	50	148	6	5	4 261
Hippopotamus	12	0	0	0	0	10	328	4	20	362
Wildebeest	20	118	10	0	5	108	24	4	0	264
Buffalo	26	74	142	4	0	92	26	38	0	381
Zebra	71	677	0	4	0	279	164	5	0	1 129
Domestic donkey	18	231	0	1	0	111	15	20	11	389
Domestic cattle	64	408	27	9	23	520	241	3	24	1 255
Total	851	15 883	377	75	33	3 928	1 514	132	98	22 039
% Occurrence		72,1	1,7	0,3	0,2	17,8	6,9	0,6	0,4	

A total of 15 883 feedings were observed for a duration of 851 min (Table 1). Scissoring on the torso had the highest frequency of occurrence (72,1%), followed by feeding in the ear (17,8%), plucking (6,9%) and scissoring in the nose (1,7%). A relationship was found between an animal's fur density and the occurrence of scissoring on the torso. Among the Rhinocerotidae, Suidae and Hippopotamidae with a nearly hairless skin, this feeding method is lacking. In the Equidae and Bovini with relatively short or few hairs, it had a relatively low occurrence (43,0%). At the other extreme are the Tragelaphini and Hippotragini with a high occurrence (85,4%).

In the roan antelope *Hippotragus equinus*, sable antelope *Hippotragus niger*, kudu *Tragelaphus strepsiceros*, eland *Taurotragus oryx*, giraffe *Giraffa camelopardalis* and zebra *Equus burchelli*, a significant negative correlation ($r = -0,97$) exists between the occurrence of scissoring on the torso and plucking. This indicates that an increase in the one method is related to a decrease in the other. The lack of correlation ($r = -0,46$) in the other species is due to the absence of preferred tick species and the utilization of other feeding methods. The tick species on the black rhinoceros *Diceros bicornis*, white rhinoceros *Ceratotherium simum*, warthog *Phacochoerus aethiopicus* and buffalo *Syncerus caffer* in the Kruger National Park are an unimportant constituent of the diet (Bezuidenhout & Stutterheim 1980). The absence of scissoring on the torso and plucking on these species are related to the composition of the tick fauna and not to a nearly hairless substrate. Scissoring is a feeding method based on touch compared to plucking where sight is important (Van Someren 1951). If the preferred tick species are predominant on a symbiont, the birds will use scissoring on a furry substrate and plucking if the ticks are visible.

In a two-way analysis of variance, no significant difference (F 0,05 = 0,03 < 4,76) was found in the utilization of the Tragelaphini and Hippotragini. These species have a furry substrate, tick species that are utilized, few or no open wounds and are fairly tolerant (Stutterheim 1979). No significant difference (F 0,05 = 2,59 < 4,28) was found in the utilization of the white and black rhinoceros. They have a naked substrate, few tick species that are utilized, large and open nostrils and are tolerant. Wound feeding was not taken into consideration because of the absence of filariid infested skin lesions in white rhinoceros (Schultz & Kluge 1960) which are common in black rhinoceros in the Hluhluwe-Umfolozi complex (Hitching & Keep 1970) and account for the high incidence (13,5%) of wound feeding.

Scissoring in the nose for mucus collecting is related to the presence of large open nostrils in white rhinoceros, black rhinoceros, buffalo, wildebeest *Connochaetes taurinus* and domestic cattle. Although the nose is also utilized in impala *Aepyceros melampus* and giraffe, a low occurrence (0,2% and 0,9% respectively) of this feeding method is attributed to relatively small nasal openings.

A high occurrence of plucking (90,6%) was observed in the hippopotamus *Hippopotamus amphibius*. Although ticks have been recorded from the hippopotamus (Theiler 1962), none were found on eight specimens examined from the Olifants river in the Kruger National Park, but the animals were heavily infested with leeches. The birds may have been feeding on these leeches although none were found in 53 stomachs examined (Bezuidenhout & Stutterheim 1980). The high incidence of open wounds in hippopotamus (Olivier & Laurie 1974) is reflected by a relatively high occurrence (5,5%) of wound feeding. In Botswana wound feeding was also observed in the domestic donkey (2,8%) because of a high incidence

(29,3%) of saddle sores (Stutterheim 1979). The degree of competition to feed at these sites indicates a strong preference for wound feeding, but an overall occurrence of 0,4% shows that it is an unimportant feeding method. However, this could also be due to an absence or low incidence of open wounds as oxpeckers cannot open sound skin.

Insect catching had a high occurrence (42,5%) on warthog. The tick species found on warthog are not readily utilized and association is due to the occurrence of tabanid species during the summer months (September to March) (Stutterheim 1979). Insect catching was also fairly high in buffalo (10,1%) because of concentrations of Simuliidae. Similarly the domestic donkey (5,1%) hosted flies that were feeding on saddle sores.

The present study indicates that the feeding methods used are determined by the covering of the skin, external morphology and the composition of food items. A factor which could also affect the feeding behaviour, is the intolerant behaviour of the symbiont species (Stutterheim 1979). A symbiont will not allow the utilization of a food resource if it occurs on a sensitive area or if a particular feeding method is not tolerated.

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Marine benthos near the Saldanha Bay iron-ore loading terminal

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The development of Saldanha Bay (33°S/18°E) for the export of iron-ore required the construction of a long breakwater, loading terminal and jetty. Associated dredging operations removed 25 million cubic metres of sediment and resulted in significant changes in the faunal structure of the bay (Moldan 1978). The present study investigated the marine benthos near the completed and functioning iron-ore loading terminal and the data may be useful in the long term monitoring of the effects of port development and industrialization of Saldanha Bay.

Five stations were occupied in Saldanha Bay (Figure 1) and SCUBA divers collected samples of macrofauna, meiofauna, bacteria and sediments from these stations during May and July 1978.

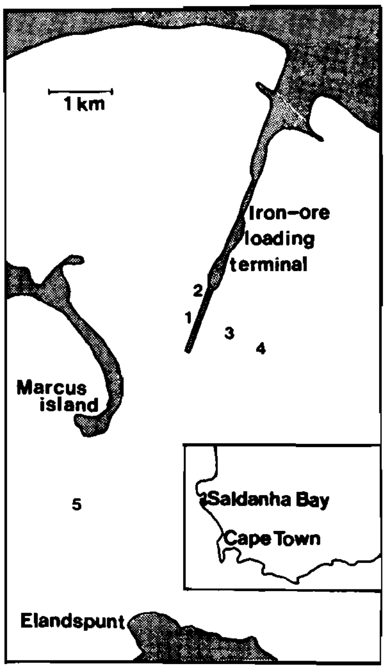

Figure 1 Saldanha Bay showing iron-ore loading terminal and sampling stations 1 – 5.

Macrofauna was collected using a diver-operated suction sampler with a cross-sectional area of 0,1 m^2 (Christie & Allen 1972). Replicate samples were taken to a depth of 30 cm at all stations except Station 2 where cables and other construction debris prevented penetration of the sampling cylinder. The samples were preserved in 10% formalin and, after identification, oven-dried at 60 °C for 48 h. Meiofauna was sampled using PVC tube corers with a cross-sectional area of 8 cm^2. Three cores were taken per station (except Station 2) and plugged with corks to prevent loss of sample. The 0 – 10-cm sections of the three cores were combined, preserved in 5% formalin, and later extracted using the saccharose centrifugation technique of Hiep, Smol & Hautekiet (1974). The meiofauna was then stained with Rose Bengal and counted in graduated perspex trays under a dissecting microscope.

Samples of bottom sediment and bottom water were collected in acid-cleaned 75 ml plastic containers and preserved with filtered formaldehyde. The bacteria were counted using acridine orange epifluorescent microscopy (Hobbie, Daley & Jasper 1977). Sediment cores were taken at the five stations using PVC tube corers and the 0 – 10-cm sections were oven-dried at 60 °C for 48 h. Particle size analysis was done using a series of Wentworth scale sieves. Samples of bottom sediment were collected in 75-ml plastic containers and frozen prior to the determination of free iron oxide (Fe_2O_3). The free iron oxide was extracted using the sodium bicarbonate buffered dithionite-citrate method (Mehra & Jackson 1960) and analysed using atomic absorption spectroscopy.

The macrobenthos at Station 1 under the loading jetty was dominated by the small polychaete, *Prionospio sexoculata*. Stomatopods, *Pterygosquilla armata*, errant polychaetes and nemerteans were also present. Station 3, 0,5 km east of the loading jetty, supported abundant macrobenthos dominated by prawns, *Upogebia capensis*, and tongue worms, *Ochaetostoma capense*. Gastropods, *Nassa speciosa*, and large errant polychaetes also occurred at the station. At Station 4, 1 km east of the loading jetty, no prawns were found and *O. capense* and *N. speciosa* dominated the macrobenthos. At Station 5, in the entrance to the bay, *N. speciosa*, errant polychaetes and sea-pens, *Virgularia schultzei*, were found.

Christie & Moldan (1977) found the small polychaete *P. sexoculata*, which was dominant at Station 1, to be tolerant of adverse conditions as it dominated the fauna occurring 25 m from the fish factory effluent outlet which they studied at Saldanha Bay. Further, though Stations 1 and 5 were at the same depth (28 m), the absence of *V. schultzei* at 1 is interesting particularly as Christie & Moldan (1977) found this species to be absent in the area of Saldanha Bay polluted by fish factory effluent.

Biomass figures (Table 1) indicate that less macrobenthos occurred beneath the loading jetty at Station 1 than at any of the other areas sampled. The high biomass of macrobenthos at Station 3 was due to the abundance of prawns (400 m^{-2}) and tongue worms (635 m^{-2}) present in this area.

Meiofauna numbers m^{-2} were highest at Station 1 under the loading jetty (Table 1) and nematodes were found to dominate the meiofauna of Saldanha Bay. McLachlan, Winter & Botha (1977) found sublittoral meiofauna numbers in Algoa Bay to range from $0{,}5 \times 10^5$ m^{-2} to $5{,}8 \times 10^5$ m^{-2} and the present figures compare well with these. Further, McLachlan (1977) has concluded, from studies on a sandy beach near an ore-loading terminal in Port Elizabeth, that iron-ore dust has no effects on meiofauna.

Bacteria numbers in the sediment were slightly higher under the jetty (Stations 1 and 2) than at the other stations (Table 1) while numbers in bottom water samples were lowest in the entrance to the bay. Mazure & Branch (1979) obtained numbers ranging from $1{,}2 \times 10^7$ to $4{,}5 \times 10^8$ bacteria cells g^{-1} wet sediment from intertidal samples in Saldanha Bay and Langebaan lagoon. In the surface water of Saldanha Bay they recorded $1{,}1 \times 10^6$ bacteria cells ml^{-1}.

Sediment cores revealed the sediments under the loading jetty (Stations 1 and 2) to be black in colour, foul-smelling and probably anoxic. Though mean particle size at Station 1 was slightly larger than at other stations (Table 1), stratification into fine surface mud and deeper grit was apparent. The higher meiofauna and bacteria numbers at this station can probably be explained by the presence of this surface mud.

The free iron oxide in the sediment was greatest at Station 1 beneath the loading jetty (Table 1) and clearly indicates a build-up of iron oxide in the sediment. Subsequent to the present study J.P. Willis (pers. comm. 1978) has found free iron oxide to be 0,8% under the jetty.

Table 1 Chemical, physical and biological features of five sampling stations in Saldanha Bay

Station	1	2	3	4	5
Depth	28 m	23 m	15 m	15 m	28 m
Macrofauna dry mass m^{-2}	35,6 g	–	306,6 g	67,3 g	46,3 g
Meiofauna numbers m^{-2}	$6{,}0 \times 10^5$	–	$1{,}3 \times 10^5$	$0{,}6 \times 10^5$	$1{,}8 \times 10^5$
Bacteria cells g^{-1} wet sediment	$1{,}03 \times 10^8$	$1{,}08 \times 10^8$	$8{,}50 \times 10^7$	$7{,}39 \times 10^7$	$6{,}67 \times 10^7$
Bacteria cells ml^{-1} water	$1{,}85 \times 10^6$	$1{,}53 \times 10^6$	$1{,}60 \times 10^6$	$1{,}51 \times 10^6$	$1{,}10 \times 10^6$
Mean particle size of sediment	2,4ϕ	2,5ϕ	3,1ϕ	3,7ϕ	2,8ϕ
Free iron oxide in sediment	0,341%	0,183%	0,069%	0,086%	0,010%

In conclusion, it appears that the benthos beneath the iron-ore loading jetty at Saldanha Bay differs from that of other areas in the bay. Macrofauna is dominated by ***Prionospio sexoculata*** which is tolerant of adverse conditions whilst meiofauna and bacteria numbers are higher under the jetty than elsewhere in Saldanha Bay.

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